TruBoard Partners

TECHNICAL DUE DILIGENCE SUMMARY REPORT ON PLANT CONFIGURATION

RE Portfolio of Solar PV and CSP Projects

IndiGrid

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List of Acronyms

Acronym	Meaning
AC	Alternate Current
ACDB	AC Distribution Board
ACSR	Aluminum Conductor Steel-Reinforced
BNEF	Bloomberg New Energy Finance
c-Si	crystalline Silicon
COD	Commercial operation date
CUF	Capacity utilization Factor
DC	Direct Current
GSS	Grid Substation
GWh	Giga Watt hour
HV	High Voltage
IAM	Incident Angle Modifier
IE	Independent Engineer
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IS	Indian Standard
ISO	International Organization for Standardization
kV	kilo Volt
kVA	kilo Volt Ampere
kWh	kilo Watt hour
LID	Light Induced Degradation
LV	Low Voltage
kA	Karnataka
MH	Maharashtra
MMS	Module Mounting Structure
MV	Medium Voltage
MVA	Mega Volt Ampere
MW / MWp	Mega Watt / Mega Watt peak
MWh	Mega Watt hour
OHSAS	Occupational Health and Safety Assessment Series
PSS	Pooling Substation
PV	Photovoltaic
RE	Renewable Energy
SLD	Single Line Diagram
SolarGIS	A weather data source
TDD	Technical Due Diligence
VDR	Virtual Data Room

1. Introduction

TruBoard Credit Monitoring Services Private Limited ('TruBoard') in capacity of Independent Engineer (IE) appointed by India Grid Trust ('the Client) for conducting technical review of a solar portfolio ('the Projects' or 'the Portfolio'). This report summarises the design configuration of each asset in the portfolio based on the review of the documents provided by the Client.

The Portfolio considered in this study comprises ground mounted solar Photovoltaic (PV) and Concentrated Solar Power (CSP) projects of cumulative capacity of 455 MW AC and 538 MWp DC.

In this Portfolio, all the Projects are operational and spread over seven different states of India. The geographical coordinates of the project sites are listed in **Table *1***.

Table 1 Project location and coordinates

S. N.	SPV	Project	Location	Coordinates (°N, °E)
1.	PLG Photovoltaic Pvt. Ltd.	PLG Patan	Sami, Patan	23.92, 71.52
2.	Terralight Solar Energy Charanka Pvt. Ltd.	Terralight Charanka	Charanka	23.91, 71.21
3.	Solar Edge Power and Energy Pvt. Ltd.	Solar Edge Beed	Beed	18.92, 76.36
4.	Solar Edge Power and Energy Pvt. Ltd.	Solar Edge Jalgaon	Jalgaon	
5.	Globus Steel and Power Pvt. Ltd.	Globus Mandsaur	Nataram Village, Sitamau, Mandsaur	24.08, 75.34
6.	Terralight Solar Energy Patlasi Pvt. Ltd.	Terralight Patlasi	Village Choti Patlasi, Mandsaur	24.04, 75.35
7.	Terralight Solar Energy Nangla Pvt. Ltd.	Terralight Nangla	Nangla, Talwandi Saboo, Bhatinda	29.86, 75.19
8.	Terralight Solar Energy Tinwari Private Limited	Terralight Tinwari	Jodhpur	26.52, 72.86
9.	Terralight Solar Energy Gadna Pvt. Ltd.	Terralight Gadna	Gadna, Bap, Jodhpur	27.44, 72.41
10.	Universal Saur Urja Pvt. Ltd.	USUPL Bap	Bap, Jodhpur	27.48, 72.31
11.	Universal Saur Urja Pvt. Ltd.	USUPL Mahoba	Mohoba district	25.31, 79.41
12.	Terralight Kanji Solar Pvt. Ltd.	Terralight Kanji Lalitpur	Lalitpur	24.69, 78.41
13.	Terralight Rajapalayam Solar Pvt. Ltd.	Terralight Rajapalayam	Rajapalayam	9.33, 77.60
14.	Terralight Kanji Solar Pvt. Ltd.	Terralight Kanji Tiruvannamalai	Tiruvannamalai	12.35, 78.95

S. N.	SPV	Project	Location	Coordinates (°N, °E)
15.	Universal Mine Developers & Service Providers Pvt. Ltd.	UMD Amathur	Amathur	9.55, 77.88
16.	Universal Mine Developers & Service Providers Pvt. Ltd.	UMD Kovilpatti	Kovilpatti	9.09, 77.78
17.	TN Solar Power Energy Pvt. Ltd.	TN Solar Thuthookudi	Thuthookudi	9.12, 78.11
18.	TN Solar Power Energy Pvt. Ltd.	TN Solar Virudhunagar	Virudhunagar	9.44, 78.17
19.	TN Solar Power Energy Pvt. Ltd.	TN Solar Dindigul	Dindigul	10.49, 78.06
20.	Godwari Green Energy Ltd.	GGEL CSP	Nokh	27.60, 72.23

Table *2* presents details on the project capacity, commercial operation date (COD) and offtaker.

Table 2 About Project capacity & COD

S. N.	SPV	Project	AC Capacity	DC Capacity	COD	Off-taker
1.	PLG	PLG Patan	20.00	20.00	23-Feb-12	GUVNL
2.	TSEC	Terralight Charanka	13.00	15.00	28-Mar-12	GUVNL
3.	SolarEdge	Solar Edge Beed	80.00	104.00	22-Apr-18	SECI
4.		Solar Edge Jalgaon	50.00	64.94	26-Apr-18	SECI
5.	Globus	Globus Mandsaur	20.00	23.60	29-Jan-16	MPPMCL
6.	TL Patlasi	Terralight Patlasi	20.00	22.10	12-Jun-15	SECI
7.	TL Nangla	Terralight Nangla	4.00	4.20	24-Mar-15	PSPCL
8.	TSETPL	Terralight Tinwari	5.00	5.84	15-Oct-11	NVVN
9.	TL Gadna	Terralight Gadna	5.00	5.50	20-Mar-13	NVVN
10.	Jodhpur	USUPL Bap	20.00	25.90	26-Mar-13	NVVN
11.	USUPL	USUPL Mahoba	30.00	36.98	15-Sep-16	UPPCL
12.	Lalitpur	Terralight Kanji Lalitpur	10.00	12.40	19-Mar-15	UPPCL
13.	TRSPL	Terralight Rajapalayam	50.00	54.00	26-Sep-18	TANGEDCO
14.	TKSPL	Terralight Kanji Tiruvannamalai	30.00	36.01	26-Mar-16	TANGEDCO
15.	UMD	UMD Amathur	12.00	14.41	16-Nov-16	TANGEDCO
16.		UMD Kovilpatti	13.00	15.60	21-Mar-16	TANGEDCO
17.	TNSEPL	TN Solar Thuthookudi	10.00	12.00	31-Oct-15	TANGEDCO
18.		TN Solar Virudhunagar	8.00	9.60	28-Sep-15	TANGEDCO
19.		TN Solar Dindigul	5.00	6.00	28-Dec-15	TANGEDCO
20.	GGEPL	Godawari Green Energy Ltd	50.00	50.00	9-Mar-14	NVVN
	Total		**455.00**	**538.09**		

TruBoard Partners has undertaken the study covering the agreed scope of works with the Client.

This report is based on documentation provided by the Client via a Virtual Data Room (VDR). The documentation review has been further supported by an ongoing Question and Answer (Q&A) process established between TruBoard and the Client. While every effort has been made to check sources of information, TruBoard takes no responsibility for the completeness or otherwise of the information provided for the purpose of the review.

The tracker in Table 3 shows the status of input data received and desktop review performed for this study.

Table 3 Summary of site-wise input data available for study

Project	Project AC SLD	Project DC SLD	PV Module Datasheet	Inverter Datasheet	Transformer Datasheet
PLG Patan	✓	✓	✓	×	×
Terralight Charanka	✓	✓	✓	×	✓
Solar Edge Beed	×	✓	✓	×	✓
Solar Edge Jalgaon	×	✓	✓	✓	✓
Globus Mandsaur	✓	✓	✓	✓	✓
Terralight Patlasi	✓	✓	✓	✓	×
Terralight Nangla	✓	✓	✓	×	✓
Terralight Tinwari	✓	✓	✓	✓	×
Terralight Gadna		×	✓	✓	×
USUPL Bap	✓	✓	✓	×	×
USUPL Mahoba					×
Terralight Kanji Lalitpur	✓	✓	✓	✓	×
Terralight Rajapalayam	×	✓	✓	✓	✓
Terralight Kanji Tiruvannamalai	×	×	✓	✓	✓
UMD Amathur	✓	✓	✓	✓	×
UMD Kovilpatti	×	✓	✓	✓	×
TN Solar Thuthookudi	×	✓	×	×	×
TN Solar Virudhunagar	✓	✓	×	×	×
TN Solar Dindigul	✓	✓	×	×	×
GGEL	×	-	-	-	-

2. PLG Patan

2.1. About Project

The 20 MW Project is located at Daisar village of Patan district in Gujarat state of India. The Project was constructed by Engineering, Procurement and Construction (EPC) Contractor; Jahmil Infra and operational since 23rd February 2012. Currently the O&M contractor is Mitarsh Energy.

The Project is situated 28 km away from Santalpur tehsil and 75 km away from Patan district headquarter. The nearest railway station is at Patan which is around 28 km away from the site. The nearest airport to the project site is at Ahmedabad which is 125 km away. The Project site is well connected.

Figure 1: PLG Patan location

Figure 2:PLG Patan – Satellite image of project layout

2.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project are indicated in Table 4.

Table 4: Summary of key components

Component	Make and Model	Quantity
Module	Kyocera - KD240GX-LPB	83,352
Inverter	Hitachi 1000 kW – Solar PCS	8
	Delta DeICEN 1000	4
	ABB PVS800-57-0500kW-A	16
IDT	Voltamp 1.25MVA	20

2.2.1. PV module

Table 5 presents the main technical characteristics of the installed PV modules.

Table 5: Technical characteristics of PV module

Parameter	UoM	Description
Technology		Polycrystalline
Peak power (Pmax)	W	240
Voltage at Pmax (Vmpp)	V	29.8
Current at Pmax (Impp)	A	8.06
Open Circuit Voltage (Voc)	V	36.9
Short Circuit Current (Isc)	A	8.59
Maximum system voltage	V	1000
Temp coefficient of Pmax	% / ^{o}C	-1.10
Module efficiency	%	16
Degradation	%	0.8%
Certification	-	IEC 61215, IEC61730, TUV certified, Safety Class-II, ISO 9001, ISO 14001

2.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over-power output at the end of 25th year.

2.2.2. Inverter

Table 6 presents the main technical characteristics of the selected model.

Table 6: Technical characteristics of inverter

Parameter	Unit	Hitachi	Delta	ABB
Model	-	1000 kW_Solar PCS	DeICEN 1000	PVS800-57-0500kW-A
Max. efficiency	%	98.6	98.6	98.6
Max. DC input voltage	V	1000	1000	1100
Max. DC current	A	2400	1670	1145
MPPT operating voltage range	V	460 to 900	610 - 930	450 to 825
Number of MPP independent inputs	No.	1	1	1
Max. AC output power	kW	1000	1000	600
Max. AC output current	A	2214	1590	965
Nominal AC voltage	V	300	400	300
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.	IEC61000, IEC 62109 IEC 61683 IEC 60068 IEC 60529	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

2.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models as listed in Table 7.

Table 7: Inverter warranty

Make	Warranty
Hitachi 1000 kW – Solar PCS	5 years
Delta DeICEN 1000	5 years
ABB PVS800-57-0500kW-A	5 years

2.2.3. Inverter Duty Transformer

Table 8 presents the key technical characteristics of the selected Voltamp Inverter Duty Transformer (IDT).

Table 8: Technical characteristics of IDT

Parameter	Unit	Description
Rating	kVA	1250
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.32-0.32/11 kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dyn11yn11
Impedance at principal tap	%	4.98

2.3. Project Design

2.3.1. DC Configuration

The design configuration of the project has been reviewed. The installed DC capacity of the project is 20 MWp which is connected to 28 inverters of 20 MW cumulative capacity. 24 modules form a string and there are total 3,473 such strings. The fixed tilt Module Mounting Structure (MMS) is at 23˚ tilt angle. The DC to AC ratio for inverters varies from 0.77 to 1.08. Figure 3 and Figure 4 show the actual photographs of PV array area and ICR.

Figure 3: Solar PV array

Figure 4: ICR

2.3.2. AC Configuration

As per the information provided by the Client, there are 28 nos. of inverters and connected to the inverter duty transformer (IDT) of suitable rating which step up the voltage to 11 kV. The output of two transformer feeder then connected to the one RMU panel. There are total such ten RMU panels at site which are connected in ring loop. All RMU panels are equipped with all necessary protection devices. The combination of RMU panels further evacuated to plant end 11 kV indoor switchgear panel. The 11 kV indoor switchgear panel having eight incoming feeders from solar PV plant, one auxiliary transformer feeder and two outgoing cable feeders. The 11 kV switchgear panel equipped with all necessary protection devices, however the details of the protections are not indicated in the SLD. Figure 5 and Figure 6 show the actual photographs of IDT and Inverter.

Figure 5: IDT

Figure 6: Inverter

2.4. Power evacuation

The output combined power at 11 kV further step to 66 kV via two numbers of 12.5 MVA 11/66 kV power transformer which is located at Pooling Substation (PSS). The step-up power at 66 kV further evacuated to 66 kV GETCO Dahisar Substation via 66 kV overhead transmission line.

Figure 7: Power Evacuation Schematic

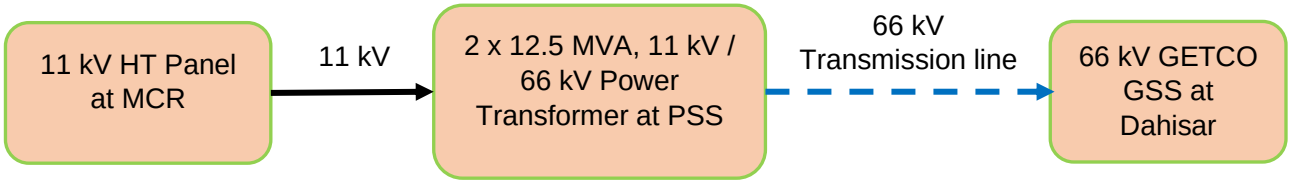


Figure 8: Plant end Pooling Substation

3. Terralight Charanka

3.1. About Project

The 15 MW Project is located at Charanka village of Patan district in Gujarat state of India. The Project was constructed by EPC Contractor; M/s. Enfinity Solar Solution Pvt. Ltd and operational since 28th March 2012. Currently the O&M contractor is Mitarsh Energy.

The Project is situated 21 km away from Santalpur and 112 km away from Patan district headquarter. The nearest railway station is at Patan which is around 21 km away from the site. The nearest airport to the project site is at Ahmedabad which is 184 km away. The Project site is well connected.

Figure 9: TL Charanka location

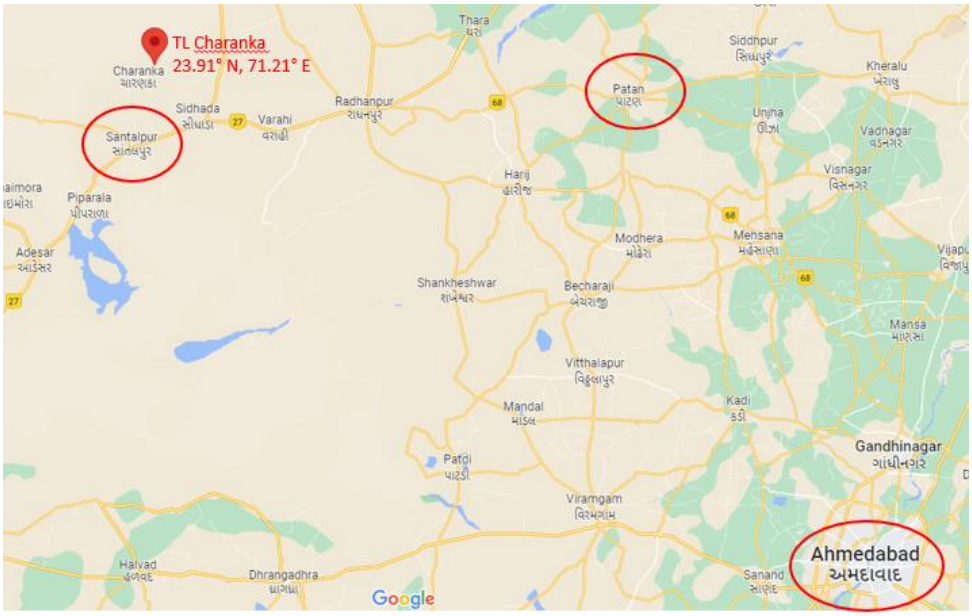


Figure 10:TL Charanka – Satellite image of project layout

3.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 9.

