Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN

Application Part 3 of 6

Part 3 includes:

- **Exhibit A Battery System Data Sheet**
- **Exhibit B Module Specifications**
- **Exhibit C Tracking Specifications**
- **Exhibit D Inverter Specifications**
- **Exhibit E Substation Transformer Specifications**
- **Exhibit F TRC Site Characterization Report October 2018**
- **Exhibit G TRC Hardin Raptor Nest Survey October 2018**

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

Date Filed: October 12, 2018

Exhibit A
Battery System Data Sheet

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

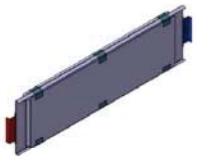
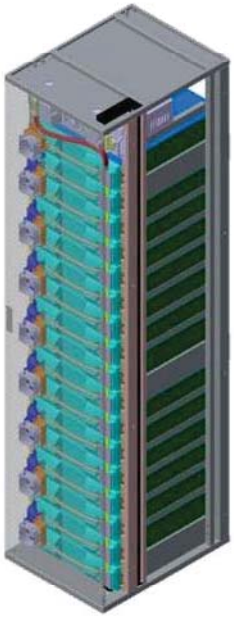
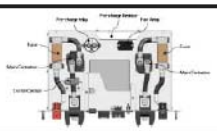
Attorneys for Hardin Solar Energy II LLC

LG Chem Gen 3 Cell/Module/Rack Data Sheet Package

2016.02.26

Rev	Date	Writer	Updates
AA	2015.08.06	Yongjun Hong	First Draft
AB	2015.09.10	Yongjun Hong	Rack Size Modification
AC	2015.09.14	Yongjun Hong	Typo Correction
AD	2015.10.20	Yongjun Hong	Picture Correction
AE	2015.11.03	Yongjun Hong	Dimension Correction
AF	2015.11.27	Yongjun Hong	JP3 Module Spec Correction
AG	2015.12.03	Yongjun Hong	Rack Width Correction
AH	2015.12.24	Injung Kim	JP3 Cell and Module Capacity Modification
AI	2016.01.25	Luke Kim	BPU info. Added
AJ	2016.02.26	Luke Kim	Module/Rack Dimension revised

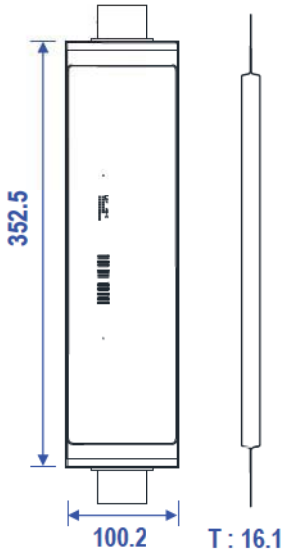
1. Battery System Overview

Main Components				
Component	**Appearance**	**Cell Model**	**Description**	**Energy**
Cell		JH3	Energy-centric cell (63Ah)	233 Wh
		JP3	Power-centric cell (63.9Ah)	234.5 Wh
Module		JH3	14S1P configuration	3.26 kWh
			14S2P configuration	6.52 kWh
			14S3P configuration	9.79 kWh
		JP3	14S1P configuration	3.28 kWh
			14S2P configuration	6.56kWh
Rack		JH3 – R800	800VDC Rack with JH3 14S2P Module	91.2 kWh
			800VDC Rack with JH3 14S3P Module	137.0 kWh
		JH3 – R1000	1000VDC Rack with JH3 14S2P Module	55.4 kWh
			1000VDC Rack with JH3 14S2P Module	110.8 kWh
			1000VDC Rack with JH3 14S3P Module	166.4 kWh
		JP3 – R800	800VDC Rack with JP3 14S1P Module	45.9 kWh
			800VDC Rack with JP3 14S2P Module	91.9 kWh
		JP3 – R1000	1000VDC Rack with JP3 14S1P Module	55.8 kWh
			1000VDC Rack with JP3 14S2P Module	111.6 kWh
BPU		P160DF1	UL Complaint DC Protection Fuse/Contactor	-

1.1. Battery Cell

Battery Cell – JH3, JP3

Dimensions



□ Cell Features

JH3	JP3
-Long Cycle Life -Safety Reinforced Separator -High Energy density -Low Self-discharge rate -Wide Temperature Range	- Long Cycle Life and High Power - Safety Reinforced Separator - High power performance - Low Self-discharge rate - Wide Temperature Range

□ Nominal Specifications: Typical values at 25°C

	JH3	JP3
Nominal Capacity (Ah)	63.0Ah (0.3C)	63.9Ah (1C)
Nominal Voltage (3.0 ~ 4.2 V, Discharge)	3.70 V (0.3C)	3.67 V (1C)
Energy Density	198 Wh/kg	202 Wh/kg
Power Density (at 50% SOC, 10 sec.)	TBD	TBD
Voltage Range	3.0 ~ 4.2 V	3.0-4.25V
Temperature Range	-30 ~ 60 °C	-30 ~ 60 °C
Weight	approx. 1175 g	approx. 1160 g
Volume	approx. 565 mL	approx. 569 mL
Ready for Shipment	'16.1Q	'16.3Q

2. Battery Module

LG Chem's Battery modules are offered in two options, namely product for Energy oriented application (JH3) and Power oriented application (JP3).

2.1. Battery Module with JH3 Cell for Energy Application

Battery Module –JH3_14S3P & 14S2P & 14S1P			
Appearance			
Module Type	**JH3_14S3P (M48189P3B)**	**JH3_14S2P (M48126P3B)**	**JH3_14S1P (M4863P3B)**
Image			
Module Features			
Built in BMS for self-diagnostic and balancing Flexible power and energy ratio Easy to integrate(19" standard rack compatible) Efficient dimension to maximize Energy density			
Nominal Characteristics			
Voltage Range	42~ 58.8 V	42~ 58.8 V	42~ 58.8 V
Capacity (0.3C)	189 Ah	126 Ah	63 Ah
Energy (0.3C)	9.79 KWh	6.52 KWh	3.26 KWh
Maximum Power Rate	0.5CP	1.0CP	1.0CP
Physical Characteristics			
Width	W/O MTG: 445 mm W MTG: 483mm	W/O MTG: 445 mm W MTG: 483mm	W/O MTG: 445 mm W MTG: 483mm
Depth	846.4 mm	586.6mm	338.8mm
Height	110 mm (2.5U)	110 mm (2.5U)	110 mm (2.5U)
Weight	68.0 kg	46.5 kg	25.0 kg
Cell Configuration	14S3P	14S2P	14S1P
Control and Protection			
Module BMS	Integrated	Integrated	Integrated
Cooling	Air-Cooled	Air-Cooled	Air-Cooled
Ready for Shipment			
Ready for Shipment	'16.1Q		

2.2. Battery Module with JP3 Cell for Power Application

Battery Module – JP3_2P & JP3_1P		
Appearance		
Module Type	**JP3_2P (M48128P6B)**	**JP3_1P (M4864P6B)**
Image		
Module Features		
Built in BMS for self-diagnostic and balancing Flexible power and energy ratio Easy to integrate(19" standard rack compatible) Efficient dimension to maximize performance for power application		
Nominal Characteristics		
Voltage Range	42~ 59.5 V	42~ 59.5 V
Capacity (1C)	127.8 Ah	63.9 Ah
Energy (1C)	6.56 kWh	3.28 kWh
Maximum Power Rate	2.0CP	2.0CP
Physical Characteristics		
Width	W/O MTG: 445 mm W MTG: 483mm	W/O MTG: 445 mm W MTG: 483mm
Depth	586.6mm	338.8 mm
Height	110 mm (2.5U)	110 mm (2.5U)
Weight	46.1 kg	24.8 kg
Cell Configuration	14S2P	14S1P
Control and Protection		
Module BMS	Integrated	Integrated
Cooling	Air-Cooled	Air-Cooled
Ready for Shipment		
Ready for Shipment	'16.3Q	

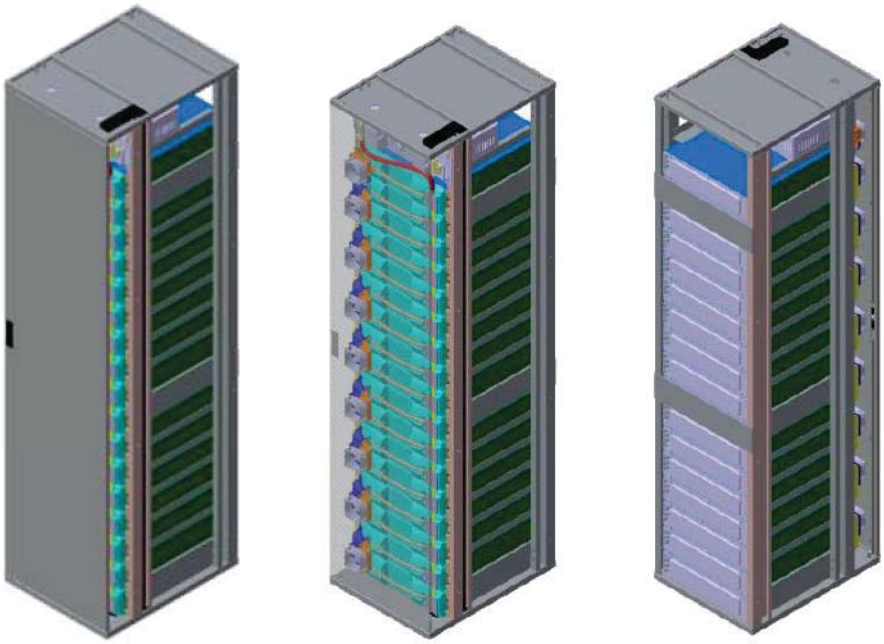
3. Battery Rack

LG Chem's Battery Rack systems are offered in two options, namely product for Energy oriented application (JH3) and Power oriented application (JP3).

3.1. Battery Rack with JH3 Modules for Energy Application

Rack Type	R1000 – JH3			R800 – JH3	
Type of Module	14S3P	14S2P	14S1P	14S3P	14S2P
Number of Modules per rack [EA]	17			14	
DC Voltage Range[VDC]	714-999.6			588-823.2	
Size [W x D x H, mm]	520 x 930 x 2200	520 x 670 x 2200	520 x 425 x 2200	520 x 945 x 2000	520 x 670 x 2000
Weight [kg]	1300	920	540	TBD	TBD
Total Rack Energy [kWh]	166.4	110.8	55.4	137.0	91.2
Rack Configuration	238S3P	238S2P	238S1P	196S3P	196S2P
Cooling	Air Cooling				

BPU can be positioned at the bottom or at the top of the rack depending on the interface with the main DC bus.

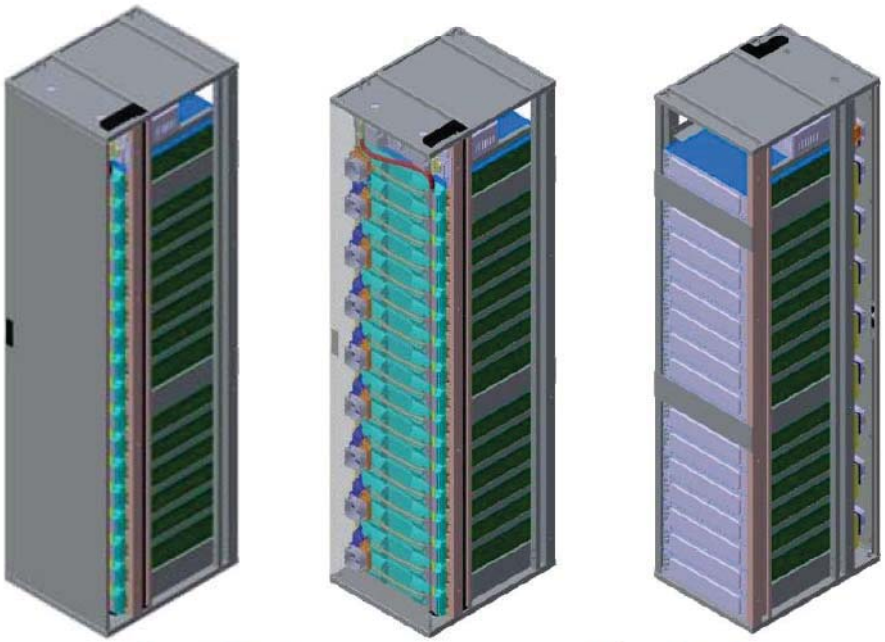


[Front View] [Rear View]

3.2. Battery Rack with JP3 Modules for Power Application

Rack Type	R1000 – JP3		R800 – JP3	
Type of Module	14S2P	14S1P	14S2P	14S1P
Number of Modules per rack [EA]	17		14	
DC Voltage Range[VDC]	714-999.6		588-823.2	
Size [W x D x H, mm]	520 x 670 x 2200	520 x 425 x 2200	520 x 670 x 2000	520 x 425 x 2000
Weight [kg]	920	540	TBD	TBD
Total Rack Energy [kWh]	111.7	55.8	91.9	45.9
Rack Configuration	238S2P	238S1P	196S2P	196S1P
Cooling	Air Cooling			

Battery Protection Unit (BPU) can be positioned at the bottom or at the top of the rack depending on the interface with the main DC bus.



[Front View] [Rear View]

4. Battery Protection Unit (BPU)

Battery Protection Unit is designed to protect Battery System during operation

Battery Protection Unit (BPU)

- Product Name : ESS BPU
- Model Name : P160DF1

4.1. ELECTRICAL SPECIPICATION

MODEL		P160DF1
Main DC	Voltage	1,000V DC
	Current (Rated)	160A
Aux power	Voltage Range	24VDC
	Input Current	113W
Insulation resistance		100 MΩ (1,000Vdc)

4.2. MECHANICAL SPECIPICATION

Housing Material		SGCC(2.0T)
Dimension (W x D x H)		438 x 282 x 126 (mm)
Unit Weight		10.2kg
Indicator	Status	Green On (Normal), Yellow On (Warning), Red On (Fault)
Cooling System		FAN
Main DC Terminal		M10 SEMS BOLT / 10.2 (N.m)
Control Power		M3 SCREW / 1.0 (N.m)
E-STOP Input Terminal		MSTB 2.5/2-STF-5.08 Connector (PHOENIX)
Main DC Wire		1/0 AWG

4.3. PROTECTION(*)

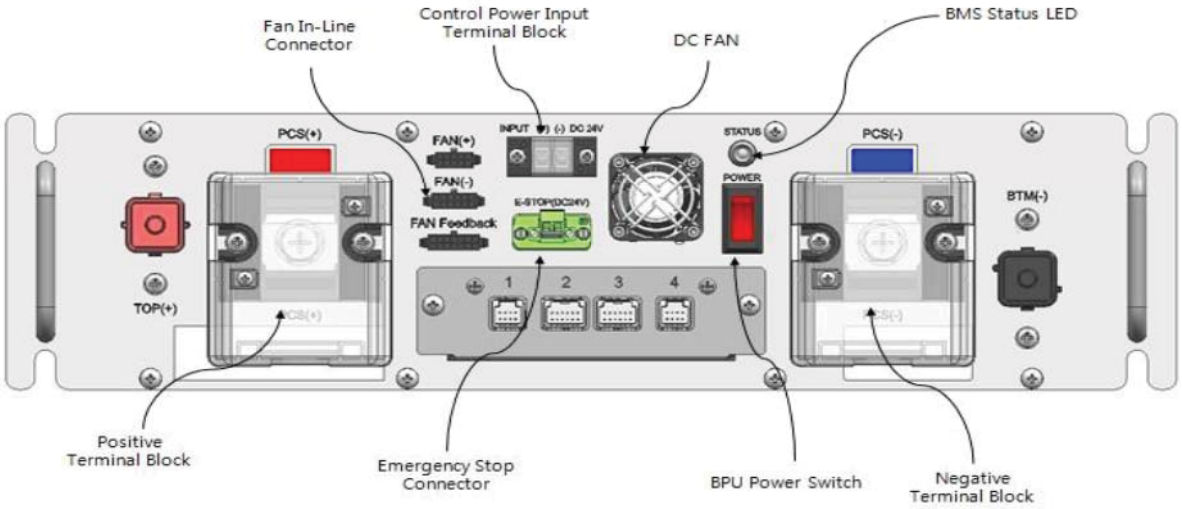
Over/Under Voltage	If the sensing value exceed or falls below a specified CB Shunt Trip by BMS
Over Current	If the sensing value exceed or falls below a specified CB Shunt Trip by BMS
Over Temperature	If the sensing value exceed or falls below a specified CB Shunt Trip by BMS
Over/Under SOC	If the sensing value exceed or falls below a specified CB Shunt Trip by BMS
Short Circuit	If a short circuit occurs CB Trip by itself
Inrush Current	Pre-charge resistor

(*) : Above condition should be defined by request from customers. Please see specification of BMS for more details.

4.4. OPERATING ENVIRONMENT

Storage temperature	-25~70℃
Operating Temperature Range	-10~40℃
Recommended Operating Temperature	23±5℃
Operating Humidity	< 95%
Operating Altitude	3,000 METERS
Pollution Degree	2
Warranty	4 Years

4.5. FRONT LAYOUT



- **DC Power Connection**

BATT POS	BATT NEG
TOP = Top Module (+) Connect	BTM = Bottom Module (-) Connect
PCS = Power Conversion System (+) Connect	PCS = Power Conversion System (-) Connect

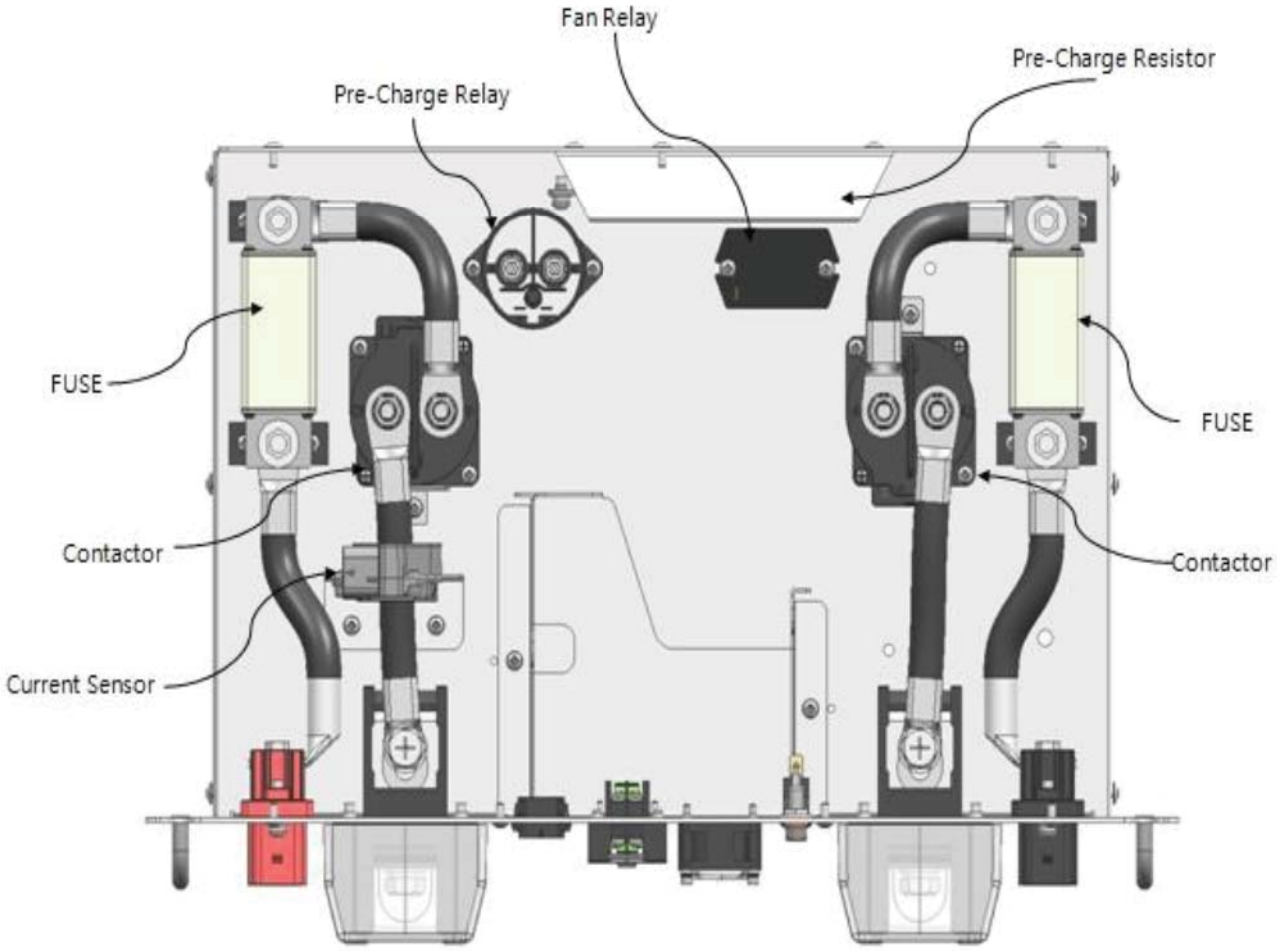
- **Auxiliary Power Connection**

Input Terminal	FAN Power / BMS Power
+	DC 24V
-	

- **E-Stop signal Connection**

E-Stop Terminal	DC 24V
2PIN Housing (Phoenix : MSTB 2.5/2-STF-5.08)	

4.6. INTERNAL LAYOUT



4.7. COMPONENTS LIST AND FUNCTION

Component	Part Number	Function
Relay	HE1aN-Q-24V	Fan ON/OFF
Pre-charge Relay	EVR100-24S	Prevents Inrush Current when the contactor to the inverter is closed.
Contactor(1)	EVR400A-24S/G	Switch Rack Circuit
Fuse	170M1811	Protect to Over Current by Battery or Grid Power System Protection from battery module failure
Current Sensor	DHAB S 118	Measuring current of Battery Charge/Discharge
Pre-charge Resistor	ULH200 20OHM 3500V	Limits Inrush Current when Pre-charge Relay On State
Terminal Block	SL33TA-1P	PCS Connection
	0168-1002	Control power
Header	2219247-1 (Positive : RD, "+")	Battery Connection
	1-2219247-2 (Negative : BK, "-")	
FAN	9GA0424G6001P	BPU Cooling
Housing	2PIN Housing (Phoenix : MSTB 2.5/2-STF-5.08)	Emergency Stop

(1) : Contactor is located on BPU in the backward direction of battery charging

4.8. SCHEMATIC DIAGRAM

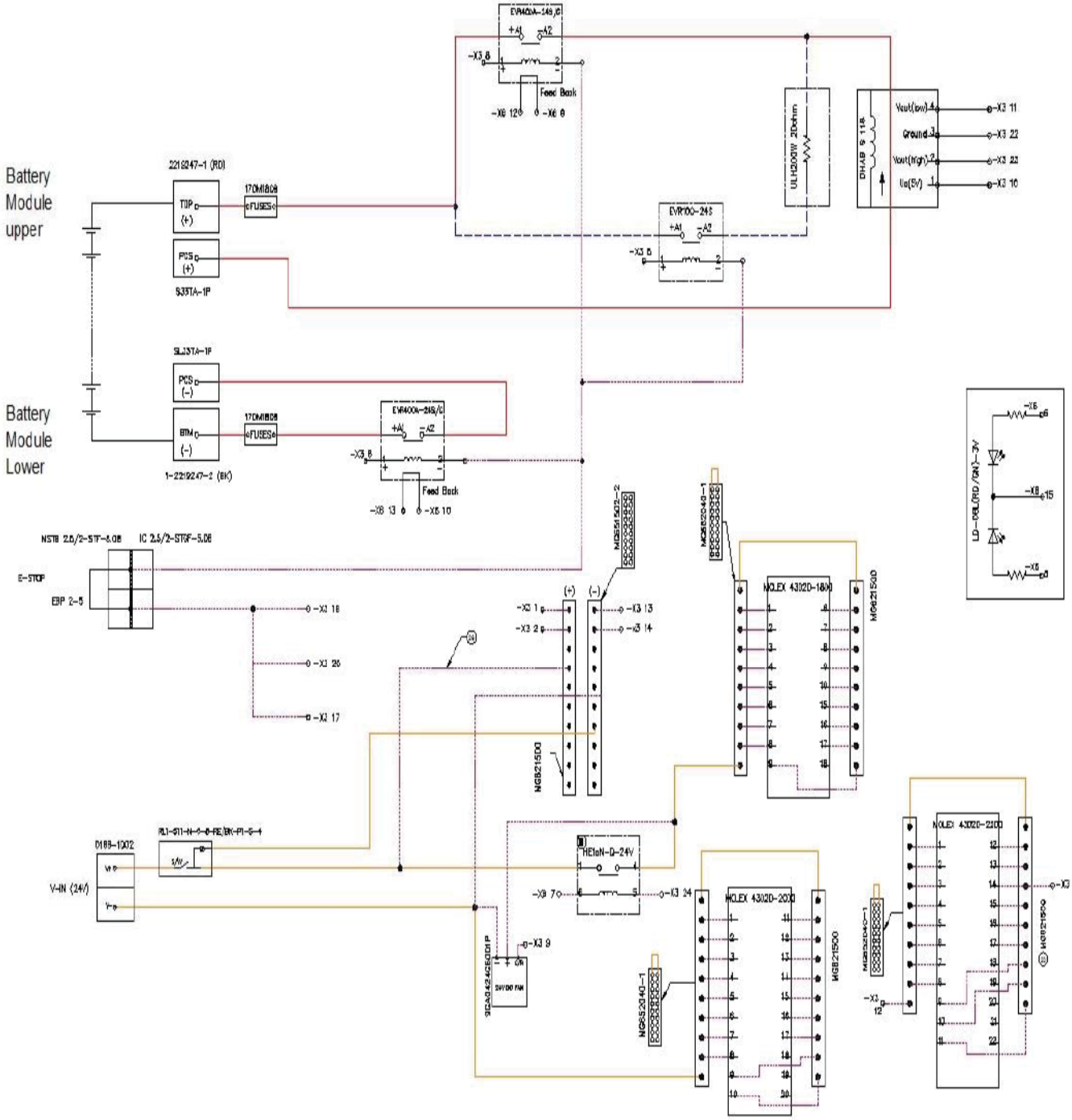


Exhibit B
Module Specifications

1) Jinko
2) Longi
3) FirstSolar
4) Trina
5) Hanwha Qcells
6) JA Solar

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

www.jinkosolar.com

Jinko Solar
Building Your Trust in Solar

Eagle HC 72M-V
355-375 Watt

MONO CRYSTALLINE MODULE

Positive power tolerance of 0~+3%

KEY FEATURES

Innovative Solar Cells
Five busbar mono half cell technology

High Efficiency
Higher module conversion efficiency (up to 19.02%) due to lower resistance characteristics

High Voltage
UL and IEC 1500V certified; lowers BOS costs and yields better LCOE

PID-Free
World's 1st PID-Free module

Low-Light Performance
Advanced glass technology improves light absorption and retention

Strength and Durability
Certified for high snow (5400 Pa) and wind (2400 Pa) loads

- ISO9001:2008 Quality Standards
- ISO14001:2004 Environmental Standards
- OHSAS18001 Occupational Health & Safety Standards
- IEC61215, IEC61730 certified products

Nomenclature:

JKM375M-72H-V

Code	Cell
null	Full
H	Half

c UL us LISTED

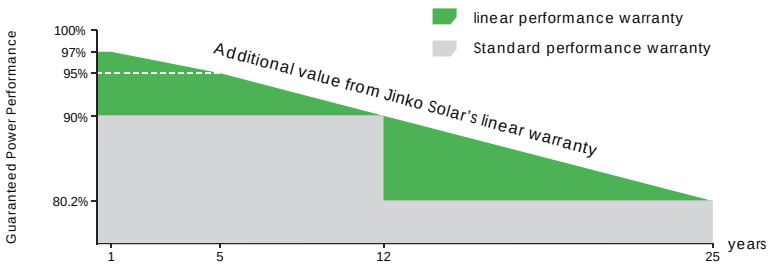
IEC

TÜVRheinland CERTIFIED

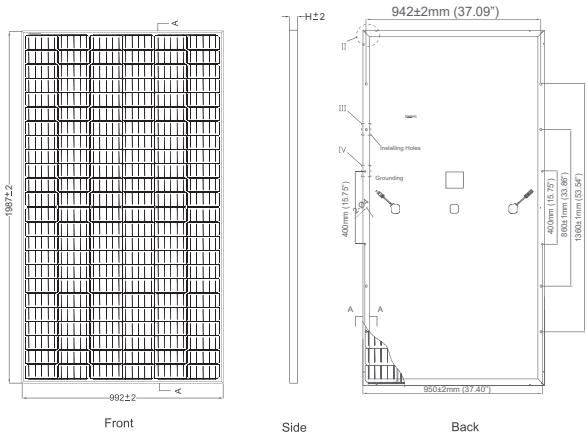
CE

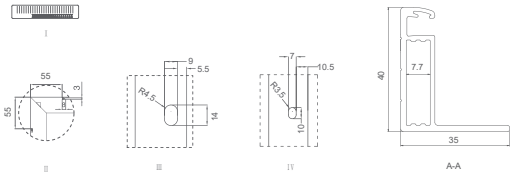
LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty • 25 Year Linear Power Warranty



Engineering Drawings



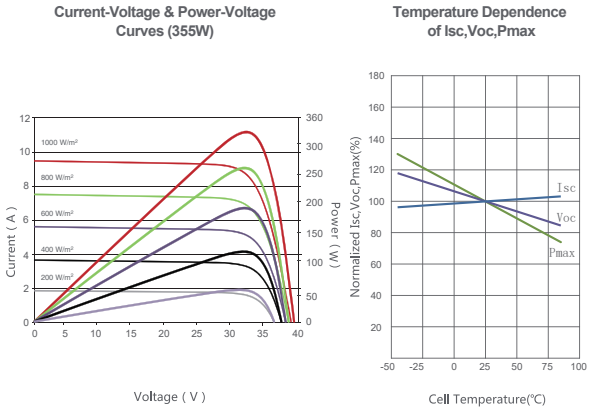


Packaging Configuration

(Two pallets =One stack)

26pcs/pallet , 52pcs/stack, 572 pcs/40'HQ Container

Electrical Performance & Temperature Dependence



Mechanical Characteristics

Cell Type	Mono-crystalline 156×156mm (6 inch)
No.of Half-cells	144 (12×12)
Dimensions	1987×992×40mm (78.23×39.05×1.57 inch)
Weight	26.5 kg (58.4 lbs)
Front Glass	4.0mm, High Transmission, Low Iron, Tempered Glass
Frame	Anodized Aluminium Alloy
Junction Box	IP67 Rated
Output Cables	anode 290mm, cathode 145mm

SPECIFICATIONS

Module Type	JKM355M-72H-V		JKM360M-72H-V		JKM365M-72H-V		JKM370M-72H-V		JKM375M-72H-V	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	355Wp	266Wp	360Wp	270Wp	365Wp	274Wp	370Wp	278Wp	375Wp	282Wp
Maximum Power Voltage (Vmp)	39.5V	37.7V	39.7V	37.9V	39.9V	38.1V	40.1V	38.3V	40.3V	38.5V
Maximum Power Current (Imp)	8.99A	7.06A	9.07A	7.12A	9.15A	7.19A	9.23A	7.26A	9.31A	7.32A
Open-circuit Voltage (Voc)	48.1V	46.5V	48.3V	46.8V	48.5V	47.1V	48.7V	47.4V	48.9V	47.7V
Short-circuit Current (Isc)	9.23A	7.25A	9.33A	7.31A	9.43A	7.37A	9.53A	7.43A	9.63A	7.49A
Module Efficiency STC (%)	18.01%		18.26%		18.52%		18.77%		19.02%	
Operating Temperature(℃)	-40℃~+85℃									
Maximum system voltage	1500VDC(UL)/1500VDC(IEC)									
Maximum series fuse rating	20A									
Power tolerance	0~+3%									
Temperature coefficients of Pmax	-0.37%/℃									
Temperature coefficients of Voc	-0.29%/℃									
Temperature coefficients of Isc	0.048%/℃									
Nominal operating cell temperature (NOCT)	45±2℃									

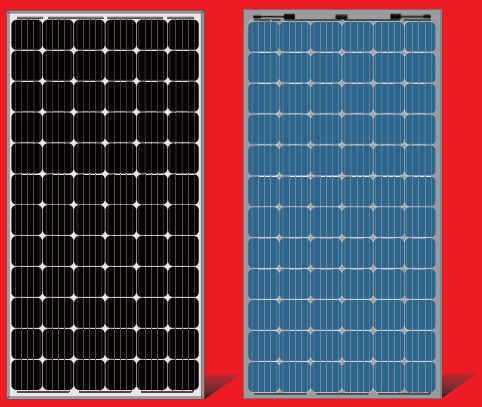
STC: Irradiance 1000W/m² Cell Temperature 25°C AM=1.5

NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM=1.5 Wind Speed 1m/s

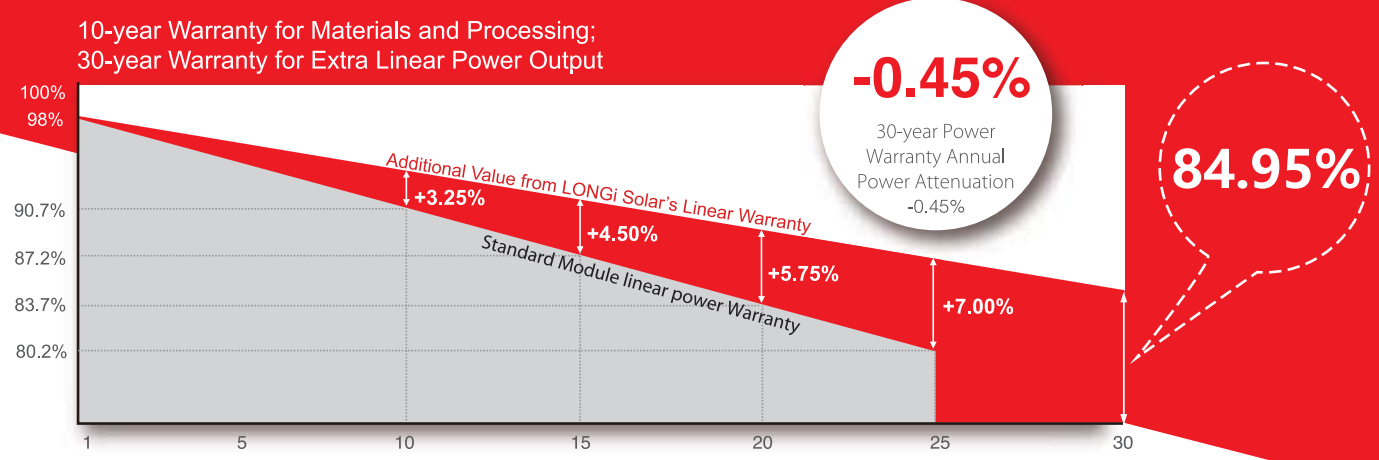
* Power measurement tolerance: ± 3%

LR6-72BP
350~370M

New



Hi-MO2 High Efficiency Low LID Bifacial PERC Technology Best Solution for Lower LCOE



Complete System and Product Certifications

IEC 61215, IEC61730, UL1703

ISO 9001:2008: ISO Quality Management System

ISO 14001: 2004: ISO Environment Management System

TS62941: Guideline for module design qualification and type approval

OHSAS 18001: 2007 Occupational Health and Safety

* Specifications subject to technical changes and tests. LONGi Solar reserves the right of interpretation.

