Stantec

Memo

To:	Tom Girman White Tail, LLC	From:	Karon Brown Stantec - Mequon, WI
File:	193707233	Date:	January 25, 2021

Reference: Charter Township of York, White Tail Solar LLC Sound Evaluation

White Tail Solar LLC (White Tail) is developing a photovoltaic (PV) solar project with a maximum generating capacity of approximately 50 megawatts (MW) in the Charter Township of York, Washtenaw County, Michigan. The White Tail Solar Project (Project) will be located on approximately 493 acres. The land parcels are roughly bound by Willis Road to the north, Willow Road to the south, Sanford Road to the west and Hitchingham Road to the east.

Local ordinances were considered, and two zoning ordinances were found that apply to the proposed project. The first ordinance is in The Charter Township of York Zoning Ordinance Section 16.7(D) *Special Uses,* indicates: "The proposed use shall not unreasonably impact upon surrounding property in terms of noise, dust, fumes, smoke, air, water, odor, light and/or vibration, and shall not unreasonably impact upon a person perceiving the operation in terms of aesthetics. Where such concerns can be remedied by way of design, construction and/or use, the proposed use shall be designed, constructed and used so as to eliminate the effects of the use which would otherwise substantiate denial thereof, taking into consideration the location, size, intensity, layout and periods of operation of such use." The second ordinance is in the Charter Township of York Zoning Ordinance Section 15.01(D) *General Standards* – "Will not generate unpleasant and objectionable noise greater in volume or intensity than the average of traffic noises at exterior property lines."

Major components of the proposed Project include solar modules mounted on a tracking system, inverter stations, access roads, and collection system. Land within the Project boundary is primarily in agricultural use. Adjacent land uses are low density rural residential properties or agricultural. Project infrastructure consists of solar panels producing direct current (DC) voltage which is converted to alternating current (AC) voltage through a series of inverters stations. Panels generate no noise and tracking systems generate no noise audible at property boundaries. The inverter stations emit a sound during daytime operation that is discussed in the following sections. They will go into "stand-by" mode after sunset, at which time they are no longer converting energy and the sound emitted is negligible until sunrise. The solar tracking system makes minor adjustments to the panel positions during daylight hours. The sound emitted during the adjustments is not a significant contributor to overall sound.

Approximately 21 inverters will be installed within the Project area. Technical data supplied by HEM, the inverter manufacturer (see attached), states that the sound level at 1 meter (3 feet) from the back of the inverter unit is less than 79 decibels (dBA) while in operation. Typical project design places inverters toward the center or interior of the project area, generally furthest from exterior property lines. Inverters locations will comply with minimum setback requirements. The operation of the inverters will be during daylight only; therefore, no sound will be emitted during nighttime hours.

The following calculation was used to determine the inverter sound impact at different distances from an inverter unit:

Reference: **Charter Township of York, White Tail Solar LLC Sound Evaluation**

Sound level L and Distance r

$$L_2 = L_1 - \left|20 \cdot \log\left(\frac{r_1}{r_2}\right)\right| \qquad L_2 = L_1 - \left|10 \cdot \log\left(\frac{r_1}{r_2}\right)^2\right|$$

$$r_2 = r_1 \cdot 10^{\left(\frac{L_1 - L_2}{20}\right)}$$

Inverter noise impacts:

HEM inverter sound level: 79 dBA

Distance to equipment: 3 feet

Distance from Inverter to Property Line	L_{eq} dBA
25	60.6
50	54.6
100	48.5
125	46.6
150	45.0
175	43.7
200	42.5

(For comparison, a whisper at three feet is about 25dBA; normal conversation at three feet is about 60 dBA.)

Based on this study, the sound generated by the project's loudest equipment (inverter) is in accordance with the Charter Township of York Zoning Ordinance Section 16.7(D) *Special Uses* and Section 15.01(D) *General Standards*. Based on the inverter locations, sound generated from the facility will be minimal and will not unreasonably impact surrounding property or generate unpleasant or objectionable noise greater in volume or intensity than average traffic noise at exterior property lines.