Table 9: Summary of key components

Component	Make and Model	Quantity
Module	First Solar FS-280	187,499
Inverter	Hitachi 1000 kW – Solar PCS	7
	Delta DeICEN 1000	6
IDT	Voltamp 1.25MVA	13

3.2.1. PV module

Table 10 presents the main technical characteristics of the installed PV modules.

Table 10: Technical characteristics of PV modules

Parameter	UoM	Description
Technology		Thin film
Peak power (Pmax)	W	80
Voltage at Pmax (Vmpp)	V	71.2
Current at Pmax (Impp)	A	1.12
Open Circuit Voltage (Voc)	V	91.5
Short Circuit Current (Isc)	A	1.22
Maximum system voltage	V	1000
Temp coefficient of Pmax	%/°C	-0.25
Degradation	%	0.7%
Certification	-	IEC 61646, IEC61730, TUV certified, CE Certified, ISO 9001

3.2.1.1. PV module warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

3.2.2. Inverter

Table 11 presents the main technical characteristics of the selected model.

Table 11: Technical characteristics of inverter

Parameter	Unit	Hitachi	Delta
Model	-	1000 kW_Solar PCS	DeICEN 1000
Max. efficiency	%	98.6	98.6
Max. DC input voltage	V	1000	1000
Max. DC current	A	2400	1670
MPPT operating voltage range	V	460 - 900	610 - 930
Number of MPP independent inputs	No.	1	1
Max. AC output power	kW	1000	1000
Max. AC output current	A	2214	1590
Nominal AC voltage	V	300	400
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.	IEC61000, IEC 62109 IEC 61683 IEC 60068 IEC 60529

3.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models as listed in Table 12.

Table 12: Inverter warranty

Make	Warranty
Hitachi 1000 kW_Solar PCS	5 years
Delta DeICEN 1000	5 years

3.2.3. Inverter Duty Transformer

Table 13 presents the key technical characteristics of the selected Voltamp IDT.

Table 13: Technical characteristics of IDT

Parameter	Unit	Description
Rating	kVA	1250
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.32-0.32/11 kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dyn11yn11
Impedance at principal tap	%	4.98

3.3. Project Design

3.3.1. DC Configuration

The design configuration of the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 15 MWp which is connected to 18 inverters of 13 MW cumulative capacity. 9 or 10 modules form a string and there are total 19,549 such strings. The fixed tilt MMS at 22˚ tilt angle has been considered. The DC to AC ratio for inverters varies from 0.58 to 1.15. Figure 11 and Figure 12 show the actual photographs of PV array area and ICR.

Figure 11: Solar PV array

Figure 12: ICR

3.3.2. AC Configuration

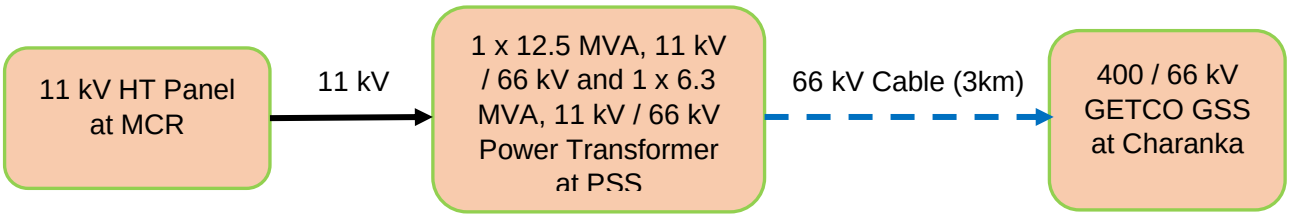
As per the information provided by the Client, there are 13 nos. of inverters of 1000 kW each connected to the inverter duty transformer (IDT) of suitable rating which step up the voltage to 11 kV. The output of two transformer feeder then connected to the one RMU panel. There are total such seven RMU panels at site which are connected in ring loop. All RMU panels are equipped with all necessary protection devices, which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The combination of RMU panels further evacuated to plant end 11 kV indoor switchgear panel. There are two nos. of 11 kV indoor switchgear panel. Each switchgear panel have four incoming feeders from solar PV plant, and one outgoing cable feeders. The 11 kV switchgear panel equipped with all necessary protection devices. Each 11 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

3.4. Power evacuation

The output of each 11 kV switchgear panel further step to 66 kV via one numbers of 12.5 MVA 11/66 kV and 6.3 MVA 11/66 kV power transformer which is located at Pooling Substation (PSS). The step-

up power at 66 kV further evacuated to 400 / 66 kV GETCO Charanka Substation via 66 kV underground cable feeder.

Figure 13: Power Evacuation Schematic



4. Solar Edge Beed

4.1. About Project

The 80 MW (30 MW and 50 MW) Project is located at Mhatargaon village (30 MW) and Bhilegaon village (50 MW) of Beed district in Maharashtra state of India. The Project was constructed by EPC Contractor; M/s. Sterling & Wilson Pvt. Ltd., and operational since 22nd April 2018. Currently the O&M contractor is Param.

The Project is situated 21 km away from Dharur tehsil and 72 km away from Beed district headquarter. The nearest railway station is at Parli Vaijnath which is around 17 km away from the site. The nearest airport to the project site is at Nanded Airport which is 90 km away. The Project site is well connected.

Figure 14: Solar Edge Beed location

Figure 15:Solar Edge Beed 30 MW – Satellite image of project layout

Figure 16:Solar Edge Beed 50 MW – Satellite image of project layout

4.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 14 and Table 15.

Table 14: Summary of key components for 30 MW

Component	Make and Model	Quantity
Module	JA Solar JAM60-S10-325-PR	120,497
Inverter	ABB PVS980-58-2000kW	15
IDT1	Shilchar 2 MVA	1
	Shilchar 4 MVA	7

Table 15: Summary of key components for 50 MW

Component	Make and Model	Quantity
Module	Canadian solar CS3K-320 MS 1500	120,714
	Astroenergy CHSM6612P-325W	79,980
Inverter	ABB PVS980-58-2000kW	25
IDT	Shilchar 2 MVA	1
	Shilchar 4 MVA	12

4.2.1. PV modules

Table 16 presents the main technical characteristics of the installed PV modules.

Table 16: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar	Canadian solar	Astroenergy
Technology		Polycrystalline	Polycrystalline	Polycrystalline	Polycrystalline
Peak power (Pmax)	W	320	325	320	325
Voltage at Pmax (Vmpp)	V	37.28	37.39	36.8	37.26
Current at Pmax (Impp)	A	9.09	9.17	8.69	9.00
Open Circuit Voltage (Voc)	V	46.12	46.38	45.3	45.98
Short Circuit Current (Isc)	A	8.58	8.69	9.26	9.57
Maximum system voltage	V	1500	1500	1000	1000 or 1500
Temp coefficient of Pmax	%/ºC	-0.41	-0.41	-0.41	-0.40
Module efficiency	%	16.5	16.7	16.46	17.2
Degradation	%	0.7%	0.7%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, IEC 61701, IEC 62716 CE Certified	IEC 61215, IEC 61730, CE Certified, TUV Nord Certified

4.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application,

installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

4.2.2. Inverter

Table 17 presents the main technical characteristics of the selected model.

Table 17: Technical characteristics of inverter

Parameter	Unit	Description
Model	-	PVS980-58-2000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1500
Max. DC current	A	2400
MPPT operating voltage range	V	935 to 1100
Number of MPP independent inputs	No.	1
Max. AC output power	kW	2000
Max. AC output current	A	1750
Nominal AC voltage	V	660
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

4.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the model listed in Table 18.

Table 18: Inverter warranty

Make	Warranty
ABB PVS980-58-2000kW	5 years

4.2.3. Inverter Duty Transformer

Table 19 presents the key technical characteristics of the selected Shilchar IDT.

Table 19: Technical characteristics of IDT

Parameter	Unit	Shilchar (2 MVA)	Shilchar (4 MVA)
Rating	kVA	2000	4000
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.66/33kV	0.66-0.66/33 kV
Windings	No.	2 (1 HV, 1 LV)	3 (1 HV, 2 LV)
Vector Group		Dy11	Dy11y11
Impedance at principal tap	%	6.25	7.15

4.3. Project Design

4.3.1. DC Configuration

The design configuration for 30 MW project has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 39.4 MWp which is connected to 15 inverters of 30 MW cumulative capacity. 31 modules form a string and there are total 3,887 such strings. The fixed tilt Module Mounting Structure at 16˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.32.

The design configuration for 50 MW project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 64.6 MWp which is connected to 25 inverters of 50 MW cumulative capacity. 31 modules form a string and there are total 6,474 such strings. The fixed tilt Module Mounting Structure at 16˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.3. Figure 17 show the actual photographs of PV array area.

Figure 17: Solar PV Array

4.3.2. AC Configuration

As per the submitted SLD for 30 MW there are 15 nos. of inverters, in which 14 are connected to the 7 nos. of three winding inverter duty transformer (IDT) of 4000 kVA, 0.66/0.66/33 kV rating and one inverter is connected to two winding IDT of 2000 kVA, 0.66/33 kV rating. The output of IDT further connected to 33kV outdoor VCB panel. The 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices has been furnished by the Client. The output of the such 8 nos. of 33 kV switchgear panels are further connected to one no. of 33 kV indoor HT switchgear panel via cable feeders at MCR building. The 33 kV switchgear panel has 8 incoming feeders from solar PV plant, one bus coupler and two outgoing cable feeders/ 33kV transmission line via double pole structure arrangement to another 50 MW solar PV plant. The 33 kV indoor HT switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions

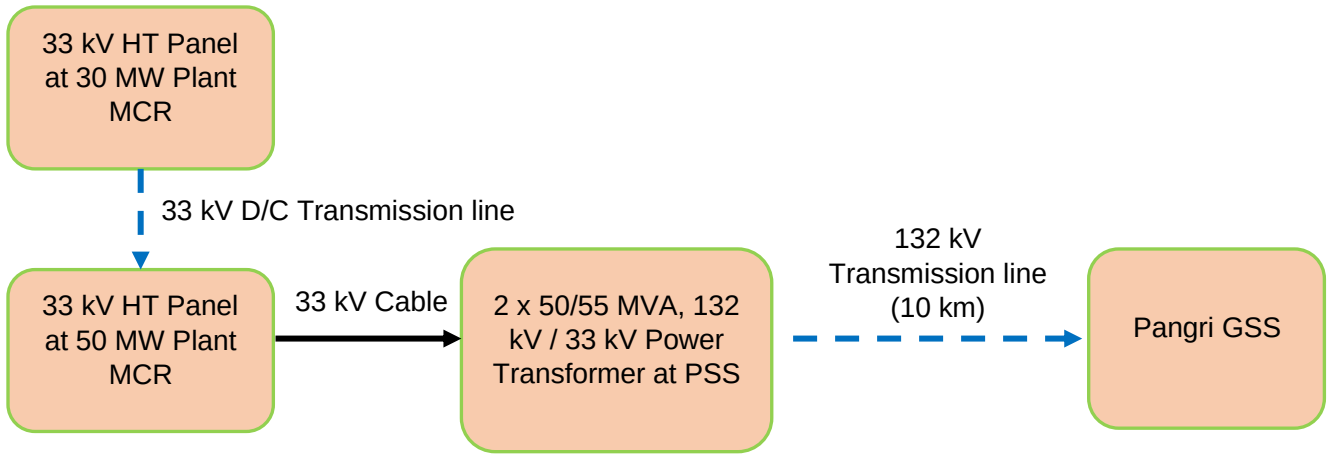
along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices has been furnished by the Client.

As per the submitted documents there are 25 nos. of inverters, in which 24 are connected to the 12 nos. of three winding inverter duty transformer (IDT) of 4000 kVA, 0.66/0.66/33 kV rating and one inverter is connected to two winding IDT of 2000 kVA, 0.66/33 kV rating. The output of IDT further connected to 33kV outdoor SF6 VCB panel / 33 kV ICOG panel. The 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices has been furnished by the Client. The output of the such 13 nos. of 33 kV switchgear panels are further connected to one no. of 33 kV indoor HT switchgear panel via cable feeders at MCR building. The 33 kV switchgear panel has 13 incoming feeders from solar PV plant, one bus coupler, one cable feeder of 30 MW solar PV plant and two outgoing cable feeders. The 33 kV indoor HT switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices has been furnished by the Client.

4.4. Power evacuation

The output of 33 kV switchgear panel further step to 132 kV via two numbers of 50/55 MVA 132/33 kV power transformer which is located at 50 MW solar PV plant end. The step-up power at 132 kV further evacuated to Pangri Grid Substation via 132 kV Transmission line.

Figure 18: Power Evacuation Schematic



5. Solar Edge Jalgaon

5.1. About Project

The 50 MW Project is located at Mauje Wadhave village of Jalgaon district in Maharashtra state of India. The Project was constructed by EPC Contractor; M/s. Sterling & Wilson Pvt. Ltd., and operational since 26th April 2018. Currently the O&M contractor is Param.

The Project is situated 25 km away from Muktainagar tehsil and 70 km away from Jalgaon district headquarter. The nearest railway station is at Bhusawal railway which is around 25 km away from the site. The nearest airport to the project site is at Aurangabad Airport which is 180 km away. The Project site is well connected.

Figure 19: Solar Edge Jalgaon location

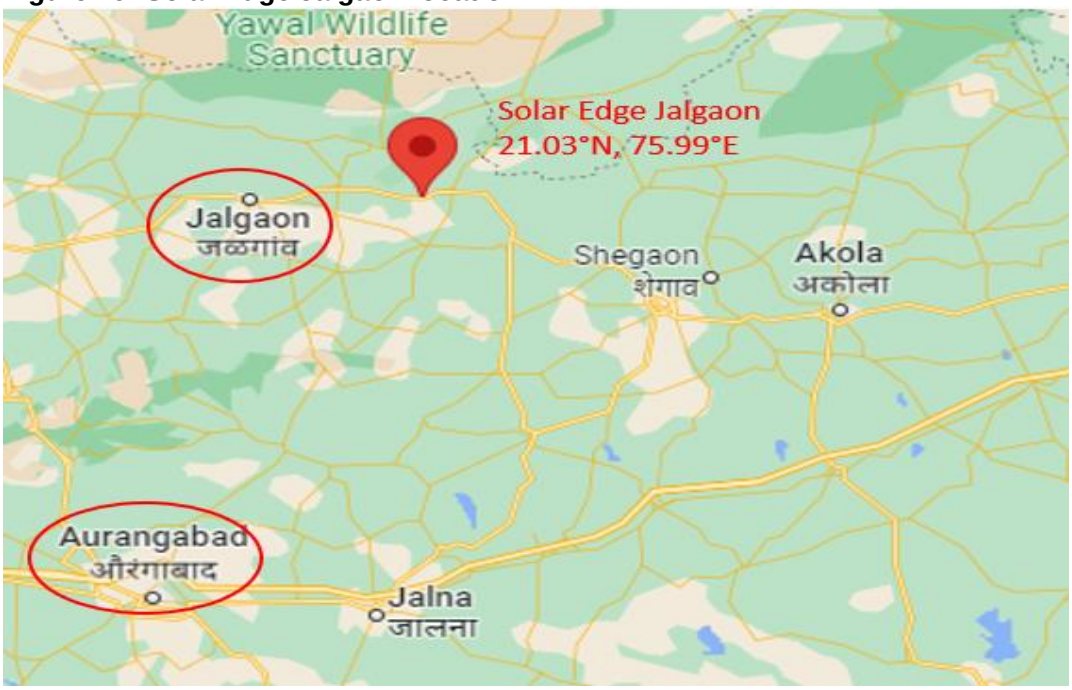


Figure 20:Solar Edge Jalgaon 50 MW – Satellite image of project layout

5.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 20.

Table 20: Summary of key components

Component	Make and Model	Quantity
Module	Canadian solar CS3K-320 MS 1500	56,699
	Astroenergy CHSM6612P-320W	121,830
	JA Solar JAM60-S10-325-PR	7,874
	JA Solar JAM60-S09-330-PR	16,027
Inverter	ABB PVS980-58-2000kW	25
IDT	Shilchar 2 MVA	1
	Shilchar 4 MVA	12

5.2.1. PV module

Table 21 presents the main technical characteristics of the installed PV modules.