Front side performance equivalent to conventional low LID mono PERC:
- High module conversion efficiency (up to 19%)
- Better energy yield with excellent low irradiance performance and temperature coefficient
- First year power degradation <2%

Bifacial technology enables additional energy harvesting from rear side (up to 25%)

Glass/glass lamination ensures 30 year product lifetime, with annual power degradation < 0.45%, 1500V compatible to reduce BOS cost

40mm frame design enables easy installation and robust mechanical strength

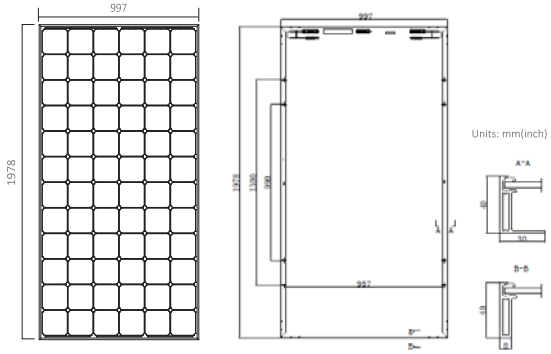
Solid PID resistance ensured by solar cell process optimization and careful module BOM selection

LONGi Solar

Room 201, Building 8, Sandhill Plaza, Lane 2290, Zuchnongzhi Road, Pudong District, Shanghai, 201203
Tel: + 86-21-61047332 Fax: +86-21-61047377 E-mail: module@longi-silicon.com
Facebook: www.facebook.com/LONGi Solar

LR6-72BP **350~370M**

Design（mm）



Mechanical Parameters

Cell Orientation: 72（6×12）

Junction Box: IP67, three diodes

Output Cable: 4mm², 300mm in length, length can be customized

Connector: MC4 or MC4 compatible

Weight: 26.5kg

Dimension: 1978×997×40mm

Packaging: 26pcs per pallet

Operating Parameters

Operational Temperature: -40℃ ~ +85℃

Power Output Tolerance: 0 ~ +5 W

Voc and Isc Tolerance: ±3%

Maximum System Voltage: DC1500V (IEC, UL)

Maximum Series Fuse Rating: 15A

Nominal Operating Cell Temperature: 45±2℃

Application Class: Class Ⅱ

Bifaciality: ≥75%

Electrical Characteristics

Model Number	LR6-72BP-350M		LR6-72BP-355M		LR6-72BP-360M		LR6-72BP-365M		LR6-72BP-370M	
Testing Condition	Front	Back	Front	Back	Front	Back	Front	Back	Front	Back
Maximum Power (Pmax/W)	350	263	355	267	360	271	365	274	370	278
Open Circuit Voltage (Voc/V)	47.2	46.8	47.4	47.0	47.6	47.2	47.8	47.4	47.9	47.5
Short Circuit Current (Isc/A)	9.39	7.19	9.48	7.26	9.58	7.34	9.66	7.40	9.77	7.49
Voltage at Maximum Power (Vmp/V)	39.2	40.2	39.4	40.4	39.5	40.5	39.7	40.7	39.8	40.8
Current at Maximum Power (Imp/A)	8.93	6.54	9.02	6.62	9.11	6.69	9.19	6.73	9.30	6.82
Module Efficiency(%)	17.8	13.3	18.0	13.5	18.3	13.7	18.5	13.9	18.8	14.1

STC (Standard Testing Conditions): Irradiance 1000W/m², Cell Temperature 25℃, Spectra at AM1.5

Electrical characteristics with different rear side power gain (reference to 360W front)

Pmax /W	Voc/V	Isc /A	Vmp/V	Imp /A	Pmax gain
378	47.6	9.98	39.5	9.57	5%
396	47.6	10.45	39.5	10.03	10%
432	47.7	11.39	39.4	10.97	20%
450	47.7	11.87	39.4	11.43	25%

Temperature Ratings（STC）

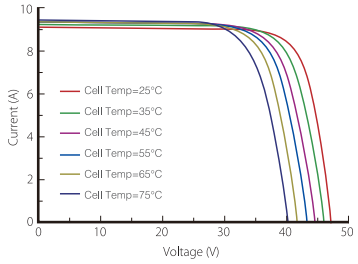
Temperature Coefficient of Isc	+0.060%/℃
Temperature Coefficient of Voc	-0.300%/℃
Temperature Coefficient of Pmax	-0.380%/℃

Mechanical Loading

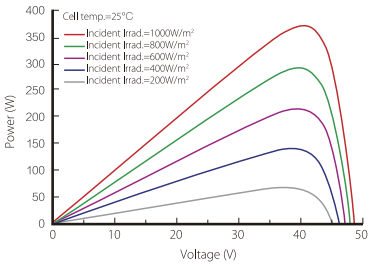
Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

I-V Curve

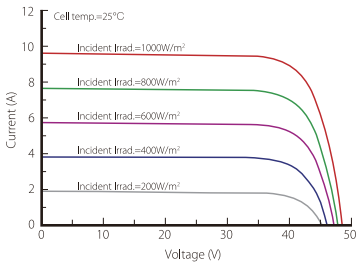
Current-Voltage Curve (LR6-72BP-360M)



Power-Voltage Curve (LR6-72BP-360M)



Current-Voltage Curve (LR6-72BP-360M)



LONGi Solar

Room 201, Building 8, Sandhill Plaza, Lane 2290, Zuchnongzhi Road, Pudong District, Shanghai, 201203
Tel: + 86-21-61047332 Fax: +86-21-61047377 E-mail: module@longi-silicon.com
Facebook: www.facebook.com/LONGi Solar

First Solar Series 6™

ADVANCED THIN FILM SOLAR TECHNOLOGY

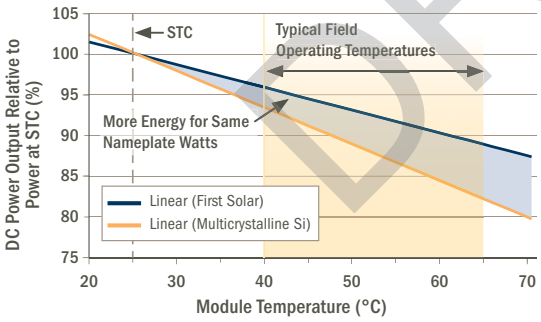
INDUSTRY BENCHMARK SOLAR MODULES

As a global leader in PV energy, First Solar's advanced thin film solar modules have set the industry benchmark with over 17 gigawatts (GW) installed worldwide and a proven performance advantage over conventional crystalline silicon solar modules. Generating more energy than competing modules with the same power rating, First Solar's Series 6™ and Series 6A™ PV Modules deliver superior performance and reliability to our customers. First Solar's Series 6™ and Series 6A™ PV Modules provide faster installation times and lower installed costs with a form factor similar to crystalline silicon modules.

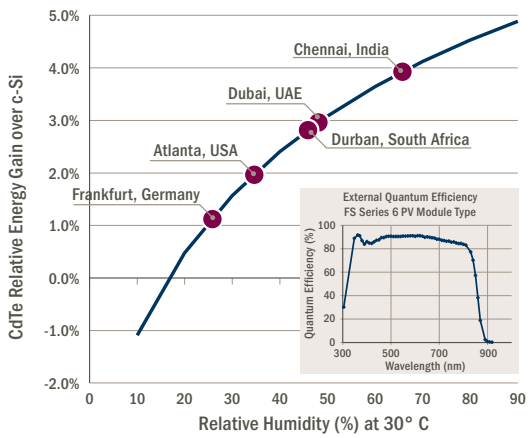
PROVEN ENERGY YIELD ADVANTAGE

- More energy than conventional c-Si with the same power in hot, humid climates
- Anti-reflective coated glass (Series 6A™) enhances energy production
- Visit PlantPredict.com - The only Energy Prediction Software designed for Utility Scale PV

Superior Temperature Coefficient



Superior Spectral Response



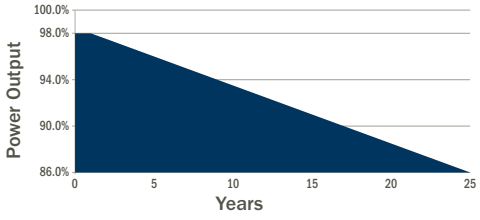
REDUCED INSTALLATION COSTS

- Easily adapts to 3rd party structures
- Single frame type for Fixed Tilt and Tracker
- More watts per connection than 72-cell multicrystalline modules

ADVANCED PERFORMANCE & RELIABILITY

- Independently certified for reliable performance in high temperature, high humidity, extreme desert and coastal environments based on accelerated life and stress tests
- Recycling services available through First Solar's industry-leading recycling program or customer-selected third party

MODULE WARRANTY[1]



- 25-Year Linear Performance Warranty[2]
- 10-Year Limited Product Warranty

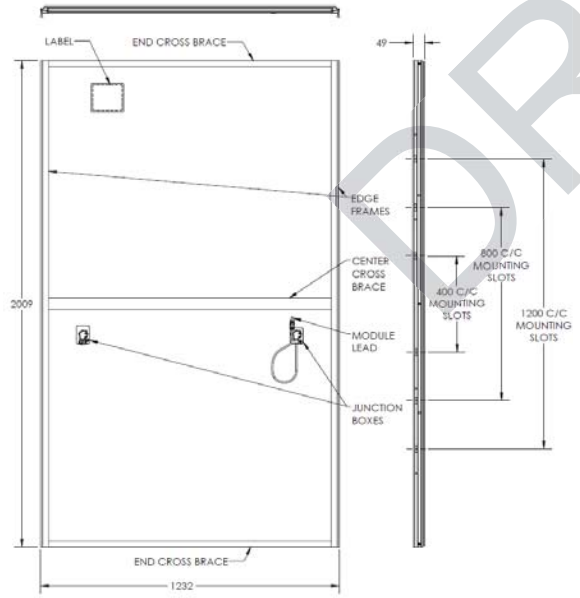
FIRST SOLAR SERIES 6™

MECHANICAL DESCRIPTION	
Length	2009 mm
Width	1232 mm
Laminate Thickness	5.4 mm
Area	2.47 m^2
Module Weight	35 kg
Leadwire[5]	2.5 mm^2, 51.5 cm (+) & Bulkhead (-)
Connectors	TBD
Bypass Diode	None
Cell Type	Thin-film CdTe semiconductor, up to 260 cells
Frame Material	Anodized Aluminum
Front Glass	2.8 mm heat strengthened Series 6A™ includes anti-reflective coating
Back Glass	2.2 mm heat strengthened
Encapsulation	Laminate material with edge seal
Frame to Glass Adhesive	Silicone
Wind Load[7]	2400 Pa
Snow Load[7]	5400 Pa

MODEL TYPES AND RATINGS AT STANDARD TEST CONDITIONS (1000W/m^2, AM 1.5, 25°C)[3]							
NOMINAL VALUES		FS-6420 FS-6420A	FS-6425 FS-6425A	FS-6430 FS-6430A	FS-6435 FS-6435A	FS-6440 FS-6440A	FS-6445 FS-6445A
Nominal Power[4] (-0/+5%)	P_{MPP} (W)	420.0	425.0	430.0	435.0	440.0	445.0
Efficiency (%)	%	17.0	17.2	17.4	17.6	17.8	18.0
Voltage at P_{MAX}	V_{MPP} (V)	178.5	179.4	180.3	181.2	182.0	182.8
Current at P_{MAX}	I_{MPP} (A)	2.35	2.37	2.38	2.40	2.42	2.43
Open Circuit Voltage	V_{OC} (V)	214.6	215.0	215.3	215.7	216.1	216.5
Short Circuit Current	I_{SC} (A)	2.62	2.63	2.63	2.64	2.65	2.65
Maximum System Voltage	V_{SYS} (V)	1500[6]					
Limiting Reverse Current	I_R (A)	6.0					
Maximum Series Fuse	I_{CF} (A)	6.0					
RATINGS AT NOMINAL OPERATING CELL TEMPERATURE OF 45°C (800W/m^2, 20°C air temperature, AM 1.5, 1m/s wind speed)[3]							
Nominal Power	P_{MPP} (W)	317.1	320.9	324.7	328.4	332.3	336.1
Voltage at P_{MAX}	V_{MPP} (V)	166.9	168.0	169.1	169.3	170.4	171.5
Current at P_{MAX}	I_{MPP} (A)	1.90	1.91	1.92	1.94	1.95	1.96
Open Circuit Voltage	V_{OC} (V)	202.6	203.0	203.3	203.7	204.0	204.4
Short Circuit Current	I_{SC} (A)	2.12	2.12	2.12	2.13	2.13	2.14

TEMPERATURE CHARACTERISTICS		
Module Operating Temperature Range	(°C)	-40 to +85
Temperature Coefficient of P_{MPP}	T_K (P_{MPP})	-0.28%/K [Temperature Range: 298.15 K to 348.15 K]
Temperature Coefficient of V_{OC}	T_K (V_{OC})	-0.28%/K
Temperature Coefficient of I_{SC}	T_K (I_{SC})	+0.04%/K

MECHANICAL DRAWING



Install in portrait only

PACKAGING INFORMATION	
Modules Per Pallet	26
Pallet Weight	1025 kg
Pallet Dimensions (L x W x H)	2200 x 1300 x 1150 mm (86 x 51 x 45 in)
Pallets per 40' Container	18

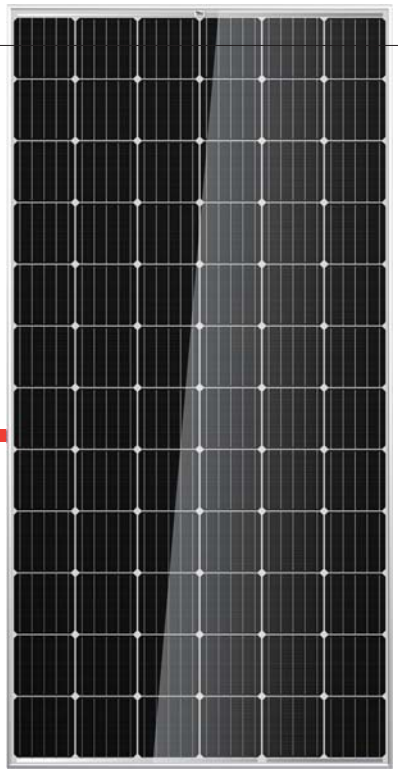
CERTIFICATIONS AND TESTS[8]		
IEC	61215 & 61730 1500V, CE 61701 Salt Mist Corrosion 60068-2-68 Dust and Sand Resistance	
UL	UL 1703 1500V Listed[6] UL Construction and Fire Performance PV Module Type [TBD]	
Regional Certifications	CSI Eligible FSEC MCS CEC Australia	JET SII InMetro
Extended Durability Tests	PID Resistant Thresher Test	Long-Term Sequential ATLAS 25+
Quality	ISO 9001:2008 & 14001:2004	

1 Limited power output and product warranties subject to warrant terms and conditions.
2 Ensures 98% rated power in first year, -0.5%/year through year 25.
3 All ratings ±10%, unless specified otherwise. Specifications are subject to change.
4 Measurement uncertainty applies.
5 Minimum leadwire length from junction box exit to connector mating surface.
6 IEC 61730-1: 2016 Class II | ULC 1703 1000V listed
7 See User Guide
8 Testing Certifications/Listings pending.

THE

TALLMAX M PLUS

FRAMED 72-CELL MODULE (1500V)



72 CELL
MONOCRYSTALLINE MODULE

335-365W
POWER OUTPUT RANGE

18.8%
MAXIMUM EFFICIENCY

0~+5W
POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading comprehensive solutions provider for solar energy. we believe close cooperation with our partners is critical to success. Trina Solar now distributes its PV products to over 60 countries all over the world. Trina is able to provide exceptional service to each customer in each market and supplement our innovative, reliable products with the backing of Trina as a strong, bankable partner. We are committed to building strategic, mutually beneficial collaboration with installers, developers, distributors and other partners.

Comprehensive Products And System Certificates

IEC61215/IEC61730/UL1703/IEC61701/IEC62716
ISO 9001: Quality Management System
ISO 14001: Environmental Management System
ISO14064: Greenhouse gases Emissions Verification
OHSAS 18001: Occupation Health and Safety Management System

Trinasolar

Ideal for large scale installations

- Reduce BOS cost by connecting more modules in a string
- 1500V UL/1500V IEC certified

Maximize limited space with top-end efficiency

- Up to 188 W/m² power density
- Low thermal coefficients for greater energy production at high operating temperatures

Highly reliable due to stringent quality control

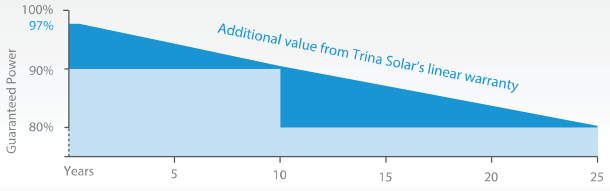
- Over 30 in-house tests (UV, TC, HF, and many more)
- In-house testing goes well beyond certification requirements
- 100% EL double inspection
- PID Resistant

Certified to withstand the most challenging environmental conditions

- 2400 Pa wind load
- 5400 Pa snow load
- 35 mm hail stones at 97 km/h

LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty · 25 Year Linear Power Warranty

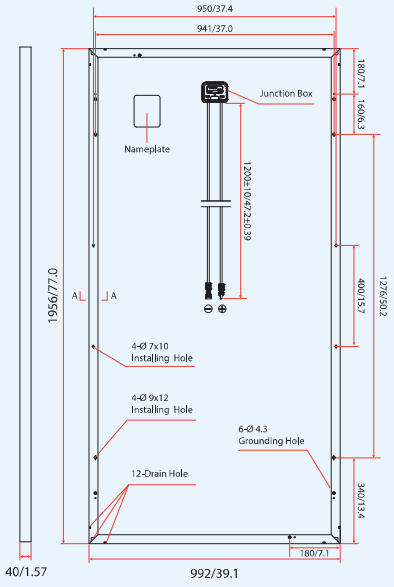


TALLMAX M PLUS

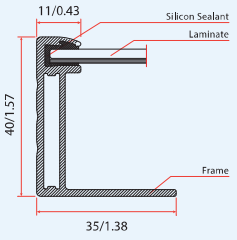
FRAMED 72-CELL MODULE (1500V)

PRODUCTS	POWER RANGE
TSM-DE14A(II)	335-365W

DIMENSIONS OF PV MODULE (mm/inch)

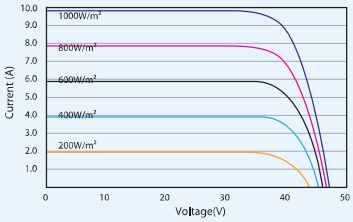


Back View

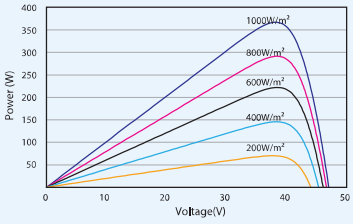


(A-A)

I-V CURVES OF PV MODULE(365W)



P-V CURVES OF PV MODULE(365W)



ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)*	335	340	345	350	355	360	365
Power Output Tolerance-P_{MAX} (W)	0 ~ +5						
Maximum Power Voltage-V_{MPP} (V)	37.9	38.2	38.4	38.5	38.7	38.9	39.1
Maximum Power Current-I_{MPP} (A)	8.84	8.90	9.00	9.09	9.17	9.26	9.35
Open Circuit Voltage-V_{OC} (V)	46.3	46.5	46.7	46.9	47.0	47.2	47.3
Short Circuit Current-I_{SC} (A)	9.36	9.45	9.50	9.60	9.69	9.79	9.88
Module Efficiency η_m (%)	17.3	17.5	17.8	18.0	18.3	18.5	18.8

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

ELECTRICAL DATA (NOCT)

Maximum Power-P_{MAX} (Wp)	250	253	257	261	264	268	272
Maximum Power Voltage-V_{MPP} (V)	35.1	35.2	35.5	35.6	35.8	35.9	36.1
Maximum Power Current-I_{MPP} (A)	7.12	7.19	7.25	7.33	7.40	7.47	7.54
Open Circuit Voltage-V_{OC} (V)	43.1	43.2	43.4	43.5	43.7	43.8	43.9
Short Circuit Current-I_{SC} (A)	7.56	7.63	7.67	7.75	7.82	7.88	7.95

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

MECHANICAL DATA

Solar Cells	Monocrystalline 156.75 × 156.75 mm (6 inches)
Cell Orientation	72 cells (6 × 12)
Module Dimensions	1956 × 992 × 40 mm (77.0 × 39.1 × 1.57 inches)
Weight	26.0 kg (57.3 lb) with 4.0 mm glass
Glass	4.0 mm (0.16 inches) High Transmission, AR Coated Tempered Glass
Backsheet	White
Frame	Silver Anodized Aluminium Alloy
J-Box	IP 67 or IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm² (0.006 inches²), 1200 mm (47.2 inches)
Connector	MC4 or Amphenol H4/UTX (1500V)
Fire Type	Type 1 or Type 2

TEMPERATURE RATINGS

NOCT(Nominal Operating Cell Temperature)	44°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.39%/°C
Temperature Coefficient of V_{OC}	- 0.29%/°C
Temperature Coefficient of I_{SC}	0.05%/°C

MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC) 1500V DC (UL)
Max Series Fuse Rating	15A

(DO NOT connect Fuse in Combiner Box with two or more strings in parallel connection)

WARRANTY

10 year Product Workmanship Warranty
25 year Linear Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION

Modules per box: 27 pieces
Modules per 40' container: 648 pieces

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Version number: TSM_EN_2017_A

www.trinasolar.com

powered by Q.ANTUM DUO

Q.PEAK DUO L-G5.2 380-395

Q.ANTUM SOLAR MODULE

The new high-performance module Q.PEAK DUO L-G5.2 is the ideal solution for commercial and utility applications thanks to a combination of its innovative cell technology Q.ANTUM and cutting edge cell interconnection. This 1500 V IEC/UL solar module with its 6 busbar cell design ensures superior yields with up to 395 Wp while having a very low LCOE.

LOW ELECTRICITY GENERATION COSTS
Higher yield per surface area, lower BOS costs, higher power classes, and an efficiency rate of up to 19.9 %.

INNOVATIVE ALL-WEATHER TECHNOLOGY
Optimal yields, whatever the weather with excellent low-light and temperature behavior.

ENDURING HIGH PERFORMANCE
Long-term yield security with Anti LID Technology, Anti PID Technology[1], Hot-Spot Protect and Traceable Quality Tra.Q™.

EXTREME WEATHER RATING
High-tech aluminum alloy frame, certified for high snow (5400 Pa) and wind loads (2400 Pa).

A RELIABLE INVESTMENT
Inclusive 12-year product warranty and 25-year linear performance warranty[2].

EUPD RESEARCH TOP BRAND PV MODULES 2018

Q CELLS

Photon Q CELLS Best polycrystalline solar module 2014

[1] APT test conditions according to IEC/TS 62804-1:2015, method B (–1500 V, 168 h)

[2] See data sheet on rear for further information.

THE IDEAL SOLUTION FOR:

Rooftop arrays on commercial/industrial buildings

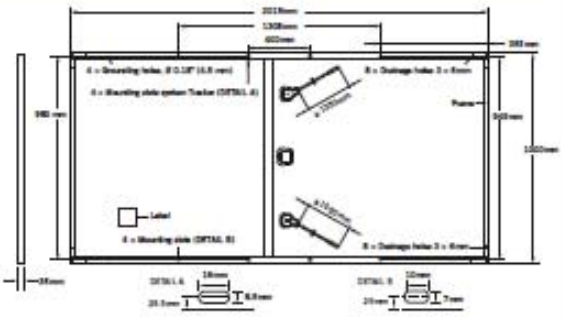
Ground-mounted solar power plants

Engineered in **Germany**

Q CELLS

MECHANICAL SPECIFICATION

Format	2015 mm × 1000 mm × 35 mm (including frame)
Weight	23.5 kg
Front Cover	3.2 mm thermally pre-stressed glass with anti-reflection technology
Back Cover	Composite film
Frame	Anodised aluminium
Cell	6 × 24 monocrystalline Q.ANTUM solar half cells
Junction box	70-85 mm × 50-70 mm × 13-21 mm Protection class IP67, with bypass diodes
Cable	4 mm² Solar cable; (+) ≥ 1350 mm, (–) ≥ 1350 mm
Connector	Multi-Contact MC4-EVO2, JMTHY PV-JM601A, IP68 or Renhe 05-6, IP67

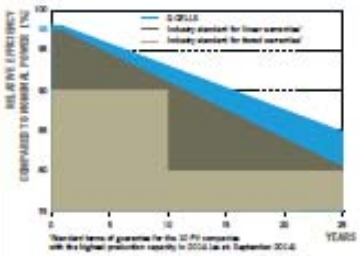


ELECTRICAL CHARACTERISTICS

POWER CLASS				380	385	390	395
MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / – 0 W)							
Minimum	Power at MPP[1]	P_{MPP}	[W]	380	385	390	395
	Short Circuit Current[1]	I_{SC}	[A]	10.05	10.10	10.14	10.19
	Open Circuit Voltage[1]	V_{OC}	[V]	47.95	48.21	48.48	48.74
	Current at MPP	I_{MPP}	[A]	9.57	9.61	9.66	9.70
	Voltage at MPP	V_{MPP}	[V]	39.71	40.05	40.38	40.71
	Efficiency[1]	η	[%]	≥ 18.9	≥ 19.1	≥ 19.4	≥ 19.6
MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NMOT[2]							
Minimum	Power at MPP	P_{MPP}	[W]	283.9	287.6	291.3	295.1
	Short Circuit Current	I_{SC}	[A]	8.10	8.14	8.17	8.21
	Open Circuit Voltage	V_{OC}	[V]	45.12	45.37	45.62	45.87
	Current at MPP	I_{MPP}	[A]	7.53	7.57	7.60	7.64
	Voltage at MPP	V_{MPP}	[V]	37.69	38.01	38.33	38.64

[1]Measurement tolerances P_{MPP} ±3%; I_{SC}; V_{OC} ±5% at STC: 1000 W/m², 25 ± 2 °C, AM 1.5G according to IEC 60904-3 · [2]800 W/m², NMOT, spectrum AM 1.5G

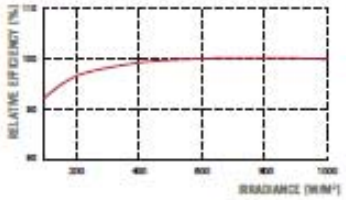
Q CELLS PERFORMANCE WARRANTY



At least 98 % of nominal power during first year. Thereafter max. 0.54 % degradation per year. At least 93.1 % of nominal power up to 10 years. At least 85 % of nominal power up to 25 years.

All data within measurement tolerances. Full warranties in accordance with the warranty terms of the Q CELLS sales organization of your respective country.

PERFORMANCE AT LOW IRRADIANCE



Typical module performance under low irradiance conditions in comparison to STC conditions (25 °C, 1000 W/m²).

TEMPERATURE COEFFICIENTS

Temperature Coefficient of I_{SC}	α	[%/K]	+ 0.04	Temperature Coefficient of V_{OC}	β	[%/K]	– 0.28
Temperature Coefficient of P_{MPP}	γ	[%/K]	– 0.37	Normal Module Operating Temperature	NMOT	[°C]	43 ± 3

PROPERTIES FOR SYSTEM DESIGN

Maximum System Voltage	V_{SYS}	[V]	1500 (IEC) / 1500 (UL)	Safety Class	II
Maximum Reverse Current	I_R	[A]	20	Fire Rating	C / TYPE 1
Max. Design Load, Push / Pull		[Pa]	3600 / 1600	Permitted Module Temperature on Continuous Duty	– 40 °C up to + 85 °C
Max. Test Load, Push / Pull		[Pa]	5400 / 2400		

QUALIFICATIONS AND CERTIFICATES

IEC 61215:2016, IEC 61730:2016, Application class A
This data sheet complies with DIN EN 50380.

PARTNER

NOTE: Installation instructions must be followed. See the installation and operating manual or contact our technical service department for further information on approved installation and use of this product.

Hanwha Q CELLS GmbH
Sonnenallee 17-21, 06766 Bitterfeld-Wolfen, Germany | TEL +49 (0)3494 66 99-23444 | FAX +49 (0)3494 66 99-23000 | EMAIL sales@q-cells.com | WEB www.q-cells.com

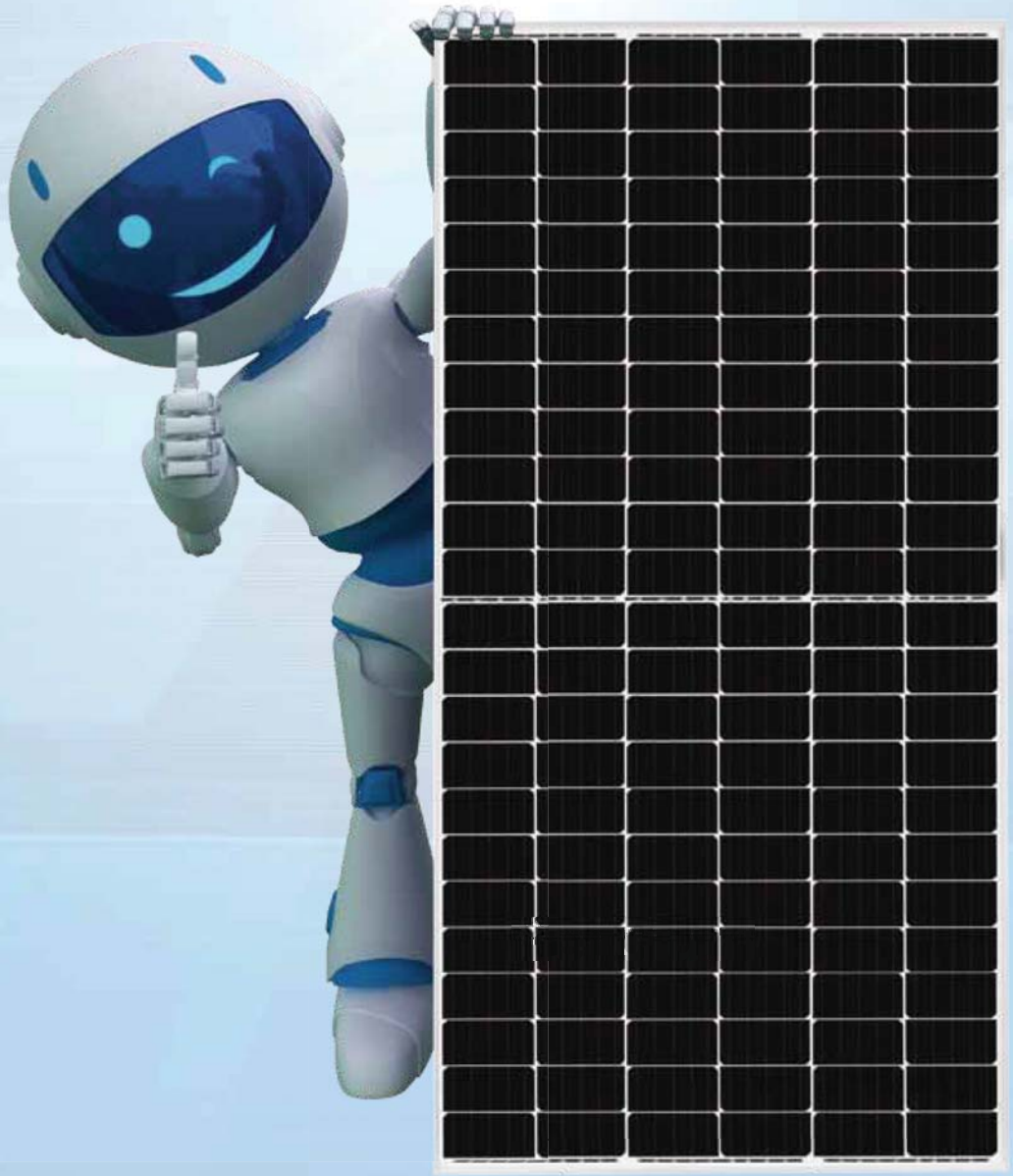
Engineered in **Germany**

JA SOLAR

PERCIUM

355-375 Series

375 Mono PERC Half-Cell



- Higher output power
- Lower temperature dependence
- Better mechanical loading tolerance
- Less shading effect

Harvest the Sunshine

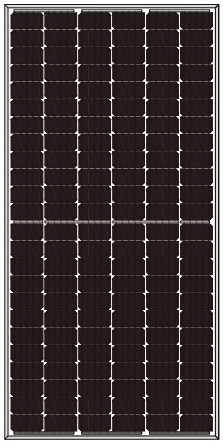
Premium Cells, Premium Modules

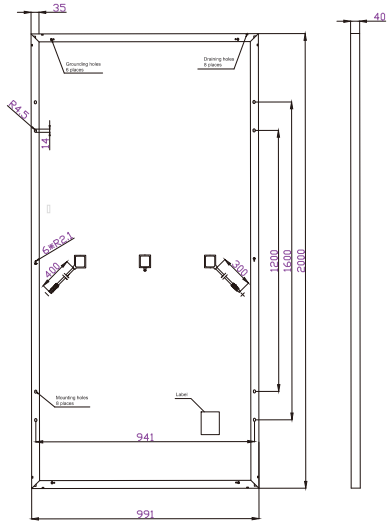
www.jasolar.com

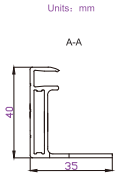
JA SOLAR

JAM72S03 355-375/PR

MECHANICAL DIAGRAMS







SPECIFICATIONS

Cell	Mono 156.75x78.38mm
Weight	23kg±3%
Dimensions	2000×991×40mm
Cable Cross Section Size	4mm^2
No. of cells	144 (12×12)
Junction Box	IP67, 3 diodes
Connector	MC4 Compatible (1000V) PV-ZH202B (1500V)
Packaging Configuration	27 Per Pallet

OPERATING CONDITIONS

Maximum System Voltage	1000V/1500V DC (IEC)
Operating Temperature	-40℃~+85
Maximum Series Fuse	20A
Maximum Static Load, Front Maximum Static Load, Back	5400Pa 2400Pa
NOCT	45±2℃
Application Class	Class A

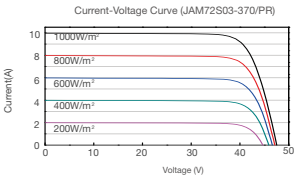
ELECTRICAL PARAMETERS AT STC

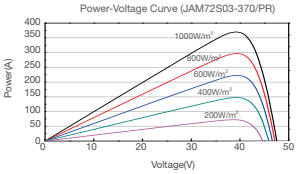
TYPE	JAM72S03 -355/PR	JAM72S03 -360/PR	JAM72S03 -365/PR	JAM72S03 -370/PR	JAM72S03 -375/PR
Rated Maximum Power (Pmax) [W]	355	360	365	370	375
Open Circuit Voltage (Voc) [V]	46.75	46.98	47.30	47.56	47.78
Maximum Power Voltage (Vmp) [V]	38.35	38.73	39.05	39.36	39.58
Short Circuit Current (Isc) [A]	9.82	9.87	9.92	9.97	10.03
Maximum Power Current (Imp) [A]	9.26	9.30	9.35	9.41	9.48
Module Efficiency [%]	17.91	18.16	18.42	18.67	18.92
Power Tolerance	-0~+5W				
Temperature Coefficient of Isc (α_Isc)	+0.051%/℃				
Temperature Coefficient of Voc (β_Voc)	-0.289%/℃				
Temperature Coefficient of Pmax (γ_Pmp)	-0.370%/℃				
STC	Irradiance 1000W/m^2 , cell temperature 25℃, AM 1.5G				

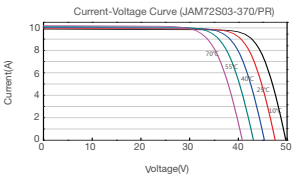
ELECTRICAL PARAMETERS AT NOCT

TYPE	JAM72S03 -355/PR	JAM72S03 -360/PR	JAM72S03 -365/PR	JAM72S03 -370/PR	JAM72S03 -375/PR
Max Power (Pmax) [W]	263	266	270	274	278
Open Circuit Voltage (Voc) [V]	43.25	43.48	43.80	44.06	44.28
Maximum Power Voltage (Vmp) [V]	35.46	35.81	36.11	36.37	36.59
Short Circuit Current (Isc) [A]	7.86	7.90	7.94	7.98	8.02
Maximum Power Current (Imp) [A]	7.41	7.44	7.48	7.53	7.58
NOCT	Irradiance 800W/m^2 , ambient temperature 20℃, wind speed 1m/s, AM 1.5G				

CHARACTERISTICS







Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

Exhibit C
Tracking Specifications

1) Soltec
2) ATI
3) NEXTracker SPT

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

SF UTILITY SOLAR TRACKER

COST EFFECTIVENESS

A cost-effective installation is assured beginning with the lowest piles-per-MW spec on the market combined with the widest range of installation and assembly tolerances that reduce all aspects of civil works, installation labor, and machine costs.

HIGHER YIELD

Higher yield is enabled by less array-gap on the tracker and less site-gaps on the ground, along with the widest tracking range of 120°+ and TeamTrack asymmetric backtracking control.

GREATER LAND-USE OPTIONS

SF Utility provides greater land-use options that enable greater site-fill even on irregular land, and reduced civil works that minimize costs and environmental impact issues including earth grading and emissions of carbon dioxide. Moreover, SF Utility standard steep-slope tolerance of 17% NS and short-track configuration makes for simple installation where others simply cannot install without special cost.

FACTORY SERVICED

SF Utility is Factory Serviced with dedicated customer project support in plant design and factory response, and onsite services including tutelage, supervision, logistics, training, commissioning, and regionally available installation and O&M contracting.

Soltec

SF UTILITY SOLAR TRACKER

Technical Datasheet

www.soltec.com

MAIN FEATURES

Tracking System	Horizontal Single-Axis with independent rows
Tracking Range	120° +
Drive System	Enclosed Slewing Drive, DC Motor
Power Supply	AC/DC Universal Input Self-Powered with Battery Backup
Tracking Algorithm	Astronomical with Adaptive Backtracking
Communication	
Wire	RS485 Cable between Trackers and Gateway
Wireless	Wireless Mesh Network
Wind Resistance	Per Local Codes
Land Use Features	
Independent Rows	YES
Slope North-South	17%
Slope East-West	Unlimited
Ground Coverage Ratio	Configurable. Typical range: 28-50%
Foundation	Driven Pile | Ground Screw | Concrete
Temperature Range	
Standard	- 4°F to +131°F | -20°C to +55°C
Extended	-40°F to +131°F | -40°C to +55°C
Availability	>99%
Tracker Installation Service	YES
Modules	Standard: 72 cells | Optional: 60 Cells; Crystalline, Thin Film (Solar Frontier, First Solar and others); Bifacial

TYPICAL MODULE CONFIGURATIONS

1000V

	Length	Height	Width
2x38	127' 7" (38.9 m)	12' 10" (3.9 m)	12' 10" (3.9 m)
2x40	123' 4' (37.6 m)		

1500V

	Length	Height	Width
2x42	141' (43 m)	12' 10" (3.9 m)	12' 10" (3.9 m)
2x43.5	146' 2" (44.8 m)		
2x45	150' 7" (45.9 m)		

MAINTENANCE

Self-lubricating Bearings	YES
Face to Face Cleaning Mode	YES
Maintenance Service	YES

WARRANTY

Structure	10 years (extendable)
Motor	5 years (extendable)
Electronics	5 years (extendable)

Soltec

UNITED STATES
5800 Las Positas Rd.
Livermore, CA 94551
usa@soltec.com
+1 510 440 9200

SPAIN
info@soltec.com
+34 968 603 153

BRAZIL
brasil@soltec.com
+55 71 3026 1444

CHILE
chile@soltec.com
+56 (02) 25738559

CHINA
china@soltec.com
+86 15021713965

MEXICO
mexico@soltec.com
+52 1 55 5557 3144

PERU
peru@soltec.com
+51 53 50 7315

INDIA
india@soltec.com
+91 124 4568202

SCANDINAVIA
scandinavia@soltec.com
+45 70 43 01 50

DNV GL Technology Review available
Bankability report
WIND TUNNEL TESTED

UL LISTED
[PV SOLAR TRACKER]
E476688

DuraTrack® HZ v3

A (r)evolutionary design that builds on the DuraTrack heritage while adding innovative features engineered to deliver the best LCOE in the industry.