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c. Kristen Gunderson-Inden, Mequon, WI office

HEM

UTILITY SCALE MV CENTRAL STRING INVERTER

The Power Electronics HEM medium voltage inverter is designed for utility scale solar applications, that require the advantages of a central inverter solution but also the modularity of a string architecture. The HEM can reach up to a nominal power of 3.6MVA, and offers a wide MPPT window. It also has the added advantage of having an integrated medium voltage transformer and switchgear.

Its architecture, composed of six field replaceable units (FRU), is designed to provide the highest availability and optimize yield production.

Its use in Utility Scale PV plants provides considerable savings in CAPEX, since having an integrated MV transformer and switchgear reduces the need of additional connections between the LV and MV sides.

Thanks to the Power Electronics iCOOL3 cooling system, the HEM is the first inverter able to provide IP65 degree of protection with an air cooling system, and as a result reducing OPEX costs.

THE INNOVATIVE MEDIUM VOLTAGE CENTRAL STRING INVERTER

IP65 AVAILABLE

TURNKEY SOLUTION

MULTI MPPT

ADJUSTABLE POWER

OUTDOOR DURABILITY

INGRESS PROTECTION

ACTIVE HEATING

3 LEVEL TOPOLOGY

iCOOL 3

ECON MODE

REAL TURN-KEY SOLUTION

With the HEM, Power Electronics offers a real turn-key solution, including the MV transformer and switchgear fully assembled and tested at the factory. The HEM is a compact turnkey solution that will reduce site design, installation and connections costs.

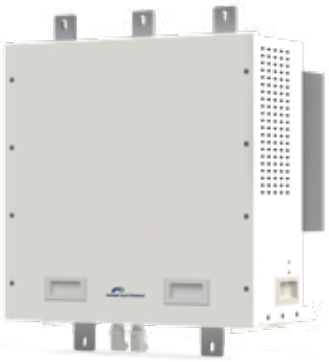
MV SWITCHGEAR	MV TRANSFORMER	STRING INVERTERS CABINET	DC RECOMBINER

STRING CONCEPT POWER STAGES

The HEM combines the advantages of a central inverter with the modularity of the string inverters. Its power stages are designed to be easily replaceable on the field without the need of advanced technical service personnel, providing a safe, reliable and fast Plug&Play assembly system.

Following the modular philosophy of the Freesun series, the HEM is composed of 6 FRUs (field replaceable units), being able to work with up to 6 different MPPts, providing a perfect solution for irregular locations, where each area of the PV plant has a different production curve.

HEM is also available with a single MPPt, where all the power stages are physically joined in the DC side and therefore, in the event of a fault, the faulty module is taken off-line and its output power is distributed evenly among the remaining functioning FRUs.



INNOVATIVE COOLING SYSTEM

Based on more than 3 years of experience with our MV Variable Speed Drive, the iCOOL3 is the first air-cooling system allowing IP65 degree of protection in an outdoor solar inverter.

iCOOL3 delivers a constant stream of clean air to the FRUs and the MV transformer, being the most effective way of reaching up to IP65 degree of protection, without having to maintain cumbersome dust filters or having to use liquid-cooling systems, avoiding the commonly known inconveniences of it (complex maintenance, risk of leaks, higher number of components...), therefore resulting in an OPEX cost reduction.