Table 21: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar	Canadian solar	Astroenergy
Technology		Polycrystalline	Polycrystalline	Polycrystalline	Polycrystalline
Peak power (Pmax)	W	330	325	320	320
Voltage at Pmax (Vmpp)	V	37.65	37.39	36.8	37.02
Current at Pmax (Impp)	A	9.28	9.17	8.69	8.65
Open Circuit Voltage (Voc)	V	46.40	46.38	45.3	45.45
Short Circuit Current (Isc)	A	8.77	8.69	9.26	9.25
Maximum system voltage	V	1500	1500	1000	1000 or 1500
Temp coefficient of Pmax	%/ºC	-0.41	-0.41	-0.41	-0.40
Module efficiency	%	17	16.7	16.46	16.5
Degradation	%	0.7%	0.7%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, IEC 61701, IEC 62716 CE Certified	IEC 61215, IEC 61730, CE Certified, TUV Nord Certified

5.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

5.2.2. Inverter

Table 22 presents the main technical characteristics of the selected model.

Table 22: Technical characteristics of Inverter

Parameter	Unit	Description
Model	-	PVS980-58-2000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1500
Max. DC current	A	2400
MPPT operating voltage range	V	935 to 1100
Number of MPP independent inputs	No.	1
Max. AC output power	kW	2000

Parameter	Unit	Description
Max. AC output current	A	1750
Nominal AC voltage	V	660
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

5.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the model listed in Table 23.

Table 23: Inverter warranty

Make	Warranty
ABB PVS980-58-2000kW	5 years

5.2.3. Inverter Duty Transformer

Table 24 presents the key technical characteristics of the selected Shilchar transformer.

Table 24: Technical characteristics of IDT

Parameter	Unit	Shilchar (2 MVA)	Shilchar (4 MVA)
Rating	kVA	2000	4000
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.66/33kV	0.66-0.66/33 kV
Windings	No.	2 (1 HV, 1 LV)	3 (1 HV, 2 LV)
Vector Group		Dy11	Dy11y11
Impedance at principal tap	%	6.25	7.15

5.3. Project Design

5.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 64.9 MWp which is connected to 25 inverters of 50 MW cumulative capacity. 31 modules form a string and there are total 6,530 such strings. The fixed tilt Module Mounting Structure at 16˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.3. Figure 21 shows the actual photographs of PV array area.

Figure 21:Solar PV Array

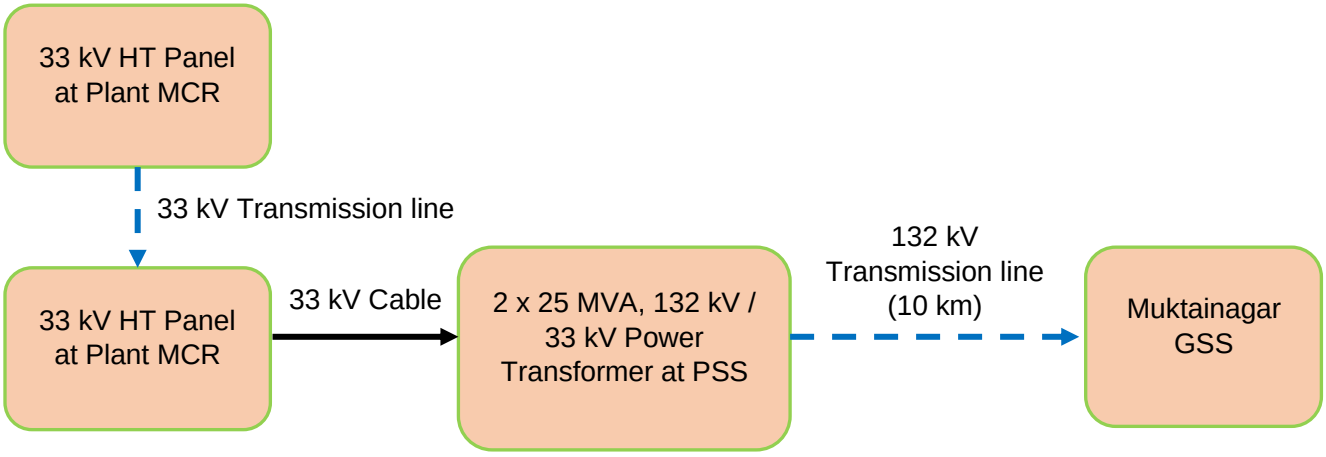
5.3.2. AC Configuration

As per the submitted documents for there are 25 nos. of inverters, in which 24 are connected to the 12 nos. of three winding inverter duty transformer (IDT) of 4000 kVA, 0.66/0.66/33 kV rating and one inverter is connected to two winding IDT of 2000 kVA, 0.66/33 kV rating. The output of IDT further connected to 33kV indoor switchgear panel. There are six no of 1-in-1 out 33kV switchgear panel present which have one incoming transformer feeder and one outgoing cable feeder in the 33 kV indoor switchgear panel. There are six no of 2-in-1 out 33kV switchgear panel present which have one incoming transformer feeder, one incoming of 1-in-1 out 33 kV switchgear panel feeder, one auxiliary transformer feeder and one outgoing cable feeder. The output of such five 2-in-1 out 33 kV switchgear panel further evacuate the power via cable feeder and the balance one evacuate the power via 33 kV overhead line via double pole structure. The 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices has been furnished by the Client.

5.4. Power evacuation

The output of 33 kV switchgear panel further step to 132 kV via two numbers of 25 MVA132/33 kV power transformer which is located at 50 MW solar PV plant end. The step-up power at 132 kV further evacuated to Muktainagar Grid Substation via 132 kV overhead Transmission line.

Figure 22: Power Evacuation Schematic



6. Globus Mandsaur

6.1. About Project

The Project is located at Nataram village of Mandasaur District in Madhya Pradesh state of India. The Project was constructed by EPC Contractor; M/s. Belectric, and operational since 29th Jan 2016. Currently the O&M contractor is Mitarsh energy.

The Project is situated 40 km away from Mandasaur district headquarters. The nearest railway station is at Mandsor railway which is around 32 km away from the site. The nearest airport to the project site is at Indore Airport which is 200 km away. The Project site is well connected.

Figure 23: Globus location

Figure 24:Globus 20 MW – Satellite image of project layout

6.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 25.

Table 25: Summary of key components

Component	Make and Model	Quantity
Module	Solar Frontier KK SF 165-S	143,400
Inverter	ABB PVS800-57-1000kW	1
	SMA Sunny Central 1000CP XT	17
IDT	Shilchar 2.2 MVA	9

6.2.1. PV modules

Table 26 presents the main technical characteristics of the installed PV modules.

Table 26: Technical characteristics of PV modules

Parameter	UoM	Solar Frontier
Technology		Thinfilm
Peak power (Pmax)	W	165
Voltage at Pmax (Vmpp)	V	85.5
Current at Pmax (Impp)	A	1.93
Open Circuit Voltage (Voc)	V	110
Short Circuit Current (Isc)	A	2.20
Maximum system voltage	V	1000
Temp coefficient of Pmax	%/^{o}C	-0.31
Degradation	%	0.8%
Certification	-	IEC 61646, IEC 61730, CE Certified, ISO 9001, ISO 14001

6.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

6.2.2. Inverter

Table 27 presents the main technical characteristics of the selected model.

Table 27: Technical characteristics of Inverter

Parameter	Unit	ABB	SMA
Model	-	PVS800-57-1000kW	Sunny Central 1000CP XT
Max. efficiency	%	98.8	98.7

Parameter	Unit	ABB	SMA
Max. DC input voltage	V	1,100	1,000
Max. DC current	A	1,710	1,635
MPPT operating voltage range	V	-	625 to 850
Number of MPP independent inputs	no.	1	1
Max. AC output power	kW	1000	1,100
Max. AC output current	A	1445	1,568
Nominal AC voltage	V	405	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.	EN 61000, EMC- Conformity, CE Certified, IEEE 1547

6.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the model listed in Table 28.

Table 28: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years
SMA Sunny Central 1000CP XT	5 years

6.2.3. Inverter Duty Transformer

Table 29 presents the key technical characteristics of the selected Shilchar transformer.

Table 29: Technical characteristics of IDT

Parameter	Unit	Description
Rating	kVA	2200
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.405/0.405/33kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dy11y11
Impedance at principal tap	%	6

6.3. Project Design

6.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 23.7 MWp which is connected to 18 inverters of 18 MW cumulative capacity. 8 modules form a string and there are total 17,930 such strings. The

fixed tilt Module Mounting Structure at 15˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.3. Figure 25 and Figure 26 show the actual photographs of PV array area and ICR.

Figure 25: Solar PV array

Figure 26: ICR

6.3.2. AC Configuration

As per the submitted SLD for there are 18 nos. of inverters which are connected to the 9 nos. of three winding IDT of 2200 kVA, 0.45/0.45/33 kV rating. The output of IDT further connected to the 1-in-1 out 33kV indoor switchgear panel. There are such nine no of 36 kV indoor switchgear panels. All 33 kV indoor switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of 1-in-1 out switchgear panel further connected to 36 kV Air Insulated Collector substations. There are two nos. of collector substations. The collector substation-2 has four no. of incoming cable feeders from 36 kV indoor switchgear panels, one auxiliary transformer feeder and one outgoing feeder which will further connected to collector substation-1.

The collector substation-1 has five no of incoming cable feeders from 36 kV indoor switchgear panels, one no. of incoming cable feeder from collector substation-2, one auxiliary transformer feeder and one outgoing feeder. Both, 36 kV outdoor collector substation are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

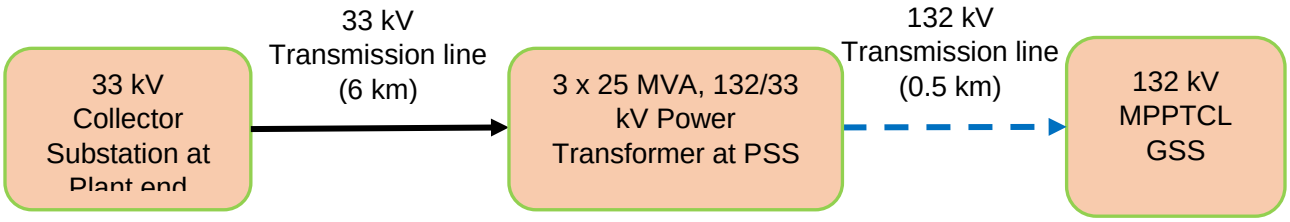
6.4. Power evacuation

The outgoing cable feeder of 33 kV collector substation-1 further converted to overhead transmission line with the help of pole structure. The generated combined power at 33 kV further evacuated to Focal Energy Three India Private Limited of 60 MW 132/33 kV pooling substation at Sitamau via 33 kV cable feeder. The transmission line length is of around 6 km.

At PSS the overhead transmission line further converted to cable feeder with the help of double pole structure. Further the cable will connect to the existing 33 kV switchgear panel along with all metering

and protection arrangements. The collected power at 33 kV further step up to 132 kV via three nos. of 20/25 MVA 132/33 kV power transformer at PSS. The step up further evacuated to MPPTCL GSS via single circuit 132 kV transmission line.

Figure 27: Power Evacuation Schematic



7. Terralight Patlasi

7.1. About Project

The Project is located at Mandasaur District in Madhya Pradesh state of India. The Project was constructed by EPC Contractor; M/s. Belectric, and operational since 12th Jun 2015. Currently the O&M contractor is Mitarsh energy.

The Project is situated 32 km away from Mandasaur district headquarters. The nearest railway station is at Mandsor railway which is around 35 km away from the site. The nearest airport to the project site is at Indore Airport which is 196 km away. The Project site is well connected.

Figure 28: TL Patlasi

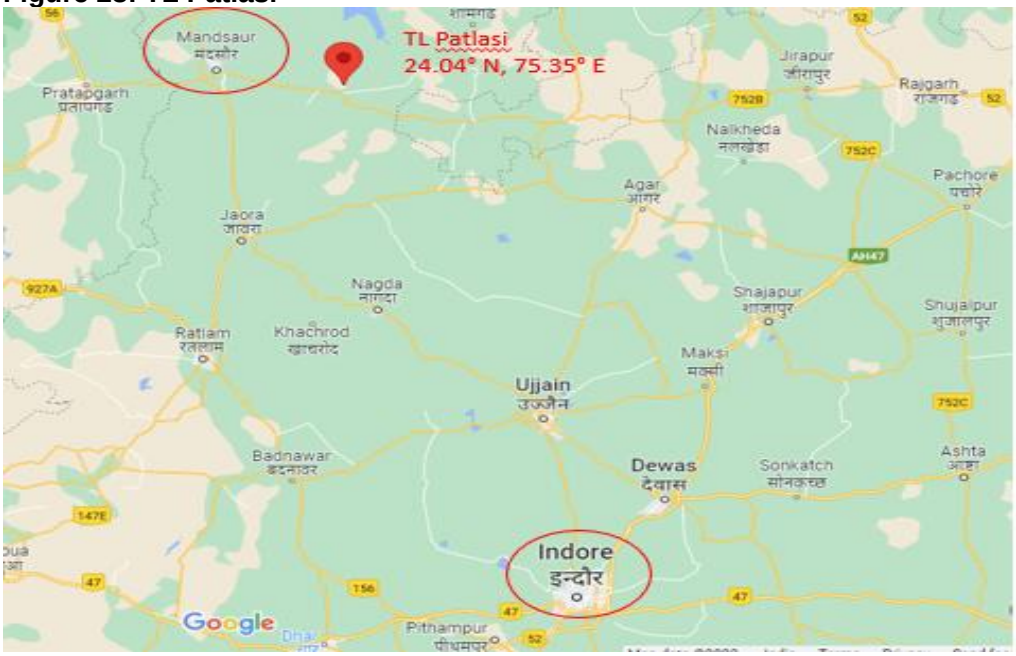


Figure 29:TL Patlasi 20 MW – Satellite image of project layout

7.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 30.

Table 30: Summary of key components

Component	Make and Model	Quantity
Module	First Solar FS-395	233,376
Inverter	ABB PVS800-57-1000kW	1
	SMA Sunny Tripower 20000 TL-30	8
	SMA Sunny Central 900CP XT	19
IDT	Shilchar 2.0 MVA	10

7.2.1. PV modules

Table 31 presents the main technical characteristics of the installed PV modules.

Table 31: Technical characteristics of PV modules

Parameter	UoM	First Solar
Technology		Thinfilm
Peak power (Pmax)	W	95
Voltage at Pmax (Vmpp)	V	45.8
Current at Pmax (Impp)	A	2.08

Parameter	UoM	First Solar
Open Circuit Voltage (Voc)	V	58.0
Short Circuit Current (Isc)	A	2.29
Maximum system voltage	V	1000
Temp coefficient of Pmax	%/ºC	-0.29
Degradation	%	0.7%
Certification	-	IEC 61646, IEC61730, TUV certified, CE Certified, ISO 9001

7.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

7.2.2. Inverter

Table 32 presents the main technical characteristics of the selected model.

Table 32: Technical characteristics of Inverter

Parameter	Unit	ABB	SMA	SMA
Model	-	PVS800-57-1000kW	Sunny Central 900CP XT	Sunny Tripower 20000 TL-30
Max. efficiency	%	98.8	98.6	98.4
Max. DC input voltage	V	1,100	1,000	1,000
Max. DC current	A	1,710	1,400	33
MPPT operating voltage range	V	-	656 to 850	320 to 800
Number of MPP independent inputs	no.	1	1	1
Max. AC output power	kW	1000	900	20
Max. AC output current	A	1445	1411	29
Nominal AC voltage	V	405	405	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.	EN 61000, EMC-Conformity, CE Certified, IEEE 1547	EN 61000, EMC-Conformity, CE Certified, IEEE 1547

7.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models listed in Table 33.

Table 33: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years
SMA Sunny Central 900CP XT	5 years
SMA Sunny Tripower 20000 TL-30	5 years

7.2.3. Inverter Duty Transformer

Table 34 presents the key technical characteristics of the selected Shilchar IDT.

Table 34: Technical characteristics of IDT

Parameter	Unit	Shilchar
Rating	kVA	2000
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.405/0.405/33kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dy11y11
Impedance at principal tap	%	6

7.3. Project Design

7.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 22.2 MWp which is connected to 28 inverters of 18 MW cumulative capacity. 16 modules form a string and there are a total of 14,586 such strings. The fixed tilt Module Mounting Structure at 15˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.3. Figure 30 show the actual photographs of PV array area.

Figure 30:Solar PV Array

7.3.2. AC Configuration

As per the information provided by the Client, there are 28 nos. of inverters and are connected to the inverter duty transformer (IDT) of suitable rating which step up the voltage to 33 kV. The output of IDT further connected to the 1-in-1 out 33kV outdoor air insulated Vacuum Circuit Breaker (VCB) panel. There are such ten nos of 33 kV outdoor air insulated VCB panels. All 33 kV VCB panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of 1-in-1 out switchgear panel further connected to 33 kV Air Insulated Collector substations. There are two nos. of collector substations. The collector substation-1 has five no. of incoming cable feeders from 33 kV VCB panels, one auxiliary transformer feeder and one outgoing feeder which will further connected to collector substation-2.