THE (R)EVOLUTION IN TRACKER DESIGN IS HERE.

DuraTrack HZ v3 is not just an evolution of our innovative single-axis horizontal solar tracker, it incorporates revolutionary features found nowhere else in the industry.

HIGHEST POWER DENSITY

In fact, 6% more than our closest competitor. Increase capacity on a reduced footprint, or add to production by cutting down on backtracking.

GREATEST RELIABILITY

Reducing the number of sensitive components has resulted in the highest operational uptime in the industry. An improved driveline design allows for fewer motors—less than two per megawatt. No stow required—a failure-free wind relief management feature takes care of that.

ULTRA-EFFICIENT INSTALLATION

One single-fastener clamp per module streamlines the most labor-intensive step. Per megawatt, this equals 15,000 fewer fasteners than competitive systems, adding up to big savings.

ZERO MAINTENANCE

Gearboxes are sealed and lubricated for life resulting in zero scheduled maintenance. All tracker rows self-calibrate twice daily ensuring that each row is always at the optimal tracking angle.

Array Technologies Inc.

A 3901 Midway Place NE
Albuquerque, NM 87109 USA

T +1 505.881.7567
+1 855.TRACKPV (872.2578)

F +1 505.881.7572

E sales@arraytechinc.com

W arraytechinc.com

DuraTrack HZ v3

THE V3 DELIVERS LOWEST LCOE

Add it up. Working together, all the features of the DuraTrack HZ v3 are designed to result in the best LCOE. When you calculate what you'll save on installation due to the streamlined design, what you won't be spending on O&M due to zero scheduled maintenance, and what you'll add in production due to 99.996% uptime, 6% more density and optimized 52° ROM, you'll discover the value added by going with the industry leader in solar tracking.

With more gigawatts installed, and nearly 30 years dedicated to tracker design and manufacturing, Array's reliability and reputation make it the low-risk choice that you and your financial institution can rely on.

THE ARRAY ADVANTAGE

Array Technologies is the worldwide leader in tracking solutions for utility and commercial solar electric generation systems, with multiple gigawatts across the globe. After more than 28 years in the industry, Array's innovations in solar tracking continue to provide the best levelized cost of electricity through reliable, easy to install and maintain systems. Array Technologies' solutions are engineered in the USA and shipped worldwide.

STRUCTURAL & MECHANICAL FEATURES/SPECIFICATIONS	
Tracking Type	Horizontal single axis
Tilt Angle	0°
kW per Drive Motor	~ 650–800 kW DC
String Voltage	Up to 1,500V DC
Maximum Linked Rows	28
Maximum Row Size	80 modules (crystalline, 1,000V DC) & 90 modules (crystalline, 1,500V DC)
Drive Type	Rotating gear drive
Motor Type	2 HP, 3 PH, 480V AC
Motors per 1 MW AC	Less than 2
East-West / North-South Dimensions	Site / module specific
Array Height	54" standard, adjustable (46" min height above grade)
Ground Coverage Ratio (GCR)	Flexible, 28–45% typical
Modules Supported	Most commercially available, including frameless crystalline and thin film
Tracking Range of Motion	± 52°
Operating Temperature Range	-30°F to 140°F (-34°C to 60°C)
Module Configuration	Single-in-portrait standard. Dual-in-landscape (crystalline), four-in-landscape (thin film) also available.
Module Attachment	Single fastener, high-speed mounting clamps with integrated grounding. Traditional rails for crystalline in landscape, custom racking for thin film and frameless crystalline per manufacturer specs.
Materials	HDG steel and aluminum structural members
Allowable Wind Load (IBC 2012)	135 mph, 3-second gust exposure C
Wind Protection	Passive mechanical system relieves wind and obstruction damage — no power required
ELECTRONIC CONTROLLER FEATURES/SPECIFICATIONS	
Solar Tracking Method	Algorithm with GPS input
Control Electronics	MCU plus Central Controller
Data Feed	MODBUS over Ethernet to SCADA system
Night-time Stow	Yes
Tracking Accuracy	± 2° standard, field adjustable
Backtracking	Yes
INSTALLATION, OPERATION & MAINTENANCE	
PE Stamped Structural Calculations & Drawings	Yes
On-site Training & System Commissioning	Yes
Connection Type	Fully bolted connections, no welding
In-field Fabrication Required	No
Dry Slide Bearings & Articulating Driveline Connections	No lubrication required
Scheduled Maintenance	None required
GENERAL	
Annual Power Consumption (kWh per 1 MW)	400 kWh per MW per year, estimated
Land Area Required per 1 MW	Approx. 5 to 5.75 acres per MW @ 33% GCR (site and design specific)
Energy Gain vs. Fixed-Tilt	Up to 25%, site specific
Warranty	10 year structural, 5 year drive & control components
Patent Numbers	US patent 8,459,249 US patent 9,281,778 US patent 9,581,678 B2 and patents pending
Codes and Standards	UL Certified (3703 & 2703)

NEXTracker

POWER ON.

NEXTrackerSPT

INTRODUCING A WHOLE NEW WAY TO TRACK THE SUN

The NEXTracker™ Self-Powered Tracker (SPT) brings self-contained motor power to each row, saving time and money. No more external power wiring. No more UPS backup systems. Safer, more reliable with higher performance.

Independent, Mechanically-Balanced Rows

The NEXTrackerSPT leverages NEXTracker's mechanically-balanced row design, which aligns the PV panels with the tracker's axis of rotation. This alignment greatly reduces torsional load, requiring less energy from the motor to track throughout the day and freeing each row to track independently.

Plug and Play with No Power Wiring

NEXTrackerSPT's independent rows eliminate external AC power source systems, wiring, and associated trenching. Self-contained units on each row include a dedicated 30W PV panel to provide power to the Self-Powered Controller (SPC), which powers the motor and hosts intelligent control electronics to position each tracker. NEXTrackerSPT's wireless power and communication from the SPC enable each row to be truly plug and play.

Higher Performance & Safety

Independently powered rows eliminate parasitic utility draw for a higher net energy yield. Those intelligent, autonomous rows optimize operation and maintenance activities. The tracking system rapidly moves into safe stow positions; an entire site can be stowed in one to two minutes, versus up to 45 minutes for other horizontal trackers. That same quick positioning makes it five times faster to clean.

More Site Flexibility, Less Site Preparation

NEXTrackerSPT's autonomous rows enable maximum flexibility in system design, freeing layouts from the rectilinear constraints of typical linked-row trackers. No East/West grading, reduced access roads, and better utilization of corner areas increase power capacity 10-20% per site while reducing construction timelines. The self-powered rows allow the system to be commissioned without grid power.

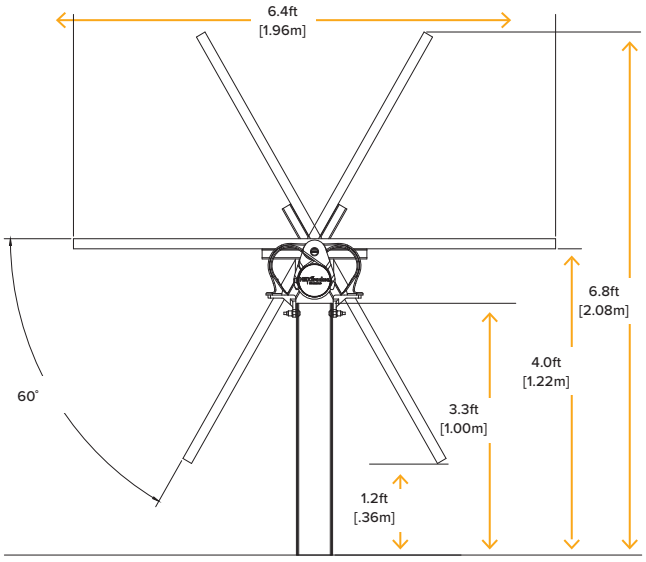
Quicker to track, quicker to commission, quicker to profits.

Document Number: MKT-000002 Revision: 01

NEXTrackerSPT Specifications

Tracking Technology	Horizontal single-axis balanced-mass tracker with independently-driven rows
Tracking Range	Up to 120° (± 60°)
Control System	1 Self-Powered Controller (SPC) per tracker; 1 Network Control Unit per 100 SPCs
Communications	Wireless ZigBee® mesh network/SCADA; no communication wiring required
Drive System	One slew gear, 24VDC motor and self-powered controller w/ dedicated solar panel per row
DC Capacity	23-35kWp per tracker row, depending on module type
System Voltage	Flexible, based on system design
Power Consumption	No grid power required
Ground Coverage Ratio	Any - fully configurable by customer; typical range 33%-50%
Installation Method	Rapid field assembly, no welding required
Foundation Types	Compatible with all major foundation types (driven pier, concrete foundation, ground screw)
Standard Wind Design	100mph/161kph, 3 second gust per ASCE7-10; configurable for higher wind speeds
Safety Stowing	Automated wind and snow stowing with self-contained backup power - no external power required
Torsional Limiter	Included at each foundation/bearing for additional wind & snow load protection
Principal Materials	Galvanized and stainless steel
Grounding Method	Self grounding structure. Separate materials and labor not required
Compliance	Grounding/bonding: UL2703; Structural Design: ASCE7-10
Other Available Options	Snow and flood sensors
Warranty	10 years on structural components, 5 years on drive and control systems
Typical Dimensions	Height 2.1m/6.8ft (@ 60 degrees), Width 2.0m/6.4ft, Length 85m/283ft

Typical 72-cell c-Si configuration: 85m row with 80 modules mounted in portrait:



NEXTracker
6200 Paseo Padre Parkway
Fremont, CA 94555 USA
+1 510 270 2500
nextracker.com

Exhibit D
Inverter Specifications

1) Power Electronics
2) TMEIC
3) SMA
4) ABB
5) INGE TEAM

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

HEM

TECHNICAL CHARACTERISTICS

		645V
REFERENCE		FS3225M
OUTPUT	AC Output Power(kVA/kW) @50°C[1]	3225
	AC Output Power(kVA/kW) @25°C[1]	3545
	Operating Grid Voltage(VAC)[2]	34.5kV
	Operating Grid Frequency(Hz)	50Hz/60Hz
	Current Harmonic Distortion (THDi)	< 3% per IEEE519
	Power Factor (cosine phi)[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night
INPUT	MPPt @full power (VDC)	913V-1310V
	Maximum DC voltage	1500V
	Number of inputs	4 per MPPt
	Number of MPPts	Up to 6
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection [4]	IP54 / NEMA3R
	Permissible Ambient Temperature	-35°C[5] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level)	1000m
	Noise level [6]	< 79 dBA
CONTROL INTERFACE	Interface	Graphic Display
	Communication protocol	Modbus TCP
	Plant Controller Communication	Optional
	Keyed ON/OFF switch	Standard
PROTECTIONS	Ground Fault Protection	GFDI and Isolation monitoring device
	General AC Protection	MV Switchgear (configurable)
	General DC Protection	Fuses
	Overvoltage Protection	AC, DC Inverter and auxiliary supply type 2
CERTIFICATIONS	Safety	UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2
	Compliance	NEC 2014 / NEC 2017 (optional)
	Utility interconnect	UL 1741SA-Sept. 2016 / IEEE 1547.1-2005

NOTES

[1] Values at 1.00•Vac nom and cos Φ=1. Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] IP65 available. Consult Power Electronics.
[4] Heating resistors kit option below -20°C.
[5] Readings taken 1 meter from the back of the unit.

HEM

TECHNICAL CHARACTERISTICS

		630V
REFERENCE		FS3150M
OUTPUT	AC Output Power(kVA/kW) @50°C[1]	3150
	AC Output Power(kVA/kW) @25°C[1]	3465
	Operating Grid Voltage(VAC)[2]	34.5kV
	Operating Grid Frequency(Hz)	50Hz/60Hz
	Current Harmonic Distortion (THDi)	< 3% per IEEE519
	Power Factor (cosine phi)[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night
INPUT	MPPt @full power (VDC)	891V-1310V
	Maximum DC voltage	1500V
	Number of inputs	4 per MPPt
	Number of MPPts	Up to 6
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection [4]	IP54 / NEMA3R
	Permissible Ambient Temperature	-35°C[5] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level)	1000m
	Noise level [6]	< 79 dBA
CONTROL INTERFACE	Interface	Graphic Display
	Communication protocol	Modbus TCP
	Plant Controller Communication	Optional
	Keyed ON/OFF switch	Standard
PROTECTIONS	Ground Fault Protection	GFDI and Isolation monitoring device
	General AC Protection	MV Switchgear (configurable)
	General DC Protection	Fuses
	Overvoltage Protection	AC, DC Inverter and auxiliary supply type 2
CERTIFICATIONS	Safety	UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2
	Compliance	NEC 2014 / NEC 2017 (optional)
	Utility interconnect	UL 1741SA-Sept. 2016 / IEEE 1547.1-2005

NOTES

[1] Values at 1.00•Vac nom and cos Φ=1. Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] IP65 available. Consult Power Electronics.
[4] Heating resistors kit option below -20°C.
[5] Readings taken 1 meter from the back of the unit.

HEM

TECHNICAL CHARACTERISTICS

		600V
REFERENCE		FS3000M
OUTPUT	AC Output Power(kVA/kW) @50°C[1]	3000
	AC Output Power(kVA/kW) @25°C[1]	3300
	Operating Grid Voltage(VAC)[2]	34.5kV
	Operating Grid Frequency(Hz)	50Hz/60Hz
	Current Harmonic Distortion (THDi)	< 3% per IEEE519
	Power Factor (cosine phi)[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night
INPUT	MPPt @full power (VDC)	849V-1310V
	Maximum DC voltage	1500V
	Number of inputs	4 per MPPt
	Number of MPPts	Up to 6
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection [4]	IP54 / NEMA3R
	Permissible Ambient Temperature	-35°C[5] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level)	1000m
	Noise level [6]	< 79 dBA
CONTROL INTERFACE	Interface	Graphic Display
	Communication protocol	Modbus TCP
	Plant Controller Communication	Optional
	Keyed ON/OFF switch	Standard
PROTECTIONS	Ground Fault Protection	GFDI and Isolation monitoring device
	General AC Protection	MV Switchgear (configurable)
	General DC Protection	Fuses
	Overvoltage Protection	AC, DC Inverter and auxiliary supply type 2
CERTIFICATIONS	Safety	UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2
	Compliance	NEC 2014 / NEC 2017 (optional)
	Utility interconnect	UL 1741SA-Sept. 2016 / IEEE 1547.1-2005

NOTES

[1] Values at 1.00•Vac nom and cos Φ=1. Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] IP65 available. Consult Power Electronics.
[4] Heating resistors kit option below -20°C.
[5] Readings taken 1 meter from the back of the unit.

TMEIC Corporation
Office: 1325 Electric Road, Suite 200, Roanoke, VA 24018 USA
Mailing Address: 2060 Cook Drive, Salem, VA 24153 USA

Electrical Equipment
Technical Specification

3360kW/3360kVA SOLAR WARE® SAMURAI
(PVH-L3360GR)

March 27, 2018, Rev 0

CHAPTER 1: General

1.1 Application

The equipment described in the specification below is intended to be used as a Grid-Connected Photovoltaic Inverter System for a photovoltaic generation power plant.

1.2 Scope

This specification will cover the design, fabrication, commissioning, and supply of the following equipment:

No.	Equipment	Description
1	PV Skid	Outdoor type
1.1	3360kW/3360kVA Inverter Unit	Outdoor type
1.2	DC Recombiner Box	Outdoor type
1.3	Aux Equipment (optional)	Outdoor type
2	MV/LV 3-phase Transformer (MV TR)	3360kVA - 34.5kV MV, 630V LV Liquid-Filled MTR Pad mounted Transformer

1.3 Applicable Standards

The following standards are applied for the equipment unless otherwise stated in the specification.

NEC 2017	(National Electrical Code, >5MW)
UL1741 2015	(Inverter, Converter, Controllers and Interconnection System Equipment for Power Systems)
IEEE 1547:2003	(IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems)
IEEE 1547.1:2005	(IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems)

All bolts, nuts, and screws for the inverter will conform to the Metric Thread of ISO (International Organization for Standardization). All manufacturing and design of the equipment will conform to the metric system standards.

1.4 Documentation

All submittals will be in electronic form and will include:

- Final Specification
- Test Reports
- Instruction Manual
- Installation Manual
- Schematic Diagrams
- Outline Drawing

1.5 Packing, Transportation and Storage

The equipment may be divided into several sections for protection during transportation when necessary. The equipment will be properly packaged for the respective mode of transportation. Customer is responsible for disposal of packaging materials. Special notations such as “Fragile”, “This side Up”, “Center of Gravity, “Weight”, etc.. when necessary, will be clearly labeled on each package. Manufacturer’s recommendations for storage should be followed upon receipt.

1.6 Product Testing

Testing will be carried out at the manufacturer’s facility for each piece of equipment. Test reports of major equipment will be submitted.

1.7 Maintenance Contract

Performing scheduled inspections and maintenance will improve the reliability of the equipment and prolong its service life. It is recommended that periodical inspections and maintenance be performed by specialists of the service representative. Such maintenance is not included in this scope and can be quoted separately. The warranty is dependent upon performing periodical inspections and maintenance as per the manufacturer’s manual.

1.8 Testing and Commissioning

The equipment presented in this proposal will require authorized startup & commissioning services by TMEIC.

The commissioning scope includes but is not limited to the following:

- De-energized checks including proper installation of equipment, torque mark verification, and proper electrical connections between major equipment.

- Energized checks including software updates, verification of set-points and IP addresses, and proper operation of communications and equipment.

- Commissioning tests will be performed per TMEIC Commissioning Checklist

Note: Testing of grid protection relay is not included. Post-shipping tests of the MV Transformer, such as NETA tests, are not included and can be quoted separately.

The commissioning scope and price are based on the following conditions:

- The pre-commissioning checklist must be filled out and returned to the TMEIC project manager at least two weeks before resources will be scheduled to mobilize to site.

- DC voltage and polarity from array inputs inside the DC recombiner box have been verified and documented by others.

- Back feed is available upon arrival of TMEIC technicians.

- De-energized and energized checks will be completed during the same trip.

- Inverters will be available for commissioning continuously.

- Conditions outside of the TMEIC technician's control which result in delay may be subject to extra charge. Conditions could include, but not limited to: Waiting time for grid connection, bad weather to clear out, other related equipment required for PV inverter commissioning to be installed.

- Technicians will not travel with commissioning spares; critical spares will be available either via client stock on hand, or via TMEIC customer support process.

- Brief operations and maintenance overview can be provided immediately following the conclusion of commissioning to available onsite personnel. This is not a formal O&M training class. TMEIC offers regularly scheduled formal classroom and hands-on training. Schedule, curriculum, and pricing can be found at tmeic.com/customer-support.

Any deviation from these conditions will result in extra charges in accordance with TMEIC's published rate sheet during the time that the work is completed. See TMEIC Solar Ware Terms and Conditions for additional information.

Added Services Technical advisory services for supervision of equipment installation and post commissioning services can be quoted but are not within the scope of TMEIC commissioning services.

1.9 Dispatch of TMEIC Engineers

Except for the purpose of implementing the repair under the warranty set forth in 1.7, the dispatch of TMEIC engineers for any service whatsoever will be made under a separate agreement offering the buyer to pay additional fees for services.

CHAPTER 2: General Conditions

2.1 Grounding System

The inverter should be grounded providing a grounding resistance of less than 5 ohms.

2.2 Installation and Operation Environment

When installing or operating the inverter and related devices, ensure that the installation and operation environment complies with Table 1. Failing to observe these standards may result in deterioration of the insulation, causing short life and malfunctions. Before installation, measure and evaluate the environment of the installation location. The inverter must be protected from marine environments and must be sealed from corrosive gas and salty air in accordance with Table1. The warranty is dependent upon meeting the environmental conditions.

Table 1. Solar Ware Inverter System installation and operation environment guidelines

No.	Item	Environment standard		
1	Installation location	Outdoors		
2	Full power ambient temperature range	-20℃ to +40℃		
	Operational Ambient temperature	-20℃ to +50℃		
3	Relative humidity	The relative humidity must be held between 5 and 95%. There must be no condensation due to temperature change.		
4	Altitude	Up to 2000 meters above sea level.		
5	Air pressure	The air pressure must be maintained in the range 860 to 1060 hPa. (pending)		
6	Vibration and mechanical shock (pending)	Vibrations in the installation environment must have frequencies lower than 10 Hz, or higher than 20 Hz. For vibrations less than 10 Hz, the resulting acceleration must not exceed 0.5G. For vibrations between 20 Hz and 50Hz, the resulting acceleration must not exceed 0.5G. For vibrations between 50Hz and 100Hz, the total amplitude must not exceed 0.1 mm.		
7	Dust	Dust in the air where the inverter is installed must not exceed normal atmospheric dust levels. In particular, that dust must not include electrically conductive particles, oils or fats, or organic materials such as silicone.		
8	Flammability	There should be no flammable or explosive gas present.		
9	Corrosive factors		Average	Max Allowable
		Hydrogen sulfide(H2S)	＜0.003 PPM	＜0.01 PPM
		Sulfurous acid gas (SO2)	＜0.01 PPM	＜0.03 PPM
		Chlorine gas (Cl2) (Relative humidity＞50%)	＜0.0005 PPM	＜0.001 PPM
		Chlorine gas(Cl2) (Relative humidity＜50%)	＜0.002 PPM	＜0.01 PPM
		Hydrogen fluoride(HF)	＜0.001 PPM	＜0.005 PPM
		Ammonia gas (NH3)	＜1 PPM	＜5 PPM
		Nitrogen oxide (NOx)	＜0.05 PPM	＜0.1 PPM
		Ozone (O3)	＜0.002 PPM	＜0.005 PPM

CHAPTER 3: Equipment Specifications

The inverter employs IGBT switches and continuously convers DC power to AC power. The inverter output voltage will automatically be synchronized with the grid AC source as long as the source is within a tolerable frequency and voltage range. Regarding the details of the unit configuration, refer to the inverter single line diagram (figure 1) and the outline of the inverter (figure 2).

3.1 3360 kW Inverter Unit

3.1.1 Main Circuit Type

Conversion method	Voltage source inverter with instantaneous current control
Switching method	Pulse Width Modulation (PWM) control
Inverter configuration	Three-phase bridge
Isolation method	Galvanic isolation provided for isolated type. External transformer is required for Transformerless type.
Cooling method	Forced Air cooling (Natural Convection Cooling when operating at less than 50% output power). Hybrid liquid – air cooling system.

3.1.2 Control Method

DC side control functions	Maximum Power Point Tracking（MPPT) control
Grid side control functions	Active power control, reactive power control, Voltage Control Mode*
Operation	Auto start/stop（soft-start at startup）
Other functions	Output power limiter. (If the capacity of solar power exceed the generation capacity of the Inverter, the Inverter limits the output power)

*Voltage Control Mode is available via TMEIC Main Site Controller integration.

3.1.3 Electrical Ratings **(Preliminary)**

ITEM		SPECIFICATIONS
System type		Grid-connected system
Output side (AC)	Rated Power*, ***	3360kW/3360kVA (derated to 3050kW at 50C)
	Rated Voltage	630V (+10%,-12%) / 3Φ3W
	Rated Frequency	60Hz (+0.5Hz, -0.7Hz)
	Rated power factor	Over 0.99
	PF Operating Range***	+/- .9PF
	Rated Current	3079 Arms
	Maximum Current	3079 Arms
Input side (DC)	Maximum Power	3265 kW @ 98% Efficiency
	Maximum Voltage	1500 Vdc
	MPPT Operation Range	915Vdc ~ 1300Vdc**
Maximum Efficiency		98.9% @ PF= 1
CEC Efficiency		98.5 % @ PF= 1
Weight		13,228 lbs (6000kg)
Inverter Dimensions (H x W x D)		90 x 200 x 76 inch (2283 x 5071 x 1920 mm)
Floor space W x D		15,200 sq. in. (9.74m^2)
Enclosure Protection Ratings		NEMA 3R
Installation		Outdoor
Full Power Temperature Range		-20°C ~ 40°C (-4°F ~ 104°F)
Communication type		Modbus
Standards Compliance		UL1741
Standard Control Power Supply		Control Power Supply form Inverter output and Capacitor backup circuit (3sec. compensation)

* Maximum output power rating is de-rated by input DC voltage, output AC voltage and temperature condition. Details are described in 3.1.5(4).

** Transition from constant DC voltage mode to MPPT mode occurs between 905V and 915V.

*** Rated output power and power factor variation range is only for rated voltage condition.

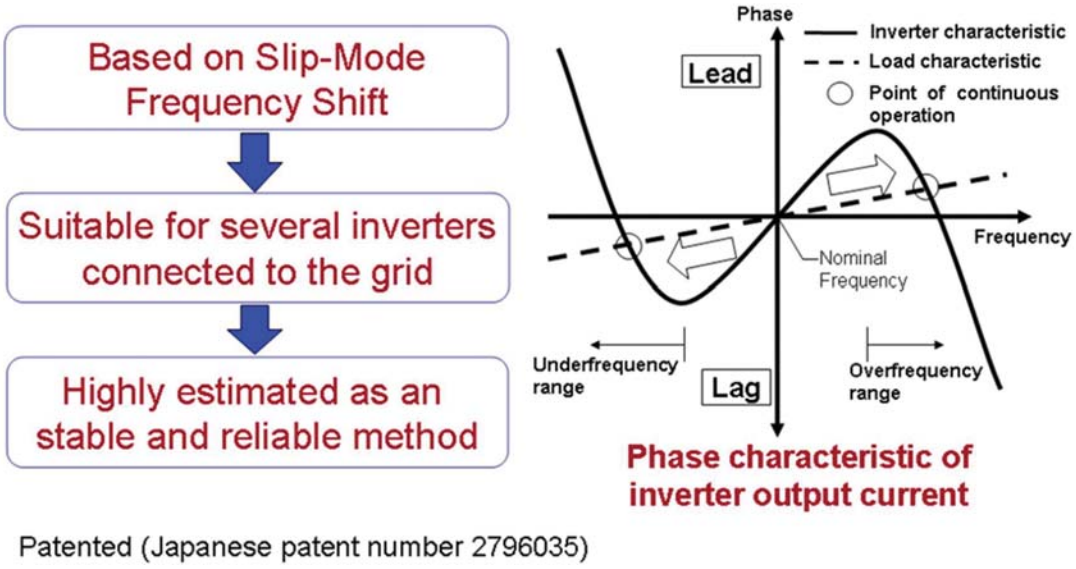
3.1.4 Protective Functions

Input (DC) side	Ground Fault, DC Reverse Current, Over Voltage, Over Current
Grid (AC) side	Anti-islanding, Over/Under Voltage, Over/Under Frequency, Over current

3.1.5 Grid Connection Features

(1) **Anti-islanding protection**

The objective of this system feature is to detect the islanding condition and drive the system to a stable operating condition.



Patented (Japanese patent number 2796035)

(2) **Reactive Power Control**

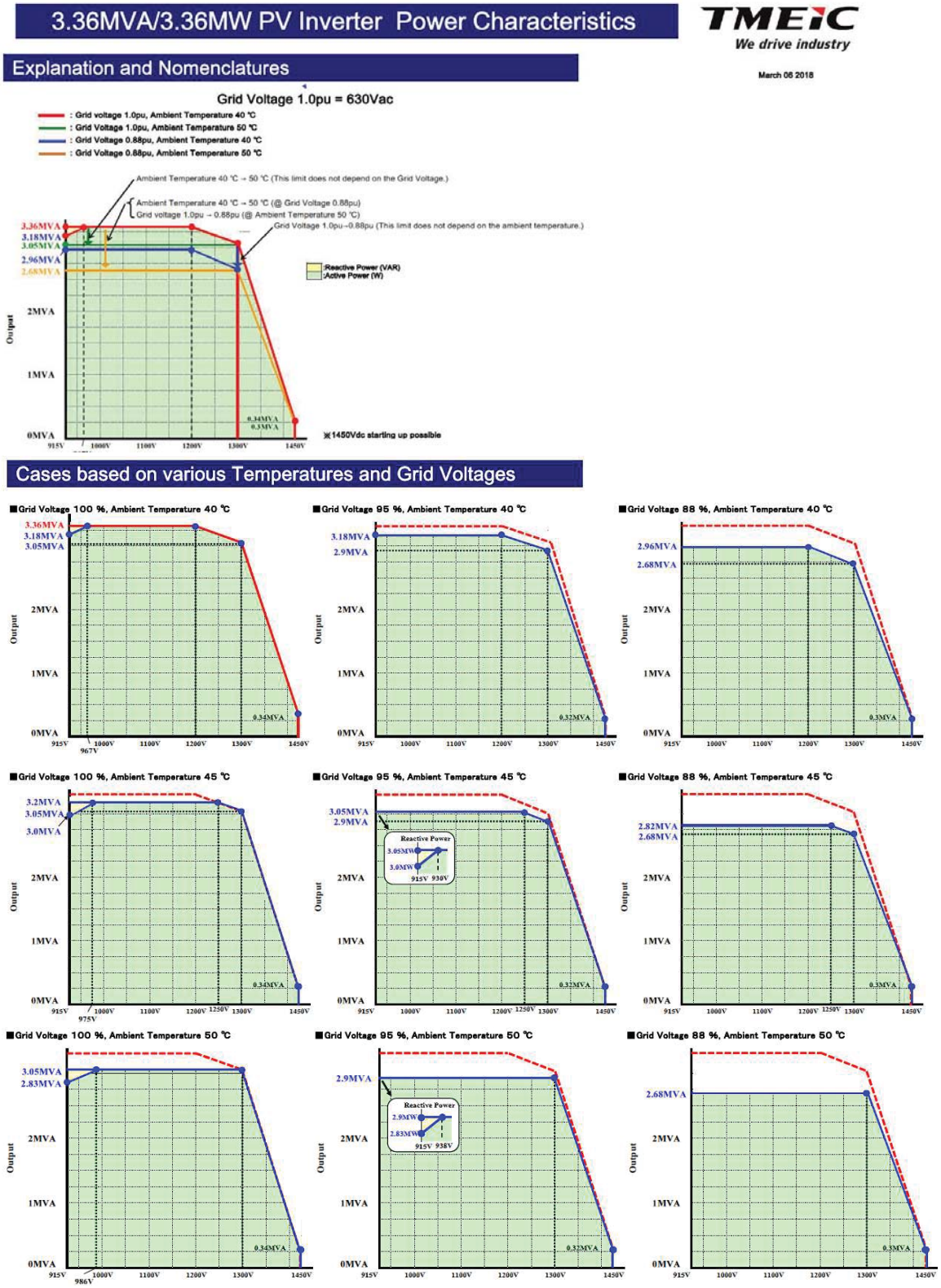
Reactive power can be injected to the grid according to the grid voltage through the TMEIC Main Site Controller. The TMEIC Main Site Controller will communicate with each inverter via a communication port, in a Modbus protocol.

(3) **Active Power Limit**

Site wide active power can be controlled via TMEIC's Main Site Controller.

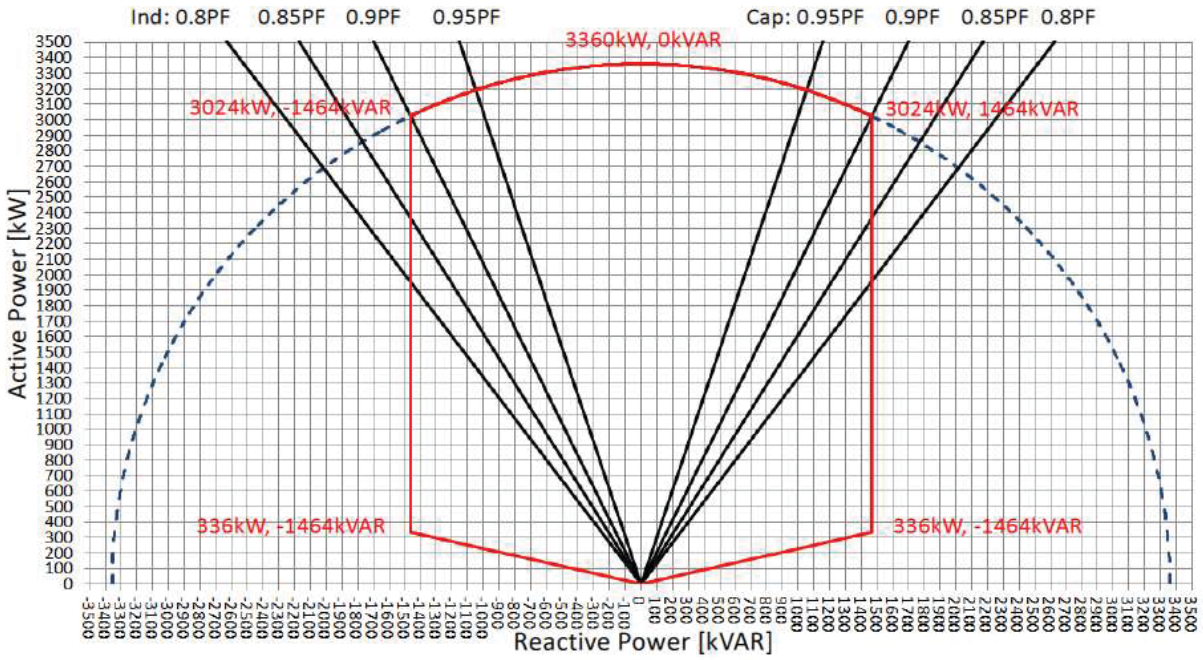
(4) **Temperature Derate Curve (Preliminary)**

The curve depicted below displays the inverter de-rate characteristics at different ambient and grid voltage conditions.



(5) **Power Factor Control (Preliminary)**

The D-Curve depicted below shows the Solar Ware Samurai PF characteristics.



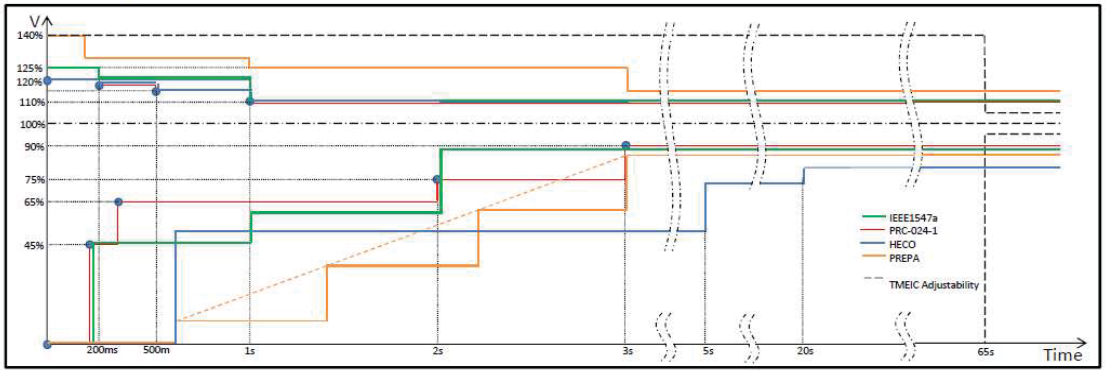
* Operation area will be curtailed by input DC voltage, output AC voltage and temperature condition.