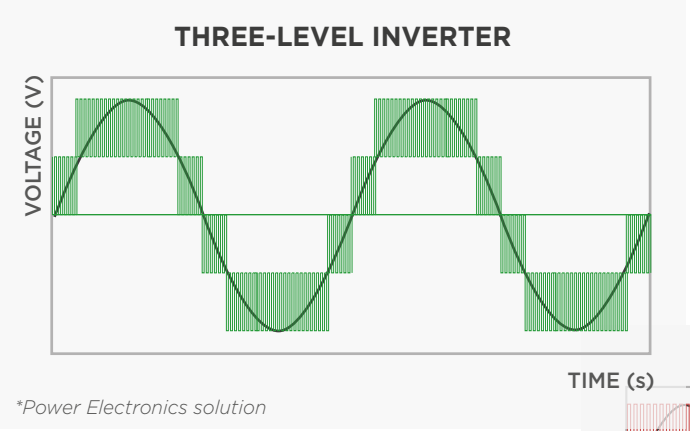
ROBUST DESIGN

HEM inverter modules have a design life of greater than 30 years of operation in harsh environments and extreme weather conditions. HEM units are tested and ready to withstand conditions from the frozen Siberian tundra to the Californian Death Valley, featuring:

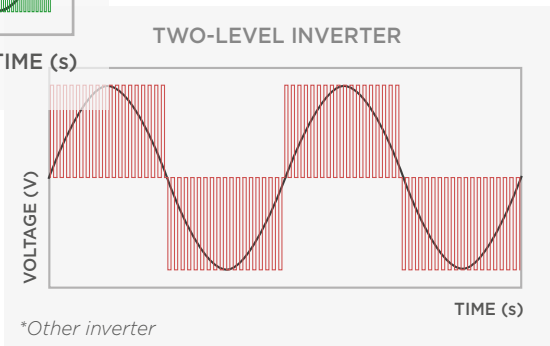
- Totally sealed electronics cabinet protects electronics against dust and moisture.
- Conformal coating on electronic boards shields PCBs from harsh atmospheres.
- Temperature and humidity controlled active heating prevents internal water condensation.
- C4 degree of protection according to ISO 12944. Up to C5-M optional.
- 50mm mineral panel isolates the cabinet from solar heat gains.
- Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages. The solid HEM structure avoids the need of additional external structures.
- Random units selected to pass a Factory Water Tightness Test ensuring product quality.

MULTILEVEL TOPOLOGY

The multilevel IGBT topology is the most efficient approach to manage high DC link voltages and makes the difference in the 1,500 Vdc design. Power Electronics has many years of power design in both inverters and MV drives and the HEM design is the result of our experience with 3 level topologies. The 3 level IGBT topology reduces stage losses, increases inverter efficiency and minimizes total harmonic distortion.



*Power Electronics solution



*Other inverter

EASY TO SERVICE

By providing full front access the HEM series simplifies the maintenance tasks, reducing the MTTR (and achieving a lower OPEX). The total access allows a fast swap of the FRUs without the need of qualified technical personnel.

EASY TO MONITOR

The Freesun app is an easy way to monitor the status of Power Electronics inverters. All inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors. The app user friendly interface allows quick and easy access to critical information (energy registers, production and events).

ACTIVE HEATING

At night, when the unit is not actively exporting power, the inverter can import a small amount of power to keep the inverter internal ambient temperature above -20°C, without using external resistors. This autonomous heating system is the most efficient and homogeneous way to prevent condensation, increasing the inverters availability and reducing the maintenance. (patented)

VAR AT NIGHT

At night, the HEM inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVAr).

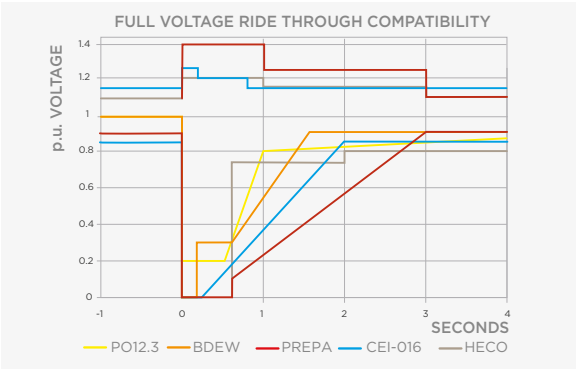
ECON MODE

This innovative control mode allows increasing the efficiency of the MV transformer up to 25%, reducing the power consumption of the plant and therefore providing considerable savings.