The collector substation-2 has five no of incoming cable feeders from 33 kV VCB panels, one no. of incoming cable feeder from collector substation-1, one auxiliary transformer feeder and one outgoing feeder. Both, 36 kV outdoor collector substation are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

7.4. Power evacuation

The outgoing cable feeder of 33 kV collector substation-1 further converted to overhead transmission line with the help of pole structure. The generated combined power at 33 kV further evacuated to Focal Energy Three India Private Limited of 60 MW 132/33 kV pooling substation at Sitamau via 33 kV double circuit transmission line. The transmission line length is of around 6 km.

At PSS the overhead transmission line further converted to cable feeder with the help of double pole structure. Further the cable will connect to the existing 33 kV switchgear panel along with all metering and protection arrangements. The collected power at 33 kV further step up to 132 kV via three nos. of 20/25 MVA 132/33 kV power transformer at PSS. The step up further evacuated to MPPTCL GSS via single circuit 132 kV transmission line.

Figure 31: Power Evacuation Schematic

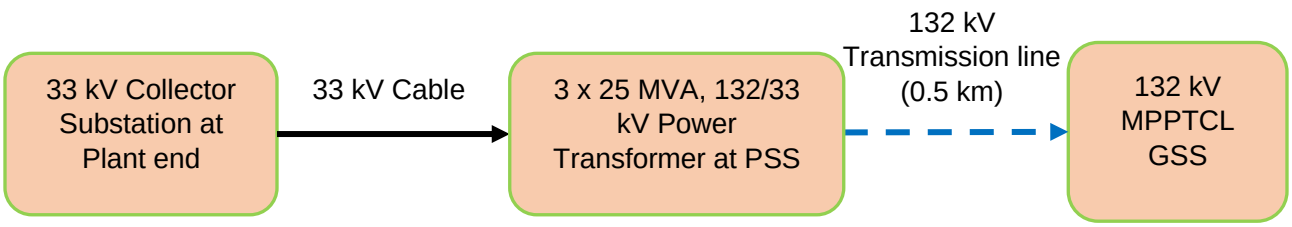


Figure 32: Power transformer

8. Terralight Rajapalayam

8.1. About Project

The Project is located at Unjampatti Village, Rajapalayam Block, Virudhunagar District Tamilnadu state of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and operational since 26th Sep 2018. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 72 km away from Virudhunagar district headquarters. The nearest railway station is at Virudhunagar railway which is around 75 km away from the site. The nearest airport to the project site is at Madurai Airport which is 125 km away. The Project site is well connected.

Figure 33: TL Rajapalayam

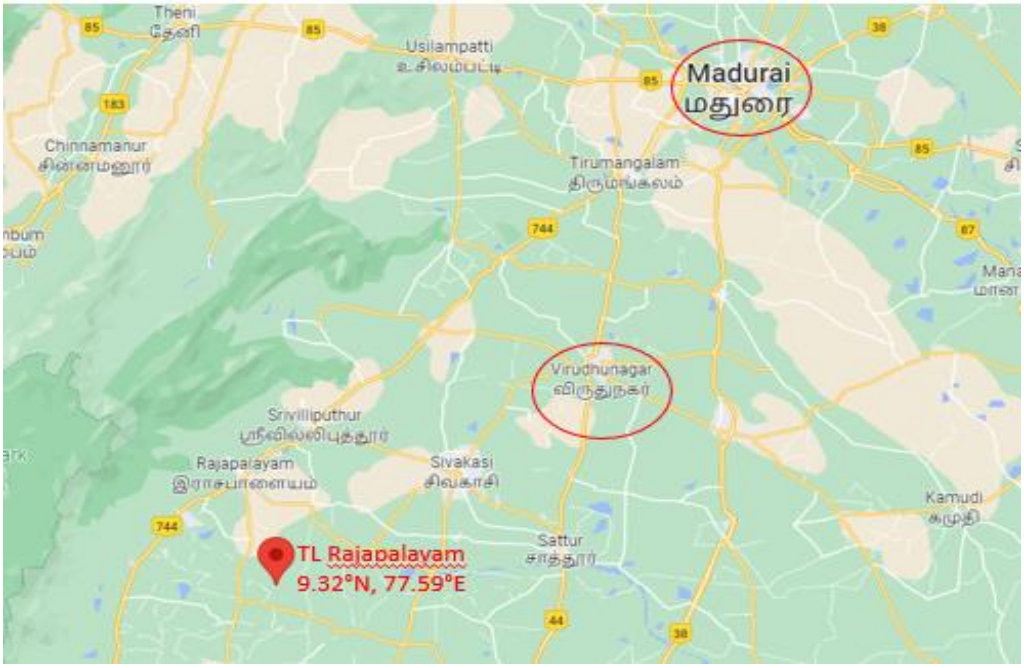
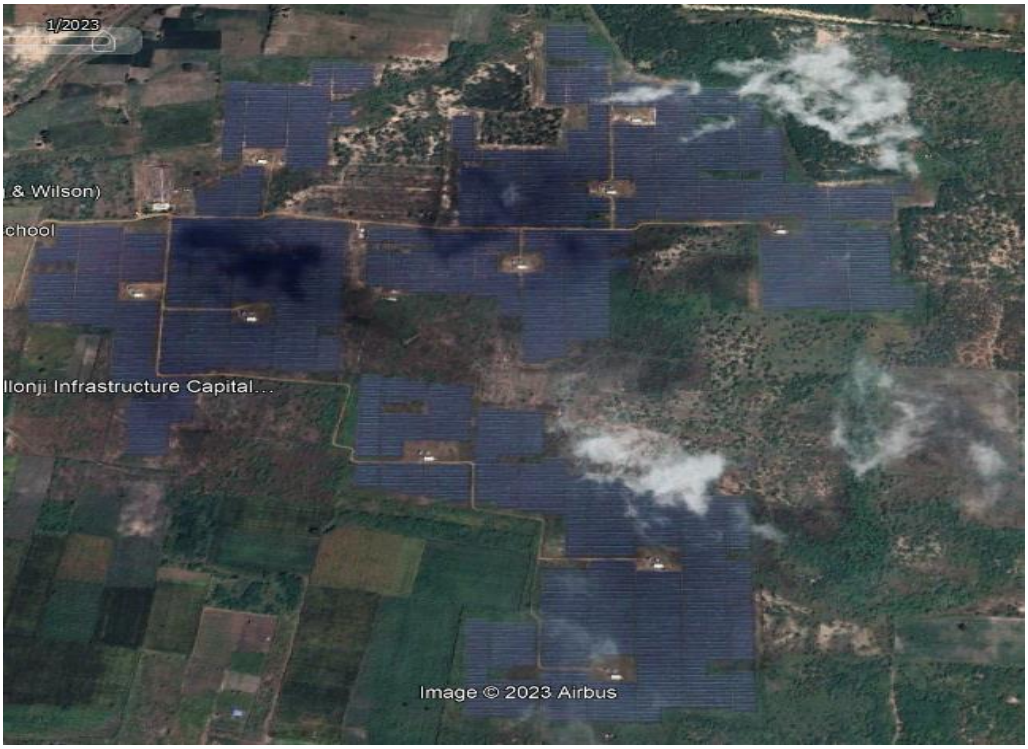


Figure 34:TL Rajapalayam 50 MW – Satellite image of project layout



8.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 35.

Table 35: Summary of key components

Component	Make and Model	Quantity
Module	JA solar JAM60-S01-325-SC	83,040
	JA solar JAM60-S01-330-SC	81,900
Inverter	Sineg EP-1250-HA	40
IDT	Shilchar 5 MVA	10

8.2.1. PV modules

Table 36 presents the main technical characteristics of the installed PV modules.

Table 36: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar
Technology		Polycrystalline	Polycrystalline
Peak power (Pmax)	W	330	325
Voltage at Pmax (Vmpp)	V	37.65	37.39
Current at Pmax (Impp)	A	9.28	9.17
Open Circuit Voltage (Voc)	V	46.40	46.38
Short Circuit Current (Isc)	A	8.77	8.69
Maximum system voltage	V	1500	1500
Temp coefficient of Pmax	%/^{o}C	-0.41	-0.41
Module efficiency	%	17	16.7
Degradation	%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001

8.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

8.2.2. Inverter

Table 37 presents the main technical characteristics of the selected model.

Table 37: Technical characteristics of Inverter

Parameter	Unit	Description
Model	-	EP-1250-HA
Max. efficiency	%	
Max. DC input voltage	V	1,500
Max. DC current	A	1.754
MPPT operating voltage range	V	800 to 1300
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1250
Max. AC output current	A	1.443
Nominal AC voltage	V	550
Certification (IEC/IEEE/EN)	-	IEC/EN 62109-1, IEC/EN 62109-2, EN 61000-6-2, EN 61000-6-3, EN 61000-3-2.

8.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the model listed in Table 38

Table 38: Inverter warranty

Make	Warranty
Sineg EP-1250-HA	5 years

8.2.3. Inverter Duty Transformer

Table 39 presents the key technical characteristics of the selected Shilchar transformer.

Table 39: Technical characteristics of IDT

Parameter	Unit	Description
Rating	kVA	5000
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.55/0.55/11kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Yd11yd11
Impedance at principal tap	%	6

8.3. Project Design

8.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 54 MWp which is connected to 40 inverters

of 50 MW cumulative capacity. 30 modules form a string and there are a total of 5,498 such strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.08.

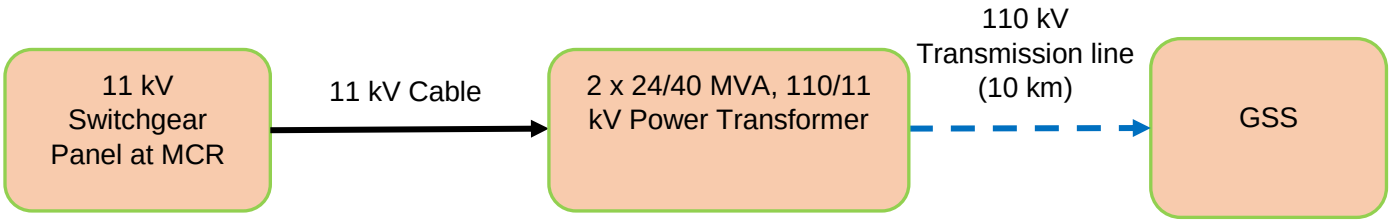
8.3.2. AC Configuration

As per the submitted SLD for there are 40 nos. of inverters which are connected to the 10 nos. of three winding IDT of 5 MVA, 0.55/0.55/11 kV rating. The output of IDT further connected to the 1-in-1 out 11 kV switchgear panel. There are such ten nos of 11 kV outdoor switchgear panels. All 11 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of 1-in-1 out switchgear panel further connected to main HT panel at MCR building. The MCR 11 kV HT panel has ten no. of incoming cable feeders from 11 kV switchgear panels, one auxiliary transformer feeder and two outgoing cable feeders. The 11 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

8.4. Power evacuation

The combined generated 50 MW power at 11 kV further step up to 110 kV via two nos. of 24/40 MVA, 110/11 kV power transformer. The elevated power 110 kV further evacuated to Grid Sub Station (GSS) via 110 kV Single Circuit (S/C) transmission line. The 110 kV transmission line is approx. 10 km away from the plant end substation.

Figure 35: Power Evacuation Schematic



9. Terralight Kanji

9.1. About Project

The Project is located at Alllyandhi village, Chengam, Tiruvannamalai, District Tamilnadu of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and operational since 26th March 2016. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 22 km away from Tiruvannamalai district headquarters. The nearest railway station is at Tiruvannamalai railway which is around 25 km away from the site. The nearest airport to the project site is at Puducherry Airport which is 140 km away. The Project site is well connected.

Figure 36: TL Kanji

Figure 37:TL Kanji 30 MW – Satellite image of project layout

9.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 40.

Table 40: Summary of key components

Component	Make and Model	Quantity
Module	Talesun TD672P-310	116,172
Inverter	ABB PVS800-57-1000kW	30
IDT	Shilchar 2.2 MVA	14
	Shilchar 1.1 MVA	2

9.2.1. PV modules

Table 41 presents the main technical characteristics of the installed PV modules.

Table 41: Technical characteristics of PV module

Parameter	UoM	Description
Technology		Polycrystalline
Peak power (Pmax)	W	310
Voltage at Pmax (Vmpp)	V	36.5

Parameter	UoM	Description
Current at Pmax (Impp)	A	8.5
Open Circuit Voltage (Voc)	V	45
Short Circuit Current (Isc)	A	9.06
Maximum system voltage	V	1000
Temp coefficient of Pmax	%/ºC	-0.4
Module efficiency	%	16
Degradation	%	0.7%
Certification	-	IEC 61215, IEC 61730, IEC 61701, IEC 62716, IEC 60068

9.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

9.2.2. Inverter

Table 42 presents the main technical characteristics of the selected model.

Table 42: Technical characteristics of Inverter

Parameter	Unit	Description
Model	-	PVS800-57-1000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1,100
Max. DC current	A	1,710
MPPT operating voltage range	V	-
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1000
Max. AC output current	A	1445
Nominal AC voltage	V	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

9.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the model listed in Table 43.

Table 43: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years

9.2.3. Inverter Duty Transformer

Table 44 presents the key technical characteristics of the selected Shilchar transformer.

Table 44: Technical characteristics of IDT

Parameter	Unit	Shilchar	Shilchar
Rating	kVA	2200	1100
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.4/0.4/11 kV	0.4/11 kV
Windings	No.	3 (1 HV, 2 LV)	2 (1 HV, 1 LV)
Vector Group		Dy11y11	Dy11
Impedance at principal tap	%	6.25	6.25

9.3. Project Design

9.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 36 MWp which is connected to 30 inverters of 30 MW cumulative capacity. 21 modules form a string and there are a total of 5,532 such strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2. Figure 38 show the actual photographs of PV array area.

Figure 38: Solar PV Array

9.3.2. AC Configuration

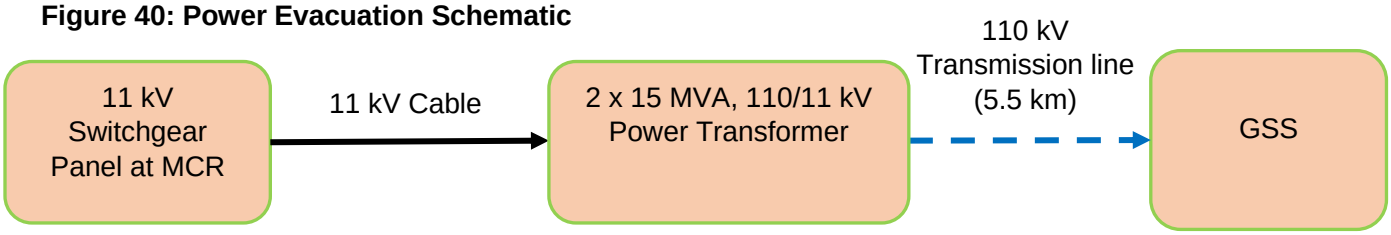
As per the submitted SLD for there are 30 nos. of inverters which are connected to the 14 nos. of three winding IDT of 2.2 MVA, 0.4/0.4/11 kV and 2 nos. of two winding IDT of 1.1 MVA, 0.4/11 kV rating. The output of IDT further connected to the 2-in-1 out 11 kV switchgear panel. There are such 8 nos of 11 kV outdoor switchgear panels. All 11 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of 2-in-1 out switchgear panel further connected to main HT panel at MCR building. The MCR 11 kV HT panel has 8 no. of incoming cable feeders from 11 kV switchgear panels, two auxiliary transformer feeder, two spare feeders and two outgoing cable feeders. The 11 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

Figure 39: Indoor Switchyard

9.4. Power evacuation

The combined generated 30 MW power at 11 kV further step up to 110 kV via two nos. of 15 MVA, 110/11 kV power transformer. The elevated power 110 kV further evacuated to Grid Sub Station (GSS) via 110 kV Single Circuit (S/C) transmission line. The 110 kV transmission line is approx. 5.5 km away from the plant end substation.

Figure 40: Power Evacuation Schematic



10. UMD 25 MW (12 MW + 13 MW)

10.1. About Project

The 12 MW Project is located at Ondioulinayakanoor village, Aruppukottai Taluk, Virudunagar District in Tamilnadu state of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and operational since 26th March 2016. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 13 km away from Virudunagar district headquarters. The nearest railway station is at Virudunagar railway which is around 15 km away from the site. The nearest airport to the project site is at Madurai Airport which is 60 km away. The Project site is well connected.

The 13 MW Project is located at Kattarankulam village, Tuticorin District in Tamilnadu state of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and operational since 26th March 2016. Currently the O&M contractor is AVI Solar Energy

The Project is situated 80 km away from Tuticorin district headquarters. The nearest railway station is at Tiruvannamalai railway which is around 25 km away from the site. The nearest airport to the project site is at Tuticorin Airport which is 90 km away. The Project site is well connected.