PQ curve for PVH-L3360GR

(6) LVRT and FRT Functionality

Fault Ride Through Capabilities for PVH-L3360GR will be better than below. TBD

Low Voltage Ride-Through

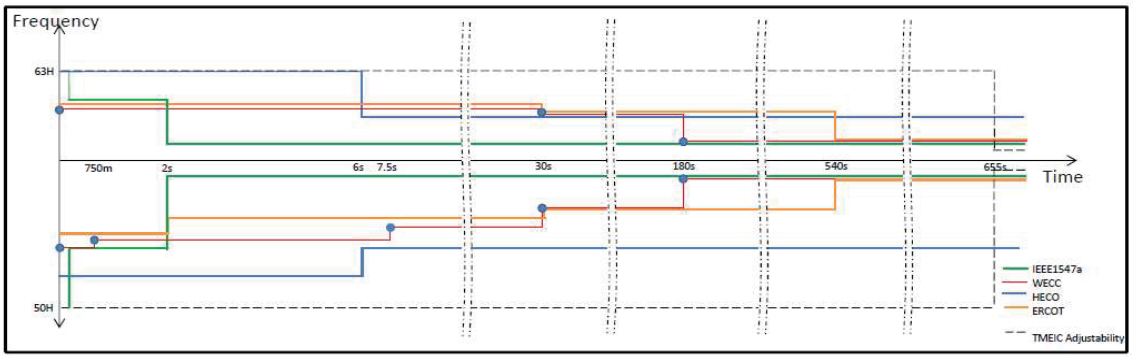


Parameter	Trip Level Adjustability			Trip Time Adjustability			IEEE1547a		PRC-024-1		HECO		PREPA (Equivalent)	
	Min	Default	Max	Min	Default	Max	Trip Level	Trip Time	Trip Level	Trip Time	Trip Level	Trip Time	Trip Level	Trip Time
OVR4	105%	125%	140%	Instantaneous			125%	-	120%	-	120%	-	140%	-
OVR3	105%	120%	140%	100ms	160ms	65s	120%	160ms	117.50%	200ms	117.50%	200ms	130%	150ms
OVR2	105%	120%	140%	100ms	160ms	65s	120%	160ms	115%	500ms	115%	500ms	125%	1s
OVR1	105%	110%	140%	100ms	1s	65s	110%	1s	110%	1s	110%	1s	115%	3s
UVR4	0%	50%	95%	100ms	160ms	65s	45%	160ms	45%	150ms	0%	600ms	10%	600ms
UVR3	10%	50%	95%	100ms	160ms	65s	45%	160ms	65%	300ms	50%	600ms	35%	1.4s
UVR2	10%	50%	95%	100ms	160ms	65s	60%	1s	75%	2s	75%	5s	60%	2.2s
UVR1	10%	88%	95%	100ms	2s	65s	88%	2s	90%	3s	88%	20s	85%	3s

Default value set according to IEEE1547

Remarks:
1) For voltage settings over 125%, an optional circuit is required for the control power supply.
2) Some embedded anti-islanding features may need to be disabled in some cases. In those cases transfer trip is allowed.
3) PRC-024-1 has been tested using down-scaled model with anti-islanding features enabled
4) The IGBTs may stop switching for voltages close to 0%.
5) The inverter is not set to supply reactive power during the fault above the settings prior to the fault.
6) During the fault, active power and reactive power will proportionally decrease depending on the voltage level
7) For overvoltage events, there may be an impact on power quality when the DC voltage is close to the minimum.
8) Current may be not perfectly sinusoidal for some asymmetrical faults.
9) Settable characteristics are limited to what the above parameter settings allow. No ramp-style characteristic.

Frequency Ride-Through



Parameter	Trip Level Adjustability			Trip Time Adjustability			IEEE1547a		WECC		HECO		ERCOT	
	Min	Default	Max	Min	Default	Max	Trip Level	Trip Time	Trip Level	Trip Time	Trip Level	Trip Time	Trip Level	Trip Time
OFR3	60.1Hz	63Hz	63Hz	0ms	0ms	650s	125%	-	61.7Hz	-	63Hz	-	61.8Hz	-
OFR2	60.1Hz	60.5Hz	63Hz	10ms	160ms	650s	62Hz	160ms	61.6Hz	30s	63Hz	10ms	61.6Hz	30s
OFR1	60.1Hz	60.5Hz	63Hz	10ms	160ms	650s	60.5Hz	2s	60.6Hz	180s	63Hz	10ms	60.6Hz	540s
UFR5	59.9Hz	55Hz	50Hz	0ms	0ms	650s	10%	-	57Hz	-	50Hz	-	57.5Hz	-
UFR4	59.9Hz	57Hz	50Hz	10ms	160ms	650s	57Hz	160ms	57.3Hz	750ms	57Hz	20s	58Hz	2
UFR3	59.9Hz	57Hz	50Hz	10ms	160ms	650s	57Hz	160ms	57.8Hz	7.5s	57Hz	20s	58Hz	2
UFR2	59.9Hz	57Hz	50Hz	10ms	160ms	650s	57Hz	160ms	58.4Hz	30s	57Hz	20s	58.4Hz	30
UFR1	59.9Hz	59.3Hz	50Hz	10ms	160ms	650s	59.5Hz	2s	59.4Hz	180s	57Hz	20s	59.4Hz	540s

Default value set according to IEEE1547

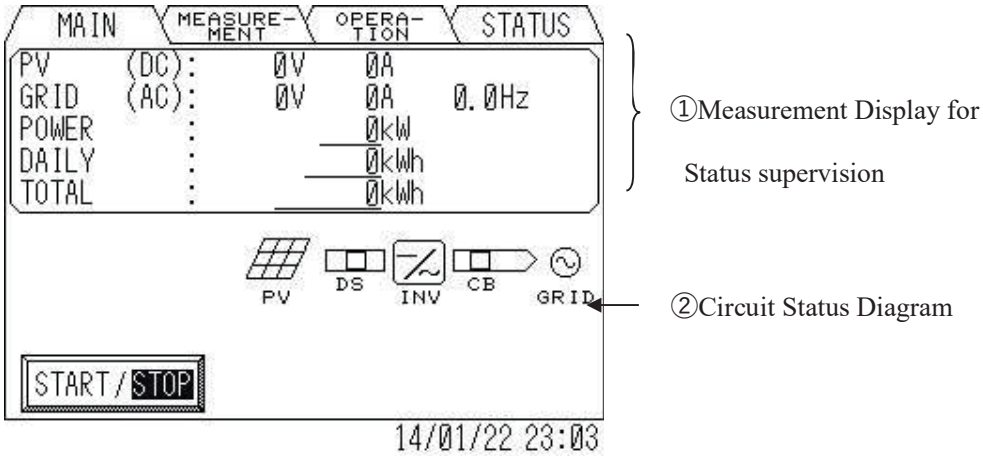
Remarks:
1) Maximum over-frequency adjustability is 63Hz
2) Settable characteristics are limited to what the above parameter settings allow. No ramp-style characteristic.

i. Back-up power supply such as UPS or CVT may be required for some of the LVRT capabilities. They are currently not included in the proposal.
ii. LVRT capabilities described in this section is available and tested but currently disabled. Inverter will have standard IEEE 1547 settings. Changing this setting will violate UL listing on inverter.

3.1.6 Panel Display Outline and Description

(1) **Main**

The display contents for the MAIN tab are explained in the picture below.



① Measurement Display for Status Supervision

In order to see the equipment status at a glance, the following information is displayed under the MAIN tab.

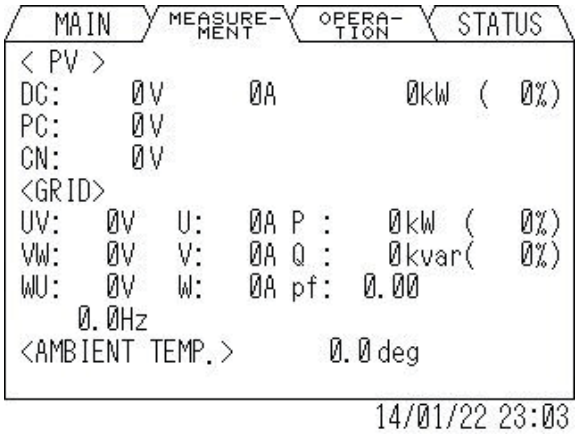
PV (DC)	DC Voltage (V), DC Current (A)
GRID (AC)	AC Voltage (V), AC Current (A), Frequency (Hz)
POWER	Instantaneous Active Power (kW)
DAILY	Power harvested during the day (kWh)
TOTAL	Total Power harvested (kWh)

② Circuit Status Diagram

PV (DC)	Photovoltaic Array
DS	DC input load-break Disconnect Switch
INV	Inverter (DC/AC Converter)
CB	Grid Connection Switch (Air Circuit Breaker)
GRID	Utility Grid

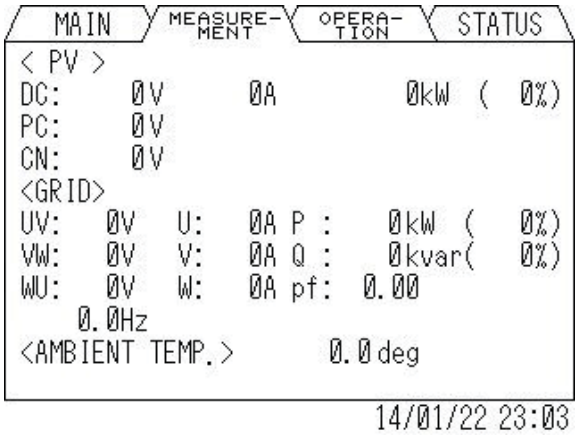
③ Start/Stop Operation

When operating in local mode and in normal conditions, the START and STOP buttons can be used to stop the operation of the inverter.



(2) **Measurement**

The screen below appears when the MEASUREMENT tab is selected.



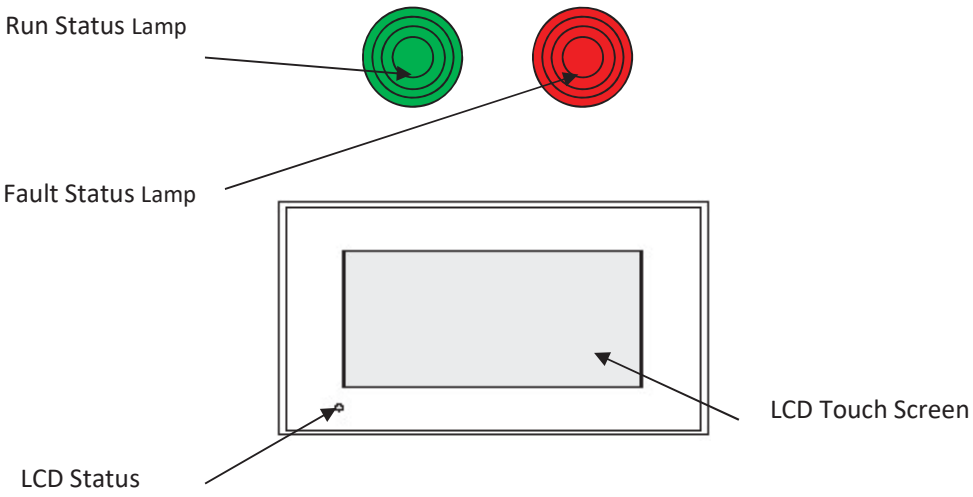
① Measurement items

DC	DC Voltage, DC current, DC power
UV	AC Voltage (U-V Line to Line)
VW	AC Voltage (V-W T Line to Line)
WU	AC Voltage (W-U Line to Line)
U	AC Current (U Phase)
V	AC Current (V Phase)
W	AC Current (W Phase)
P	Active Power (kW)
Q	Reactive Power (kVAR)
Pf	Power Factor
Blank Space (No Indicator)	Frequency (Hz)

(3) **LED Indicator**

The Inverter is equipped with 2 LED Lamps. The following table shows its available statuses.

Item	Status
Run Status Lamp (Green)	Turns On; Operating Turns Off; Stopping or Stand-by condition or Grid-connected stand-by condition
Status Lamp (Red)	Turns On; Fault status happens Turns Off; Normal condition



3.1.7 Relay Signal for Remote Use

(1) **Output signal for remote use will entail the following minimum items.**

OUT1	Running	Normally open (1a)
OUT2	Restricted Running	Normally open (1a)
OUT3	Stop	Normally open (1a)
OUT4	Minor Failure	Normally open (1a)
OUT5	Stand-By	Normally open (1a)
Major Fault	Major Failure	Normally open (1a)

(2) **Relay input signal for remote use will entail the following minimum items.**
The Relay signal will be dry contact with a rating of DC24V1A or AC100V .2A.

IN1	Ready	Normally open (1a)
IN2	N/A	N/A
IN3	N/A	N/A
IN4	N/A	N/A

3.1.8 Communication Interface
Communication system: Modbus TCP or Ethernet socket

3.1.9 Utility Interactive Protection Items

Protection Item	Detection Phase Number	Operating Conditions	
		GB(*1)	CB Trip (*2)
Over Voltage Relay (OVR)	3	Y	Y
Under Voltage Relay (UVR)	3	Y	Y
Over Frequency Relay (OFR)	1	Y	Y
Under Frequency Relay (UFR)	1	Y	Y
Passive anti-islanding Detection (Voltage phase jump detection) PDR	1	Y	N
Active anti-islanding detection*3 (frequency shift)	1	Y	Y

*1 “Y” indicates the inverter gate signal is blocking and stops its operation. “N” indicates grid side circuit breaker (CB) is still closed.
*2 “Y” indicates a trip and opening of the grid side circuit breaker (CB). “N” indicates grid side circuit breaker (CB) is still closed.
*3 Refer to paragraph 3.1.5(1)

3.1.10 Structural Specifications

(1) General Construction of Equipment		Metal-enclosed, free standing cubicle outdoor-use NEMA3R.
(2) Inverter Cabinet Dimensions (Height×Width×Depth)		: 90” x 200” x 76” (2,283mm x 5,071mm x 1,920 mm)
(3) Weight		: approx. 13,228lbs (6,000kg) ／ 1 set
(4) Paint	Outside general surface	: Sand White
	Inside surface	: Sand White
	Base	: Sand White
	Roof	: Munsel N4.5
(5) Input/output interface	DC input	: Lower left DC side
	AC output	: Upper left AC side
	Control Wire	: Internal in the AC cabinet
	Grounding Wire	: Bottom part of the AC and first inverter cabinets

BILL OF MATERIAL

Per Skid

1000 3.36 MW SOLAR WARE® SKID

Generic System configuration is shown in Figure 1. The equipment described below: 1000-NA, 1000-NB and 1000-NC will be installed on the Solar Ware® Skid.

Engineering

Package integration engineering for 3.2MW Solar Ware® Skid.

Control Circuit and Communication Wiring

Control circuit and communication wiring for TMEIC supplied equipment are included.

Auxiliary Power (Optional)

10kVA Auxiliary Transformer 630V-208/120V
30A Fused Safety Disconnect Switch
120V Panelboard

All Auxiliary equipment is NEMA 3R rated.

Canopy Shade Structure

Not included

Customer Furnished Equipment (CFE)

SCADA, DAS and site data controller should be provided by others. Wiring and Installation of customer supplied equipment is not included in the base price. Optional pricing can be provided with additional information on CFE equipment. FO cables and tracker motor wiring are also not included.

Stairs and Safety Railings

If the skid(s) are to be mounted on piers requiring stairs and safety railings, the stairs and safety railings are not part of this quote and will be supplied by others.

Stamped Drawings

PE stamped drawings are included.

Back-up Power Requirement

This quote does not include any backup power provision (UPS or Generator). If this is required, it will be quoted separately. This can also affect the length of the skid and overall skid pricing.

Note: The skid dimensions are approximately 33′L x 6′6″W. Customer is to provide other means for additional maintenance space if required to meet any code or county specific requirements.

1000-NA **SOLAR WARE® SAMURAI**

1 x 3.36 MW Solar Ware® inverter per Skid. Refer to Chapter-3 for inverter specifications.

1000-NB **DC RE-COMBINER BOX***

1 x DC master combiner Box per Solar Ware® Inverter

20-Circuit 1500 VDC Dead break switch Box with the following (customer specify other than 20-inputs available):

1) 5 x 400-amp, 4 Pole, 1500 VDC dead-break disconnect switches
2) Fuses sized for: 20 x 400 amp
3) 20 x Positive inputs with ½" - 13 hardware for compression lugs
4) 20 x Negative inputs with ½" - 13 hardware for compression lugs
5) 2 x DC bus bars for connections with inverter
6) Door switch and LED
7) Temperature sensor

Zone Monitoring Accessories:
1) 0 - 400A solid core CTs, 24VAC/DC
2) 7-8 x EZ I/O modules
3) EZ I/O PLC Monitoring 8 Slots
4) EZIOP-4DC14DCOP module
5) 30 watt, 24 VDC power supply

Note: The DC recombiner can accept up to 40 positive and negative inputs. Alternate configurations to the description shown above may impact cost.

Note: TMEIC interprets compliance with NEC 2017 to mean that Article 691 should govern for sites larger than 5MWac. As such, this recombiner box does not include the capability breaking the negative legs of inputs from the field.

1000-NC MV 3-Phase Transformer (Typical; specific designs can be requested)

kVA	3360 kVA 3 Phase Pad Mounted Transformer
Special Application	Two-Winding
Temperature Rise	65 degree rise at 30C average, 40C maximum ambient temperature
Efficiency	NLL less than .1% of rated power LL less than .9% of rated power >99% Efficient @ 100% load
Cooling Class	ONAN
Frequency	60 Hz
Duty Cycle	Designed for step-up operation
Insulating fluid	Mineral Oil
Elevation	Typically designed for operation at 1000 m (3300 ft.) above sea level
Sound Level	NEMA TR1 Standard
High Voltage	34500 Grounded Wye Volts, 150kV BIL
Electrostatic Shield	Electrostatic Shield between Primary & Secondary Windings
	Ground Shield Bushing
kV Class	35 kV
High Voltage Configuration	Dead Front, Loop Feed
High Voltage Bushings	600 amp Cooper dead break one-piece bushings (Qty: 6)
Neutral Bushings	250 amp 2 hole spade bushing
Load-break Switching	38 kV, 300A 2 Position
Switch Cover	Padlock cover over Switch (Outside of Cabinet)
Overcurrent Protection	Internal Cartridge in Series with Parallel oil-immersed partial range current limiting fuse x 6
Expulsion Fuses	Internal Expulsion x 3
Low Voltage	630 Volts Delta, 45kV BIL
kV Class	1.2 kV
Low Voltage Bushings	Integral aluminum 6-hole spade bushings (Qty: 3)
Bushing Supports	Standard LV Bushing Support Assembly
Cabinet hardware	Penta-head cabinet door bolts
Coatings	Touch-up paint (Qty: 2)
Taps	2 - 2.5% taps above and 2 - 2.5% taps below nominal
Certifications	UL Listed (UL logo on nameplate)
Notifications	Shock and Arc Flash Warning Decal
Gauges & Fittings	Liquid level gauge with Alarm Contact
	Thermometer, dial-type with Alarm Contact
	Pressure/vacuum gauge with Alarm Contact
	Schrader valve
	Pressure relief device, 50 SCFM
	Drain valve with sampler (1”) located outside of cabinet, with cover
	Oil Fill Plug
Tank accessories	IEEE standard two-hole ground pads (Qty: 3)
	Nitrogen Blanket
Special Feature	Load break switch located outside cabinet on HV side padlocked door
	Padlock cover over drain valve

Note: Secondary oil containment is not included with transformer. If required, a provision should be made onsite by others.

Factory Tests:

The following standard factory tests will be performed on the MV Transformer:

- Ratio, Polarity and Phase Rotation Test
- Resistance Test
- Routine Impulse Test
- Applied Potential Test
- Induced Potential Test
- Loss Test
- Leak Test
- ANSI Routine Testing
- Nameplate verifications, alarm, trip setting verifications
- Physical and Mechanical inspections
- Demag Test
- No-Load Loss and Excitation Current

Transformer is pressurized at manufacture's facility and may vary depending on site location and conditions; customer is responsible for maintaining transformer pressure per manufacturer's recommendations.

1000-ND **Qty 1 (1/site)** **MAIN SITE CONTROLLER (Option)**

Hardware

1 - RTAC SEL-3355-4 Real Time Automation Controller

Communications	
Ethernet Ports	2 rear; 10 or 100/Mbps, RJ-45
USB Ports	2 front, 4 rear
Encrypted Communications	RDP
Protocols	DNP3, Modbus TCP/IP
User Interface	2 rear; 10 or 100/Mbps, RJ-45

Physical	
Dimensions	19" (W) x 5.22" (H) x 11.49" (D) 482.6mm (W) x 132.6mm (H) x 291.8mm (D)
Weight	20 lb (9.072kg)
Mounting	Treated for chemically harsh / humid environments
Enclosure	125/250 VDC or 120/240 VAC, 160W HV power supply
Power Supply	-40C to +75C
Operating Temperature	2000m
Maximum Altitude	19" (W) x 5.22" (H) x 11.49" (D)

Main Site Controller (MSC) Function

One Main Site Controller communicates over an Ethernet network to control multiple power converters for a single site.

1) Sequential Start-up/Shut-down
   - Based on a command from the SCADA system, the MSC issues a single command to start and stop all inverters.
2) Power Factor Control
   - Using power generation feedback from the inverter network, the MSC will calculate a reactive current reference for each power converter such that the total power factor does not change with load.
3) Output Limitation Control
   - Using power generation feedback from the inverter network, the MSC will calculate a power limit for each inverter such that the power output of the entire site does not exceed a preset value.
4) Power slew rate control
   - Based on an adjustable power slew rate the MSC controls the rate at which power output from the system changes.
5) Live Trending
   - Capable of monitoring inverter signals such as input current, total power output, power factor etc.
6) Data Historian
   - Record of all site signals that are processed by the MSCex. Stored for a week before they are replaced with new data.
7) Dynamic Power Factor Control:
   - Using feedback from a Power Factor meter at the POCC (customer supplied), the MSC will adjust the behavior of the Solar Ware® inverters to meet a required PF at the measured point.

8) Q Priority Control
   - Prioritize maintaining reactive power contribution by limiting site real power output.

9) Frequency Droop Control

Adds or Subtracts to the site power limit reference in proportion to grid frequency when frequency exceeds th e frequency deadband.

Note: The customer will provide one (1) Grid Meter for use in our integration and test procedures to be performed in Roanoke, VA.

SMA UTILITY POWER SYSTEM
MEDIUM VOLTAGE BLOCK 2200 / 2500

Flexible

- Global solution for international markets
- For all medium-voltage grids from 6.6 kV to 35 kV
- System with modular design
- Various options

Reliable

- All components are type-tested
- 5-year statutory warranty
- Life expectancy of at least 25 years

Easy to Use

- Optimized for new Sunny Central inverters
- Outdoor transformer with effective, thermal design
- Short power connection between inverter and transformer

Cost-Optimized

- Concrete housing not required
- Low operating costs thanks to highest efficiencies of over 99%
- Inexpensive transport by standard truck or in sea freight container

SMA UTILITY POWER SYSTEM
MEDIUM-VOLTAGE BLOCK ACCORDING TO IEC STANDARDS

Compact Medium-Voltage Block for the perfect interplay with Sunny Central

The transformer is highly efficient and has been optimized for installation outdoors in accordance with the Ecodesign regulation, making it the perfect partner for the new Sunny Central inverters. The busbar connection between the inverter and transformer is contained as standard. The medium-voltage transformer can be expanded modularly with medium-voltage switchgear, an oil tray and a low-voltage transformer.

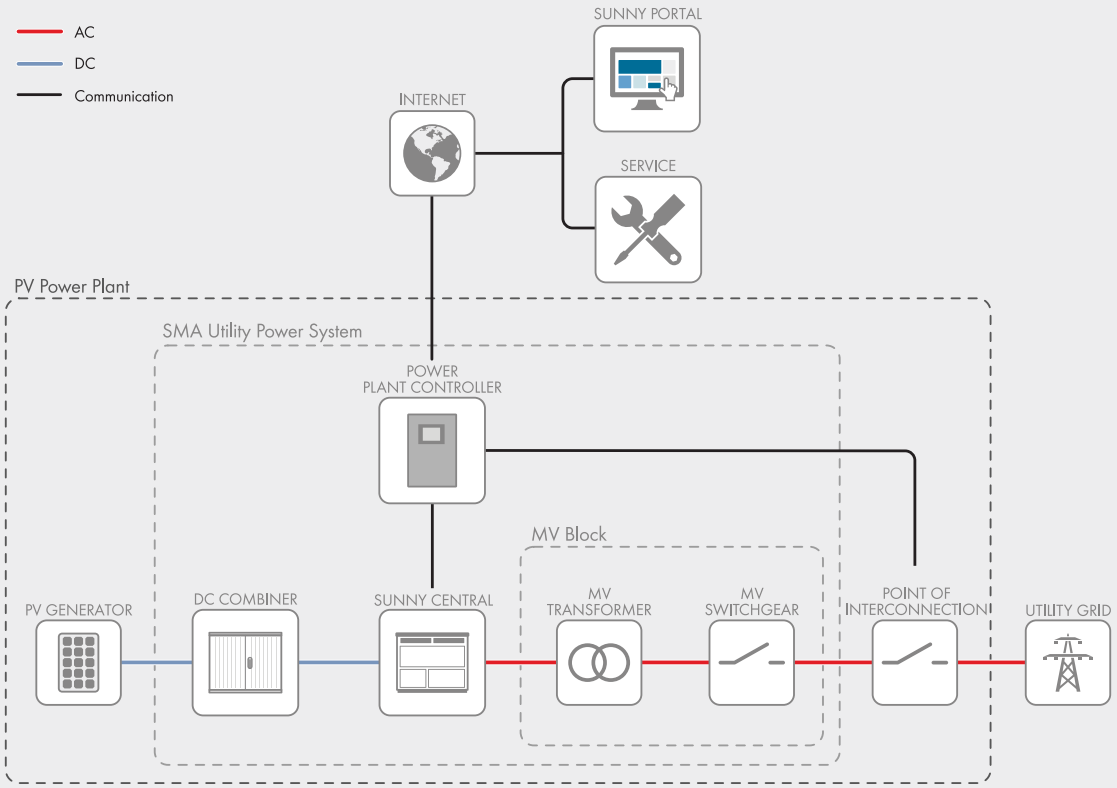
SMA UTILITY POWER SYSTEM
MEDIUM-VOLTAGE BLOCK 2200 / 2500

Technical Data	MV Block IEC for Sunny Central 2200 (1,000 V DC)
Input MV Transformer	
Rated power (at 25°C)	2200 kVA
Rated power (at 40°C)	2080 kVA
Rated power (at 50°C)	2000 kVA
Nominal voltage	385 V
Power frequency	50 Hz, 60 Hz
Max. input current at nominal voltage	3300 A
Output MV Transformer	
Nominal voltage	20 kV
Optional nominal voltages	6.6 kV to 35 kV
Transformer tap changer	–5.0% / –2.5% / 0% / +2.5% / +5.0%
Max. output current at nominal voltage	64 A
Standby power losses[1]	1.595 kW
Short-circuit losses[1]	19.8 kW
Efficiency MV Transformer	
Max. efficiency / European weighted efficiency / CEC weighted efficiency	99.4% / 99.2% / 99.2%
Degree of protection	
Degree of protection according to IEC 60529	IP23D
Degree of protection according to IEC 60721-3-4 (4C1, 4S2 / 4C2, 4S2)	● / ○
General Data	
Dimensions (W / H / D)[2]	5724 mm / 2601 mm / 2150 mm
Weight[3]	9150 kg
Ambient temperature (–25°C to 50°C)	●
Max. permissible value for relative humidity (condensing)	0% to 95%
Maximum operating altitude above MSL	1000 m at 50°C, 2000 m at 45°C, 3000 m at 40°C
Equipment	
Transformer with mineral oil / organic oil	● / ○
Transformer vector group Dy11 / YNd11	● / ○
Without / with oil tray	● / ○
Without / with medium-voltage switchgear, 3 panels (2 cable panels with load-break switch, 1 transformer panel with circuit breaker), medium-voltage switchgear with arc fault classification IAC AFL 20 kA 1 s outdoor enclosure with arc fault classification IAC A 20 kA 1 s	● / ○
Without / with low-voltage transformer (10 kVA, 20 kVA, 30 kVA)	● / ○
Application in unprotected outdoor environment / in chemically active environment	● / ○
Enclosure color	RAL 9016
Certificates and Approvals	IEC 60076, IEC 62271-200, IEC 62271-202, IEC 61936-1
● Standard features ○ Optional	
Type designation	MVB-2200-SC

Technical Data	MV Block IEC for Sunny Central 2500-EV (1,500 V DC)
Input MV Transformer	
Rated power (at 25°C)	2500 kVA
Rated power (at 40°C)	2350 kVA
Rated power (at 50°C)	2250 kVA
Nominal voltage	550 V
Power frequency	50 Hz, 60 Hz
Max. input current at nominal voltage	2624 A
Output MV Transformer	
Nominal voltage	20 kV
Optional nominal voltages	6.6 kV to 35 kV
Transformer tap changer	–5.0% / –2.5% / 0% / +2.5% / +5.0%
Max. output current at nominal voltage	72 A
Standby power losses[1)]	1.76 kW
Short-circuit losses[1)]	22 kW
Efficiency MV Transformer	
Max. efficiency / European weighted efficiency / CEC weighted efficiency	99.4% / 99.2% / 99.2%
Degree of protection	
Degree of protection according to IEC 60529	IP23D
Degree of protection according to IEC 60721-3-4 (4C1, 4S2 / 4C2, 4S2)	● / ○
General Data	
Dimensions (W / H / D)[2)]	5724 mm / 2601 mm / 2150 mm
Weight[3)]	9150 kg
Ambient temperature (–25°C to 50°C)	●
Max. permissible value for relative humidity (condensing)	0% to 95%
Maximum operating altitude above MSL	1000 m at 50°C, 2000 m at 45°C, 3000 m at 40°C
Equipment	
Transformer with mineral oil / organic oil	● / ○
Transformer vector group Dy11 / YNd11	● / ○
Without / with oil tray	● / ○
Without / with medium-voltage switchgear, 3 panels (2 cable panels with load-break switch, 1 transformer panel with circuit breaker), medium-voltage switchgear with arc fault classification IAC AFL 20 kA 1 s outdoor enclosure with arc fault classification IAC A 20 kA 1 s	● / ○
Without / with low-voltage transformer (10 kVA, 20 kVA, 30 kVA)	● / ○
Application in unprotected outdoor environment / in chemically active environment	● / ○
Enclosure color	RAL 9016
Certificates and Approvals	IEC 60076, IEC 62271-200, IEC 62271-202, IEC 61936-1
● Standard features ○ Optional	
Type designation	MVB-2500-SC-EV

1) Loss class Bk +10%, Ao +10% according to eco design standard
2) Maximum dimensions of the entire medium-voltage block without platform for power block
3) Maximum weight of the entire medium-voltage block without platform for power block

SYSTEM DIAGRAM



Solar inverters

ABB central inverters
PVS980
1818 to 2000 kVA

ABB central inverters raise reliability, efficiency and ease of installation to new levels. The inverters are aimed at system integrators and end users who require high-performance solar inverters for large photovoltaic (PV) power plants. PVS980 central inverters are available from 1818 kVA up to 2000 kVA, and are optimized for cost-effective, multi-megawatt power plants.

World's leading inverter platform

Like other ABB central inverters, the PVS980 has been developed on the basis of decades of experience in the industry and proven technology platform. Unrivalled expertise from the world's market and technology leader in frequency converters is the hallmark of this solar inverter series.

The PVS980 inverter is one of the most efficient and cost-effective ways of converting the direct current (DC) generated by solar modules into high-quality and CO_2-free alternating current (AC) that can be fed into the power distribution network.

PVS980 central inverters from ABB

ABB PVS980 central inverters are ideal for large PV power plants. The high DC input voltage, high efficiency, proven components, compact and modular design and a host of life cycle services ensure ABB PVS980 central inverters provide a rapid return on investment.

Highlights

- High total performance
- Outstanding endurance for outdoor use
- Compact, modular product design
- High DC input voltage up to 1500 V_{DC}
- Extensive DC and AC side protection
- Self-contained cooling system with high efficiency
- Versatile design for large-scale PV plants to minimize system costs
- Complete range of industrial data communication options, including remote monitoring
- Life cycle service and support through ABB's extensive global service network

Maximum energy revenues

Maximum energy revenues

ABB central inverters have a high total efficiency. Precise, optimized system control and maximum power point tracking (MPPT) combine with the unit's highly efficient power converter design to deliver the maximum energy from the PV modules to the power distribution network. For end users, this generates the highest possible revenues from the energy sales.

Self-contained, low-maintenance cooling system

PVS980 inverters feature a proven closed loop cooling system used in other ABB industrial applications. This innovative, truly low-maintenance cooling solution is designed for demanding applications and harsh environments, cutting maintenance costs and ensuring outstanding endurance.

Compact and modular design

PVS980 inverters are designed for fast and easy installation. The industrial design and modular platform provide a wide range of options, such as remote monitoring, fieldbus connection and modular and flexible DC input connections. The integrated DC saves space and costs as the solar array junction boxes can be connected directly to the fused busbars in the DC cabinet. PVS980 inverters are customized for the needs of end users and will be available with short delivery times.

Versatile design for large-scale PV plants to minimize system costs

ABB's PVS980 central inverter enables system integrators to design PV power plants that use the optimum combination of inverters with different power ratings. Equipped with extensive electrical and mechanical protection, the inverters are engineered to provide a long and reliable service life of at least 25 years.

Advanced grid support features

The PVS980 software includes all the latest grid support and monitoring features, including active power limitation, fault ride through (FRT) with current feed-in and reactive power control. Active and reactive power output can be controlled by an external control system or automatically by the inverter.

All grid support functions are parameterized, allowing easy adjusting for local utility requirements. ABB central inverters are also able to support grid stability at night by providing reactive power with the DC input disconnected.