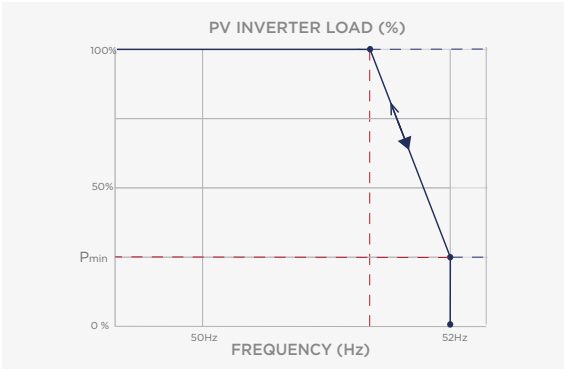
Available as an optional kit, this feature has a pay-back time of less than a few years, therefore resulting in the increase of the plant lifetime overall revenue.

DYNAMIC GRID SUPPORT

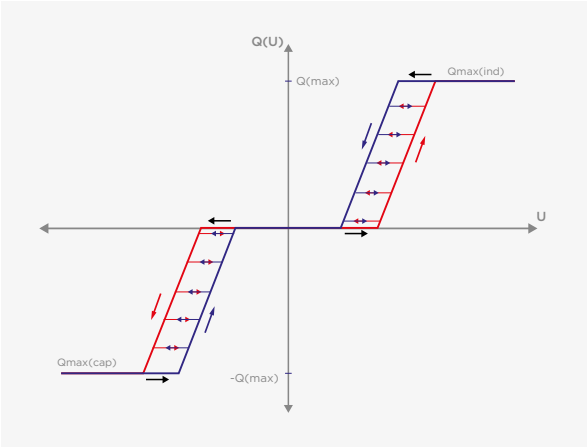
HEM firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment...), and can be configured to meet specific utility requirements.

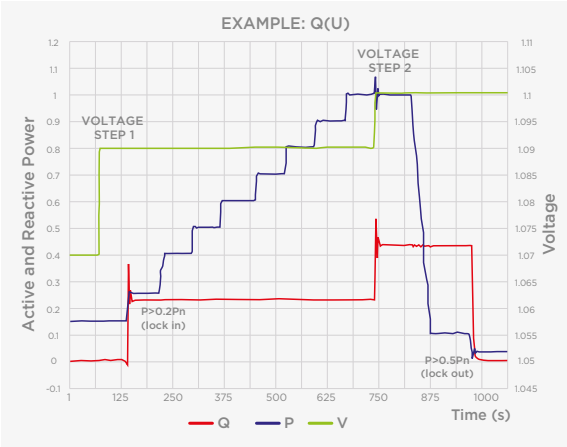


▲ **LVRT or ZVRT (Low Voltage Ride Through).** Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive power, as long as the protection limits are not exceeded.



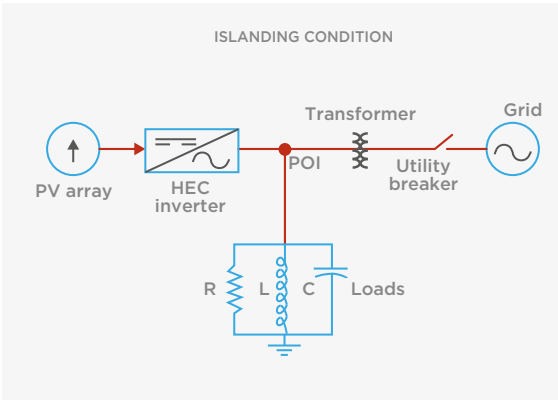
▲ **FRS (Frequency Regulation System).** Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.





▲ **Q(V) curve:** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.