Figure 41: UMD 12 MW

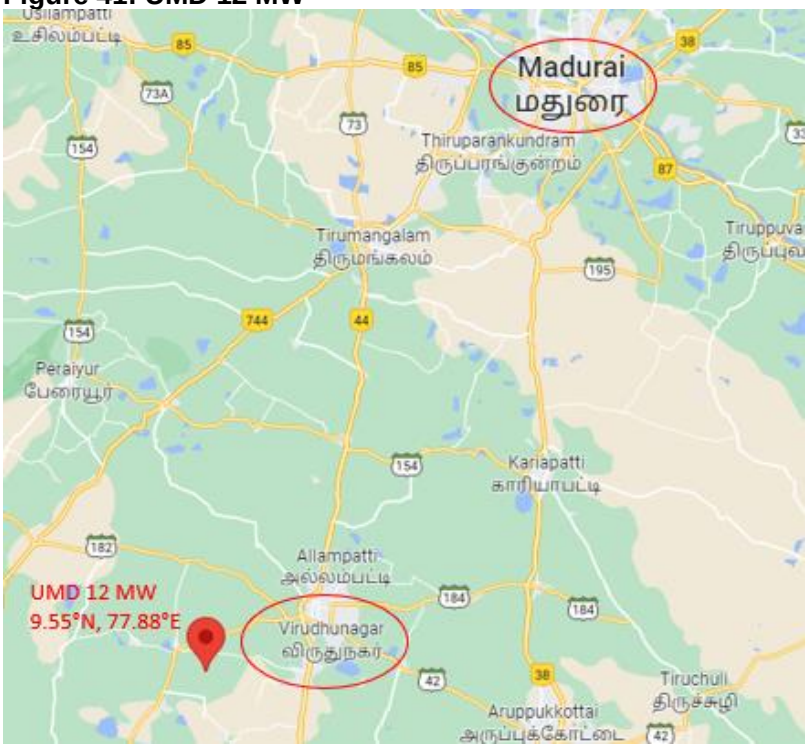


Figure 42: UMD 13 MW

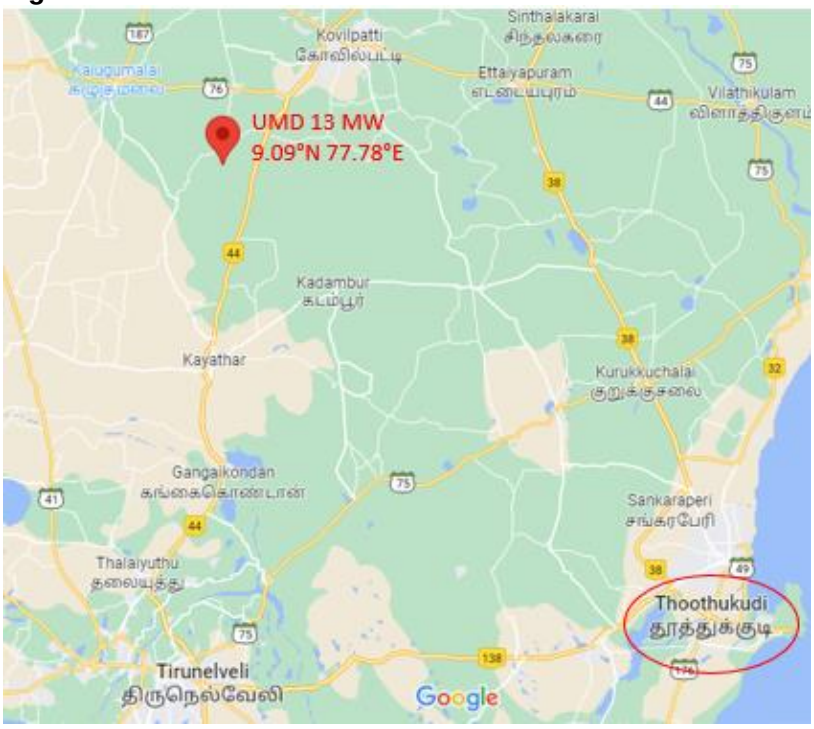


Figure 43:UMD 12 MW – Satellite image of project layout

Figure 44:UMD 13 MW – Satellite image of project layout

10.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 45 and Table 46.

Table 45: Summary of key components for 12 MW

Component	Make and Model	Quantity
Module	JA solar JAP6-72-310-3BB	23,226
	JA solar JAP6-72-315-3BB	22,869
Inverter	ABB PVS800-57-1000kW	12
IDT	Voltamp 2.2 MVA	6

Table 46: Summary of key components for 13 MW

Component	Make and Model	Quantity
Module	JA solar JAP6-72-310-3BB	11,508
	JA solar JAP6-72-315-3BB	38,220
Inverter	ABB PVS800-57-1000kW	13
IDT	Voltamp 2.2 MVA	6
	Voltamp 1.1 MVA	1

10.2.1. PV modules

Table 47 presents the main technical characteristics of the installed PV modules.

Table 47: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar
Technology		Polycrystalline	Polycrystalline
Peak power (Pmax)	W	310	315
Voltage at Pmax (Vmpp)	V	37.00	37.28
Current at Pmax (Impp)	A	8.38	8.45
Open Circuit Voltage (Voc)	V	45.45	45.60
Short Circuit Current (Isc)	A	8.85	8.91
Maximum system voltage	V	1000	1000
Temp coefficient of Pmax	%/°C	-0.41	-0.41
Module efficiency	%	15.99	16.25
Degradation	%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001

10.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

10.2.2. Inverter

Table 48 presents the main technical characteristics of the selected model.

Table 48: Technical characteristics of Inverter

Parameter	Unit	ABB
Model	-	PVS800-57-1000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1,100
Max. DC current	A	1,710
MPPT operating voltage range	V	-
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1000
Max. AC output current	A	1445
Nominal AC voltage	V	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

10.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models listed in Table 49 .

Table 49: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years

10.2.3. Inverter Duty Transformer

Table 50 presents the key technical characteristics of the selected Shilchar transformer.

Table 50: Technical characteristics of IDT

Parameter	Unit	Voltamp	Voltamp
Rating	kVA	2200	1100
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.4/0.4/33kV	0.4/0.4/33kV
Windings	No.	3 (1 HV, 2 LV)	2 (1 HV, 1 LV)
Vector Group		Dy11y11	Dy11y11
Impedance at principal tap	%	6	6

10.3. Project Design

10.3.1. DC Configuration

The design configuration for the UMD 12 MW project has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 14.41 MWp which is connected to 12 inverters of 12 MW cumulative capacity. 21 modules form a string and there are a total of 2,195 such strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2.

The design configuration for the UMD 13 MW project has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 15.6 MWp which is connected to 30 inverters of 30 MW cumulative capacity. 21 modules form a string and there are a total of 2,368 such strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2.

10.3.2. AC Configuration

As per the SLD for UMD 12 MW project, there are 12 nos. of inverters which are connected to the 6 nos. of three winding IDT of 2.2 MVA, 0.4/0.4/33 kV rating. There total four no of 33 kV outdoor switchgear panels are at site. 2 of 4 have 2-in-1 out combination and other 2 have 1-in-1 out combination. In 2-in-1 out combination there are two incoming IDT feeders and one outgoing feeder. Similarly, In 1-in-1 out combination there is one incoming IDT feeders and one outgoing feeder. All 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of both 1-in-1 out and 2-in-1 out 33 kV outdoor switchgear panel further connected to main 33 kV HT panel at MCR building. The main HT panel have four no of incoming cable feeder from PV plant side and one outgoing cable feeder. The 33 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

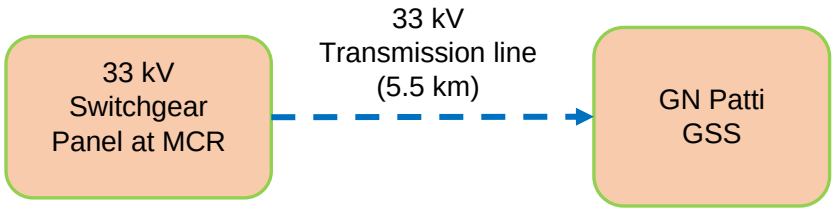
As per the SLD of UMD 13MW project, there are 13 nos. of inverters which are connected to the 6 nos. of three winding IDT of 2.2 MVA, 0.4/0.4/33 kV and 1 no of two winding IDT of 1.1 MVA, 0.4/ 33 kV rating. There total three no of 33 kV outdoor switchgear panels are at site. The 33 kV switchgear panel have 2-in-1 out combination. In 2-in-1 out combination there are two incoming IDT feeders and one outgoing feeder. All 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of both 2-in-1 out 33 kV outdoor switchgear panel further connected to main 33 kV HT panel at MCR building. The main HT panel have four no of incoming cable feeder from PV plant side and one outgoing cable feeder. The 33 kV switchgear panel are equipped with all necessary protection devices which includes

instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

10.4. Power evacuation

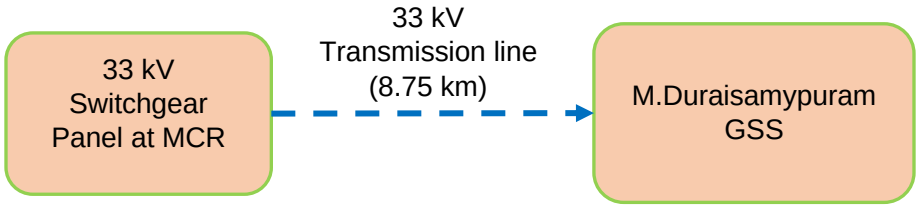
The combined generated 12 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to GN Patti Grid Substation via 33 kV transmission line. The transmission line length is 5.5 km.

Figure 45: Power Evacuation Schematic



Similarly, the combined generated 13 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to M.Duraisamypuram Grid Substation via 33 kV transmission line. The transmission line length is 8.75 km.

Figure 46: Power Evacuation Schematic



11. TN Solar Thuthookudi

11.1. About Project

The Project is located at Chithavanaickenpatti village, Villathikulam Taluka, Tuticorin, District Tamilnadu of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and has been operational since 31st October 2015. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 50 km away from Tuticorin district headquarters. The nearest railway station is at Tiruvannamalai railway which is around 45 km away from the site. The nearest airport to the project site is at Tuticorin Airport which is 60 km away. The Project site is well connected.

Figure 47: TN Solar Thuthookudi

Figure 48: TN Solar Thuthookudi – Satellite image of project layout

11.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 51.

Table 51: Summary of key components

Component	Make and Model	Quantity
Module	JA solar JAP6-72-310-3BB	23,184
	JA solar JAP6-72-315-3BB	15,288
Inverter	ABB PVS800-57-1000kW	10
IDT	Voltamp 2.2 MVA	5

11.2.1. PV modules

Table 52 presents the main technical characteristics of the installed PV modules.

Table 52: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar
Technology		Polycrystalline	
Peak power (Pmax)	W	310	315
Voltage at Pmax (Vmpp)	V	37.00	37.28
Current at Pmax (Impp)	A	8.38	8.45
Open Circuit Voltage (Voc)	V	45.45	45.60
Short Circuit Current (Isc)	A	8.85	8.91
Maximum system voltage	V	1000	1000
Temp coefficient of Pmax	%/°C	-0.41	-0.41
Module efficiency	%	15.99	16.25
Degradation	%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001

11.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

11.2.2. Inverter

Table 53 presents the main technical characteristics of the selected model.

Table 53: Technical characteristics of Inverter

Parameter	Unit	Description
Model	-	PVS800-57-1000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1,100
Max. DC current	A	1,710
MPPT operating voltage range	V	-
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1000
Max. AC output current	A	1445
Nominal AC voltage	V	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

11.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models listed in Table 54.

Table 54: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years

11.2.3. Inverter Duty Transformer

Table 55 presents the key technical characteristics of the selected Voltamp transformer.

Table 55: Technical characteristics of IDT

Parameter	Unit	Description
Rating	kVA	2200
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.4/0.4/33kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dy11y11
Impedance at principal tap	%	6

11.3. Project Design

11.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 12 MWp which is connected to 10 inverters of 10 MW cumulative capacity. 21 modules form a string and there are a total of 1,832 such strings.

The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2.

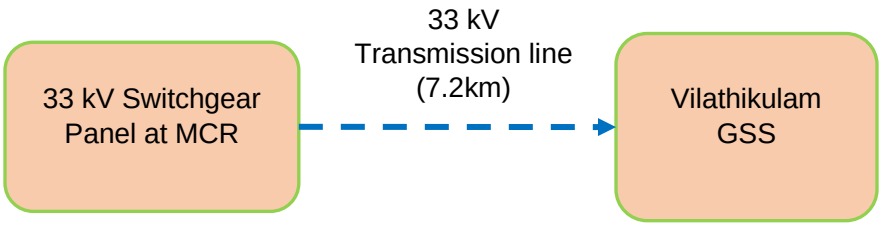
11.3.2. AC Configuration

As per the submitted SLD for there are 5 nos. of inverters which are connected to the 10 nos. of three winding IDT of 2.2 MVA, 0.4/0.4/33 kV rating. The output of IDT further connected to two nos. of 2-in-1 out 33 kV switchgear panel. All 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of 2-in-1 out switchgear panel further connected to main 33 kV HT panel at MCR building. The MCR 33 kV HT panel has 2 no. of incoming cable feeders from 33 kV switchgear panels, one from IDT and one outgoing cable feeders. The 33 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

11.4. Power evacuation

The combined generated 10 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to Vilathikulam Grid Substation via 33 kV transmission line. The transmission line length is 7.2 km.

Figure 49: Power Evacuation Schematic



12. TN Solar Virudhunagar

12.1. About Project

The Project is located at Aruppukkottai village, Virudhunagar, District Tamilnadu of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and has been operational since 31st October 2015. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 35 km away from Virudhunagar district headquarters. The nearest railway station is at Virudhunagar railway which is around 32 km away from the site. The nearest airport to the project site is at Madurai Airport which is 60 km away. The Project site is well connected.

Figure 50: TN Solar Virudhunagar

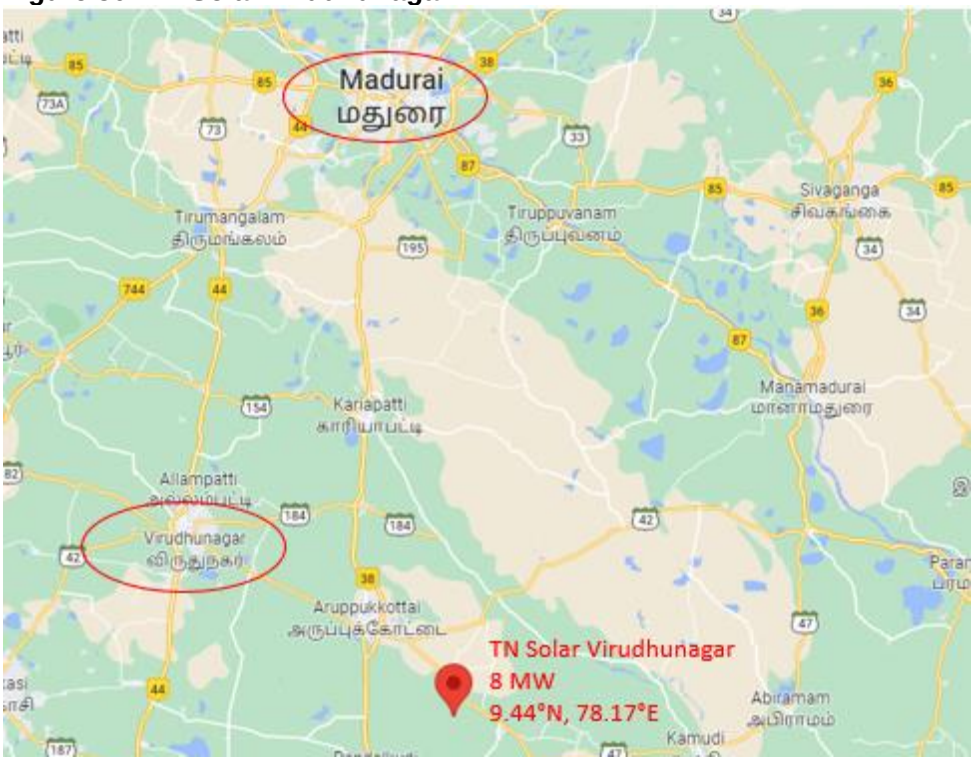


Figure 51: TN Solar Virudhunagar – Satellite image of project layout

12.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 56.

Table 56: Summary of key components

Component	Make and Model	Quantity
Module	JA solar JAP6-72-310-3BB	23,184
	JA solar JAP6-72-315-3BB	15,288
Inverter	ABB PVS800-57-1000kW	8
IDT	Voltamp 2.2 MVA	4

12.2.1. PV modules

Table 57 presents the main technical characteristics of the installed PV modules.