ABB central inverters

PVS980

1818 to 2000 kVA

High total performance

- High efficiency
- Low auxiliary power consumption
- Innovative controlled cooling
- Efficient maximum power point tracking
- Long and reliable service life of at least 25 years

ABB self-contained cooling system

- Closed loop cooling system based on phase transition and thermosiphon technology
- Liquid-cooled inverter power ratings with the simplicity of air cooling
- No fillable liquids, pumps, valves, inhibitors or leaks
- Low maintenance

Outstanding endurance for outdoor use

- Water- and dustproof outdoor enclosure
- Designed to withstand the toughest environments
- Long and reliable service life following the ABB life cycle model

Versatile design for large-scale PV plants

- Integrated DC connection with variable number of inputs
- Wide standard option palette for tailoring
- Versatile AC connection methods

Modular industrial design

- Compact and easy-to-maintain product design
- Fast and easy installation
- Integrated and flexible DC input section

Minimizes system costs

- 1500 V_{DC} system voltage
- Wide ranged and highly efficient MPPT algorithm
- Integrated protection to minimize external components
- Fast and easy installation and commissioning

Life cycle service and support

- ABB's extensive global service network
- Extended warranties
- Service contracts
- Technical support throughout the service life

Wide communication options

- Complete range of industrial data communication options for SCADA connections
- Ethernet/Internet Protocol
- Remote monitoring

ABB central inverters

PVS980

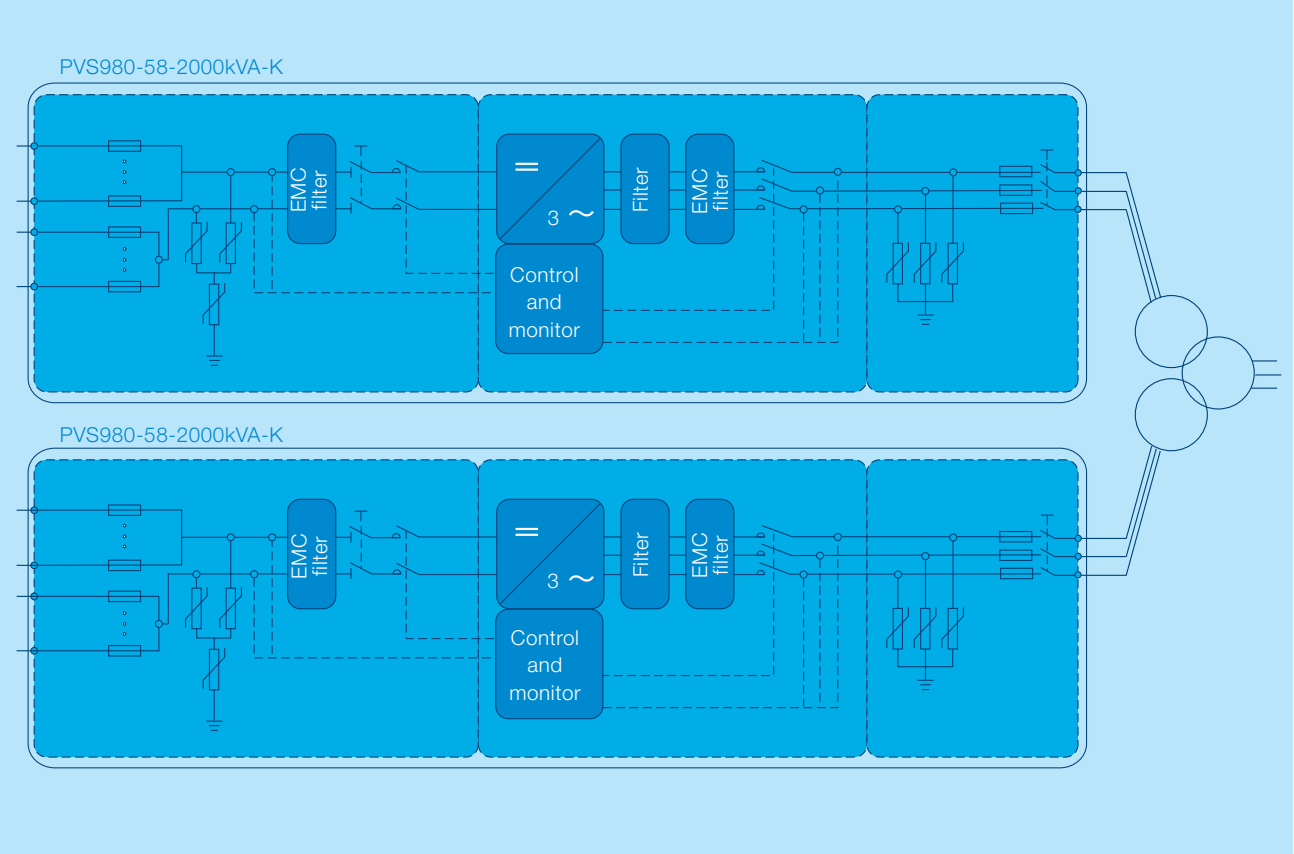
1818 to 2000 kVA

Technical data and types

Type designation	-1818kVA-I	-1909kVA-J	-2000kVA-K
PVS980-58	1818 kVA	1909 kVA	2000 kVA
Input (DC)			
Maximum input power ($P_{PV,max}$) [1]	2910 kWp	3055 kWp	3200 kWp
DC voltage range, mpp ($U_{DC, mpp}$) at 50 °C	850 to 1100 V	893 to 1100 V	935 to 1100 V
DC voltage range, mpp ($U_{DC, mpp}$) at 35 °C	850 to 1500 V	893 to 1500 V	935 to 1500 V
Maximum DC voltage ($U_{max (DC)}$)	1500 V	1500 V	1500 V
Number of MPPT trackers	1	1	1
Number of protected DC inputs	8 [2] to 24 (+/-)	8 [2] to 24 (+/-)	8 [2] to 24 (+/-)
Output (AC)			
Nominal power ($S_{N(AC)}$) [3]	1818 kVA	1909 kVA	2000 kVA
Maximum output power ($S_{max (AC)}$) [4]	2000 kVA	2100 kVA	2200 kVA
Nominal AC current ($I_{N(AC)}$)	1750 A	1750 A	1750 A
Nominal output voltage ($U_{N(AC)}$) [5]	600 V	630 V	660 V
Output frequency	50/60 Hz	50/60 Hz	50/60 Hz
Harmonic distortion, current [6]	< 3%	< 3%	< 3%
Distribution network type [7]	TN and IT	TN and IT	TN and IT
Efficiency			
Maximum [8]	98.8%	98.8 %	98.8%
Euro-eta [8]	98.6%	98.6 %	98.6%
Power consumption			
Own consumption in operation	2500 W	2500 W	2500 W
Standby operation consumption	225 W	225 W	225 W
Auxiliary voltage type	internal	internal	internal
Dimensions and weight			
Width/Height/Depth, mm (W/H/D)	3180/2366/1522	3180/2366/1522	3180/2366/1522
Weight appr.	3850 kg	3850 kg	3850 kg

[1] DC/AC ratio over 1.6 might decrease time between maintenance intervals
[2] As standard
[3] At 50 °C
[4] At 35 °C
[5] ±10%
[6] At nominal power
[7] Inverter side must be IT type
[8] Without auxiliary power consumption at min U_{DC}

ABB PVS980 central inverter design and power network connection

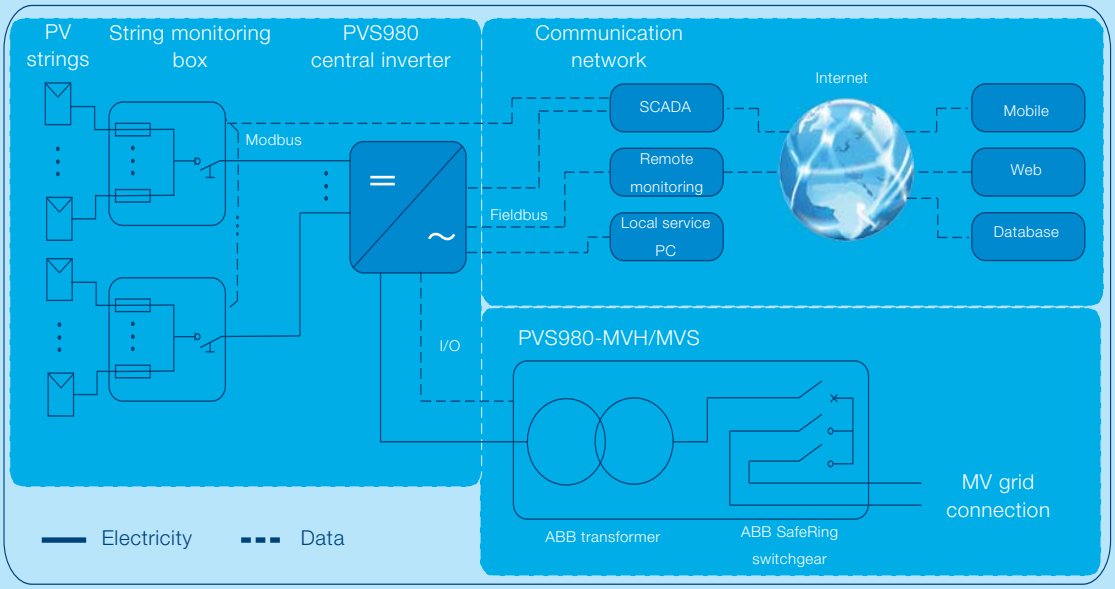


Technical data and types

Type designation	-1818kVA-I	-1909kVA-J	-2000kVA-K
PVS980-58	1818 kVA	1909 kVA	2000 kVA
Environmental limits			
Degree of protection	IP65 [9]/Type 4X		
Ambient temp. range (nom. ratings) [10]	-20 °C to +50 °C		
Maximum ambient temperature [11]	+60°C		
Relative humidity	5% to 100%		
Maximum altitude (above sea level)	4000 m [12]		
Maximum noise level	85 dBA [13]		
Protection			
Ground fault monitoring [14]	Yes		
Grid monitoring	Yes		
Anti-islanding	Yes		
DC reverse polarity	Yes		
AC and DC short circuit and overcurrent	Yes		
AC and DC overvoltage and temperature	Yes		
User interface and communications			
Local user interface	ABB local control panel		
Analog inputs/outputs	Extendable as option		
Digital inputs/relay outputs	Extendable as option		
Fieldbus connectivity	Modbus, Profinet, Ethernet [14]		
Product compliance			
Safety and EMC [15]	CE conformity according to LV and EMC directives		
Certifications and approvals [15]	IEC, UL, CEI, RD, EDF, P.O. 12.3, BDEW, GOST, AS		
Grid support and grid functions	Reactive power compensation [16], Power reduction, LVRT, Anti-islanding		

[9] Excluding underpressure testing
[10] -40 °C as option
[11] Power derating after 50 °C
[12] Derating above 1000 m
[13] At partial power typically < 75 dBA
[14] More communication options as engineered option
[15] Approvals pending, contact ABB for more information
[16] Also at night

Data communication principle for ABB PVS980 central inverters



3AXD50000027473 REV D EN 11.4.2016

Options

- Integrated and flexible DC input extension
- AC breaker
- AC busbar interface
- DC grounding (negative and positive)
- Fieldbus and Ethernet connections
- Current measurement to each DC input
- High altitude version
- Warranty extensions
- Solar inverter care contracts

Related products

- Medium voltage station (transformer and switchgear) as outdoor or containerised solution
- String monitoring junction boxes
- Remote monitoring solutions

Support and service

ABB supports its customers with a dedicated service network in more than 60 countries and provides a complete range of life cycle services from installation and commissioning to preventative maintenance, spare parts, repairs and recycling.

For more information please contact your local ABB representative or visit:

www.abb.com/solarinverters
www.abb.com

Power and productivity for a better world™

INGECON SUN

PowerMax U B Series
1,500 Vdc

TRANSFORMERLESS CENTRAL INVERTERS WITH A SINGLE POWER BLOCK

B Series inverter up to 1.8 MVA at 1500 V

Maximum power density
These PV central inverters feature more power per cubic foot. Thanks to the use of high-quality components, this inverter series performs at the highest possible level.

Latest generation electronics
The B Series inverters integrate an innovative control unit that runs faster and performs a more efficient and sophisticated inverter control, as it uses a last-generation digital signal processor. Furthermore, the hardware of the control unit allows some more accurate measurements and very reliable protections.

These inverters feature a low voltage ride-through capability and also a lower power consumption thanks to a more efficient power supply electronic board.

Improved AC connection
The output connection has been designed in order to facilitate a direct close-coupled connection with the MV transformer.

Maximum protection
These PV inverters are supplied with the combiner box already integrated. Thus, they can guarantee the maximum protection thanks to their DC load break switches and the motorized DC switch to decouple the PV generator from the inverter.

Moreover, they are also supplied with a motorized AC circuit breaker. Optionally, they can be supplied with DC fuses, smart grounding kit and input current monitoring.

Maximum efficiency values
Through the use of innovative electronic conversion topologies, efficiency values of up to 98.9% can be achieved.

Enhanced functionality
This new INGECON® SUN PowerMax range features a revamped, improved enclosure which, together with its innovative air cooling system, makes it possible to increase the ambient operating temperature.

UL 1741 COMPLIANT

www.ingeteam.com
solar.us@ingeteam.com

Ingeteam

Long-lasting design
These inverters have been designed to guarantee a long life expectancy. Standard 5 year warranty, extendable for up to 25 years.

Grid support
The INGECON® SUN PowerMax B Series has been designed to comply with the grid connection requirements UL1741SA, IEEE1547 and RULE21, contributing to the quality and stability of the electric system. These inverters therefore feature a low voltage ride-through capability, and can deliver reactive power and control the active power delivered to the grid. Moreover, they can operate in weak power grids with a low SCR.

Ease of maintenance
All the elements can be removed or replaced directly from the inverter's front side, thanks to its new design.

Easy to operate
The INGECON® SUN PowerMax inverters feature an LCD screen for the simple and convenient monitoring of the inverter status and a range of internal variables. The display also includes a number of LEDs to show the inverter operating status with warning lights to indicate any incidents. All this helps to simplify and facilitate maintenance tasks.

Monitoring and communication
Ethernet communications supplied as standard. The following applications are included at no extra cost: INGECON® SUN Manager, INGECON® SUN Monitor and its Smartphone version Web Monitor, available on the App Store. These applications are used for monitoring and recording the inverter's internal operating variables through the Internet (alarms, real time production, etc.), in addition to the historical production data.

Two communication ports available (one for monitoring and one for plant controlling), allowing fast and simultaneous plant control.

PROTECTIONS

- Integrated combiner box with DC isolators.
- DC Reverse polarity.
- Short-circuits and overloads at the output.
- Anti-islanding with automatic disconnection.
- Insulation failure DC.
- Up to 12 pairs of fuse holders (up to 15 if the combiner box is not integrated).
- Lightning induced DC and AC surge arrestors, type II.
- Motorized DC switch to automatically disconnect the inverter from the PV array.
- Low voltage ride-through capability.
- Motorized AC circuit breaker.
- Hardware protection via firmware.
- Additional protection for the power stack, as it is air cooled by a closed loop.

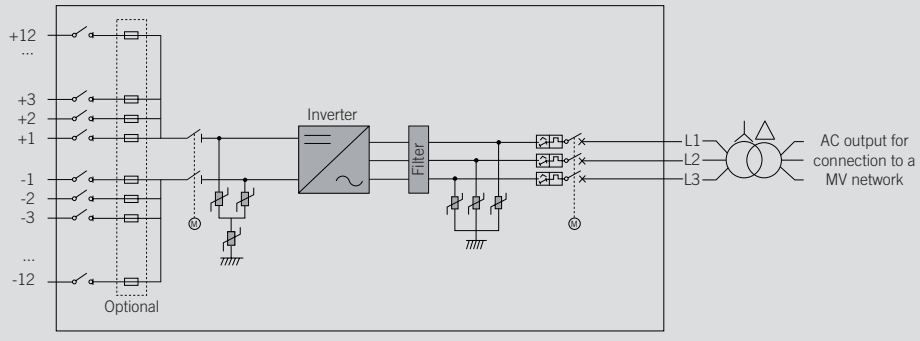
OPTIONAL ACCESSORIES

- Insulation failure AC.
- Grounding kit.
- Sand trap kit.
- Heating kit, for operating at an ambient temperature of down to -22 °F.
- DC fuses.
- Monitoring of the group currents at the DC input.
- Extendable up to 15 fuse holders per inverter.
- PID prevention kit (PID: Potential Induced Degradation).
- Night time reactive power injection.

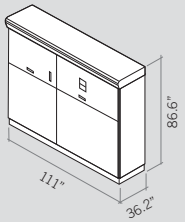
ADVANTAGES OF THE B SERIES

- Higher power density.
- Latest generation electronics.
- More efficient electronic protection.
- Night time supply to communicate with the inverter at night.
- Enhanced performance.
- Easier maintenance thanks to its new design and enclosure.
- Lightweight spares.
- It allows to ground the PV array.
- Components easily replaceable.

PowerMax B Series

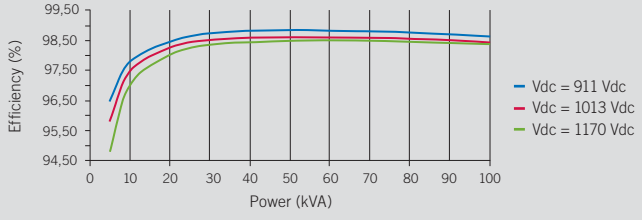


Size and weight (inches and lbs)



3,572 pounds

Efficiency INGECON® SUN 1640TL U B630



	1170TL U B450	1245TL U B480	1400TL U B540	1500TL U B578	1560TL U B600	1600TL U B615
Input (DC)						
Recommended PV array power range[1]	1,157 - 1,520 kWp	1,234 - 1,622 kWp	1,389 - 1,824 kWp	1,486 - 1,952 kWp	1,543 - 2,027 kWp	1,581 - 2,077 kWp
Voltage Range MPP[2]	655 - 1,300 V	697 - 1,300 V	783 - 1,300 V	837 - 1,300 V	868 - 1,300 V	889 - 1,300 V
Maximum voltage[3]	1,500 V					
Maximum current	1,850 A					
N° inputs with fuse-holders	6 up to 12 (up to 15 if the combiner box is not integrated)					
Fuse dimensions	63 A / 1,500 V to 500 A / 1,500 V fuses (optional)					
Type of connection	Connection to copper bars					
Power blocks	1					
MPPT	1					
Input protections						
Overvoltage protections	Type II surge arresters					
DC switch	Motorized DC load break disconnect					
Other protections	Integrated DC combiner box / Up to 12 pairs of DC fuses (optional) / Reverse polarity / Insulation failure monitoring / Anti-islanding protection / Emergency pushbutton					
Output (AC)						
Power NEMA 3 @86 °F / @122 °F	1,169 kVA / 1,052 kVA	1,247 kVA / 1,122 kVA	1,403 kVA / 1,263 kVA	1,502 kVA / 1,352 kVA	1,559 kVA / 1,403 kVA	1,598 kVA / 1,438 kVA
Current NEMA 3 @86 °F / @122 °F	1,500 A / 1,350 A					
Power NEMA 4 @80.5 °F / @122 °F[4]	1,169 kVA / 1,035 kVA	1,247 kVA / 1,104 kVA	1,403 kVA / 1,242 kVA	1,502 kVA / 1,330 kVA	1,559 kVA / 1,380 kVA	1,598 kVA / 1,415 kVA
Current NEMA 4 @80.5 °F / @122 °F[4]	1,500 A / 1,328 A					
Rated voltage	450 V IT System	480 V IT System	540 V IT System	578 V IT System	600 V IT System	615 V IT System
Frequency	50 / 60 Hz					
Power Factor[5]	1					
Power Factor adjustable	Yes, 0-1 (leading / lagging)					
THD (Total Harmonic Distortion)[6]	<3%					
Output protections						
Overvoltage protections	Type II surge arresters					
AC breaker	Motorized AC circuit breaker					
Anti-islanding protection	Yes, with automatic disconnection					
Other protections	AC short-circuits and overloads					
Features						
Maximum efficiency	98.9%					
CEC	98.5%					
Max. consumption aux. services	4,250 W					
Stand-by or night consumption[7]	90 W					
Average power consumption per day	2,000 W					
General Information						
Ambient temperature	-4 °F to +140 °F					
Relative humidity (non-condensing)	0-100%					
Protection class	NEMA 3 (NEMA 4 with the sand trap kit)					
Maximum altitude	14,770 ft (for installations beyond 3,300 ft, please contact Ingeteam's solar sales department)					
Cooling system	Air forced with temperature control (230 V phase+ neutral power supply)					
Air flow range	0 - 84 ft³/s (0 - 7,800 m³/h)					
Average air flow	45 ft³/s (4,200 m³/h)					
Acoustic emission (100% / 50% load)	<66 dB(A) at 33 ft / <54.5 dB(A) at 33 ft					
Marking	CE, ETL					
EMC and security standards	UL1741, FCC Part 15, IEEE C37.90.1, IEEE C37.90.2, CSA22.2 No107					
Grid connection standards	IEC 62116, UL1741SA, IEEE1547, IEEE1547.1, NEC CODE, Rule 21, Rule 14H, CSA22.2 No107					

Notes: [1] Depending on the type of installation and geographical location. Data for STC conditions [2] Vmpp.min is for rated conditions (Vac=1 p.u. and Power Factor=1) [3] Consider the voltage increase of the 'Voc' at low temperatures [4] With the sand trap kit [5] For P_{out}>25% of the rated power [6] For P_{out}>25% of the rated power and voltage in accordance with IEC 61000-3-4 [7] Consumption from PV field when there is PV power available.

	1640TL U B630	1665TL U B640	1690TL U B650	1715TL U B660	1740TL U B670	1800TL U B690
Input (DC)						
Recommended PV array power range[1]	1,620 - 2,128 kWp	1,646 - 2,162 kWp	1,672 - 2,195 kWp	1,698 - 2,229 kWp	1,723 - 2,263 kWp	1,775 - 2,330 kWp
Voltage Range MPP[2]	911 - 1,300 V	925 - 1,300 V	939 - 1,300 V	953 - 1,300 V	968 - 1,300 V	996 - 1,300 V
Maximum voltage[3]	1,500 V					
Maximum current	1,850 A					
N° inputs with fuse-holders	6 up to 12 (up to 15 if the combiner box is not integrated)					
Fuse dimensions	63 A / 1,500 V to 500 A / 1,500 V fuses (optional)					
Type of connection	Connection to copper bars					
Power blocks	1					
MPPT	1					
Input protections						
Overvoltage protections	Type II surge arresters					
DC switch	Motorized DC load break disconnect					
Other protections	Integrated DC combiner box / Up to 12 pairs of DC fuses (optional) / Reverse polarity / Insulation failure monitoring / Anti-islanding protection / Emergency pushbutton					
Output (AC)						
Power NEMA 3 @86 °F / @122 °F	1,637 kVA / 1,473 kVA	1,663 kVA / 1,497 kVA	1,689 kVA / 1,520 kVA	1,715 kVA / 1,543 kVA	1,741 kVA / 1,567 kVA	1,793 kVA / 1,613 kVA
Current NEMA 3 @86 °F / @122 °F	1,500 A / 1,350 A					
Power NEMA 4 @80.5 °F / @122 °F[4]	1,637 kVA / 1,449 kVA	1,663 kVA / 1,472 kVA	1,689 kVA / 1,495 kVA	1,715 kVA / 1,518 kVA	1,741 kVA / 1,541 kVA	1,793 kVA / 1,587 kVA
Current NEMA 4 @80.5 °F / @122 °F[4]	1,500 A / 1,328 A					
Rated voltage	630 V IT System	640 V IT System	650 V IT System	660 V IT System	670 V IT System	690 V IT System
Frequency	50 / 60 Hz					
Power Factor[5]	1					
Power Factor adjustable	Yes, 0-1 (leading / lagging)					
THD (Total Harmonic Distortion)[6]	<3%					
Output protections						
Overvoltage protections	Type II surge arresters					
AC breaker	Motorized AC circuit breaker					
Anti-islanding protection	Yes, with automatic disconnection					
Other protections	AC short-circuits and overloads					
Features						
Maximum efficiency	98.9%					
CEC	98.5%					
Max. consumption aux. services	4,250 W					
Stand-by or night consumption[7]	90 W					
Average power consumption per day	2,000 W					
General Information						
Ambient temperature	-4 °F to +140 °F					
Relative humidity (non-condensing)	0-100%					
Protection class	NEMA 3 (NEMA 4 with the sand trap kit)					
Maximum altitude	14,770 ft (for installations beyond 3,300 ft, please contact Ingeteam's solar sales department)					
Cooling system	Air forced with temperature control (230 V phase+ neutral power supply)					
Air flow range	0 - 84 ft³/s (0 - 7,800 m³/h)					
Average air flow	45 ft³/s (4,200 m³/h)					
Acoustic emission (100% / 50% load)	<66 dB(A) at 33 ft / <54.5 dB(A) at 33 ft					
Marking	CE, ETL					
EMC and security standards	UL1741, FCC Part 15, IEEE C37.90.1, IEEE C37.90.2, CSA22.2 No107					
Grid connection standards	IEC 62116, UL1741SA, IEEE1547, IEEE1547.1, NEC CODE, Rule 21, Rule 14H, CSA22.2 No107					

Notes: [1] Depending on the type of installation and geographical location. Data for STC conditions [2] Vmpp.min is for rated conditions (Vac=1 p.u. and Power Factor=1) [3] Consider the voltage increase of the 'Voc' at low temperatures [4] With the sand trap kit [5] For P_{out}>25% of the rated power [6] For P_{out}>25% of the rated power and voltage in accordance with IEC 61000-3-4 [7] Consumption from PV field when there is PV power available.

Exhibit E
Substation Transformer Specifications

1) GE Prolec

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

COLLECTOR STEP UP TRANSFORMER
ONAN/ONAF/ONAF
100/133/165 MVA
60 HZ, THREE PHASE, 65°C, 3300 FASL
138/79.674 KV Δ - 34.5/19.92 KV Y
TERTIARY BURIED: 13.8 KV Δ

INVENERGY, LLC
PROJECT: WAU11459
GE Req. No: TD168585
PROLEC GE Serial No: G3926-01
SUBSTATION: BISHOP HILL 3
Transformer Specification 3/9/2017

PROLEC GE
APPROVED FOR MANUFACTURING
05/23/2018
FOR APPROVAL, ENTER
PLEASE REVIEW ALL DATA
COMMENTS TO THIS DATA, ENTER
THE DATE MARKED IN THIS STAMP.

PROLEC GE

http://www.prolecge.com

TRANSFORMER

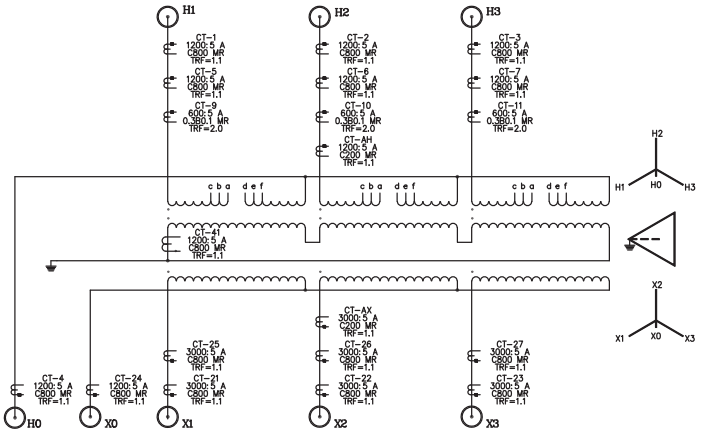
SERIAL No G3926-__, THREE-PHASE, 60 Hz, ALTITUDE 3300 ft

VOLTAGE RATING 138 000 GrdY/79 674 - 34 500 Y/19 920 - 13 800		
kVA RATING	100 000	CONTINUOUS @ 65 °C RISE ONAN
kVA RATING	133 000	CONTINUOUS @ 65 °C RISE ONAF
kVA RATING	165 000	CONTINUOUS @ 65 °C RISE ONAF

APPROXIMATE WEIGHTS (POUNDS)	
CORE AND COILS	163510
TANK AND FITTINGS	63100
MAIN TANK LIQUID (8449 GALS)	63455
COOLING EQUIPMENT LIQUID (609 GALS)	4575
CONSERVATOR TANK LIQUID (406 GALS)	3050
TOTAL WEIGHT	297690
UNTANKING WEIGHT (HEAVIEST PIECE)	163510
SHIPPING WEIGHT (WITHOUT OIL):	199135
TOTAL WEIGHT OF INSULATION	3012000 grams

IMPEDANCE @ 85 °C			
	%Z	kVA BASE	kV BASE
H-X		100 000	138 - 34.5
H-Y	14.2	100 000	138 - 13.8
X-Y	3.69	100 000	34.5-13.8

BASIC IMPULSE LEVEL (kV)				
	H1,H2,H3	X1,X2,X3	H0	X0
BUSHING	650	200	200	200
WINDING	650	200	200	200



TRANSFORMER DESIGNED FOR A NOMINAL IMPEDANCE H-X OF 8.0 % @ 100 000 kVA THE ACTUAL MEASURED IMPEDANCE VALUE WILL BE SHOWN ON THE NAMEPLATE.

MATERIAL: STAINLESS STEEL
DIMENSIONS: 20" x 12"

HIGH VOLTAGE WINDING			
VOLTS	AMPERES	DE-ENERGIZED TAP CHANGER	
H1, H2, H3	165 000 kVA	POS	CONNECTS
144 900	657	1	a TO d
141 450	673	2	d TO b
138 000	690	3	b TO e
134 550	708	4	e TO c
131 100	727	5	c TO f

LOW VOLTAGE WINDING	
VOLTS	AMPERES
X1, X2, X3	165 000 kVA
34 500	2 760

CAUTION !

1- BEFORE INSTALLING OR OPERATING READ INSTRUCTIONS G3926
2- DO NOT OPERATE TRANSFORMER WHEN THE READING OF LIQUID LEVEL GAUGE IS BELOW THE LOW POINT OF THE SCALE.
3- DO NOT OPERATE DE-ENERGIZED TAP CHANGER WITH THE TRANSFORMER ENERGIZED.

NOTES

1- MAXIMUM OPERATING PRESSURES OF LIQUID PRESERVATION SYSTEM: 0 Lbf/in²
2- TANK DESIGNED FOR 15 Lbf/in² VACUUM FILLING
3- ALL WINDINGS COPPER.
4- FILLED WITH MINERAL OIL WHICH CONTAIN NO DETECTABLE LEVEL OF PCB AT THE TIME OF MANUFACTURE.
5- WINDINGS CONSTRUCTION :
TERTIARY, HELICAL WINDING.
LOW VOLTAGE, HELICAL WINDING.
HIGH VOLTAGE, INTERSHIELDED DISC WINDING.
6- TERTIARY WINDING IS FOR STABILIZATION ONLY.

SUITABLE FOR STEP UP OPERATION

MANUFACTURE DATE: ___/ 2 0 __

MADE IN MEXICO

REV	DESCRIPTION
0	

DESIGN GROUP LPT-1

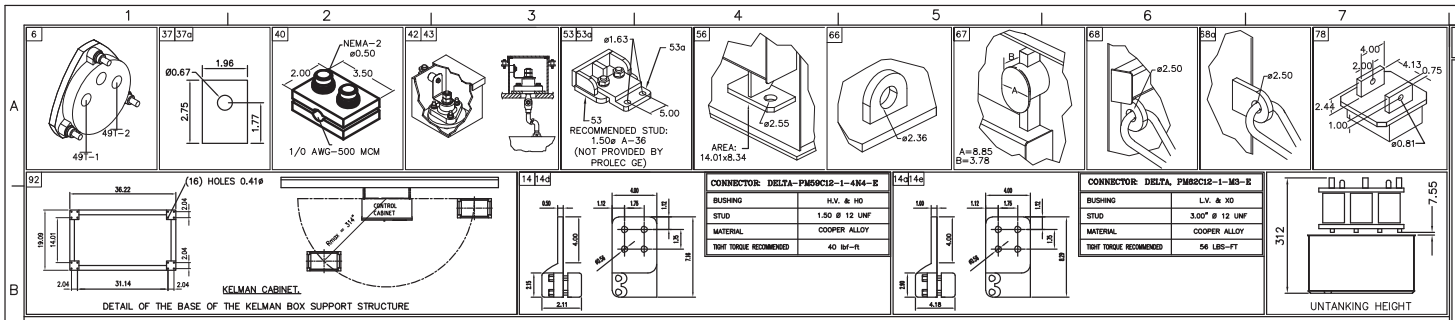
TITLE: NAMEPLATE

PROLEC GE ENGINEERING POWER DIVISION
http://www.prolecge.com

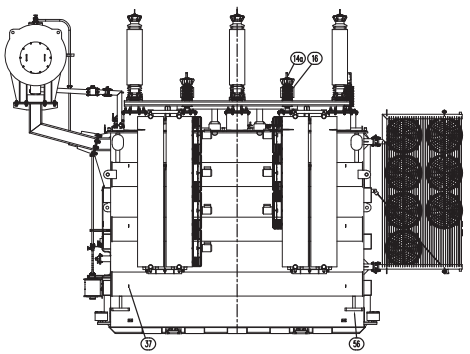
DFTM: ROM 07/19/2017
CHKD: CSP 07/19/2017

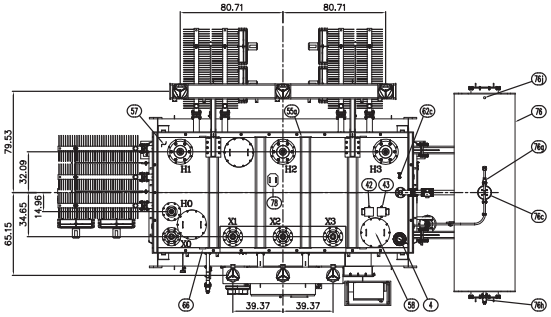
PROJECTION
SCALE: NONE
DIMENSIONS IN: NONE
REVISION: INDICATED

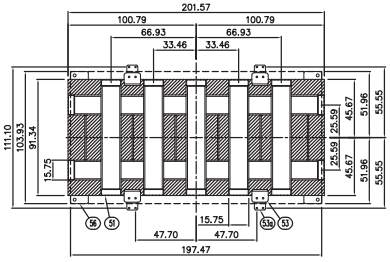
DRAWING NO.: G3926D1802
SHEET: 1 of 1



GUIDE		QTY.	ITEM	DESCRIPTION	CAT./MOD.
		1	1a	H.V. WINDING TEMPERATURE INDICATOR (49T-1)	QUALITROL, 104-412-01
		1	1b	L.V. WINDING TEMPERATURE INDICATOR (49T-2)	QUALITROL, 104-412-01
		1	1d	LIQUID TEMPERATURE INDICATOR (26Q-1)	QUALITROL, 104-685-03
		1	2d	THERMAL-WELL FOR LIQUID TEMPERATURE INDICATOR	
5.4	*	1	4	PRESSURE RELIEF DEVICE WITH SEMAPHORE (63PR-1)	QUALITROL, LPRD00-00008306
5.6	*	1	5	RAPID PRESSURE RELAY (OIL) (63FP-1)	QUALITROL, 900-014-05
		1	5c	RAPID PRESSURE RELAY VALVE (2.00 ø) GATE-TYPE	
		1	6	THERMAL PLATE (TPT-1)	QUALITROL, 3WT-1025-1
		1	11	PRESSURE-VACUUM GAUGE FOR SHIPPING	
		1	11b	PRESSURE-VACUUM GAUGE AND BLEEDER WITH CONTACTS (63PV-1)	QUALITROL, 148-011-01 CS35537
5.15	*	3	14	H.V. BUSHING EXTERNAL CONNECTOR	DELTA, PM59C12-1-4N4-E
5.15	*	3	14a	L.V. BUSHING EXTERNAL CONNECTOR	DELTA, PM52C12-1-M3-E
5.15	*	1	14d	NEUTRAL BUSHING HO EXTERNAL CONNECTOR	DELTA, PM59C12-1-4N4-E
5.15	*	1	14e	NEUTRAL BUSHING XO EXTERNAL CONNECTOR	DELTA, PM62C12-1-M3-E
3.2	*	3	15	H.V. BUSHING	ABB, 136N8128A
3.2	*	3	16	L.V. BUSHING	ABB, 034N3000AA
3.2	*	1	19	NEUTRAL BUSHING HO	ABB, 034N0412AA
3.2	*	1	20	NEUTRAL BUSHING XO	ABB, 034N3000AA
4.2	*	3	25	H.V. SURGE-ARRESTERS	ABB, P108GA088A
4.1	*	1	26	H.V. SURGE-ARRESTER SUPPORT	
4.2	*	3	27	L.V. SURGE-ARRESTER	ABB, Q030NA024A
4.1	*	1	28	L.V. SURGE-ARRESTER SUPPORT	
		10	37	H.V. SUPPORT GROUND CABLE (CABLE AND CONNECTOR PROVIDED BY OTHERS)	
		10	37a	L.V. SUPPORT GROUND CABLE (CABLE AND CONNECTOR PROVIDED BY OTHERS)	
		4	40	GROUND PAD	
		1	42	CORE GROUND BUSHING TERMINAL BOX (MAIN UNIT)	
		1	43	FRAME GROUND BUSHING BOX	
		1	46	NAMEPLATE	
		1	47	CONTROL CABINET WITH SHOCK MOUNTINGS	
		1	50	DE-ENERGIZED TAP-CHANGER	ABB, DTW
		1	51	REINFORCED BASE WELDED TO TANK	
		4	53	TRANSFORMER ANCHOR PADS	
	*	4	53a	TRANSFORMER ANCHORAGE CLAMPS	
		12	55	TANK BRACES	
		4	55a	COVER BRACES	
		4	56	JACKING PADS AND PULLING EYES	
		1	57	MAIN COVER	
		3	58	INSPECTION MANHOLE (COVER)	
		1	62c	VACUUM FILLING VALVE (0.75 ø) GLOBE-TYPE WITH INTERNAL SPLASH BAFFLE	
		1	65	CT TERMINAL BOX	
		4	66	LIFTING EYE COVER ONLY	
		4	67	LIFTING HOOK FOR LIFTING COMPLETE UNIT	
		4	68	SHIPPING LUGS FOR SECURING THE UNIT LONGITUDINALLY (SHORT LUGS)	
		4	68a	SHIPPING LUGS FOR SECURING THE UNIT LONGITUDINALLY (LONG LUGS)	
		1	72c	TOP FILTER PRESS VALVE (2.00 ø) GLOBE-TYPE WITH INTERNAL SPLASH BAFFLE	
		1	73	MAIN TANK DRAIN VALVE (2.00 ø) GLOBE-TYPE WITH SAMPLING DEVICE (0.38 ø) AND PLUG	
		1	74	IMPACT RECORDER FOR SHIPPING	
1.3	*	7	75	COOLING RADIATORS	
		14	75b	RADIATOR VENT AND DRAIN PLUG (1.00 ø)	
		14	75d	RADIATOR VALVE BUTTERFLY-TYPE (4.00 ø)	
	*	20	75h	COOLING FAN, FULL LOAD AMPS= 1.8 A, STARTING AMPS= 5.1 A, 240V 1 PHASE 60 HZ, 1/3 HP, 7400 CFMS, 1140 RPM, 332 WATTS	KRENZ, F26D-A9712
1.4	*	6	75n	TOP/BOTTOM RADIATOR SHUTS	
1.2	*	4	75o	RADIATOR BRACE	
2.3	*	1	76	CONSERVATOR TANK WITH INTERNAL BLADDER	
2.1	*	2	76a	CONSERVATOR TANK SUPPORT	
2.2	*	1	76b	CONSERVATOR MAGNETIC LIQUID LEVEL GAUGE (71Q-1)	QUALITROL, 042-144-15 CS-47050
		1	76c	HANDHOLE TO INSTALL BLADDER	
5.8	*	1	76d	SILICA-GEL BREATHER WITH PIPE	BROWNELL LTD, BL/D6290/04-OR
		2	76e	CONSERVATOR MANHOLE	
5.8	*	1	76f	SILICA-GEL SHUT OFF VALVE (1.00 ø) GLOBE-TYPE	
		1	76g	CONSERVATOR PRESSURE EQUALIZATION VALVE (1.00 ø) GLOBE-TYPE	
		1	76h	CONSERVATOR FILL VALVE (2.00 ø) GLOBE-TYPE	
		1	76i	CONSERVATOR DRAIN VALVE (2.00 ø) GLOBE-TYPE	
		1	76l	CONSERVATOR TANK COUPLING FOR VENT WITH PLUG	
2.2	*	2	76k	CONSERVATOR TANK TO MAIN TANK VALVE (3.00 ø) BUTTERFLY-TYPE	
		1	76l	GAS SAMPLING DEVICE	
2.4	*	1	76m	PROTECTIVE RELAY FOR GAS ACCUMULATION (BUCHHOLZ) (63BH-1)	EMB, 53-6.28.44.-0336
		1	78	TETHER POLE MOUNTING PLATE	
	*	1	92	KELMAN CABINET	KELMAN, TRANSFIX DGA 500
		2	92a	KELMAN VALVE (1.00 ø) BALL-TYPE	
	*	1	92b	KELMAN FLEXIBLE PIPE	
	*	2	92c	KELMAN PIPE CONDUIT (SET)	

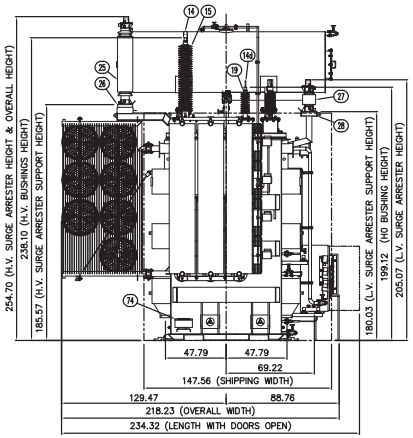


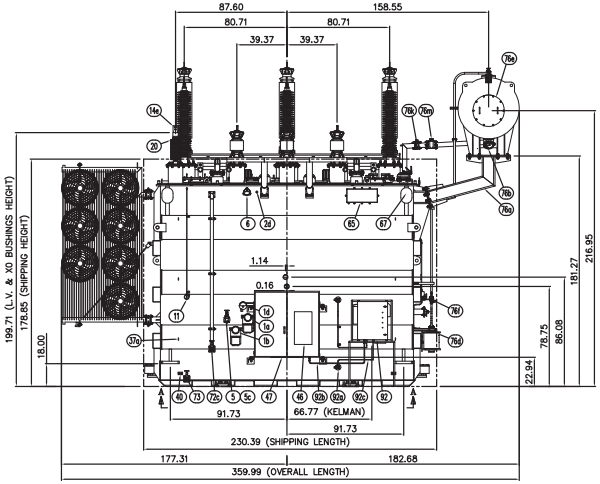


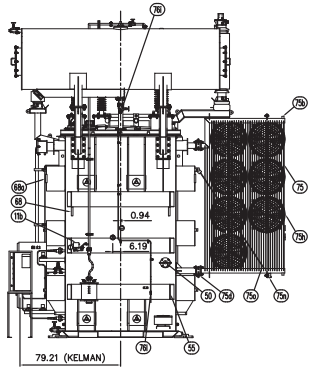


SECTION A - A

* THE HATCHED AREA REPRESENT THE BOTTOM OF THE TRANSFORMER, THIS AREA IS NOT IN CONTACT WITH FOUNDATION OR PAD







APPROXIMATE WEIGHTS (POUNDS)	
CORE AND COILS	163510
TANK AND FITTINGS	63100
MAIN TANK LIQUID (8449 GALS)	63455
COOLING EQUIPMENT LIQUID (609 GALS)	4575
CONSERVATOR TANK LIQUID (406 GALS)	3050
TOTAL WEIGHT	297690
UNTANKING WEIGHT (HEAVIEST PIECE)	163510
SHIPPING WEIGHT (WITHOUT OIL):	199135

PROLEC GE
APPROVAL DRAWING
05/23/2018
DEAR CUSTOMER:
WE WANT TO GIVE YOU A BETTER SERVICE, PLEASE REVIEW THIS DRAWING AND SEND BACK YOUR COMMENTS TO PROLEC-GE AT THE LATEST WITHIN 10 DAYS AFTER THE DATE MARKED IN THIS STAMP.