▲ **FRT (Frequency Ride Through):** Freesun solar inverters have flexible frequency protection settings and can be easily adjusted to comply with future requirements.



▲ **Anti-islanding:** This protection combines passive and active methods that eliminates nuisance tripping and reduces grid distortion according to IEC 62116 and IEEE1547.

HEM

TECHNICAL CHARACTERISTICS

REFERENCE		FS3300M
OUTPUT	AC Output Power(kVA/kW) @50°C[1]	3300
	AC Output Power(kVA/kW) @25°C[1]	3630
	Operating Grid Voltage(VAC)[2]	34.5kV ±10%
	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)	934V-1310V
	Maximum DC voltage	1500V
	Number of inputs[2]	Up to 36
	Max. DC continuous current (A)	3970
	Max. DC short circuit current (A)	6000
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% including MV transformer (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection	NEMA3R - IP54 / IP65 available
	Permissible Ambient Temperature	-35°C[4] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level) [5]	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] Depending on the project configuration.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Heating resistors kit option below -20°C.
[5] Consult Power Electronics for other altitudes.
[6] Readings taken 1 meter from the back of the unit.

HEM

TECHNICAL CHARACTERISTICS

REFERENCE		FS3225M
OUTPUT	AC Output Power(kVA/kW) @50°C[1]	3225
	AC Output Power(kVA/kW) @25°C[1]	3550
	Operating Grid Voltage(VAC)[2]	34.5kV ±10%
	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[2]	Up to 36
	Max. DC continuous current (A)	3970
	Max. DC short circuit current (A)	6000
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% including MV transformer (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection	NEMA3R - IP54 / IP65 available
	Permissible Ambient Temperature	-35°C[4] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level) [5]	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] Depending on the project configuration.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Heating resistors kit option below -20°C.
[5] Consult Power Electronics for other altitudes.
[6] Readings taken 1 meter from the back of the unit.

HEM

TECHNICAL CHARACTERISTICS

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 ±10%
	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[2]	Up to 36
	Max. DC continuous current (A)	3970
	Max. DC short circuit current (A)	6000
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% including MV transformer (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection	NEMA3R - IP54 / IP65 available
	Permissible Ambient Temperature	-35°C[4] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level) [5]	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] Depending on the project configuration.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Heating resistors kit option below -20°C.
[5] Consult Power Electronics for other altitudes.
[6] Readings taken 1 meter from the back of the unit.

HEM

TECHNICAL CHARACTERISTICS

REFERENCE		FS3075M
OUTPUT	AC Output Power(kVA/kW) @50°C[1]	3075
	AC Output Power(kVA/kW) @25°C[1]	3380
	Operating Grid Voltage(VAC)[2]	34.5kV ±10%
	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)	870V-1310V
	Maximum DC voltage	1500V
	Number of inputs[2]	Up to 36
	Max. DC continuous current (A)	3970
	Max. DC short circuit current (A)	6000
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% including MV transformer (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection	NEMA3R - IP54 / IP65 available
	Permissible Ambient Temperature	-35°C[4] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level) [5]	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
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[2] Depending on the project configuration.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Heating resistors kit option below -20°C.
[5] Consult Power Electronics for other altitudes.
[6] Readings taken 1 meter from the back of the unit.

HEM

TECHNICAL CHARACTERISTICS

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 ±10%
	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[2]	Up to 36
	Max. DC continuous current (A)	3970
	Max. DC short circuit current (A)	6000
EFFICIENCY & AUXILIARY SUPPLY	Max. Efficiency PAC, nom (η)	98% including MV transformer (preliminary)
	Max. Power Consumption (KVA)	20
CABINET	Dimensions [WxDxH] (ft)	20x6.5x7 (preliminary)
	Type of ventilation	Forced air cooling
ENVIRONMENT	Degree of protection	NEMA3R - IP54 / IP65 available
	Permissible Ambient Temperature	-35°C[4] to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
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	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
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