Table 57: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar
Technology		Polycrystalline	Polycrystalline
Peak power (Pmax)	W	310	315
Voltage at Pmax (Vmpp)	V	37.00	37.28
Current at Pmax (Impp)	A	8.38	8.45
Open Circuit Voltage (Voc)	V	45.45	45.60
Short Circuit Current (Isc)	A	8.85	8.91
Maximum system voltage	V	1000	1000
Temp coefficient of Pmax	%/°C	-0.41	-0.41
Module efficiency	%	15.99	16.25
Degradation	%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001

12.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

12.2.2. Inverter

Table 58 presents the main technical characteristics of the selected model.

Table 58: Technical characteristics of Inverter

Parameter	Unit	ABB
Model	-	PVS800-57-1000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1,100
Max. DC current	A	1,710
MPPT operating voltage range	V	-
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1000
Max. AC output current	A	1445
Nominal AC voltage	V	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

12.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models listed in Table 43.

Table 59: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years

12.2.3. Inverter Duty Transformer

Table 60 presents the key technical characteristics of the selected Voltamp transformer.

Table 60: Technical characteristics of IDT

Parameter	Unit	Voltamp
Rating	kVA	2200
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.4/0.4/33 kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dy11y11
Impedance at principal tap	%	6

12.3. Project Design

12.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 9.6 MWp which is connected to 8 inverters of 8 MW cumulative capacity. 21 modules form a string and there are a total of 1,464 such strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2.

12.3.2. AC Configuration

As per the submitted SLD for there are 8 nos. of inverters which are connected to the 4 nos. of three winding IDT of 2.2 MVA, 0.4/0.4/33 kV rating. The output of one IDT is directly connected to 33 kV main switchgear panel at MCR Building. However, the output of the remaining three IDTs further connected to the 2-in-1 out 33 kV switchgear panel and 1-in-1 out 33 kV switchgear panel. There are such two nos. of 33 kV outdoor switchgear panels one is 2-in-1 out 33 kV switchgear panel and another one is 1-in-1 out 33 kV switchgear panel. The 1-in-1 out switchgear panel has one incoming feeder from IDT and one outgoing feeder to 33kV main HT panel. Similarly, the 2-in-1 out switchgear panel have two incoming feeder from IDT and one outgoing feeder to 33kV main HT panel.

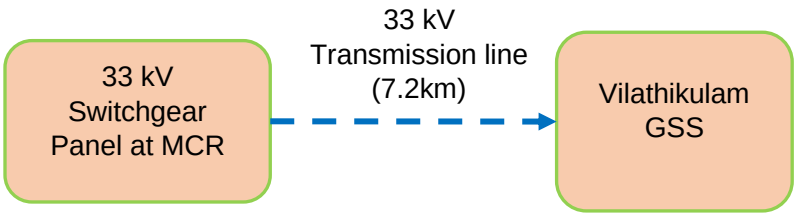
All 33 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices.

The 33 kV main HT panel has two nos. of incoming cable feeders from 33 kV switchgear panels, one incoming feeder from IDT and one outgoing cable feeder. The 33 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

12.4. Power evacuation

The combined generated 8 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to Vilathikulam Grid Substation via 33 kV transmission line. The transmission line length is 7.2 km.

Figure 52: Power Evacuation Schematic



13. TN Solar Dindigul

13.1. About Project

The Project is located at Vedasandur Village, Dindigul, District Tamilnadu of India. The Project was constructed by EPC Contractor; M/s. M/s. Sterling & Wilson Pvt. Ltd, and has been operational since 28th December 2015. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 27 km away from Dindigul district headquarters. The nearest railway station is at Dindigul railway which is around 26 km away from the site. The nearest airport to the project site is at Madurai Airport which is 120 km away. The Project site is well connected.

Figure 53: TN Solar Dindigul

Figure 54: TN Solar Dindigul– Satellite image of project layout

13.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 61

Table 61: Summary of key components

Component	Make and Model	Quantity
Module	JA solar JAP6-72-310-3BB	23,184
	JA solar JAP6-72-315-3BB	15,288
Inverter	ABB PVS800-57-1000kW	10
IDT	Voltamp 2.2 MVA	2
	Voltamp 1.1 MVA	1

13.2.1. PV modules

Table 62 presents the main technical characteristics of the installed PV modules.

Table 62: Technical characteristics of PV modules

Parameter	UoM	JA Solar	JA Solar
Technology		Polycrystalline	
Peak power (Pmax)	W	310	315
Voltage at Pmax (Vmpp)	V	37.00	37.28
Current at Pmax (Impp)	A	8.38	8.45

Parameter	UoM	JA Solar	JA Solar
Open Circuit Voltage (Voc)	V	45.45	45.60
Short Circuit Current (Isc)	A	8.85	8.91
Maximum system voltage	V	1000	1000
Temp coefficient of Pmax	%/°C	-0.41	-0.41
Module efficiency	%	15.99	16.25
Degradation	%	0.7%	0.7%
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001

13.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees power output at the end of 25th year.

13.2.2. Inverter

Table 63 presents the main technical characteristics of the selected model.

Table 63: Technical characteristics of Inverter

Parameter	Unit	ABB
Model	-	PVS800-57-1000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1,100
Max. DC current	A	1,710
MPPT operating voltage range	V	-
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1000
Max. AC output current	A	1445
Nominal AC voltage	V	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

13.2.2.1. Warranty

The inverters are with standard product warranty of 5 years for the models listed in Table 64.

Table 64: Inverter Warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years

13.2.3. Inverter Duty Transformer

Table 65 presents the key technical characteristics of the selected Voltamp transformer.

Table 65: Technical characteristics of IDT

Parameter	Unit	Voltamp	Voltamp
Rating	kVA	2200	1100
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.4/0.4/11 kV	0.4/11 kV
Windings	No.	3 (1 HV, 2 LV)	2 (1 HV, 1 LV)
Vector Group		Dy11y11	Dy11
Impedance at principal tap	%	6	6

13.3. Project Design

13.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 6 MWp which is connected to 5 inverters of 5 MW cumulative capacity. 21 modules form a string and there are a total of 916 such strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2.

13.3.2. AC Configuration

As per the submitted SLD for there are 5 nos. of inverters which are connected to the two nos. of three winding IDT of 2.2 MVA, 0.4/0.4/11 kV rating and one no of two winding IDT of 1.1 MVA, 0.4/11 kV rating. The output of one IDT is directly connected to 11 kV main switchgear panel at MCR Building. However, the output of the remaining two IDTs further connected to the 2-in-1 out 11 kV switchgear panel. The 2-in-1 out switchgear panel have two incoming feeder from IDT and one outgoing feeder to 11 kV main HT panel. The 11 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices.

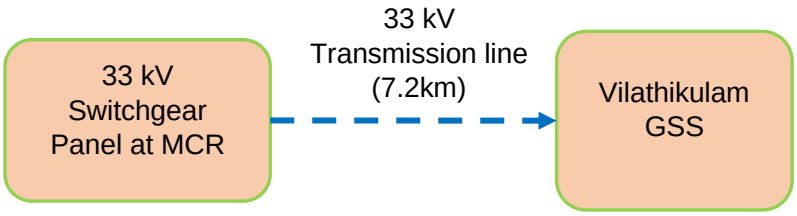
The 11 kV main HT panel has one incoming cable feeders from 11 kV switchgear panels, one incoming feeder from IDT and one outgoing cable feeder. The 11 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip

circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

13.4. Power evacuation

The combined generated 5 MW power at 11 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to Vilathikulam Grid Substation via 11 kV transmission line. The transmission line length is 7.2 km.

Figure 55: Power Evacuation Schematic



14. USUPL Bap

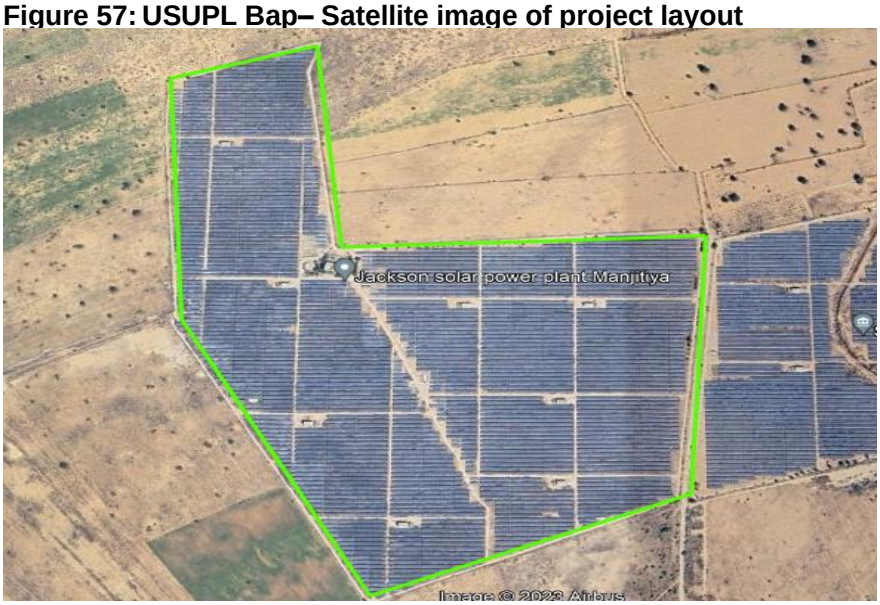
14.1. About Project

The Project is located at Manchitiya Village, Bap Tehsil, District Jodhpur, Rajasthan state of India. The Project was constructed by EPC Contractor; M/s. Jackson and has been operational since 26th March 2013. Currently the O&M contractor is Mahindra Teqo.

The Project is situated 15 km away from Bap district headquarters. The nearest railway station is at Jodhpur railway which is around 180 km away from the site. The nearest airport to the project site is at Jodhpur Airport which is 185 km away. The Project site is well connected.

Figure 56: USUPL Bap

Figure 57: USUPL Bap– Satellite image of project layout



14.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 66.

Table 66: Summary of key components

Component	Make and Model	Quantity
Module	Jinko Solar JKM545M-72HL4-V	29,355
	Trina Solar Trina 295	1,500
	JA solar JAP6-72-300/3BB	9,520
	Vikram solar Eldora 60.255.03.04	25,800
Inverter	Schneider Electric Conext Core XC-680	46
IDT	Raychem 1.6 MVA, 0.38/0.38/33kV	14
	Raychem 0.8 MVA 0.38/11 kV	2

14.2.1. PV modules

Table 67 presents the main technical characteristics of the installed PV modules.

Table 67: Technical characteristics of PV modules

Parameter	UoM	Jinko Solar	JA Solar	Vikram solar	Trina
Technology		Mono-PERC	Polycrystalline	Polycrystalline	Polycrystalline
Peak power (Pmax)	W	545	300	255	295
Voltage at Pmax (Vmpp)	V	40.80	36.41	30.8	32.2
Current at Pmax (Impp)	A	13.36	8.24	8.29	9.01
Open Circuit Voltage (Voc)	V	49.42	45.20	37.7	39.5
Short Circuit Current (Isc)	A	13.94	8.73	8.82	9.5
Maximum system voltage	V	1000/1500	1000	1000	1000
Temp coefficient of Pmax	%/°C	-0.35	-0.41	-0.41	-0.39
Module efficiency	%	21.13	15.48	15.7	17.7
Degradation	%	0.5	0.7	0.7	0.7
Certification	-	IEC 61215, IEC 61730, ISO 9001, ISO 14001, ISO 45001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, IEC 62716, IEC 62804, CE Certified	IEC 61215, IEC 61730, IEC 62716, CE Certified, TUV Certified

14.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

14.2.2. Inverter

Table 68 presents the main technical characteristics of the selected model.

Table 68: Technical characteristics Inverter

Parameter	Unit	Schneider Electric
Model	-	Conext Core XC-680
Max. efficiency	%	98.9
Max. DC input voltage	V	1000
Max. DC current	A	1280
MPPT operating voltage range	V	550 to 800
Number of MPP independent inputs	no.	-
Max. AC output power	kW	680
Nominal AC voltage	V	380
Certification (IEC/IEEE/EN)	-	IEC 61000, IEC62103, IEC 61727, IEC62116, IEC 62109.

14.2.2.1. Warranty

Table 69 presents the Inverter product warranty:

Table 69: Inverter Warranty

Make	Warranty
Schneider Electric Conext Core XC-680	5 years

14.2.3. Inverter Duty Transformer

Table 70 presents the key technical characteristics of the selected Raychem transformer.

Table 70: Technical characteristics of IDT

Parameter	Unit	Raychem	Raychem
Rating	kVA	2000	4000
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.38/0.38/11kV	0.38/0.38/0.38/0.38/11kV
Windings	No.	3 (1 HV, 2 LV)	5 (1 HV, 4 LV)
Vector Group		Dy11y11	
Impedance at principal tap	%	6.25	

14.3. Project Design

14.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 25.88 MWp which is connected to 46 inverters of 20.4 MW cumulative capacity. 19 and 20 modules form a string and there are a total of 1,545 and 1,841 strings respectively. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2.

14.3.2. AC Configuration

As per the submitted SLD for there are 46 nos. of inverters which are connected to the 22 nos. of three winding IDT of 1.6 MVA, 0.38/0.8/33 kV rating and one no of two winding IDT of 0.8 MVA, 0.38/33 kV rating. The output of every two IDT is connected to 33 kV RMU panel. There are such 12 RMU panels at site. All RMU panels are equipped with all necessary protection system which includes both transformer electrical and mechanical protections. All RMU panel interconnected with each other. The combined power further evacuated to main 33 kV switchgear panel at site via 2 no's of cable feeders. The 33 kV main HT panel has two incoming cable feeders from RMU panels and one outgoing cable feeder. The 33 kV switchgear panel are equipped with all necessary protection devices.

14.4. Power evacuation

The combined generated 20 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to 132 kV Bap Grid Substation via 33 kV transmission line. The transmission line length is 8 km.

Figure 58: Power Evacuation Schematic

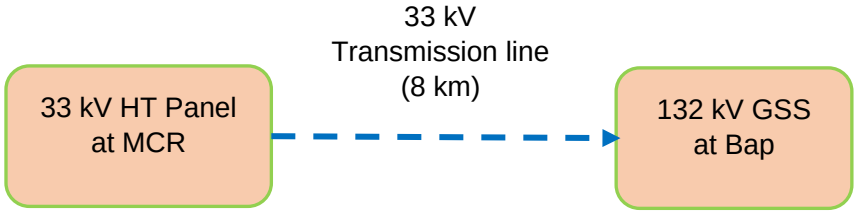


Figure 59: Plant entry gate

Figure 60: MCR Building

15. USUPL Mohoba

15.1. About Project

The Project is located at Kankua Village, Mahoba district, Uttar Pradesh state of India. The Project was constructed by EPC Contractor; M/s. Sukhbir Agro and has been operational since 25th September 2013. Currently the O&M contractor is Meera.

The Project is situated 65 km away from Mahoba district headquarters. The nearest railway station is at Naugao railway which is around 25 km away from the site. The nearest airport to the project site is at Gwalior Airport which is 215 km away. The Project site is well connected.

Figure 61: USUPL Mahoba

Figure 62: USUPL Mahoba – Satellite image of project layout

15.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 71

Table 71: Summary of key components

Component	Make and Model	Quantity
Module	Canadian solar CS6U-320P	115,560
Inverter	ABB PVS800-57-1000kW	30
Tracker		
IDT	Raychem 4 MVA 0.38/0.38/0.38/0.38/11 kV	7
	Raychem 2 MVA 0.38/0.38/11 kV	1

15.2.1. PV modules

Table 72 presents the main technical characteristics of the installed PV modules.

Table 72: Technical characteristics of PV module

Parameter	UoM	Canadian solar
Technology		Polycrystalline
Peak power (Pmax)	W	320
Voltage at Pmax (Vmpp)	V	36.8
Current at Pmax (Impp)	A	8.69

Parameter	UoM	Canadian solar
Open Circuit Voltage (Voc)	V	45.3
Short Circuit Current (Isc)	A	9.26
Maximum system voltage	V	1000
Temp coefficient of Pmax	%/°C	-0.41
Module efficiency	%	16.46
Degradation	%	0.7%
Certification	-	IEC 61215, IEC 61730, IEC 61701, IEC 62716 CE Certified

15.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

15.2.2. Inverter

Table 73 presents the main technical characteristics of the selected model.

Table 73: Technical characteristics of Inverter

Parameter	Unit	ABB
Model	-	PVS800-57-1000kW
Max. efficiency	%	98.8
Max. DC input voltage	V	1,100
Max. DC current	A	1,710
MPPT operating voltage range	V	-
Number of MPP independent inputs	no.	1
Max. AC output power	kW	1000
Max. AC output current	A	1445
Nominal AC voltage	V	405
Certification (IEC/IEEE/EN)	-	IEC 62116, IEC 61727, IEC 61683, IEC 60068, IEC 62109.