INVENERGY LLC
P.O. No: WNA111459
GE Req No: TD168585
PROLEC GE Serial No: G3926-01
SUBSTATION BISHOP HILL 3
Transformer Specification 3/9/2017

COLLECTOR STEP UP TRANSFORMER
ONAN/ONAF/ONAF
100/133/165 MVA
60 HZ, THREE PHASE, 65°C, 3300 FASL
138/79.674 KV Δ — 34.5/19.92 KV Y
TERTIARY BURIED: 13.8 KV Δ

TOLERANCES	
Centerline distance of not inclined bushings	±.25
Centerline distance of inclined bushings	+1.00 −.62
Bushings height (distance to floor)	±.50
Outlet of control cabinet distance	±.25
Hv & Lv bushings center line	±.25
Bushings & surge arrester center line	±.25
Surge arrester height (distance to floor)	±.50
Center tank distance to short side	±.50
Center tank distance to large side	±.50
Conservator height	±.50
Anchoring center line	±.12
Bracing base center line	±.12
Pattern distance	+.06 −.18
Outline 0–118.00	±1.00
Dimensions 118.00–197.00	±1.50
197.00 & Above	±2.00

NOTES:
a) ITEMS REMOVED FOR SHIPMENT ARE MARKED WITH (*).
b) NUMBERING IS ACCORDING WITH G.E. PROLEC STD. LIST.
c) THE NUMBER IN COLUMN "GUIDE" CORRESPONDS TO THE "IN-FIELD ASSEMBLY GUIDE"

OPERATION CENTER OF GRAVITY
SHIPPING CENTER OF GRAVITY

REV	DESCRIPTION	DESIGN	DATE
1	ITEM 92 CATALOG NUMBER WAS MODIFIED	ROM	08/29/17

PROLEC GE ENGINEERING POWER DIVISION
http://www.prolecge.com

TITLE: TRANSFORMER'S OUTLINE

DFTM: ROM 07/19/17
CHKD: CSP 07/19/17

PROJECTION
SCALE: 1:48
DIMENSIONS: IN
REVISION: INDICATED
DRAWING NO.: G392601D801
sheet: 1 of 1

Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN

Exhibit F

TRC Site Characterization Report October 2018

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

SITE CHARACTERIZATION STUDY REPORT

Hardin Solar II Energy Center

Hardin County, Ohio

October 2018

TRC Project No. 302899.0002.0000

Prepared For:

Hardin Solar Energy II LLC
One South Wacker Drive, Suite 1800
Chicago, IL 60606
Phone: 312.224.1400

Prepared By:

TRC Environmental Corporation
921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6353

Tracy Engle
Office Practice Leader

Justin Pitts
Ecological Project Manager

TRC
Results you can rely on

CONFIDENTIAL BUSINESS INFORMATION

Table of Contents

List of Tables

List of Figures

Acronyms

DOW	Division of Wildlife
Ft	Feet
GIS	Geographic Information System
GPS	Global Positioning System
HSE	Hardin Solar Energy II LLC
IPaC	Information for Planning and Conservation
MW	Megawatt
m	Meter
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
OAC	Ohio Administration Code
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OPSB	Ohio Power Siting Board
ORAM	Ohio Rapid Assessment Method
TRC	TRC Environmental Corporation
U.S.	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1.0 INTRODUCTION

On behalf of Hardin Solar Energy II LLC (HSE), TRC Environmental Corporation (TRC) has prepared this Site Characterization Report as part of the environmental studies conducted for the Hardin Solar II Energy Center Project (Project). The proposed solar facility will generate up to 170 megawatts (MW) of power. The October 2018 Project Area is the area which HSE will propose to include within their Ohio Power Siting Board (OPSB) application for a certificate of environmental compatibility and public need, issued by the OPSB. In total, the Project Area is approximately 3,388 acres (1,371 hectares), including 396 acres (160 hectares) of underground collection corridors. The privately owned land is located approximately 2.5 miles (3.9 kilometers) southeast of Alger, in Hardin County, Ohio. The Project Area is bisected by Township Road 120 (east/west) and is bounded by Township Road 100 on the north, County Road 65 on the east, and neighboring landowners to the south and west in Marion, McDonald, and Roundhead Township, Hardin County, Ohio (Figure 1.1).

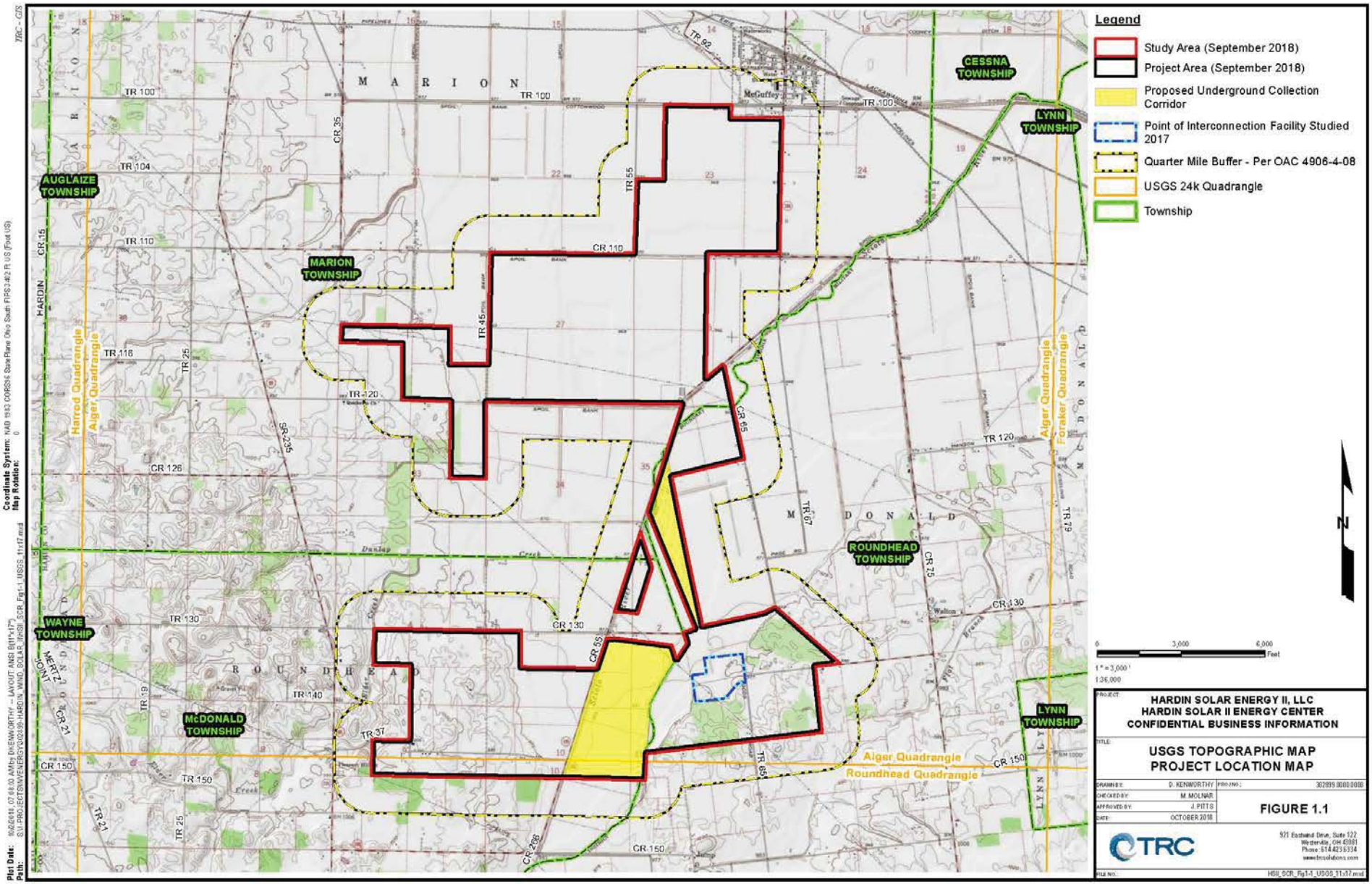
The Study Area consists of the potential construction Project Area and a 100-foot (30-meter) buffer in accordance with Ohio Administrative Code (OAC) 4906-4-08(B)(1)(b). This Study Area is approximately 3,696 acres (1,496 hectares) of primarily cultivated, rotational cropland.

A literature review was completed using publicly available data sources, including a 0.25-mile (0.40-kilometer) buffer beyond the Project Area boundary in accordance with OAC 4906-4-08(B)(1)(c). The approximate area studied for the literature review is 7,525 acres (3,045 hectares).

The study objectives were to provide information needed to address questions posed under the Tier 1 Preliminary Site Evaluation and Tier 2 Site Characterization Study tiers of the United States Fish and Wildlife Service's (USFWS) Land-Based Wind Energy Guidelines (WEG; USFWS 2012), and to provide data to comply with the Ohio Power Siting Board (OPSB) requirements at OAC 4906-4-08(B)(1). The wind guidelines were used because a similar tiered approach for solar development projects has not been established by the USFWS.

The Project lies within the Eastern Corn Belt Plains Ecoregion. The Eastern Corn Belt Plains is generally characterized by loamy and well-drained soils associated with rolling plains and local end moraines (Wilkin, E, F J Nava, and G Griffith. 2011). The vegetation of the ecoregion was originally dominated by American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*) and American basswood (*Tilia americana*) forests (Wilkin, E, F J Nava, and G Griffith. 2011). Field observations, aerial photography and National Land Cover Database (NLCD) mapping show this landscape has been significantly altered by farming practices. Project Area elevation ranges from approximately 950 feet (290 meters) to 1,022 feet

(312 meters) above mean sea level. Soils consist of Blount silt loam, end moraine, 0 to 2 percent slopes (Ble1A1); Blount silt loam, end moraine, 2 to 4 percent slopes (Ble1B1); Blount silt loam, ground moraine, 0 to 2 percent slopes (Blg1A1); Blount silt loam, ground moraine, 2 to 4 percent slopes (Blg1B1); Carlisle muck, Central Ohio clayey till plain, drained, 0 to 2 percent slopes (Ca); Colwood loam (Co); Glynwood clay loam, 6 to 12 percent slopes, eroded (Gwd5C2); Glynwood silt loam, end moraine, 2 to 6 percent slopes (Gwe1B1); Glynwood silt loam, ground moraine, 2 to 6 percent slopes (Gwg1B1); Glynwood clay loam, ground moraine, 2 to 6 percent slopes, eroded (Gwg5B2); Glynwood clay loam, ground moraine, 6 to 12 percent slopes, eroded (Gwg5C2); Linwood muck (Ln); McGuffey muck (Mc); Milford silty clay loam, 0 to 2 percent slopes (Mf); Morley clay loam, 12 to 18 percent slopes, eroded (MrD2); Olentangy silt loam (Ot); Pewamo silty clay loam, 0 to 1 percent slopes (PkA); Pewamo variant muck (Po); Roundhead muck (Ro); and Sloan silt loam, frequently flooded (So) (NRCS 2018).



2.0 METHODS

The preliminary site assessment and site characterization were completed using a combination of a) existing information obtained from available public sources including reports, published literature, on-line databases, and geographic information system (GIS) data, b) field reconnaissance, and c) agency consultation.

2.1 EXISTING INFORMATION FROM AVAILABLE PUBLIC SOURCES

The following publicly available data sources were used to complete a literature review required by OAC 4906-4-08(B)(1)(c), which specifies review of a 0.25-mile (0.40-kilometer) buffer beyond the Project Area boundary – (Figure 1.1 - Quarter Mile Buffer). The following data sources were used to complete this review:

- Google Earth™ ("Google Earth – Google Earth." Google Earth. Google, no date (n.d.) Web. 1 June 2018. *https://earth.google.com/*).
- National Audubon's Important Bird Areas ("Important Bird Areas." Audubon. No publisher (N.p., n.d.) Web. 1 June 2018. *http://www.audubon.org/important-bird-areas*).
- National Audubon's Christmas Bird Count ("Christmas Bird Count." Audubon. N.p., n.d. Web. 1 June 2018. *http://www.audubon.org/conservation/science/christmas-bird-count*).
- National Land Cover Database (NLCD) (Survey, U.S. Geological. "National Land Cover Database (NLCD)." LCS Program: NLCD. N.p., n.d. Web. 1 June 2018. *https://www2.usgs.gov/climate_landuse/lcs/projects/nlcd.asp*).
- Ohio Department of Natural Resources (ODNR), Division of Wildlife and USFWS, Ohio Ecological Services Field Office. "Ohio Mussel Survey Protocol." April 2018. *https://wildlife.ohiodnr.gov/portals/wildlife/pdfs/licenses%20&%20permits/OH%20Mussel%20Survey%20Protocol.pdf*
- ODNR National Heritage Database (Ohio DNR Division of Wildlife. "Ohio.gov / search." ODNR Division of Wildlife (DOW). N.p., n.d. Web. 7 June 2018. *http://wildlife.ohiodnr.gov/species-and-habitats/ohio-natural-heritage-database*).
- U.S. Department of Agriculture (USDA), National Resource Conservation Service (NRCS), Web-Soil Survey (Web Soil Survey. N.p., n.d. Web. 1 June 2018. *https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx*).
- USFWS Information for Planning and Conservation (IPaC) IPaC: Home. N.p., n.d. Web. 8 June 2018. *https://ecos.fws.gov/ipac/*).
- USFWS National Wetlands Inventory (NWI) (U.S. Fish and Wildlife Service (USFWS (2018a); National Wetlands Inventory; National Standards and Support Team. "Wetlands Mapper." Official Web page of the USFWS. N.p., n.d. Web. 21 May 2018. *https://www.fws.gov/wetlands/data/Mapper.html*).

From these sources, TRC generated a NLCD Land Cover Types map (Figure 3.1), a NWI wetland features map (Figure 3.2), a Breeding Bird Survey Routes, Christmas Bird Count Circles, and Important Bird Areas Locations map (Figure 3.3). TRC also generated a summary of designated sensitive lands and of sensitive species possibly occurring in the Study Area, along with their typical habitat requirements (Section 3.4 Wildlife Species). Sensitive species include: state and federally-listed species (endangered, threatened or candidate), potentially threatened species, USFWS birds of conservation concern, and special interest or species of concern species.

Correspondence with the USFWS (2018b) was received in a Technical Assistance Letter on June 25, 2018. The USFWS conducted a literature review within a 1-mile radius of the Project, including records review of federally-listed threatened and endangered species and their habitats, and known locations of bald eagle nests. For additional information, a review of the USFWS County Distribution List (2018d) was conducted to determine the species distribution of federally-listed endangered, threatened and proposed species in Hardin County, Ohio. Based on this literature review and subsequent field reconnaissance (Section 2.2) of the Study Area, the likelihood of species occurrence (e.g. High Potential, Moderate Potential, Low Potential, No Potential and Confirmed Sighting) within the Study Area was determined by TRC.

Correspondence with the ODNR (2018a) through an inter-disciplinary review within the Department was received July 2, 2018. For this Project, the ODNR conducted a Natural Heritage Database review within a 1-mile radius including known eagle's nests, an Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) records review within a 5-mile radius, and hibernacula records review within a 10-mile radius of the Project.

2.2 FIELD RECONNAISSANCE

A field reconnaissance of the Study Area was conducted on May 16th, 18th, 22nd, 23rd, 29th, June 12th – 14th, and September 14th and 17th, 2018 to complete the following:

- Ground-truth NLCD land cover types and locations;
- Document where land cover types provide habitat for species of concern;
- Ground-truth NWI mapped potential wetland locations;
- Document readily observable features that may serve to attract wildlife, if any; and
- Record incidental wildlife and plant observations while in the Study Area.

Vegetation and surface waters were surveyed in the Study Area. Based on field observations within the Study Area, the NLCD classification map units were either confirmed or reclassified. Readily identifiable

land cover changes (i.e., areas that had been converted to cultivated crops) were recorded and mapped. Land cover changes were mapped based on vegetative structure and dominant species composition. The boundaries were mapped in the field using a global positioning system (GPS) (where land parcel was accessible) and completed using current Google Earth™ imagery.

Data developed from existing information were utilized during the field reconnaissance to document areas where land cover types may provide suitable habitat for federal and state species of concern. Land cover types were field-verified, and locations were documented if they provided potentially suitable habitat for species of concern. For species with specific or narrowly defined habitat requirements, potentially suitable habitats were viewed (where land parcel was accessible), and the presence or absence of the specific habitat requirements were recorded.

NWI mapped wetland locations within the Study Area were assessed during field reconnaissance to ascertain the presence or absence of wetland vegetation and wetland hydrology (noting the predominant vegetative strata, dominant plant species, and type: stream, pond, lake, etc.). Wetland resources within the Study Area were identified and their boundaries determined in accordance with the United States Army Corps of Engineers (USACE) *Wetlands Delineation Manual (1987 Manual)* (USACE 1987), utilizing the *Regional Supplement to the United States (U.S.) Army Corps of Engineers Wetland Delineation Manual: Midwest (Version 2.0) (Regional Supplement)* (USACE 2012). Consistent with the *1987 Manual*, wetland determinations were based on dominant plant species, soil characteristics, and hydrologic characteristics. In addition, wetlands and other waters of the U.S. were evaluated in accordance with the State of Ohio's Water Quality Standards (OAC Chapter 3745-1) as managed by the Ohio Environmental Protection Agency (OEPA). Areas that exhibit hydric soils, wetland hydrology, and a dominance of hydrophytic vegetation were considered potentially jurisdictional wetlands. See the Wetlands and Other Waters of the U.S. Delineation Report (TRC 2018) for additional information.

NWI wetlands other waters of the U.S. are summarized in the Results (Section 3.2 Wetlands and Other Waters) section of this Report. Based on results of the field investigations, fourteen (14) wetlands, ten (10) streams, one (1) ditch, and six (6) open water resources (ponds) were field-identified and delineated within the Study Area.

Readily observable features that could serve as suitable habitat for wildlife such as summer bat roosting habitat, caves, freshwater mussel beds, and wetlands were mapped and briefly described. Additionally, animal and plant observations made during field reconnaissance were recorded for inclusion in this Report (Table 3.4).

3.0 RESULTS

3.1 LAND COVER

Land cover types within the Study Area consist primarily of cultivated crops (Figure 3.1). As shown in Table 3.1, approximately 94.53 percent of the Study Area is comprised of cultivated crops.

Table 3.1 Field-Verified National Land Cover Database Land Cover Types within the Hardin Solar II Energy Center Study Area, Hardin County, Ohio, 2018.

Cover Type	Acres	Hectares	Percent (%)
Cultivated Crops	3,494.24	1,414.07	94.53
Deciduous Forest	52.18	21.12	1.41
Developed, Open Space	118.72	48.04	3.21
Developed, Medium Intensity	2.21	0.89	0.06
Developed, Low Intensity	23.76	9.62	0.64
Developed, High Intensity	0.03	0.01	< 0.01
Grassland/Herbaceous	5.22	2.11	0.14
Woody Wetlands	0.17	0.07	< 0.01
Total	**3,696.53**	**1,495.93**	**100.00**

3.2 WETLANDS AND OTHER WATERS

Prior to conducting the field reconnaissance, in accordance with OAC 4906-4-08(B)(1)(c), a literature review of NWI maps (USFWS 2018a) identified freshwater forested/shrub wetlands, freshwater emergent wetlands, and freshwater ponds as being located within the 0.25-mile (0.40-kilometer) buffer around the Project Area boundary (Figure 3.2). Table 3.2.1 summarizes the wetland types noted on the NWI maps (Figure 3.2). In total, ten (10) NWI features are located within the 0.25-mile (0.40-kilometer) buffer.

Table 3.2.1 National Wetlands Inventory Wetland Types within the Hardin Solar II Energy Center 0.25-Mile (0.40-Kilometer) Buffer Area, Hardin County, Ohio, 2018.

Wetland Type	Number of Features	Acres	Hectares
Freshwater Forested/Shrub Wetland	3	27.28	11.04
Freshwater Emergent Wetland	5	12.48	4.89
Freshwater Pond	2	5.19	2.10
Total	**10**	**44.95**	**18.03**

TRC field-determined and delineated the boundaries of a combined total of one (1) freshwater forested/shrub wetland, one (1) freshwater forested/emergent wetland, nine (9) freshwater emergent wetlands, and three (3) freshwater forested wetlands, comprising 16.51 acres (6.68 hectares), within the Study Area. In addition, six (6) freshwater ponds, totaling 3.58 acres (1.45 hectares) were also identified within the Study Area (TRC 2018).

Table 3.2.2 Wetland and Waterbody Features Delineated within the Hardin Solar II Energy Center Study Area, Hardin County, Ohio, 2018.

Wetland Type	Number of Features	Acres	Hectares
Freshwater Forested/Shrub Wetland	1	1.91	0.77
Freshwater Forested/Emergent Wetland	1	0.14	0.07
Freshwater Emergent Wetland	9	9.21	3.73
Freshwater Forested Wetland	3	5.25	2.12
Freshwater Pond	6	3.58	1.45
Total	**20**	**20.09**	**8.14**

Ten (10) streams and one (1) ditch were identified within the Study Area, including Elder Creek, Scioto River, Cottonwood Ditch, Twin Branches, and their unnamed tributaries (TRC 2018). In general, the streams have perennial, intermittent and ephemeral flow with substrates comprised primarily of silt, gravel and muck. Instream cover (i.e. shallows, overhanging vegetation, large woody debris, and boulders) was minimal throughout the Study Area. The dominant vegetation within the Study Area along the channelized streams and ditches consists of smooth brome (*Bromus inermis*) and reed canary grass (*Phalaris arundinacea*).

Table 3.2.3 Other Waters of the United States Delineated within the Hardin Solar II Energy Center Study Area, Hardin County, Ohio, 2018.

Stream Type	Number of Feature	Length (ft.; m)[1]
Intermittent	2	42.30 (12.89)
Perennial	8	28,554.18 (8,703.31)
Ditch	1	1,307.61 (398.56)
Total	**11**	**29,904.09 (9,114.77)**

1 Represents delineated length, in feet, and meters within Study Area

3.3 HABITAT DESCRIPTION

Habitat diversity within the Study Area is low; the area is comprised primarily of agricultural fields with a corn (*Zea mays*) and soybean (*Glycine max*) monoculture that provides minimal habitat for foraging and

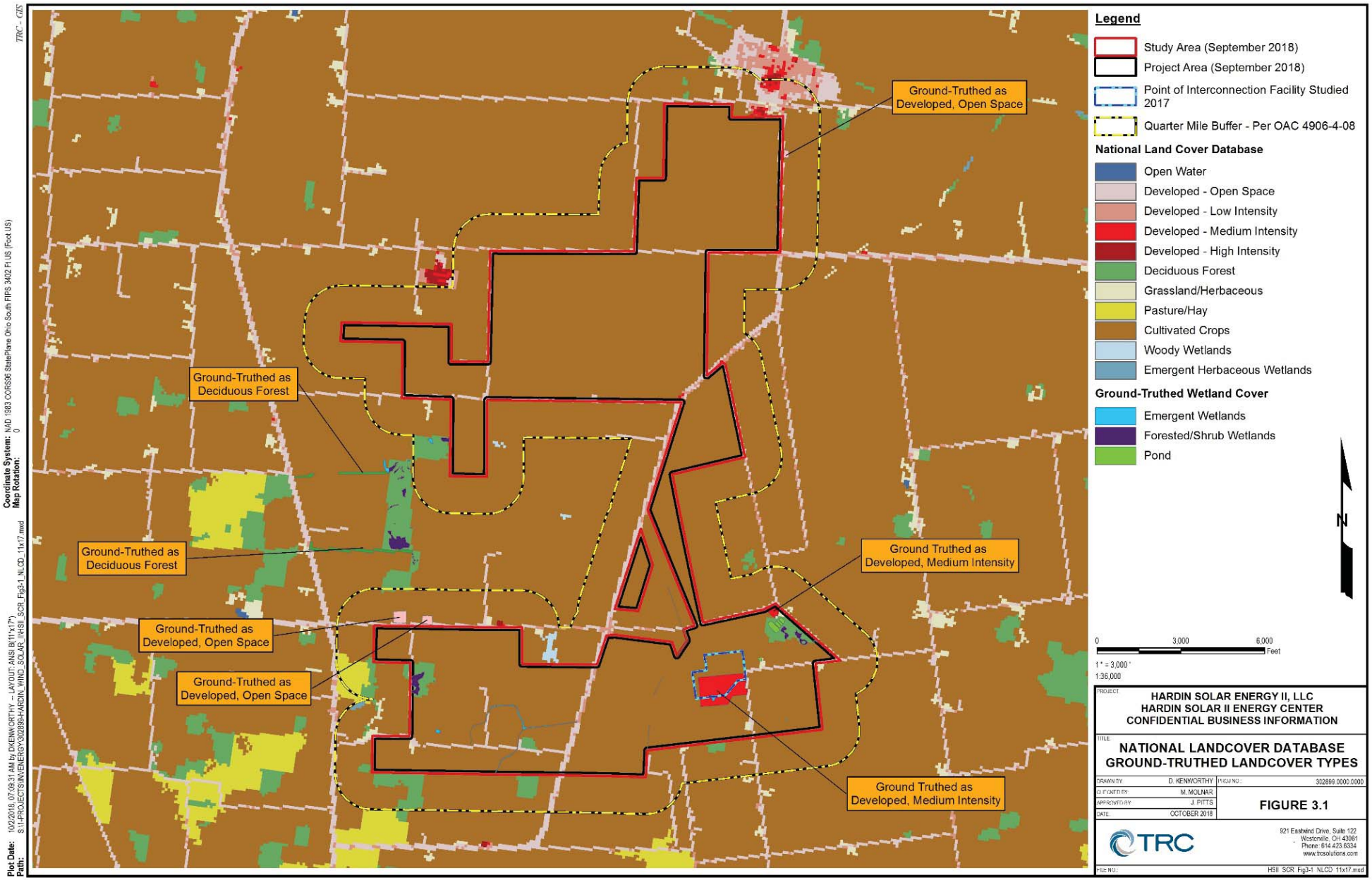
nesting. The Study Area lacks large areas of remnant forests, however, there are areas of early successional to mature deciduous woodlots and tree lines, emergent, scrub/shrub and forested wetlands, streams, and grasslands that offer some habitat variability for terrestrial and aquatic wildlife (Figure 3.1).

Areas of early successional to mature deciduous forests contain typical Ohio hardwoods, including but not limited to, the American elm (*Ulmus americana*), American basswood, eastern cottonwood (*Populus deltoids*), silver maple (*Acer saccharinum*), sugar maple, green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), red oak (*Quercus rubra*) and white oak (*Quercus alba*). The understory of forested wetland areas identified during field reconnaissance were comprised primarily of spicebush (*Lindera benzoin*), while the understory of the upland forested areas was dominated by stinging nettle (*Urtica dioica*). A complete list of vegetation, including herbaceous, scrub/shrub and trees, is documented in Table 3.4.

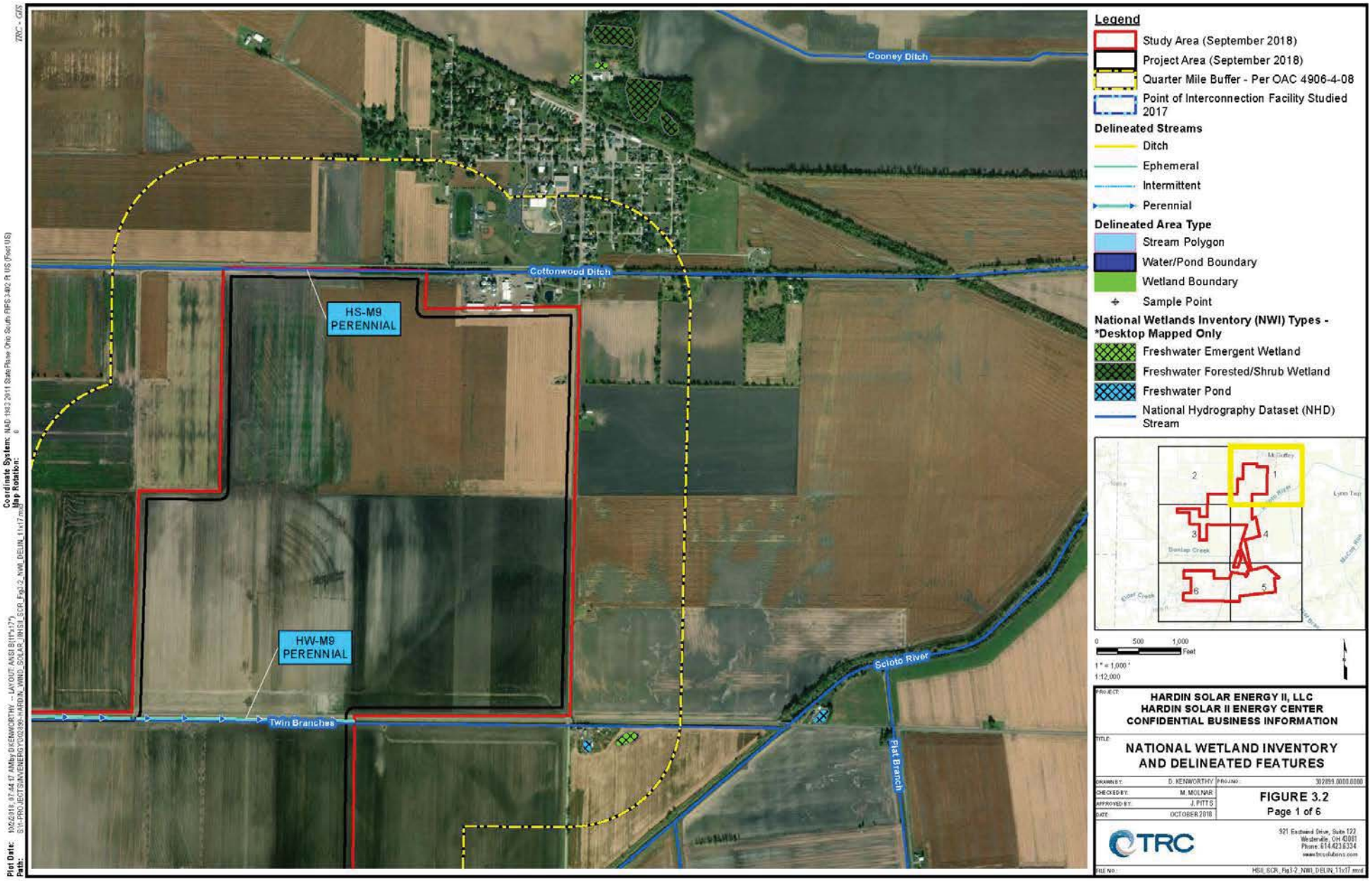
Overall, wetland habitat within the Study Area occurred within the agricultural fields, tree lines, grass swales and forested depressions. Vegetation and shallow water levels in these wetland habitats benefit plant and animal species by providing them with a source of food and water, shelter, social interactions, breeding, and nesting.

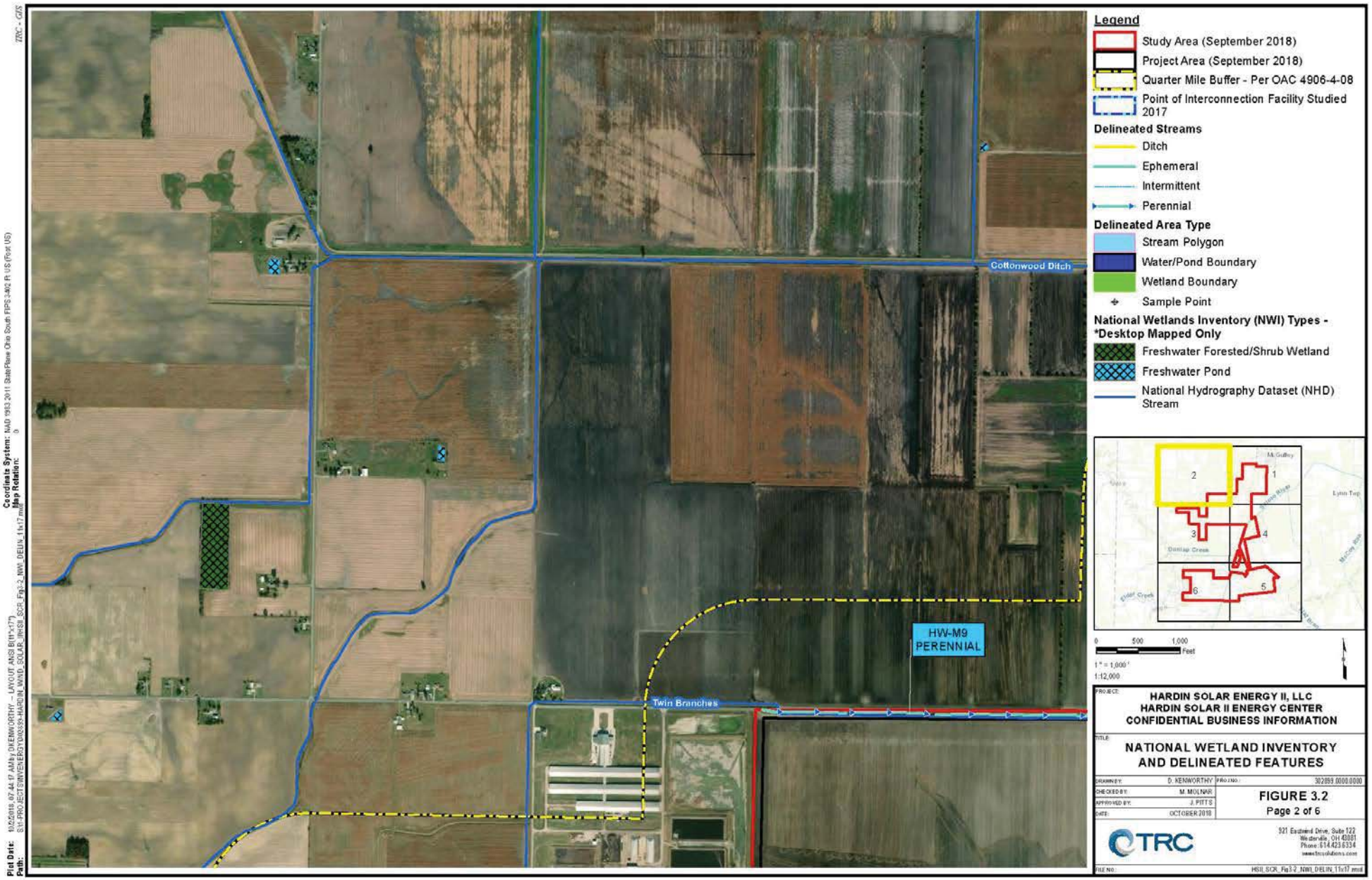
Field tiles, which drain hydrology from the agricultural fields for the purpose of creating manageable farmland, traverse the Study Area creating a network of channelized streams. Stream substrates were comprised of silt, gravel and muck, and instream cover (i.e. shallows, overhanging vegetation, large woody debris, and boulders) was minimal throughout the Study Area. Vegetation along the streams and ditches was dominated by smooth brome and reed canary grass. These modified streams exhibit an ordinary high water mark and possess a defined channel within the Study Area; however, drainage from the drain tiles have influenced the channel morphology, increased embeddedness, reduced sinuosity, and affected the overall water quality of the streams.

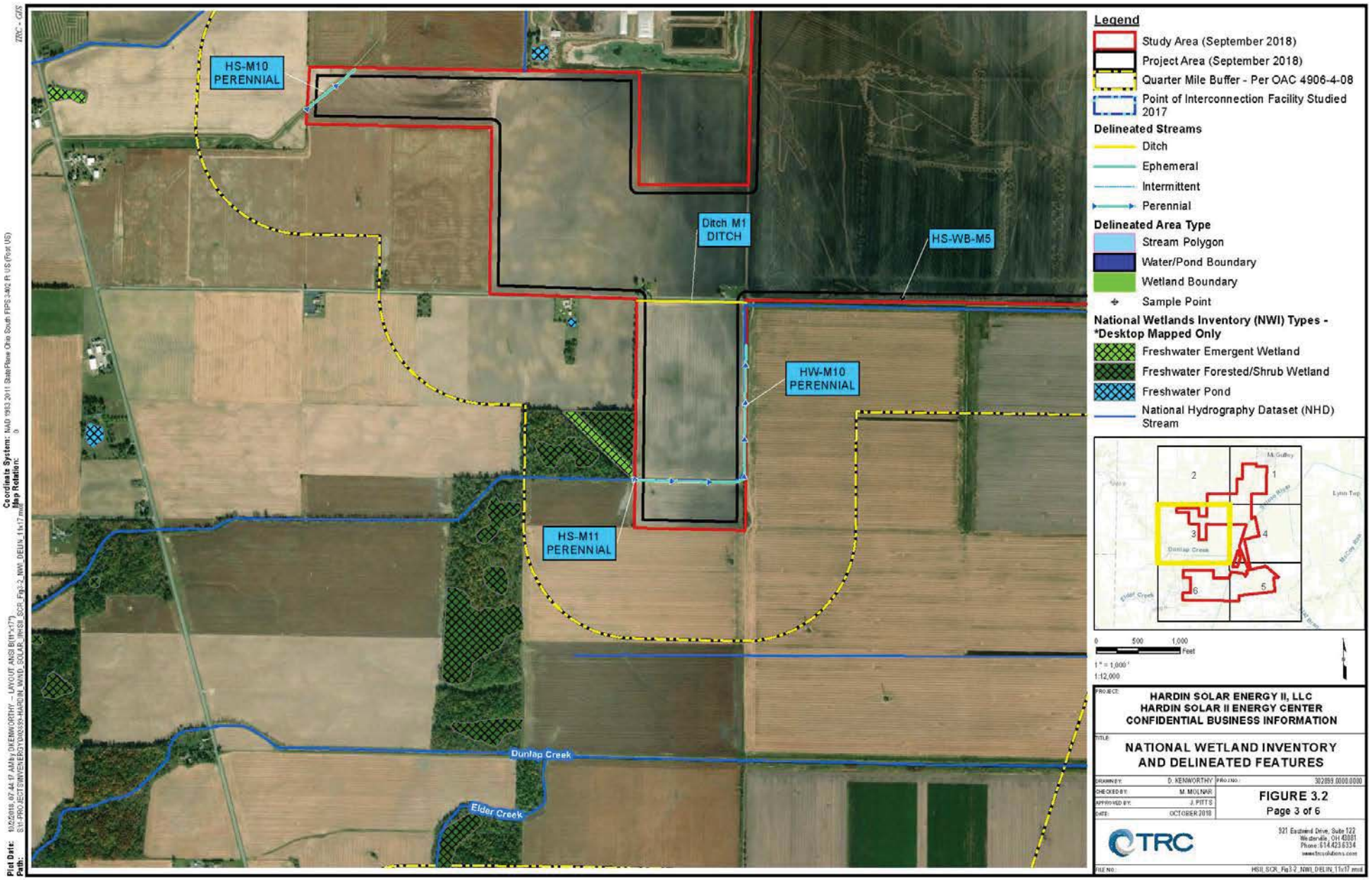
Desktop assessment completed within the Study Area confirmed USFWS (2018b) and ODNR (2018a) results; no federal wilderness areas, wildlife refuges, and dedicated, unique, sensitive or critical habitats are present within the Study Area. In addition, field survey results are consistent with the land use data, indicating that minimal habitat diversity exists within the Study Area.

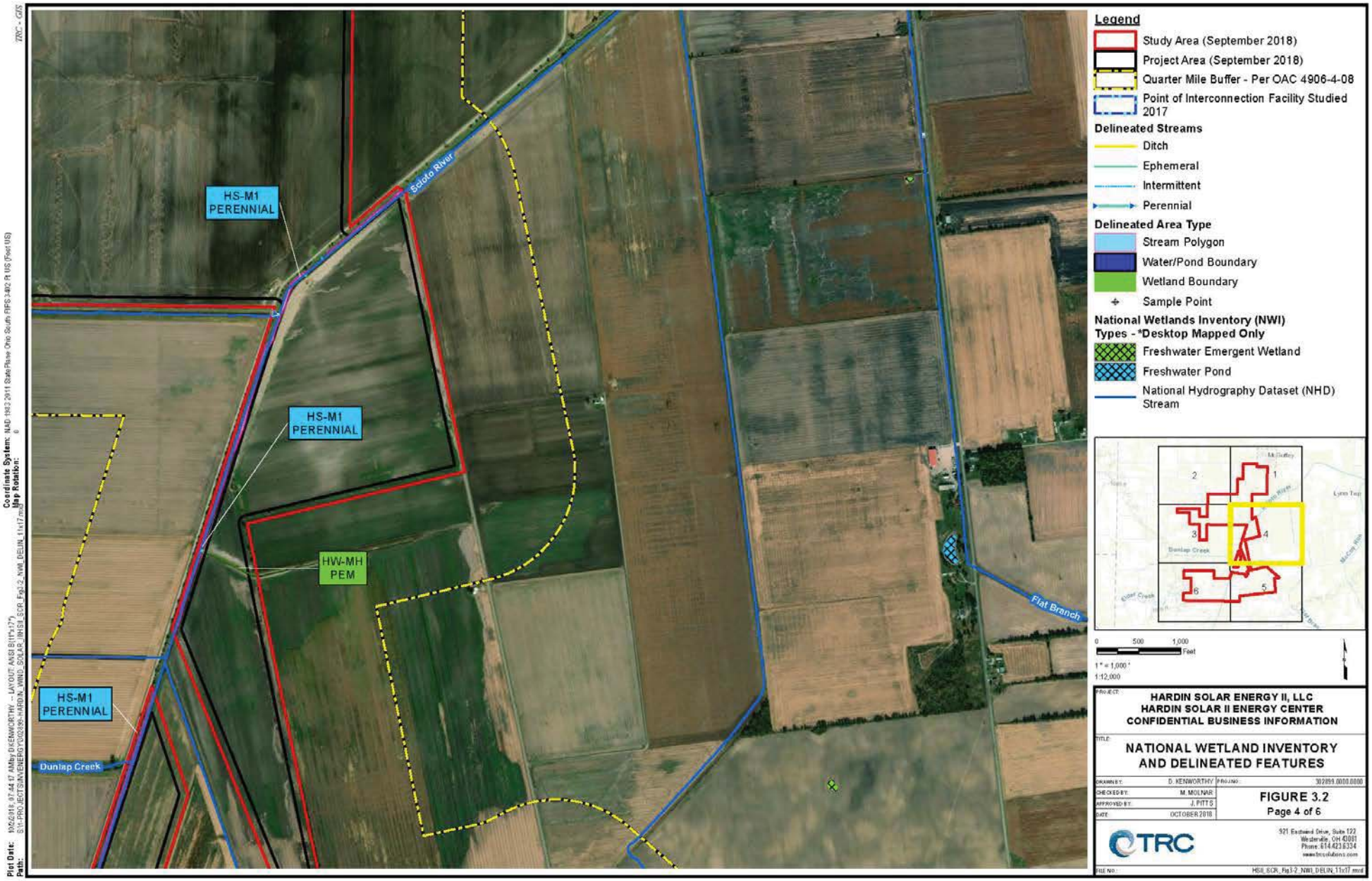


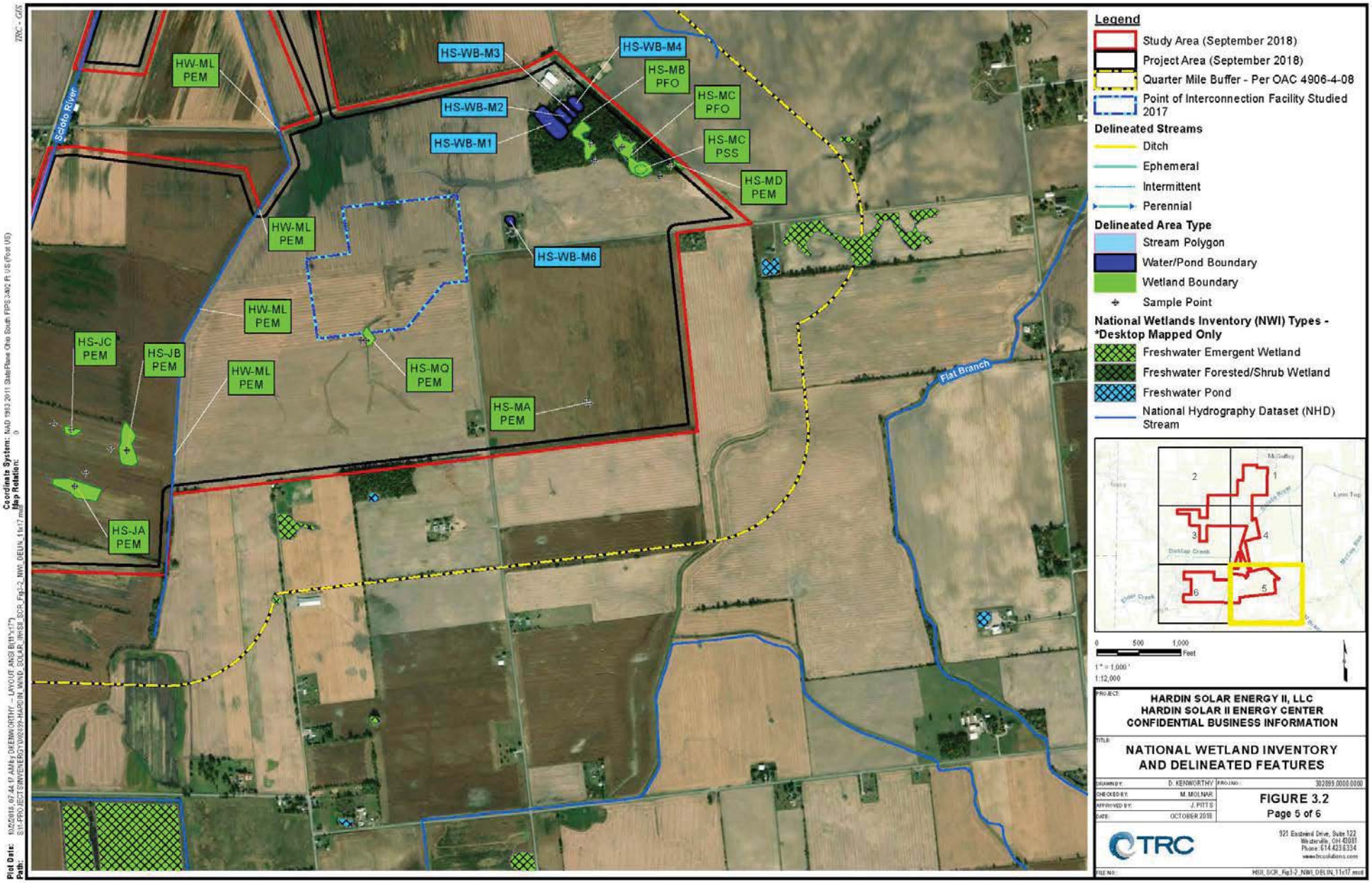
TRC
Results you can rely on

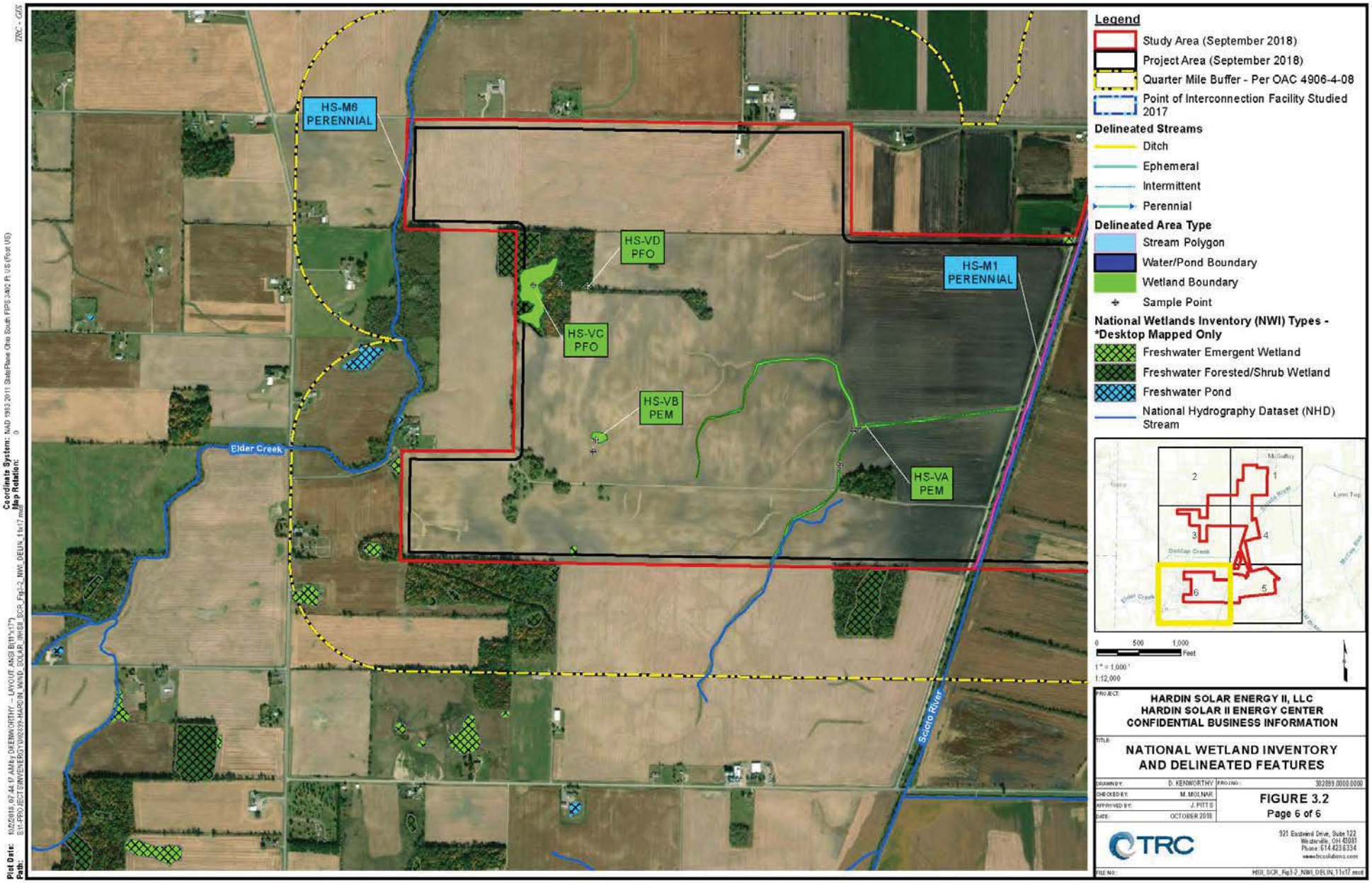

Cooney Ditch
Cottonwood Ditch
HS-M9
PERENNIAL
HW-M9
PERENNIAL
Twin Branches
Scioto River
Flat Branch
Legend
Study Area (September 2018)
Project Area (September 2018)
Quarter Mile Buffer - Per OAC 4906-4-08
Point of Interconnection Facility Studied 2017
Delineated Streams
Ditch
Ephemeral
Intermittent
Perennial
Delineated Area Type
Stream Polygon
Water/Pond Boundary
Wetland Boundary
Sample Point
National Wetlands Inventory (NWI) Types - *Desktop Mapped Only
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
National Hydrography Dataset (NHD) Stream
0 500 1,000 Feet
1 " = 1,000 '
1:12,000
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION
NATIONAL WETLAND INVENTORY AND DELINEATED FEATURES
D. KENWORTHY
M. MOLNAR
J. PITTS
OCTOBER 2018
FIGURE 3.2
Page 1 of 6
TRC
921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
www.trcsolutions.com


Cottonwood Ditch
HW-M9
PERENNIAL
Twin Branches
Legend
Study Area (September 2018)
Project Area (September 2018)
Quarter Mile Buffer - Per OAC 4906-4-08
Point of Interconnection Facility Studied 2017
Delineated Streams
Ditch
Ephemeral
Intermittent
Perennial
Delineated Area Type
Stream Polygon
Water/Pond Boundary
Wetland Boundary
Sample Point
National Wetlands Inventory (NWI) Types - *Desktop Mapped Only
Freshwater Forested/Shrub Wetland
Freshwater Pond
National Hydrography Dataset (NHD) Stream
0 500 1,000 Feet
1" = 1,000'
1:12,000
PROJECT:
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION
TITLE:
NATIONAL WETLAND INVENTORY AND DELINEATED FEATURES
DRAWN BY: D. KENWORTHY
CHECKED BY: M. MOLNAR
APPROVED BY: J. PITTS
DATE: OCTOBER 2018
PROJ NO.: 302899.0000.0000
FIGURE 3.2
Page 2 of 6
TRC
921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
FILE NO.: HSII_SCR_Fig3-2_NWI_DELIN_11x17.mxd


HS-M10 PERENNIAL
Ditch M1 DITCH
HS-WB-M5
HW-M10 PERENNIAL
HS-M11 PERENNIAL
Dunlap Creek
Elder Creek
Legend
Study Area (September 2018)
Project Area (September 2018)
Quarter Mile Buffer - Per OAC 4906-4-08
Point of Interconnection Facility Studied 2017
Delineated Streams
Ditch
Ephemeral
Intermittent
Perennial
Delineated Area Type
Stream Polygon
Water/Pond Boundary
Wetland Boundary
Sample Point
National Wetlands Inventory (NWI) Types - *Desktop Mapped Only
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
National Hydrography Dataset (NHD) Stream
0 500 1,000 Feet
1" = 1,000'
1:12,000
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION
NATIONAL WETLAND INVENTORY AND DELINEATED FEATURES
D. KENWORTHY
M. MOLNAR
J. PITTS
OCTOBER 2018
FIGURE 3.2
Page 3 of 6
TRC
Coordinate System: NAD 1983 2011 StatePlane Ohio South FIPS 3402 Ft US (Post US)
Map Rotation: 0
Plot Date: 10/25/2018, 07:44:17 AM by DKENWORTHY -- LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\WVES\EBGY\W0339-HARDIN_WIND_SOLAR_IIH\SII_SCR_Fig3-2_NWI_DELIN_11x17.mxd
TRC - GIS




HW-ML PEM
HS-WB-M3
HS-WB-M4
HS-MB PFO
HS-WB-M2
HS-MC PFO
HS-WB-M1
HS-MC PSS
HS-MD PEM
HW-ML PEM
HS-WB-M6
HW-ML PEM
HS-JC PEM
HS-JB PEM
HW-ML PEM
HS-MQ PEM
HS-MA PEM
HS-JA PEM
Scioto River
Flat Branch
Legend
Study Area (September 2018)
Project Area (September 2018)
Quarter Mile Buffer - Per OAC 4906-4-08
Point of Interconnection Facility Studied 2017
Delineated Streams
Ditch
Ephemeral
Intermittent
Perennial
Delineated Area Type
Stream Polygon
Water/Pond Boundary
Wetland Boundary
Sample Point
National Wetlands Inventory (NWI) Types - *Desktop Mapped Only
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
National Hydrography Dataset (NHD) Stream
0 500 1,000 Feet
1" = 1,000'
1:12,000
PROJECT: HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION
TITLE: NATIONAL WETLAND INVENTORY AND DELINEATED FEATURES
DRAWN BY: D. KENWORTHY
CHECKED BY: M. MOLNAR
APPROVED BY: J. PITTS
DATE: OCTOBER 2018
PROJ NO.: 302899.0000.0000
FIGURE 3.2
Page 5 of 6
TRC
921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
www.trcsolutions.com
FILE NO.: HSII_SCR_Fig3-2_NWI_DELIN_11x17.mxd



TRC
Results you can rely on

3.4 WILDLIFE SPECIES

According to ODNR (2018a) and USFWS (2018b), there are no records of sensitive species within the Study Area; however, there were sensitive species with records in the vicinity of the Study Area or with ranges that overlap the Study Area. Consultation correspondence with the ODNR (2018a) indicated the Project is within the range of the Indiana bat, a state endangered and federally endangered species, clubshell (*Pleurobema clava*), a state endangered and federally endangered mussel, the rayed bean (*Villosa fabalis*), a state endangered and federally endangered mussel, purple lilliput (*Toxolasma lividus*), a state endangered mussel, the pondhorn (*Uniomerus tetralasmus*), a state threatened mussel, eastern massasauga (*Sistrurus catenatus*), a state endangered and federal candidate snake species, upland sandpiper (*Bartramia longicauda*), a state endangered bird, and northern harrier (*Circus cyaneus*), a state endangered bird. Consultation with the USFWS (2018b) indicated the Project is within the range of the federally endangered Indiana bat and the federally threatened northern long-eared bat.

The USFWS IPaC resource (USFWS 2018c) identified the clubshell and rayed bean mussels, the copperbelly water snake (*Nerodia erythrogaster neglecta*), the bobolink (*Dolichoyx oryzivorus*), and the Indiana and northern long-eared bats species as having ranges that overlap the Study Area.

The USFWS County Distribution of Federally-Listed Endangered, Threatened, and Proposed Species (2018d) identified the federally endangered Indiana bat, clubshell mussel, and rayed bean mussel, and the federally threatened northern long-eared bat, eastern massasauga rattlesnake, and copperbelly water snake as having the potential to occur within Hardin County, Ohio.

The following sections and Table 3.3 outline the seasonal habitat requirements and potential for sensitive species to occur in the Project Area.

Table 3.3 Wildlife Species Of Concern, Status, Preferred Habitat, And Potential Seasons Of Occurrence For Species That Are Known Or Likely To Occur In The Hardin Solar II Energy Center Study Area.

Wildlife Type / Common Name	Scientific Name	Status[1]	Habitat by Season	Seasons of Potential Occurrence and Likelihood of Occurrence in the Study Area[2]			
				Spring	Summer	Fall	Winter
MUSSELS							
Rayed Bean	*Villosa fabilis*	FE	Small, headwater creeks, but has potential to occur in large rivers and wave-washed areas of glacial lakes	N	N	N	N
Clubshell	*Pleurobema clava*	FE	Clean, loose sand and gravel in medium to small rivers and streams	N	N	N	N
Purple Lilliput	*Toxolasma lividus*	SE	Headwaters of rivers, lakes, and reservoirs. From slow to swift currents, in mud, sand, and gravel substrates or shallow rocky gravel points and sandbars	M	M	M	M
Pondhorn	*Uniomerus tetralasmus*	ST	Ponds, small creeks, and the headwaters of larger streams in mud or sand.	M	M	M	M
REPTILES							
Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	FT	Mosaic of shallow wetlands or floodplain wetlands surrounded by forested uplands; seasonally flooded wetlands without fish favored for foraging	M	M	M	M
Eastern Massasauga rattlesnake	*Sistrurus catenatus*	FT	Wet areas, including wet prairies, marshes and low-lying areas along rivers and lakes; adjacent uplands	N	N	N	N

Table 3.3 Wildlife Species Of Concern, Status, Preferred Habitat, And Potential Seasons Of Occurrence For Species That Are Known Or Likely To Occur In The Hardin Solar II Energy Center Study Area.

Wildlife Type / Common Name	Scientific Name	Status[1]	Habitat by Season	Seasons of Potential Occurrence and Likelihood of Occurrence in the Study Area[2]			
				Spring	Summer	Fall	Winter
BIRDS							
Raptors							
Bald eagle	*Haliaeetus leucocephalus*	FSC	Bald eagle nesting season occurs in January through the end of August, and roosting season begins in mid-October and ends mid-March. Outside the breeding season, eagles of all ages typically perch and forage near open water where food and tall trees for perching are available.	L	L	L	L
Northern Harrier	*Circus cyaneus*	SE	Northern harriers breed from April to late July in wide-open habitats ranging from Arctic tundra to prairie grasslands to fields and wetlands (marshes). During migration and winter, harriers typically move south away from areas that receive heavy snow cover.	L	L	L	L
Golden eagle	*Aquila chrysaetos*	FSC	Inhabits the mountainous and hilly areas of western North America and winters as far as the southern Great Plains. During migration or over winter months, eagles are known to inhabit the Great Lakes region.	N	N	N	N
Non-raptors							
Bobolink	*Dolichonyx oryzivorus*	SSC	Resides in grassy hayfields and pastures, clover/alfalfa hayfields, wet prairies, and the grassy margins of marshes. Fallow fields comprised of grasses and weeds also provide suitable nesting habitat.	M	M	M	M

Table 3.3 Wildlife Species Of Concern, Status, Preferred Habitat, And Potential Seasons Of Occurrence For Species That Are Known Or Likely To Occur In The Hardin Solar II Energy Center Study Area.

Wildlife Type / Common Name	Scientific Name	Status[1]	Habitat by Season	Seasons of Potential Occurrence and Likelihood of Occurrence in the Study Area[2]			
				Spring	Summer	Fall	Winter
Upland Sandpiper	*Bartramia longicauda*	SE	Dry grasslands including native, seeded, grazed and ungrazed pasture, hayfields, and grasslands established through the Conservation Reserve Program.	L	L	L	L
MAMMALS							
Indiana bat	*Myotis sodalis*	FE	Summer roosting in trees with loose bark over 9.0 inches (22.9 centimeters) in diameter; winters in caves.	L	L	L	N
Northern long-eared bat	*Myotis septentrionalis*	FT	Summer roosting in trees with loose bark over 3.0 inches (7.6 centimeters) in diameter; winters in caves.	L	L	L	N

Sources:

Cornell Lab of Ornithology, Birds of North America website https://birdsna.org/Species-Account/bna/species, accessed June 8, 2018

McCormac, Jim, and Gregory Kennedy. Birds of Ohio. Edmonton: Lone Pine Pub., 2004. Print.

ODNR website http://wildlife.ohiodnr.gov/species-and-habitats/state-listed-species, accessed June 8, 2018

USFWS website https://www.fws.gov/midwest/endangered/index.html, accessed June 8, 2018.

[1] FE = Federal-endangered, FT = Federal-threatened, SE = State-endangered, ST=State-threatened, FSC = Federal Species of Concern, SSC = State Species of Concern

[2] *Likelihood of occurrence Key: H = High potential; M = Moderate potential; L = Low potential and N = No potential; C = Confirmed sighting*

3.4.1 FEDERALLY THREATENED AND ENDANGERED SPECIES

According to USFWS (2018b, 2018c and 2018d), there are six (6) species with ranges that overlap the Study Area, including the rayed bean mussel, clubshell mussel, copperbelly water snake, eastern massasauga rattlesnake, Indiana bat and northern long-eared bat. No federally-listed species were observed during field reconnaissance for the Project (Table 3.4).

Rayed Bean Mussel (*Villosa fabilis*)

The federally endangered rayed bean mussel is generally found in small, headwater creeks, but has the potential to occur in large rivers and wave-washed areas of glacial lakes (USFWS 2018d). A total of ten (10) streams including Elder Creek, Scioto River, Cottonwood Ditch, Twin Branches, and their unnamed tributaries are present within the Study Area. Based on stream size and the potential presence for federally listed mussel species to occur, the Ohio Mussel Survey Protocol (ODNR and USFWS 2018) provides a list of the streams where mussels may occur. The Scioto River and Cottonwood Ditch within the Study Area are listed as Group 1 Streams (small to mid-size stream, federally listed species not expected). According to USFWS (2018b) and ODNR (2018a), no rayed bean mussels have been recorded in the Study Area. Based on the information obtained from the USFWS and ODNR, the rayed bean mussel has no potential to occur in the Study Area (Table 3.3).

Clubshell Mussel (*Pleurobema clava*)

The federally endangered clubshell mussel occurs in areas of clean, loose sand and gravel in medium to small rivers and streams. This mussel will bury itself in the bottom of substrate to depths up to 4.0 inches (10.1 centimeters) (USFWS 2018d). According to USFWS (2018b) and ODNR (2018a), no clubshell mussel occurrences have been recorded in the Study Area. Based on the information obtained from the USFWS and ODNR, the clubshell mussel has no potential to occur in the Study Area (Table 3.3).

Copperbelly Water Snake (*Nerodia erythrogaster neglecta*)

The federally threatened copperbelly water snake requires a mosaic of shallow wetlands or floodplain wetlands surrounded by forested uplands. Copperbelly water snakes frequently move between these shallow wetland areas through use of the upland forested areas. Seasonally flooded wetlands without fish, which are a predator to the copperbelly water snake, are favored for foraging. During winter, copperbelly water snakes hibernate, often in crayfish burrows, in forested wetlands and immediately adjacent to forested uplands. They remain underground from late October until late April (USFWS 2018d). According to USFWS (2018b) and ODNR (2018a), no recorded occurrences of the copperbelly water snake exist in the Study Area.

A portion of the Study Area contains a mosaic of forested shallow wetlands, which is suitable habitat for the copperbelly water snake. However, with the predominance of actively farmed cropland and channelized tributaries, the copperbelly water snake has a moderate potential of occurring in the Study Area (Table 3.3).

Eastern Massasauga Rattlesnake (*Sistrurus catenatus*)

The federally threatened eastern massasauga rattlesnake primarily occurs in wet areas, including wet prairies, marshes and low-lying areas along rivers and lakes, as well as in adjacent uplands during their life history (USFWS 2018d). Eastern massasauga rattlesnakes may hibernate in crayfish burrows, under logs and tree roots, or in small mammal burrows during hibernation from late October to late April (USFWS 2018d). According to USFWS (2018b) and ODNR (2018a), no recorded occurrences of the eastern massasauga rattlesnake exist in the Study Area.

Based on the predominance of actively farmed cropland and lack of wet prairies, marshes and low-lying areas along rivers and lakes, the Study Area does not contain suitable habitat for the eastern massasauga rattlesnake. Therefore, the eastern massasauga rattlesnake has no potential to occur in the Study Area (Table 3.3).

Indiana bat (*Myotis sodalis*)

The federally endangered, Indiana bat occurs over a range that extends from the east coast to Midwestern United States, including Ohio (USFWS 2018d). Indiana bats hibernate during winter in caves and mines, subsequently migrating to their summer habitat in wooded areas where they usually roost under loose tree bark on dead or dying trees. Spring through fall, Indiana bats utilize a variety habitats to forage on flying insects found along rivers, lakes, open fields and uplands (USFWS 2018d).

Although Indiana bats have the potential to inhabit all counties in Ohio, correspondence with the ODNR (2018a) indicated no Indiana bat capture locations within a 5.0-mile (8.0-kilometer) radius, or hibernacula within a 10-mile (16-kilometer) radius of the Study Area. Suitable wooded habitat for roosting and foraging was found to be present in the Study Area. However, based on data reviewed, agency consultation and field reconnaissance, the potential of occurrence for the Indiana bat within the Study Area is low during spring, summer and fall months, and there is no potential to occur within the Study Area during winter months (Table 3.3).

Northern long-eared bat (*Myotis septentrionalis*)

The federally threatened northern long-eared bat range extends throughout most southern Canada, the eastern and midwestern United States (excluding parts of the southeast United States), and is primarily associated with North American forests (USFWS 2018d). Historically, the northern long-eared bat is found

statewide in Ohio (USFWS 2018b). Currently, ODNR (2018a) data related to the northern long-eared bat species remains incomplete.

During the spring through fall active seasons, the northern long-eared bat forages over open fields near caves and forests (USFWS 2018d). The northern long-eared bat is similar to the Indiana bat in its use of caves and mines for hibernation. The northern long-eared bat requires very high humidity in selected hibernacula. After hibernation, the bats are found in wooded or semi-wooded habitats for the duration of the summer months. The northern long-eared bat utilizes crevices and loose bark on trees ($\geq$ 3.0 inches [7.6 centimeters]) in diameter at breast height) for roosting, although it is considered to be opportunistic and less selective than the Indiana bat (USFWS 2018d). The northern long-eared bat primarily flies through the understory of forested areas foraging on a variety of insects.

Suitable wooded habitat for roosting and foraging was found to be present in the Study Area. However, based on data reviewed, agency consultation and field reconnaissance, the likelihood of occurrence of the northern long-eared bat within the Study Area is low during spring, summer and fall months, and there is no potential to occur within the Study Area during winter months (Table 3.3).

Bald and Golden Eagle Protection Act

Bald eagle (*Haliaeetus leucocephalus*) habitat typically includes estuaries, large lakes, reservoirs, rivers and some seacoasts and marshes where they forage for fish. Bald eagles will also feed on waterfowl, turtles, rabbits, snakes, other small animals and carrion located in a variety of habitats (USFWS 2018c). Bald eagles require a combination of readily available prey, perching areas, and nesting sites. In winter, bald eagles congregate near open water in tall trees for spotting prey and night roosts for shelter (USFWS 2018c).

Golden eagles (*Aquila chrysaetos*) build nests on cliffs or in the largest trees of forested stands that often provide an unobstructed view of the surrounding habitat (USFWS 2018c). Golden eagles are rare in the eastern United States; however, may be observed during migration or winter months in the Great Lakes region. Based on data reviewed, agency consultation and field reconnaissance, bald and golden eagles have a low potential of occurrence in the Study Area.

According to USFWS (2018b) and ODNR (2018a), eagles are not known to occur within the Study Area. While eagles could pass through the Study Area, features (i.e. nests in tall trees near large lakes, reservoirs and rivers) that would attract an eagle to roost or forage were not observed.

3.4.2 STATE-LISTED SPECIES

According to ODNR (2018a), the Natural Heritage Database indicates no records of state-listed species in the Study Area or the surrounding area within a 1.0-mile (1.6-kilometer) radius. Although summer roosting occurrences for the state-listed Indiana bat have been recorded in Hardin County, ODNR (2018a) data indicates no occurrences for capture locations or roosts have been recorded within a 5.0-mile (8.0-kilometer) radius, or hibernacula within a 10-mile (16-kilometer) radius of the Study Area. However, ODNR (2018a) identified state-listed species with ranges that overlap the Study Area, including: the clubshell, rayed bean, purple lilliput and pondhorn mussels; the Indiana bat; eastern massasauga rattlesnake; upland sandpiper; and northern harrier. No state-listed species were observed during field reconnaissance for the Project (Table 3.4).

3.4.3 FEDERAL AND STATE SPECIES OF CONCERN[1]

The Study Area is primarily active rotational cropland, resulting in limited habitat diversity. The ODNR Natural Heritage Database did not identify any of any species of concern at or within a 1.0-mile (1.6-kilometer) radius of the Project (ODNR 2018a). However, the Study Area is within the range of three (3) species of concern, including the bobolink, bald eagle, and golden eagle (Table 3.3). Additionally, no federal or state species of concern were observed during field reconnaissance for the Project (Table 3.4).

3.4.4 WILDLIFE OBSERVATIONS

During field reconnaissance, the following plant and animal species were observed within the Study Area for the Project.

Table 3.4 Species Observations at the Hardin Solar Energy Center Study Area, Hardin County, Ohio, 2018.

Common Name	Scientific Name	Listed Status
American basswood	*Tilia americana*	--
American bur-weed	*Sparganium americanum*	--
American hophornbeam	*Ostrya virginiana*	--
American hornbeam	*Carpinus caroliniana*	--
American sycamore	*Platanus occidentalis*	--
American crow	*Corvus brachyrhynchos*	--
American elm	*Ulmus americana*	--
American goldfinch	*Cardulis tristis*	--
American kestrel	*Falco sparverius*	--

[1] Federal Species of Concern is an informal term. It is not defined in the federal Endangered Species Act. The term commonly refers to species that are declining or appear to be in need of conservation to avoid listing.

Table 3.4 Species Observations at the Hardin Solar Energy Center Study Area, Hardin County, Ohio, 2018.