15.2.2.1. Warranty

Table 74 presents the Inverter product warranty:

Table 74: Inverter warranty

Make	Warranty
ABB PVS800-57-1000kW	5 years

15.2.3. Inverter Duty Transformer

Table 75 presents the key technical characteristics of the selected Raychem transformer.

Table 75: Technical characteristics of IDT

Parameter	Unit	Raychem	Raychem
Rating	kVA	2000	4000
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	3
Frequency	Hz	50	50
Voltage	kV	0.38/0.38/11kV	0.38/0.38/0.38/0.38/11kV
Windings	No.	3 (1 HV, 2 LV)	5 (1 HV, 4 LV)
Vector Group		Dy11y11	
Impedance at principal tap	%	6.25	

15.3. Project Design

15.3.1. DC Configuration

The design configuration for the fixed tilt project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 31.9 MWp which is connected to 26 inverters of 26 MW cumulative capacity. 20 modules form a string and there are a total of 4,992 strings. The fixed tilt Module Mounting Structure at 19˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.23.

Similarly, the design configuration for the tracker system project has been considered. The installed DC capacity of the project is 5 MWp which is connected to 4 inverters of 4 MW capacity. 20 modules form a string and there are a total of 786 strings. The DC to AC ratio for inverters are 1.26. Figure 63 and Figure 64 show the actual photographs of PV array area and ICR.

Figure 63: Solar PV array

Figure 64: ICR

15.3.2. AC Configuration

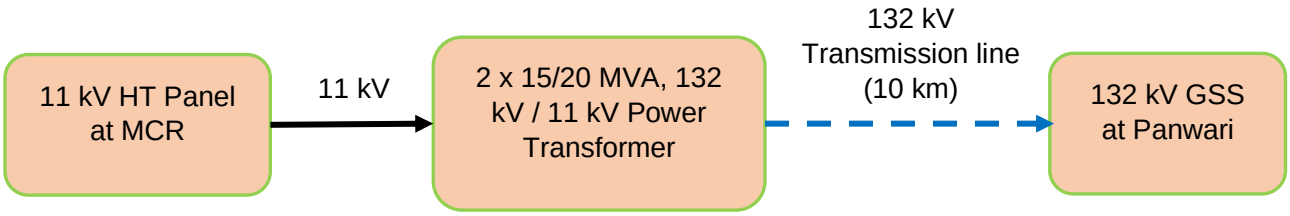
As per the submitted SLD for there are 30 nos. of inverters which are connected to the seven nos. of five winding IDT of 4 MVA, 0.38/0.38/0.38/0.38/11 kV rating and one no of two winding IDT of 2 MVA, 0.38/0.38/11 kV rating. The output of each IDT is further connected to 11 kV outdoor VCB panel. The 1-in-1 out VCB panel have one incoming feeder from IDT and one outgoing feeder to 11 kV main HT panel. The 11 kV switchgear panels are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. along with transformer electrical and mechanical protection devices. The output of each 11 kV outdoor VCB panel further connected to the 11 kV main HT panel.

The 11 kV main HT panel has eight incoming cable feeders from 11 kV VCB panels, one spare feeder and two outgoing cable feeder. The 11 kV switchgear panel are equipped with all necessary protection devices which includes instantaneous and inverse time phase and earth fault over-current protection functions along with the master trip relay to ensure breaker tripping and trip circuit supervision relay for identification of anomaly in the trip circuit. Relevant indications like On, Off, Trip, Test position, Service position etc. has been furnished by the Client.

15.4. Power evacuation

The combined generated 30 MW power at 11 kV further step up to 132 kV via 2 nos. of 15/20 MVA, 132/11 kV power transformer at plant end. The elevated power from 11 kV to 132 kV evacuated to 132 kV Panwari Grid Substation via 132 kV transmission line. The transmission line length is around 10 km.

Figure 65: Power Evacuation Schematic



16. TL Kanji

16.1. About Project

The Project is located at Mahroni khurd Village, District Lalitpur, Uttarpradesh state of India. The Project was constructed by EPC Contractor; M/s. Jackson and has been operational since 19th March 2015. Currently the O&M contractor is AVI Solar Energy.

The Project is situated 15 km away from Lalitpur district headquarters. The nearest railway station is at Lalitpur railway which is around 20 km away from the site. The nearest airport to the project site is at Gwaliar Airport which is 200 km away. The Project site is well connected.

Figure 66: TL Kanji

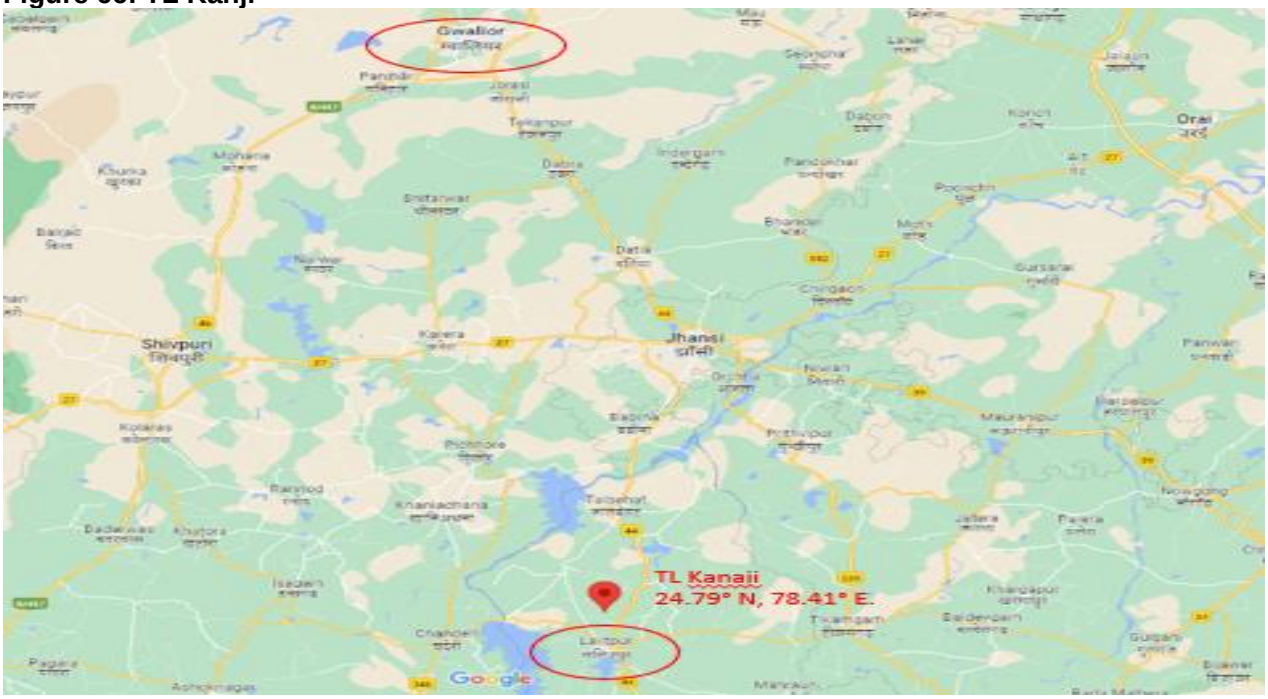


Figure 67: TL Kanji– Satellite image of project layout

16.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 76.

Table 76: Summary of key components

Component	Make and Model	Quantity
Module	Waaree WS-315_4BB	36,500
	Trina TSM 295	1,360
	JA solar JAP6-72-300/3BB	1,720
Inverter	Schneider Electric Conext Core XC-680	17
IDT	Raychem 1.4 MVA, 0.38/0.38/33kV	7
	Raychem 0.75 MVA 0.38/11 kV	1

16.2.1. PV modules

Table 77 presents the main technical characteristics of the installed PV modules.

Table 77: Technical characteristics of PV modules

Parameter	UoM	JA Solar	Waaree	Trina
Technology		Polycrystalline	Polycrystalline	Polycrystalline
Peak power (Pmax)	W	300	315	295
Voltage at Pmax (Vmpp)	V	36.41	32.9	32.2
Current at Pmax (Impp)	A	8.24	9.58	9.01
Open Circuit Voltage (Voc)	V	45.20	40.38	39.5
Short Circuit Current (Isc)	A	8.73	9.9	9.5
Maximum system voltage	V	1000	1000	1000
Temp coefficient of Pmax	%/ºC	-0.41	-0.37	-0.39
Module efficiency	%	15.48	18.92	17.7
Degradation	%	0.7	0.7	0.7
Certification	-	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001	IEC 61215, IEC 61730, IEC 62804, ISO 9001, ISO 14001	IEC 61215, IEC 61730, IEC 62716, CE Certified, TUV Certified

16.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

16.2.2. Inverter

Table 78 presents the main technical characteristics of the selected model.

Table 78: Technical characteristics of Inverter

Parameter	Unit	Schneider Electric
Model	-	Conext Core XC-680
Max. efficiency	%	98.9
Max. DC input voltage	V	1000
Max. DC current	A	1280
MPPT operating voltage range	V	550 to 800
Number of MPP independent inputs	no.	-
Max. AC output power	kW	680
Nominal AC voltage	V	380
Certification (IEC/IEEE/EN)	-	IEC 61000, IEC62103, IEC 61727, IEC62116, IEC 62109.

16.2.2.1. Warranty

Table 79 presents the Inverter product warranty:

Table 79: Inverter warranty

Make	Warranty
Schneider Electric Conext Core XC-680	5 years

16.2.3. Inverter Duty Transformer

Table 80 presents the key technical characteristics of the selected Raychem transformer.

Table 80: Technical characteristics of IDT

Parameter	Unit	Raychem	Raychem
Rating	kVA	1400	750
Type		ONAN, Oil Immersed, Outdoor	ONAN, Oil Immersed, Outdoor
Phases	No.	3	2
Frequency	Hz	50	50
Voltage	kV	0.38/0.38/11kV	0.38/11kV
Windings	No.	3 (1 HV, 2 LV)	2 (1 HV, 1 LV)
Vector Group		Dyn11yn11	Dyn11
Impedance at principal tap	%		

16.3. Project Design

16.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 12.4 MWp which is connected to 17 inverters of 10 MW cumulative capacity. 20 modules form a string and there are a total of 1,979 strings. The fixed tilt Module Mounting Structure at 8˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.2. Figure 68 show the actual photographs of PV array area.

Figure 68: Solar PV array

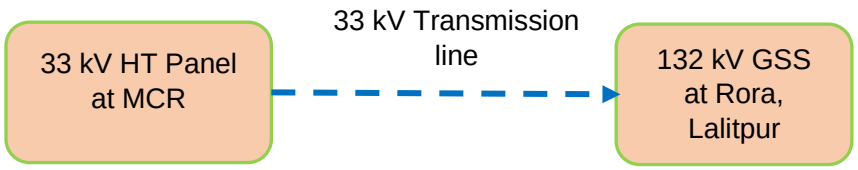
16.3.2. AC Configuration

As per the information provided by the Client, there are 16 nos. of inverters of 680 kW each connected to the inverter duty transformer (IDT) of suitable rating which step up the voltage to 33 kV. The output of every two IDT is connected to 33 kV RMU panel. All RMU panels are equipped with all necessary protection system which includes both transformer electrical and mechanical protections. All RMU panel interconnected with each other. The combined power further evacuated to main 33 kV switchgear panel at site via 2 no's of cable feeders. The 33 kV main HT panel has two incoming cable feeders from RMU panels and one outgoing cable feeder. The 33 kV switchgear panel are equipped with all necessary protection devices.

16.4. Power evacuation

The combined generated 10 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to 132 kV Rora, Lalitpur Grid Substation via 33 kV transmission line. The transmission line length is 8 km.

Figure 69: Power Evacuation Schematic



17. TL Nangla

17.1. About Project

The Project is located at Nangla Village, District Bhatinda, Punjab state of India. The Project was constructed by EPC Contractor; M/s. Belectric and has been operational since 24th March 2015. Currently the O&M contractor is Mitarsh Energy.

The Project is situated 50 km away from Bhatinda district headquarters. The nearest railway station is at Bhatinda railway which is around 50 km away from the site. The nearest airport to the project site is at Chandigarh Airport which is 215 km away. The Project site is well connected.

Figure 70: TL Nangla

Figure 71: TL Nangla– Satellite image of project layout

17.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 81.

Table 81: Summary of key components

Component	Make and Model	Quantity
Module	First Solar FS-395	44205
Inverter	SMA Sunny Central 900CP XT	4
IDT	Raychem 2 MVA, 0.405/0.405/11 kV	2

17.2.1. PV modules

Table 82 presents the main technical characteristics of the installed PV modules.

Table 82: Technical characteristics of PV module

Parameter	UoM	First Solar
Technology		Thinfilm
Peak power (Pmax)	W	95
Voltage at Pmax (Vmpp)	V	45.8
Current at Pmax (Impp)	A	2.08

Parameter	UoM	First Solar
Open Circuit Voltage (Voc)	V	58.0
Short Circuit Current (Isc)	A	2.29
Maximum system voltage	V	1000
Temp coefficient of Pmax	%/°C	-0.29
Degradation	%	0.7%
Certification	-	IEC 61646, IEC61730, TUV certified, CE Certified, ISO 9001

17.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

17.2.2. Inverter

Table 83 presents the main technical characteristics of the selected model.

Table 83: Technical characteristics of Inverter

Parameter	Unit	SMA
Model	-	Sunny Central 900CP XT
Max. efficiency	%	98.6
Max. DC input voltage	V	1,000
Max. DC current	A	1,400
MPPT operating voltage range	V	656 to 850
Number of MPP independent inputs	no.	1
Max. AC output power	kW	900
Max. DC current	A	1411
MPPT operating voltage range	V	405
Certification (IEC/IEEE/EN)	-	EN 61000, EMC- Conformity, CE Certified, IEEE 1547

17.2.2.1. Warranty

Table 84 presents the Inverter product warranty:

Table 84: Inverter warranty

Make	Warranty
SMA Sunny Central 900CP XT	5 years

17.2.3. Inverter Duty Transformer

Table 85 presents the key technical characteristics of the selected Raychem transformer.

Table 85: Technical characteristics of IDT

Parameter	Unit	Raychem
Rating	kVA	2000
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.405/0.405/11 kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dy11y11
Impedance at principal tap	%	5.95

17.3. Project Design

17.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 4.2 MWp which is connected to 2 inverters of 4 MW cumulative capacity. 15 modules form a string and there are a total of 2,979 strings. The fixed tilt Module Mounting Structure at 15˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.05. Figure 72 show the actual photographs of PV array area.

Figure 72: Solar PV array

17.3.2. AC Configuration

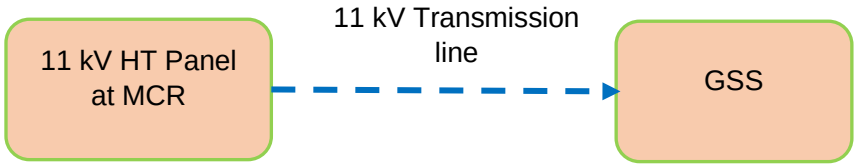
As per the submitted SLD for there are 4 nos. of inverters which are connected to the 2 nos. of three winding IDT of 2 MVA, 0.405/0.405/11 kV rating. The output of every two IDT is connected to 33 kV RMU panel. All RMU panels are equipped with all necessary protection system which includes both transformer electrical and mechanical protections. All RMU panel interconnected with each other. The

combined power further evacuated to main 11 kV switchgear panel at site. The 11 kV main HT panel has two incoming cable feeders from RMU panels and one outgoing cable feeder. The 11 kV switchgear panel are equipped with all necessary protection devices.

17.4. Power evacuation

The combined generated 10 MW power at 11 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to Grid Substation via 11 kV transmission line.