Common Name	Scientific Name	Listed Status
American robin	*Turdus migratorius*	--
Baltimore Oriole	*Icterus galbula*	--
Barn swallow	*Hirundo rustica*	--
Black cherry	*Prunus serotina*	--
Blackgum	*Nyssa sylvatica*	--
Bluejoint	*Calamagrostis candensis*	--
Boxelder	*Acer negundo*	--
Calico aster	*Symphyotrichum laterflorum*	--
Canada goose	*Branta canadensis*	--
Canada thistle	*Cirsium arvense*	--
Canadian wildginger	*Asarum canadense*	--
Cattail	*Typha x glauca*	--
Clearweed	*Pilea pumila*	--
Common barnyard grass	*Echinochloa crus-galli*	--
Common chicory	*Cichorium intybus*	--
Common dandelion	*Taraxacum officinale*	--
Common duckweed	*Lemna minor*	--
Common grackle	*Quiscalus quiscula*	--
Common hackberry	*Celtis occidentalis*	--
Common ragweed	*Ambrosia artemisiifolia*	--
Common rush	*Juncus effusus*	--
Common velvetgrass	*Holcus lanatus*	--
Corn	*Zea mays*	--
Curly duck	*Rumex crispus*	--
Cursed buttercup	*Ranunculus sceleratus*	--
Duckweed	*Lemna minor*	--
Dutchman’s breeches	*Dicentra cucullaria*	--
Eastern black walnut	*Juglans nigra*	--
Eastern chipmunk	*Tamias striatus*	--
Eastern cottonwood	*Populus deltoids*	--
Eastern gray squirrel	*Sciurus carolinensis*	--
Eastern poison ivy	*Toxicodendron radicans*	--
Eastern towhee	*Pipilo erythrophthalmus*	--

Table 3.4 Species Observations at the Hardin Solar Energy Center Study Area, Hardin County, Ohio, 2018.

Common Name	Scientific Name	Listed Status
Eastern woodland sedge	*Carex blanda*	--
European privet	*Ligustrum vulgare*	--
European starling	*Sturnus vulgaris*	--
Fall panicgrass	*Panicum dichotomiflorum*	--
Field sparrow	*Spizella pusilla*	USFWS Bird of Conservation Concern
Fringed sedge	*Carex crinita*	--
Fowl bluegrass	*Poa palustris*	--
Fowl mannagrass	*Glyceria striata*	--
Fuller's teasel	*Dipsacus fullonum*	--
Garden yellowrocket	*Barbarea vulgaris*	--
Garlic mustard	*Alliaria petiolate*	--
Giant ragweed	*Ambrosia trifida*	--
Gray's sedge	*Carex grayi*	--
Greater bladder sedge	*Carex intumescens*	--
Green arrow arum	*Peltandra virginica*	--
Groundhog	*Marmota monax*	--
Green ash	*Fraxinus pennsylvanica*	--
Hawthorne	*Crataegus spp.*	--
Honey locust	*Gleditsia triacanthos*	--
House sparrow	*Passer domesticus*	--
Indianhemp	*Apocynum cannabinum*	--
Indigo bunting	*Passerina cyanea*	--
Jack in the pulpit	*Arisaema triphyllum*	--
Killdeer	*Charadrius vociferus*	--
Knotweed	*Polygonum spp.*	--
Longhair sedge	*Carex comosa*	--
Mallard	*Anas platyrhynchos*	--
Mayapple	*Podophyllum peltatum*	--
Mourning dove	*Zenaida macroura*	--
Multiflora rose	*Rosa multiflora*	--
Northern cardinal	*Cardinalis*	--
Northern Spicebush	*Lindera benzoin*	--
Ohio buckeye	*Aesculus glabra*	--

Table 3.4 Species Observations at the Hardin Solar Energy Center Study Area, Hardin County, Ohio, 2018.

Common Name	Scientific Name	Listed Status
Orchard grass	*Dactylis glomerata*	--
Path rush	*Juncus tenuis*	--
Pin oak	*Quercus palustris*	--
Purple deadnettle	*Lamium purpureum*	--
Raccoon	*Procyon lotor*	--
Reed canary grass	*Phalaris arundinacea*	--
Red clover	*Trifolium pretense*	--
Red fescue	*Festuca rubra*	--
Red maple	*Acer rubrum*	--
Red oak	*Quercus rubra*	--
Red-tailed hawk	*Buteo jamaicensis*	--
Red-winged blackbird	*Agelaius phoeniceus*	--
Rice cutgrass	*Leersia oryzoides*	--
Rock pigeon	*Columba livia*	--
Rough barnyardgrass	*Echinochloa muricata*	--
Sandbar willow	*Salix interior*	--
Sensitive fern	*Onoclea sensibilis*	--
Shagbark hickory	*Carya ovata*	--
Shellbark hickory	*Carya laciniosa*	--
Shepherd's purse	*Capsella bursa-pastoris*	--
Silky dogwood	*Cornus amomum*	--
Silver maple	*Acer saccharinum*	--
Slippery elm	*Ulmus rubra*	--
Smooth brome	*Bromus inermis*	--
Smooth Solomon's-seal	*Polygonatum biflorum*	--
Soft-stemmed bulrush	*Schoenoplectus tabernaemontani*	--
Soybean	*Glycine max*	--
Spearmint	*Mentha spicata*	--
Spotted geranium	*Geranium maculatum*	--
Spotted ladysthumb	*Persicaria maculosa*	--
Spotted touch-me-not	*Impatiens capensis*	--
Stickwilly	*Galium aparine*	--
Stinging nettle	*Urtica dioica*	--

Table 3.4 Species Observations at the Hardin Solar Energy Center Study Area, Hardin County, Ohio, 2018.

Common Name	Scientific Name	Listed Status
Sugar maple	*Acer saccharum*	--
Swamp white oak	*Quercus bicolor*	--
Timothy grass	*Phleum pretense*	--
Turkey vulture	*Cathartes aura*	--
Twinleaf	*Jeffersonia diphylla*	--
Virginia creeper	*Parthenocissus quinquefolia*	--
Virginia waterleaf	*Hydrophyllum virginianum*	--
Woodland agrimony	*Agrimonia rostellata*	--
White ash	*Fraxinus americana*	--
White oak	*Quercus alba*	--
White-tailed deer	*Odocoileus*	--
Yellow nutsedge	*Cyperus esculentus*	--
Yellowseed	*Lindernia dubia*	--
Yellow troutlily	*Erythronium rostratum*	--

3.4.5 Migratory Birds of Conservation Concern

TRC reviewed the USFWS IPaC Resources Report for Migratory Birds of Conservation Concern that could potentially occur in the Study Area, which included one (1) species, the bobolink. As described in Table 3.3 above, the bobolink resides in grassy hayfields and pastures, clover/alfalfa hayfields, wet prairies, and the grassy margins of marshes. Fallow fields comprised of grasses and weeds also provide suitable nesting habitat. Based on field reconnaissance, the Study Area is primarily comprised of cultivated crop fields and developed, open space. Such areas primarily contain monotypic vegetation and poor habitat diversity, resulting in poor potential for a diversity of migratory bird species compared to grasslands and other diverse habitats (NABCI 2016). Therefore, the bobolink is not expected to occur because of the lack of preferred habitat within the Study Area.

3.4.6 USGS Breeding Bird Survey

The nearest USGS Breeding Bird Survey Route (USGS 2018), the NO Kenton Route, Ohio (BBS Route 66032), is located approximately 6.0 miles (9.7 kilometers) east of the Study Area (Figure 3.3). Of the forty-three (43) total species recorded, the ten (10) most common birds recorded on the breeding bird survey route (Table 3.5) are characteristic of open habitats with an agricultural landscape. Land cover along the NO Kenton Route is similar to the landscape found in the Project Area. Additionally, there are four (4) birds of conservation concern recorded along the NO Kenton Route, Ohio, including the red-headed

woodpecker (*Melanerpes erythrocephalus*), northern flicker (*Colaptes auratus*), wood thrush (*Hylocichla mustelina*), and field sparrow (*Spizella pusilla*). None of the species listed in Table 3.5 are birds of conservation concern.

Table 3.5 Ten Most common Species Observed on the NO Kenton Breeding Bird Survey Route, Hardin County, Ohio, 2018.

Common Name	Scientific Name
Red-winged blackbird	*Agelaius phoeniceus*
House sparrow	*Passer domesticus*
European starling	*Sturnus vulgaris*
American robin	*Turdus migratorius*
Turkey vulture	*Cathartes aura*
Song sparrow	*Melospiza melodia*
Mourning dove	*Zenaida macroura*
American crow	*Corvus brachyrhynchos*
Chipping sparrow	*Spizella passerina*
Killdeer	*Charadrius vociferus*

3.4.7 CHRISTMAS BIRD COUNTS

Indian Lake, located approximately 10.0 miles (16.1 kilometers) south of the Study Area, is the nearest Christmas Bird Count Circle (Figure 3.3). Of the fifty-four (54) total species recorded, the eight (8) most common species observed (Table 3.6) are birds that primarily utilize open spaces and water bodies (National Audubon Society 2018a). Additionally, there are four (4) birds of conservation concern recorded at the Christmas Bird Count area, including the peregrine falcon (*Falco peregrinus*), short-eared owl (*Asio flammeus*), red-headed woodpecker and northern flicker. None of these species listed in Table 3.6 are birds of conservation concern.

Table 3.6 Bird Species Commonly Observed on National Audubon Society's Indian Lake Christmas Bird Counts.

Common Name	Scientific Name
Canada goose	*Branta canadensis*
Mallard (all forms)	*Anas platyrhynchos*
Rock pigeon	*Columba livia*
Mourning dove	*Zenaida macroura*
Dark-eyed junco	*Junco hyemalis*
European starling	*Sturnus vulgaris*
Horned lark	*Eremophila alpestris*

Common Name	Scientific Name
House sparrow	*Passer domesticus*

3.4.8 IMPORTANT BIRD AREAS

The nearest Important Bird Area (National Audubon Society 2018b) in the vicinity of the Study Area is in the Lawrence Woods State Nature Preserve located approximately 10.0 miles (16.1 kilometers) southeast of the Study Area (Figure 3.3). The Lawrence Woods State Nature Preserve is owned by the ODNR, Division of Natural Areas and Preserves and contains over 500 acres (202 hectares) of remnant wet forest habitat, mature woodland, and about 500 acres (202 hectares) of grassland and meadows. It has the largest known mature forest with large areas of button bush wetlands in west-central Ohio.

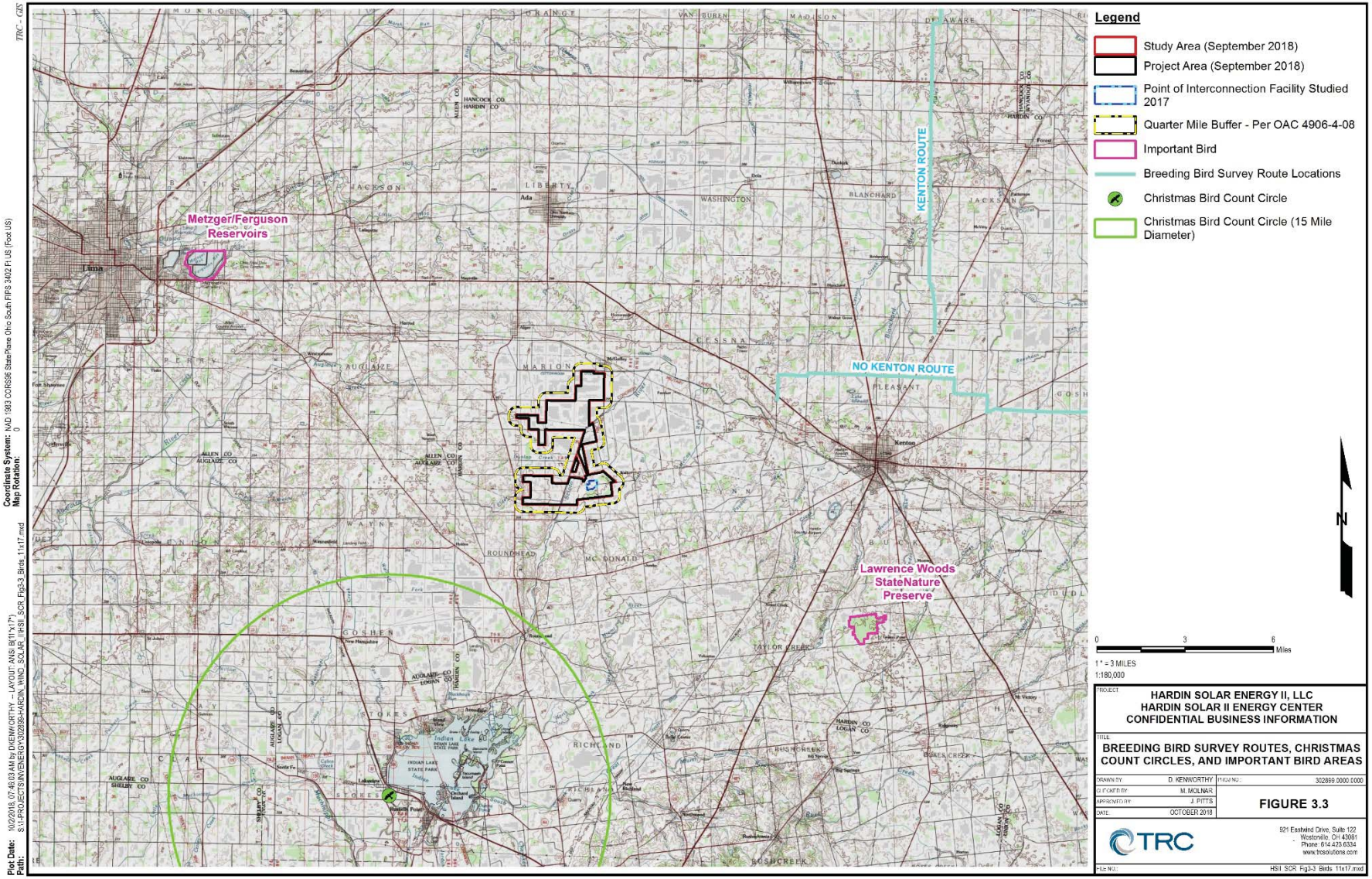
As determined by the National Audubon Society, important breeding species within the Lawrence Woods State Nature Preserve are the yellow-billed cuckoo (*Coccyzus americanus*), cerulean warbler (*Setophaga cerulea*), Kentucky warbler (*Geothlypis formosa*), ovenbird (*Seiurus aurocapilla*), American redstart (*Setophaga ruticilla*), hooded warbler (*Wilsonia citrina*), yellow-throated vireo (*Vireo flavifrons*), Acadian flycatcher (*Empidonax virescens*), eastern meadowlark (*Sturnella magna*), sedge wren (*Sturnella magna*), bobolink (*Dolichonyx oryzivorus*), Henslow's sparrow (*Ammodramus henslowii*), veery (*Catharus fuscescens*), pileated woodpecker (*Dryocopus pileatus*), and a breeding colony of great blue herons (*Ardea herodias*) (Audubon 2018). As noted in Section 3.4 of this Report, the bobolink is a state-listed species of concern in Ohio. Additionally, there are four (4) birds of conservation concern recorded at this Important Bird Area, including the cerulean warbler, Kentucky warbler, Acadian flycatcher, and Henslow's sparrow.

The Important Bird Area within the Lawrence Woods State Nature Preserve is located approximately 10.0 miles (16.1 kilometers) from the proposed Project. Based on data reviewed, agency consultation and field reconnaissance confirming the lack of large grasslands, marshlands and forests within the Study Area, as well as the distance of the Lawrence Woods State Nature Preserve, avian species identified at this Preserve have low potential to occur in the Study Area.

3.4.9 SPECIES OF HABITAT FRAGMENTATION CONCERN

The Study Area consists mainly of an agricultural monoculture of cropped fields, traversed by channelized tributaries, with small pockets of herbaceous and scrub/shrub wetland. The Study Area contains lesser amounts of wetland and upland deciduous forest. The region was once dominated by hardwood deciduous forests however, land conversion from forest to agricultural fields has altered the environment and biodiversity in the Study Area. Based on agency consultation, data reviewed and field reconnaissance, the Study Area and surrounding lands contain minimal habitat suitable for roosting and foraging, including the

agricultural lands, wetlands, streams, and forest complexes.. Finally, due the mobile nature of most of the wildlife within the Study Area and due to the minimal impact to aquatic and forested area, the Project will likely have a minimal impact to wildlife and its habitat.



TRC
Results you can rely on

4.0 SPECIAL STATUS LANDS

4.1 CONSERVATION LANDS

Agency correspondence and queries were based on a 1.0-mile (1.6-kilometer) radius surrounding the Study Area.

The USFWS (2018b) Technical Assistant Letter reported "no federal wilderness areas, wildlife refuges or designated critical habitat is present within the vicinity" of the Study Area. Correspondence from ODNR (2018a) reported that the agency is unaware of any unique ecological sites, geologic features, animal assemblages, scenic rivers, state wildlife areas, nature preserves, parks or forests, national wildlife refuges, parks or forests or other protected natural areas within a 1.0-mile (1.6-kilometer) radius of the Study Area.

Publicly available databases showed public lands located within 10.0 miles (16.1 kilometers) of the Study Area include Indian Lake State Park and Lawrence Woods State Nature Preserve (Figure 3.3). Both are located more than 8.0 miles (13.0 kilometers) from the Study Area. Indian Lake State Park (5,800 acres; 2,347 hectares) is utilized by the public for water-related recreational opportunities. Lawrence Woods State Nature Preserve, located approximately 10.0 miles (16.1 kilometers) from the Study Area, is both a State Nature Preserve and an Important Bird Area (National Audubon Society 2018b).

No designated conservation lands were identified within the Study Area or within the surrounding 1.0-mile (1.6-kilometer) radius.

4.2 HABITATS OF BIODIVERSITY SIGNIFICANCE

Ohio has a Natural Areas and Preserves program and it designates State Nature Preserves based on unique features that could be indicative of the presence of habitats with biodiversity significance. These include areas with pre-settlement habitat remnants, protected habitat for rare and endangered species, and/or distinctive geologic formations (ODNR 2018b). Lawrence Woods State Nature Preserve, located approximately 10.0 miles (16.1 kilometers) from the Study Area, is both a State Nature Preserve and an Important Bird Area (National Audubon Society 2018b). Unlike the Study Area, it has a diverse mosaic of buttonbush swamps, upland forests and lowland forests.

Additionally, correspondence received from the USFWS (2018b) and ODNR (2018a) indicated that no federal wilderness areas, wildlife refuges or designated critical habitat, unique ecological sites, geologic features, animal assemblages, scenic rivers, state wildlife, state nature preserves, state or nation parks, state or national forests, national wildlife refuges, or other protected naturals areas within the Study Area. Field

reconnaissance results are consistent with the information received from the USFWS and ODNR, indicating that no designated areas of biodiversity significance occurs within the Study Area.

5.0 PLANT COMMUNITIES OF CONCERN

Lawrence Woods State Nature Preserve, 10.0 miles (16.1 kilometers) from the Study Area, is both a State Nature Preserve and an Important Bird Area (National Audubon Society 2018b). Unlike the Study Area, it has a diverse mosaic of buttonbush swamps, upland forests and lowland forests that would support high quality plant communities.

Based on data reviewed, agency consultation (USFWS 2018b and ODNR 2018a) and field reconnaissance, no plant communities of concern were identified within the Study Area or within the surrounding 1.0-mile (1.6-kilometer) radius.

6.0 REFERENCES CITED

Cornell University. 2018. *Birds of North America*. The Cornell Lab of Ornithology, New York. Web. 25 June 2018. http://birdsna.org/Species-Account/bna/species/.

Google Earth™. 2018. Google-Earth – Google Earth. Retrieved from Google Earth: http://earth.google.com/.

McCormac, Jim and Gregory Kennedy. Birds of Ohio. Edmonton: Lone Pine Pub., 2004. Print.

National Audubon Society. 2018a. Christmas Bird County. Retrieved from Audubon: http://www.audubon.org/conservation/science/christmas-bird-count/.

National Audubon Society. 2018b. Important Bird Areas. Retrieved from Audubon: http://www.audubon.org/important-bird-areas.

ODNR and USFWS. 2018. Ohio Mussel Protocol. https://wildlife.ohiodnr.gov/portals/wildlife/pdfs/licenses%20&%20permits/OH%20Mussel%20Survey%20Protocol.pdf. Accessed May 5, 2018.

ODNR. 2018a. Natural Heritage Database Environmental Review response from John Kessler dated July 2, 2018. Ohio Department of Natural Resources (ODNR) National Heritage Database (Wildlife, Ohio DNR Division of. "Ohio.gov / search." Ohio DNR Division of Wildlife. N.p., n.d. Web. 7 June 2018. http://wildlife.ohiodnr.gov/species-and-habitats/ohio-natural-heritage-database).

ODNR. 2018b. Natural Areas and Preserves website review: June 30, 2018. http://naturepreserves.ohiodnr.gov/.

TRC. 2018. *Wetlands and Other Waters of the U.S. Delineation Report*. Westerville, Ohio.

USACE. 1987. Corps of Engineers Wetlands Delineation Manual. Vicksburg, MS: Environmental Laboratory U.S. Armey Corps of Engineers, Waterways Experiment Station, Wetlands Research Project Technical Report Y-87-1.

USACE. 2012. Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Midwest (Version 2.0). U.S. Army Corps of Engineers, Vicksburg: U.S. Army Engineer Research and Development Center Environmental Laboratory, 176.

USDA. 2018. Web Soil Survey 3.0. U.S. Department of Agriculture, Natural Resources Conservation Service: http://websoilsurvey.sc.egov.usda.gov/App?WebSoilSurvey.aspx.

USFWS. 2012. Land-Based Wind Energy Guidelines. https://www.fws.gov/ecological-services/es-library/pdfs/WEG_final.pdf. Accessed May 1, 2018.

USFWS. 2018a. *National Wetlands Inventory Online Mapper v 2.0*. https://www.fws.gov/wetlands/data/mapper.html.

USFWS. 2018b. Technical Assistance Letter from Scott Pruit. Dated June 25, 2018. TAILS #03E15000-2018-TA-1543.

USFWS. 2018c. Information for Planning and Conservation (IPaC) IPaC: Home. N.p., n.d. Web. 8 June 2018. https://ecos.fws.gov/ipac/

USFWS. 2018d. Endangered, Threatened, Proposed, and Candidates in the Upper Midwest. Available online: https://www.fws.gov/midwest/endangered/lists/ohio-cty.html.

USGS. 1994. Topographical Quadrangle Maps (7.5-minute series). U.S. Geological Survey.

USGS. 2016. Land Change Science Program: National Land Cover Database. Washington D.C.: U.S. Department of the Interior, U.S. Geological Survey. Web. 25 June 2018. https://www2.usgs.gov/climate_landuse/lcs/projects/nlcd.asp.

USGS. 2018. Patuxent Wildlife Research Center, North American Breeding Bird Survey. https://www.pwrc.usgs.gov/bbs/index.cfm.

U.S. North American Bird Conservation Initiative. 2016. State of North America's Birds 2016. http://www.stateofthebirds.org/2016/. Accessed June 14, 2018.

Wilkin, E, F J Navan, and G Griffith. 2011. North American Terrestrial Ecoregions Level III. Commission for Environmental Cooperation, Canada. http://www.cec.org/tools-and-resources/map-files/terrestrial-ecoregions-level-iii

Exhibit G

TRC Hardin Raptor Nest Survey October 2018

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

RAPTOR NEST SURVEY REPORT

Hardin Solar II Energy Center

Hardin County, Ohio

October 2018

TRC PROJECT NO. 302899.0003.0000

Prepared For:

Hardin Solar Energy II LLC
One South Wacker Drive, Suite 1800
Chicago, IL 60606
Phone: 312.224.1400

Prepared By:

TRC Environmental Corporation
921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6353

Tracy Engle
Office Practice Leader

Justin Pitts
Ecological Project Manager

TRC
Results you can rely on

CONFIDENTIAL BUSINESS INFORMATION

TABLE OF CONTENTS

List of Tables

List of Figures

ACRONYMS

GPS	Global Positioning System
HSE	Hardin Solar Energy, LLC
HW	Hardin Wind
IPaC	Information for Planning and Conservation
MW	Megawatt
NLCD	National Land Cover Database
ODNR	Ohio Department of Natural Resources
Project	Hardin Solar II Energy Center Project
Project Area	Potential Construction Impact Area
Report	Hardin Solar II Energy Center Raptor Nest Survey Report
Survey Area	Project Area and an Additional Buffer of 1.0 Mile
TRC	TRC Environmental Corporation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1.0 INTRODUCTION

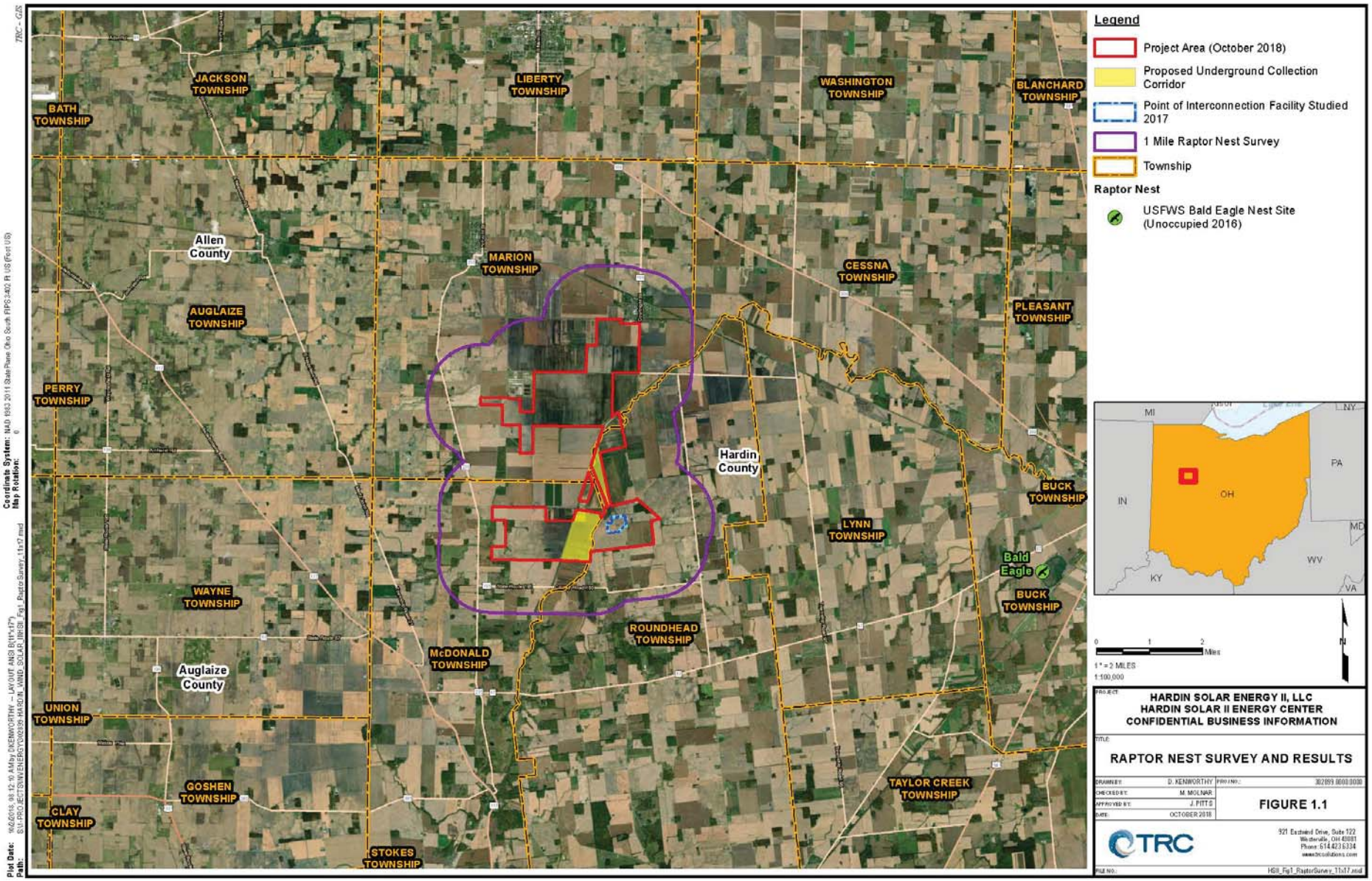
On behalf of Hardin Solar Energy II LLC (HSE), TRC Environmental Corporation (TRC) has prepared this Hardin Solar II Energy Center Raptor Nest Survey Report (Report) as part of environmental studies conducted for the Hardin Solar II Energy Center (Project) located in Hardin County, Ohio. The proposed solar facility will generate up to 170 megawatts (MW) of power. The land is privately owned and is located approximately 2.5 miles (3.9 kilometers) southeast of Alger, in Hardin County, Ohio. The Project Area totals approximately 3,388 acres (1,371 hectares), including 396 acres (160 hectares) of underground collection corridors. The Project Area is a subset of the Survey Area, and is bisected by Township Road 120 (east/west) and is bounded by Township Road 100 on the north, County Road 65 on the east, and private landholdings to the south and west. The Project is located in Marion, McDonald, and Roundhead Townships, Hardin County, Ohio (Figure 1.1).

The objective of this desktop survey was to map previously known raptor nests within the Project Area and an additional surrounding buffer of 1.0 mile (1.6 kilometers), representing an area of 17,616 acres (5,369 hectares) (1 Mile Raptor Nest Survey Area [Survey Area]).

Within the Survey Area, elevations range from approximately 958 feet (292 meters) to 1,050 feet (320 meters) above mean sea level. Review of National Land Cover Database (NLCD) mapping (USGS 2016) indicates the Survey Area consists primarily of agricultural lands (95 percent cultivated crops). Generally, these conditions are not conducive to providing habitat for raptors (Cornell Lab of Ornithology 2018). Developed, open space accounted for three (3) percent; deciduous forest accounted for one (1) percent; and developed, low-, medium-, and high intensity; grassland/herbaceous and woody wetlands accounted for less than one (1) percent land cover (Table 1.1). Several large lakes that likely provide more suitable habitat for raptor nesting and foraging occur within 10 miles (16,093 meters) of the Survey Area.

Table 1.1 Field-Verified National Land Cover Database Land Cover Types within the Hardin Solar II Energy Center Study Area, Hardin County, Ohio, 2018.

Cover Type	Acres	Hectares	Percent (%)
Cultivated Crops	3,494.24	1,414.07	94.53
Deciduous Forest	52.18	21.12	1.41
Developed, Open Space	118.72	48.04	3.21
Developed, Medium Intensity	2.21	0.89	0.06
Developed, Low Intensity	23.76	9.62	0.64
Developed, High Intensity	0.03	0.01	< 0.01
Grassland/Herbaceous	5.22	2.11	0.14
Woody Wetlands	0.17	0.07	< 0.01
Total	**3,696.53**	**1,495.93**	**100.00**


JACKSON TOWNSHIP
LIBERTY TOWNSHIP
WASHINGTON TOWNSHIP
BLANCHARD TOWNSHIP
BATH TOWNSHIP
Allen County
MARION TOWNSHIP
CESSNA TOWNSHIP
AUGLAIZE TOWNSHIP
PLEASANT TOWNSHIP
PERRY TOWNSHIP
Hardin County
BUCK TOWNSHIP
LYNN TOWNSHIP
Bald Eagle
WAYNE TOWNSHIP
BUCK TOWNSHIP
ROUNDHEAD TOWNSHIP
McDONALD TOWNSHIP
Auglaize County
UNION TOWNSHIP
GOSHEN TOWNSHIP
TAYLOR CREEK TOWNSHIP
CLAY TOWNSHIP
STOKES TOWNSHIP
Legend
Project Area (October 2018)
Proposed Underground Collection Corridor
Point of Interconnection Facility Studied 2017
1 Mile Raptor Nest Survey
Township
Raptor Nest
USFWS Bald Eagle Nest Site (Unoccupied 2016)
MI
NY
PA
IN
OH
WV
KY
VA
MD
1" = 2 MILES
1:100,000
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION
RAPTOR NEST SURVEY AND RESULTS
FIGURE 1.1
TRC

2.0 METHODS

TRC conducted a desktop review of the *Hardin Wind Raptor Nest Survey Report* (Tetra Tech 2016) provided by HSE, as the Survey Area is completely within the area surveyed by Tetra Tech (2016) for the Hardin Wind Project. The results of the Tetra Tech (2016) Report are valid for five (5) years. In addition, information available from the United States Fish and Wildlife Service (USFWS) (USFWS 2018a) and Ohio Department of Natural Resources (ODNR 2018) on known eagle nests within the Survey Area and in the vicinity of the Survey Area was reviewed. A literature review and agency inquiry was performed to determine if records of historic nest sites were reported (ODNR-DOW, July 2, 2018; USFWS, June 25, 2018). In addition, TRC accessed the USFWS Information for Planning and Conservation (IPaC) tool (IPaC report, June 8, 2018).

The data regarding raptor nests was reviewed and raptor nests were searched for during on-the-ground subsequent field visits on May 16th, 18th, 22nd, 23rd, 29th, June 12th – 14th, and September 14th and 17th, 2018.

3.0 RESULTS

3.1 Agency Consultation Data

On June 8, 2018, TRC accessed the USFWS IPaC tool. Although the IPaC report identified the Study Area to be within known range of the bald eagle, no specific records were identified (USFWS 2018b). In addition, correspondence from the USFWS (USFWS 2018a) Technical Assistance Letter, dated June 25, 2018; and the ODNR Natural Heritage Database Review, dated July 2, 2018 did not identify known records of raptor nests within the Project's Survey Area or within a one-mile radius of the Survey Area.

3.2 Tetra Tech 2016 Raptor Nest Survey

Prior to conducting field surveys, Tetra Tech (2016) performed a desktop analysis of publicly available data and existing Project reports, including a review of Wildlife Baseline Protocol for the Proposed Hardin Wind Farm, Hardin County, Ohio (Carder and Good 2009) and the Hardin Wind Wildlife Baseline Report (Good et al 2009) (Tetra Tech 2016).

Tetra Tech (2016) then conducted raptor nest surveys between August 1, 2016 and August 4, 2016, along public roadways and within suitable raptor nest habitats, to locate new and known raptor nests and historical bald eagle (*Haliaeetus leucocephalus*) nests previously documented by the USFWS within suitable habitat. Suitable habitats included woodlots, forested riparian areas, shelterbelts, and utility poles. Nests were searched for and observed with binoculars and a spotting scope. The species and locations of nest sites were marked on United States Geological Survey (USGS) 1:24,000 topographic maps or aerial photograph field maps. Data recorded for each nest site included nest status (active or inactive), the number of adult and young present, species occupying the nest site, behavior of adults at the nest, nest condition (poor, fair, or good), nest location (geographic position system coordinates), and nest substrate. Definitions for active and inactive nests were not provided in the Tetra Tech (2016) report. For all active raptor nests that were identified, biologists exercised caution when in proximity to the nest to avoid disturbance to nesting raptors. Any raptor activity observed during the surveys was noted as an incidental observation and recorded using the global positioning system (GPS) (Tetra Tech 2016).

Review of the Tetra Tech (2016) report identified there were no raptor nests recorded within this Project's Survey Area. In addition, several raptor nests had been identified outside of but near the Survey Area in 2009, however in 2016, they were determined to be no longer present (Tetra Tech 2016). A historically documented USFWS bald eagle nest was located at France Lake and confirmed as unoccupied during the 2016 field survey (Tetra Tech 2016) (Figure 1.1). This nest is approximately 7.3 mi (11.7 km) from the

Project Area. The unoccupied status would be expected during the August window in which the survey was performed because most eaglets would have already fledged (USFWS Midwest Region 2018).

3.3 Summary

The desktop review of available sources determined there are no known raptor nests within the Survey Area. The subsequent field visits did not yield any additional raptor nest locations.

4.0 REFERENCES CITED

Cornell University. 2018. *Birds of North America*. The Cornell Lab of Ornithology, New York. Web. 25 June 2018. birdsna.org/Species-Account/bna/species.

Carder, M.L., and R.E. Good. 2009. *Wildlife Baseline Protocol for the Hardin Wind Farm, Hardin County, Ohio*. Prepared for Invenergy, LLC by WEST, Inc. Revised Report June 25, 2009. 31 pp.

Good, R.E., M. Rizert, and K. Bay. 2009. *Wildlife Baseline Studies for the Hardin Wind Farm, Hardin County, Ohio*. Prepared for Invenergy, LLC by WEST, Inc. Final Report September 3, 2008 – September 14, 2009. 100 pp.

ODNR. 2018. Natural Heritage Database Environmental Review response from John Kessler dated July 2, 2018. Ohio Department of Natural Resources (ODNR) National Heritage Database (Wildlife, Ohio DNR Division of. "Ohio.gov / search." Ohio DNR Division of Wildlife. N.p., n.d. Web. 7 June 2018. http://wildlife.ohiodnr.gov/species-and-habitats/ohio-natural-heritage-database).

USGS. 2016. *Land Change Science Program*: *National Land Cover Database (NLCD).* Washington D.C.: U.S. Department of the Interior, U.S. Geological Survey. Web. 25 June 2018. https://www2.usgs.gov/climate_landuse/lcs/projects/nlcd.asp.

Tetra Tech. 2016. *Hardin Wind Energy Project Raptor Nest Survey Report – Final.* Prepared for Hardin Wind, LLC. by Tetra Tech. Final Report October 27, 2016. 6 pp.

USFWS. 2018a. Technical Assistance Letter from Scott Pruit dated June 25, 2018. TAILS: 03E15000-2018-TA-1543.

USFWS. 2018b. Information for Planning and Conservation (IPaC). IPaC: Home. N.p., n.d. Web. 8 June. 2018. https://ecos.fws.gov/ipac/.

USFWS Midwest Region. 2018. *Bald Eagle Conservation: Bald Eagle Natural History and Sensitivity to Human Activity Information.* Web. 30 September 2018. https://www.fws.gov/midwest/eagle/conservation/baea_nhstry_snstvty.html.

Summary: Application Part 3 of 6, Exhibits A through G electronically filed by Christine M.T. Pirik on behalf of Hardin Solar Energy II LLC