Figure 73: Power Evacuation Schematic



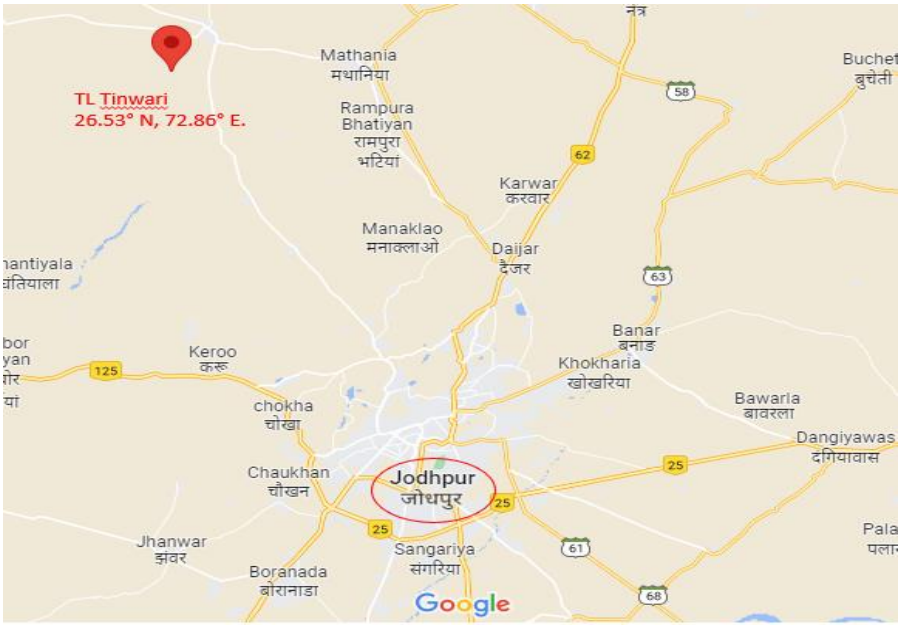
18. TL Tinwari

18.1. About Project

The Project is located at Tinwari Village, District Jodhpur, Rajasthan state of India. The Project was constructed by EPC Contractor; M/s. Juwi and has been operational since 15th October 2011. Currently the O&M contractor is Meera.

The Project is situated 50 km away from Jodhpur district headquarters. The nearest railway station is at Jodhpur railway which is around 45 km away from the site. The nearest airport to the project site is at Jodhpur Airport which is 48 km away. The Project site is well connected.

Figure 74: TL Tinwari



18.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 86.

Table 86: Summary of key components

Component	Make and Model	Quantity
Module	First Solar FS-380	64,800
	First Solar FS-4115A	5,709
Inverter	SMA Sunny Central 630CP XT	8
IDT	Raychem 1.25 MVA, 0.315/0.315/33 kV	4

18.2.1. PV modules

Table 87 presents the main technical characteristics of the installed PV modules.

Table 87: Technical characteristics of PV modules

Parameter	UoM	First Solar	First Solar
Technology		Thinfilm	Thinfilm
Peak power (Pmax)	W	80	115
Voltage at Pmax (Vmpp)	V	48.5	69.3
Current at Pmax (Impp)	A	1.65	1.66
Open Circuit Voltage (Voc)	V	60.8	87.6
Short Circuit Current (Isc)	A	1.88	1.83

Parameter	UoM	First Solar	First Solar
Maximum system voltage	V	1000	1000
Temp coefficient of Pmax	%/°C	-0.29	-0.28
Degradation	%	0.7%	0.7%
Certification	-	IEC 61646, IEC61730, TUV certified, CE Certified, ISO 9001	IEC 61646, IEC61730, TUV certified, CE Certified, ISO 9001

18.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

18.2.2. Inverter

Table 88 presents the main technical characteristics of the selected model.

Table 88: Technical characteristics of Inverter

Parameter	Unit	SMA
Model	-	Sunny Central 630CP XT
Max. efficiency	%	98.6
Max. DC input voltage	V	1,000
Max. DC current	A	1,350
MPPT operating voltage range	V	500 to 850
Number of MPP independent inputs	no.	1
Max. AC output power	kW	630
Max. AC current	A	1,350
MPPT operating voltage range	V	315
Certification (IEC/IEEE/EN)	-	EN 61000, EMC- Conformity, CE Certified, IEEE 1547

18.2.2.1. Warranty

Table 89 presents the Inverter product warranty:

Table 89: Inverter warranty

Make	Warranty
SMA Sunny Central 630CP XT	5 years

18.2.3. Inverter Duty Transformer

Table 90 presents the key technical characteristics of the selected Raychem transformer.

Table 90: Technical characteristics of IDT

Parameter	Unit	Raychem
Rating	kVA	1250
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.315/0.315/33 kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		Dyn11yn11
Impedance at principal tap	%	5

18.3. Project Design

18.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 5.84 MWp which is connected to 8 inverters of 5 MW cumulative capacity. 15 and 11 modules form a string and there are a total of 4,320 and 519 strings. The fixed tilt Module Mounting Structure at 20˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.17. Figure 75 show the actual photographs of PV array area.

Figure 75: Solar PV array

18.3.2. AC Configuration

As per the submitted SLD for there are 8 nos. of inverters which are connected to the 4 nos. of three winding IDT of 1.25 MVA, 0.315/0.315/33 kV rating. The output of the two IDT is connected to 2-in-1-out 33 kV outdoor switchgear panel. The 2-in-1-out 33 kV outdoor switchgear panel have two incoming feeders from IDT and one outgoing to 3-in-1-out 33 kV switchgear panel. The 3-in-1-out 33 kV switchgear panel have two incoming feeders from IDT, one incoming from 2-in-1-out 33 kV switchgear

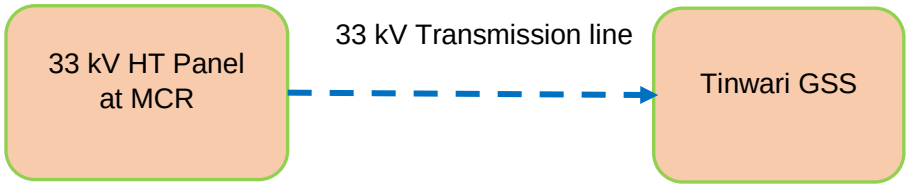
panel and one outgoing to 33 kV main switchgear panel ay MCR. All 33 kV switchgear panel are equipped with all necessary protection devices.

At MCR the 33 kV switchgear panel have one incoming feeder from PV plant side, one auxiliary transformer feeder and one outgoing feeder cable. The 33 kV switchgear panel are equipped with all necessary protection devices.

18.4. Power evacuation

The combined generated 5 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of double pole structure. The combined power further evacuated to Tinwari Grid Substation via 33 kV transmission line.

Figure 76: Power Evacuation Schematic



19. TL Gadna

19.1. About Project

The Project is located at Bap Village, District Jodhpur, Rajasthan state of India. The Project was constructed by EPC Contractor; M/s. Sun Bome services and has been operational since 20th March 2013. Currently the O&M contractor is Mitarsh Energy.

The Project is situated 176 km away from Jodhpur district headquarters. The nearest railway station is at Jodhpur railway which is around 170 km away from the site. The nearest airport to the project site is at Jodhpur Airport which is 180 km away. The Project site is well connected.

Figure 77: TL Gadna

19.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 91.

Table 91: Summary of key components

Component	Make and Model	Quantity
Module	Nex Power NT-150 AF	64,800
	Nex Power NT-155 AF	
	JA Solar JAP6-72-330/3BB	5,709
Inverter	Schneider Electric Conext Core XC-680	7
	Sungrow SG-110-CX	2
IDT	Raychem 1.4 MVA, 0.380/0.380/33 kV	4

19.2.1. PV modules

Table 92 presents the main technical characteristics of the installed PV modules.

Table 92: Technical characteristics of PV modules

Parameter	UoM	Nex Power	Nex Power	JA Solar
Technology		Thinfilm	Thinfilm	Polycrystalline
Peak power (Pmax)	W	150	155	330
Voltage at Pmax (Vmpp)	V	64.7	65.2	37.65
Current at Pmax (Impp)	A	2.32	2.38	9.28
Open Circuit Voltage (Voc)	V	85.5	85.5	46.40

Parameter	UoM	Nex Power	Nex Power	JA Solar
Short Circuit Current (Isc)	A	2.56	2.54	8.77
Maximum system voltage	V	1000	1000	1500
Temp coefficient of Pmax	%/ºC	-0.28	-0.28	-0.41
Module efficiency	%	-	-	17
Degradation	%	0.7%	0.7%	0.7%
Certification	-	IEC 61646, IEC61730, CE Certified, ISO 9001 ISO 14001	IEC 61646, IEC61730, CE Certified, ISO 9001 ISO 14001	IEC 61215, IEC 61730, CE Certified, ISO 9001, ISO 14001

19.2.1.1. Warranty

According to the module datasheet, the limited product warranty covers PV modules for 10 years from the warranty start date against defects in materials and workmanship under normal application, installation, use, and service conditions. The linear performance warranty guarantees over power output at the end of 25th year.

19.2.2. Inverter

Table 93 presents the main technical characteristics of the selected model.

Table 93: Technical characteristics of Inverter

Parameter	Unit	Schneider Electric	Sungrow
Model	-	Conext Core XC-680	SG-110-CX
Max. efficiency	%	98.9	98.7
Max. DC input voltage	V	1000	1100
Max. DC current	A	1280	30
MPPT operating voltage range	V	550 to 800	550 to 800
Number of MPP independent inputs	no.	-	2
Max. AC output power	kW	680	110
Nominal AC voltage	V	380	320 – 460
Certification (IEC/IEEE/EN)	-	IEC 61000, IEC62103, IEC 61727, IEC62116, IEC 62109.	IEC 62109, IEC 61727, IEC 62116, IEC 60068, IEC 61683,

19.2.2.1. Warranty

Table 94 presents the Inverter product warranty:

Table 94: Inverter warranty

Make	Warranty
Schneider Electric Conext Core XC-680	5 years
Sungrow SG-110-CX	5 years

19.2.3. Inverter Duty Transformer

Table 95 presents the key technical characteristics of the selected Raychem transformer.

Table 95: Technical characteristics of IDT

Parameter	Unit	Raychem
Rating	kVA	1400
Type		ONAN, Oil Immersed, Outdoor
Phases	No.	3
Frequency	Hz	50
Voltage	kV	0.380/0.380/33 kV
Windings	No.	3 (1 HV, 2 LV)
Vector Group		
Impedance at principal tap	%	

19.3. Project Design

19.3.1. DC Configuration

The design configuration for the project and has reviewed the module, string, and inverter configurations. The installed DC capacity of the project is 5.50 MWp which is connected to 10 inverters of 5 MW cumulative capacity. 10 and 18 modules form a string and there are a total of 3,404 and 42 strings. The fixed tilt Module Mounting Structure at 22˚ tilt angle has been considered. The DC to AC ratio for inverters are 1.1.Figure 78 show the actual photographs of PV array area.

Figure 78: Solar PV array

19.3.2. AC Configuration

As per the submitted SLD for there are 9 nos. of inverters which are connected to the 4 nos. of three winding IDT of 1.4 MVA, 0.380/0.380/33 kV and 1 no of two winding IDT of 750 kVA, 0.380/33 kV rating. The output of each IDT is connected 33 kV HT breaker. Each HT breaker further looped to other HT panels. There are four nos. of HT panels. The looped power further evacuated to 33 kV main HT panel.

The 33 kV main HT panel have two incoming feeders from PV plant side, one aux transformer feeder and outgoing feeder cable. The 33 kV switchgear panel are equipped with all necessary protection devices.

19.4. Power evacuation

The combined generated 5 MW power at 33 kV further converted from cable feeder to overhead line feeder with the help of six pole structure. The combined power further evacuated to XX Grid Substation via 33 kV transmission line.

Figure 79: Power Evacuation Schematic

20. TL GGEL

20.1. About Project

The Project is located at Nokh Village, District Jaisalmer, Rajasthan state of India. The Project was constructed by EPC Contractor; M/s. Lauren Engineering and has been operational since 9th March 2014. Currently the O&M contractor is by PS-2 Dhaleri.

The Project is situated 193 km away from Jaisalmer district headquarters. The nearest railway station is at Jaisalmer railway which is around 200 km away from the site. The nearest airport to the project site is at Jaisalmer Airport which is 210 km away. The Project site is well connected.

Figure 80: GGEL

Figure 81: GGEL – Satellite image of project layout

20.2. Technology

TruBoard has reviewed the technology considered in the project. Summary of the key components installed in the project is indicated in Table 96.

Table 96: Summary of key components

Component	UoM	Quantity
Solar Field Area	m2	392,400
Solar Field Loops (30 loops in each field)	No.	120
Length of collector per module	M	12

Component	UoM	Quantity
Length of Solar Collector Assembly	M	148.5
Aperture width	M	5.76
No. of Solar Collector Assembly per loop	No.	4
Number of Mirrors	No.	161,280
HTF Outlet temperature	°C	393.00
HTF Inlet temperature	°C	293.00
Generator Output	MWe	50
Auxiliary power requirement	%	10 – 11
Auxiliary Transformer 7.5/9.375MVA, 10.5/6.6kV	No.	1
2.5/3.125MVA, 10.5/0.440kV	No.	2
1.5/1.725MVA, 6.6/0.440kV	No.	1
0.75/0.863MVA, 6.6/0.440kV	No.	1
Emergency DG set of 1.5 MVA, 440 V	No.	1
Turbine Generator (TG) 50 MW	No.	1
Generator Step Up transformer (GSUT) of rating 45/60/75MVA	No.	1

20.3. Project Design

The Solar Parabolic Trough field (SPTF) consists of 120 loops, with each loop having 4 Solar Collection Assemblies (SCA). Each SCA will include 12 trough collectors or Solar Collector Elements (SCE). Access to the mirrors for periodic washing has been provided.

Each SCE is 12m long and consists of 28 individual Parabolic Trough Mirrors. The Parabolic Trough Mirrors are arranged in four rows running the 12m long SCE. Each SCE is supported at its ends by pylons. The SCA is comprised of 12 SCE's. The combined overall length of the SCA is approximately 150m. Each Solar Collector Loop is comprised of 4 SCA's. The Solar Collector Loop is configured in a U-shape such that two (SCA's) collectors make up each leg of the U. Such configuration of thirty loops has been present which further resulting in 120 loops. The loops and fields are configured such that each loop and field operates in parallel with the others. The plant also includes drive systems, mirrors, receiver tubes, ball joints, HTF supply-and-return piping and manual isolation valves, the electrical power system, and instrumentation and controls to track movement of the sun and control the trough collectors' position to maximize collection of solar energy. Figure 82 show the actual photographs of PV collector area.

Figure 82: Solar PV collector

20.3.1. AC Configuration

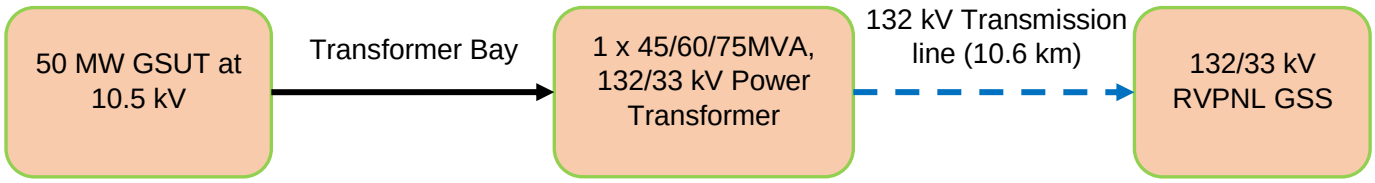
The electrical system of the plant consists of solar island electricals and power block electricals. The solar island electricals include the power distribution for the solar collector arrays. The power block electricals include the generating unit, power evacuation system auxiliary power supply system, emergency power supply system, DC system, uninterrupted power supply system and its associated equipment. The power is generated using one number of Turbine Generator (TG) of 50MW capacity. The generator output voltage is 10.5 kV. which is stepped up to 132kV using a Generator Step Up transformer (GSUT) of rating 45/60/75MVA.

The power is evacuated through the 132kV line to 132/33kV GSS PS-2 substation of Rajasthan Rajya Vidyut Prasaran Nigam Lit., (RVPNL). The distance of the transmission line is 10.65km.

20.4. Power evacuation

The generated 50 MW power at 10.5 kV further stepped up to 132kV using a Generator Step Up transformer (GSUT) of rating 45/60/75MVA. The power is evacuated through the 132kV transmission line to 132/33 kV GSS PS-2 substation of Rajasthan Rajya Vidyut Prasaran Nigam Ltd., (RVPNL). The distance of the transmission line is 10.65 km.

Figure 83: Power Evacuation Schematic



21. Terralight Solar Energy SitamauSS Private Limited (TL SitamauSS)

The technical details of the assets of TL SitamauSS has not been provided for review. However, as per the information shared by the Client, “TL SitamauSS is engaged in the business of providing transmission and step-up services to its shareholder companies. The services provided by TL SitamauSS are essential and integral to the functioning of the solar plants owned by these shareholder companies. TL SitamauSS serves as an interconnection between the electricity delivery point and the electricity generating plant. Moreover, TL SitamauSS offers transmission services to four Special Purpose Vehicles (SPVs). Among these SPVs, two are owned by VRET (Globus and TL Patlasi), while the other two are owned by Brookfield (Focal Photovoltaic India Private Limited and Focal Renewable Energy Two India Private Limited). VRET hold a 66.06% ownership stake in TL SitamauSS through its SPVs, TL Patlasi and Globus, with each SPV owning 33.03%, the remaining balance is owned by Brookfield entities.”

TruBoard Partners

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