White Harvest
ENERGY

TECHNICAL SPECIFICATION

Avus 1600e

16V4000L64FNER | 2,014 kWe Natural Gas Generator Set

AT A GLANCE

Electrical output	**2,014 kWe**
Electrical service	**480 V / 60 Hz**
Engine	**16V4000L64FNER, V-16**
Fuel	**Natural gas, CH_4 > 95 vol.%**
Methane number	**MN 80 minimum**
NOx (raw, dry)	**1.0 g/bhp-hr**
Electrical efficiency	**43.3 %**
Total efficiency	**90.0 %**
Special equipment	**Gearbox / SRD**
Reference conditions	**ISO 3046-1**

Manufacturer technical data

Prepared and issued by White Harvest Energy, an authorized 2G Energy sales distributor and service provider. Equipment data is OEM manufacturer data and is subject to project-specific engineering and technical revision. Performance figures apply at the stated layout conditions and are subject to project-specific derating. Source document: OEM technical data sheet 93800052548_V01_en_US, V01 (22.07.2019), GG16V4000A2.

2G®
Authorized Sales Distributor & Service Provider

CONTENTS

1 **Layout conditions** **3**
2 **Energy balance** **3**
3 **Combustion air and exhaust gas** **4**
4 **Fuel** **4**
4.1 Reference fuel 4
4.2 Fuel requirements 4
5 **Exhaust gas emissions** **4**
6 **Engine** **5**
7 **Generator** **5**
8 **Gearbox** **5**
9 **Cooling circuits** **5**
9.1 Engine cooling water system 5
9.2 Exhaust gas heat exchanger (EGHE) 6
9.3 Mixture cooler 1st stage, external 6
9.4 Mixture cooling 2nd stage, external 6
9.5 Heating circuit interface 6
10 **Room ventilation** **7**
11 **Starter battery and filling quantities** **7**
11.1 Starter battery 7
11.2 Filling quantities 7
12 **Gas regulation line** **7**
13 **Sound levels** **8**
13.1 Engine sound level 8
13.2 Undampened exhaust noise 8
14 **Dimensions and weights** **8**
15 **Technical framework** **9**
15.1 Power derating and boundary conditions 9
15.2 Notes 9

1 Layout conditions

Layout condition	Value
Voltage / frequency	**480 V / 60 Hz**
Cooling water temperature (in / out)	**171 / 198 °F**
NOx emissions (dry)	**1.0 g/bhp-hr**
Mixture cooler 1st stage water temperature (in)	**—**
Mixture cooler 2nd stage water temperature (in)	**136 °F**
Exhaust gas temperature	**802 °F**
Catalytic converter	**Not included**
Special equipment	**Gearbox / SRD**
Elevation above sea level	**328 ft (10 psi)**
Combustion air temperature	**95 °F**
Relative combustion air humidity	**60 %**
Standard specifications and regulations	**—**

Notes

- This configuration is supplied with a gearbox: the engine runs at 1,500 rpm and the gearbox steps the speed up to drive the generator at 60 Hz. Gearbox efficiency is given in section 8.
- A catalytic converter is not included in this configuration. Emission values in section 5 are raw engine-out values.

2 Energy balance

Energy balance	100 %	75 %	50 %	Unit
Electrical power [2], [3]	**2,014**	**1,511**	**1,007**	kWe
Energy input [4], [5]	**15,867**	**12,202**	**8,412**	kBTU/hr
Thermal output total [6]	**4,009**	**3,040**	**2,084**	kBTU/hr
Thermal output engine (block, lube oil, 1st stage mixture cooler) [6]	**4,009**	**3,040**	**2,084**	kBTU/hr
Thermal output mixture cooler 1st stage [6]	**—**	**—**	**—**	kBTU/hr
Thermal output mixture cooler 2nd stage [6]	**331**	**202**	**124**	kBTU/hr
Exhaust heat (248 °F) [6]	**(3,398)**	**(2,824)**	**(2,075)**	kBTU/hr
Engine power ISO 3046-1 [2]	**2,789**	**2,095**	**1,405**	bhp
Generator efficiency at power factor = 1	**97.4**	**97.4**	**96.9**	%
Electrical efficiency [4]	**43.3**	**42.3**	**40.9**	%
Total efficiency	**90.0**	**90.3**	**90.3**	%
Power consumption [7]	**—**	**—**	**—**	kWe

Notes

- Thermal output total is stated equal to the engine thermal output. The recoverable exhaust heat shown in parentheses is additional to it, and the 2nd-stage mixture cooler heat is listed separately.

3 Combustion air and exhaust gas

Combustion air / exhaust gas	100 %	75 %	50 %	Unit
Combustion air volume flow [1]	**4,503**	**3,392**	**2,283**	ft³/min
Combustion air mass flow	**21,782**	**16,407**	**11,045**	lb/hr
Exhaust gas volume flow, wet [1]	**4,734**	**3,570**	**2,406**	ft³/min
Exhaust gas volume flow, dry [1]	**4,227**	**3,180**	**2,138**	ft³/min
Exhaust gas mass flow, wet	**22,536**	**16,987**	**11,446**	lb/hr
Exhaust temperature after turbocharger	**802**	**856**	**910**	°F

4 Fuel

4.1 Reference fuel

Reference fuel	Value
Natural gas	**CH_4 > 95 vol.%**
Sewage gas	**Not applicable**
Biogas	**Not applicable**
Landfill gas	**Not applicable**

Notes

- Reference fuel per note (8): deviations from the layout parameters or the reference fuel can influence the efficiency and exhaust emissions obtained.

4.2 Fuel requirements

Fuel requirement	Value
Minimum methane number	**MN 80**
Range of heating value — design	**966.2 – 1,014.5 BTU/ft³**
Range of heating value — operation range without power derating	**773.0 – 1,062.8 BTU/ft³**

Notes

- Fuel requirements per note (9): functional capability.

5 Exhaust gas emissions

Raw emissions, dry. Catalytic converter not included.

Exhaust gas emission	Value
NOx, stated as NO_2 (dry)	**1.0 g/bhp-hr**
CO (dry)	**3.5 g/bhp-hr**
HCHO (dry)	**—**
VOC (dry)	**0.7 g/bhp-hr**

Notes

- Compliance with emissions standards only for ≥ 1,007 kWel.
- Values shown are raw engine-out emissions. See notes (23) and (24) in section 15 regarding engine certification status and the possible need for a catalyst.

6 Engine

Engine	Value
Combustion process	**Otto-gas engine, lean burn operation with turbocharging**
Number of cylinders / configuration	**16 / V**
Engine type	**16V4000L64FNER**
Engine speed	**1,500 rpm**
Bore	**6.7 in**
Stroke	**8.3 in**
Displacement	**4,656.1 in³**
Mean piston speed	**34.4 ft/sec**
Compression ratio	**12.5**
BMEP at nominal engine speed	**316.3 psi**
Lube oil consumption (10)	**0.09 gal/hr**
Exhaust back pressure min. – max. after module	**12 – 24 in H_2O**

7 Generator

Generator	Value
Rating power (temperature rise class F) (11)	**2,583 kVA**
Insulation class / temperature rise class	**H / F**
Winding pitch	**2/3**
Protection	**IP 23**
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) (12)	**0.8 / 1.0**
Voltage tolerance / frequency tolerance	**± 5 % / ± 5 %**

8 Gearbox

Gearbox	100 %	75 %	50 %	Unit
Efficiency	**99.4**	**99.3**	**99.2**	%

9 Cooling circuits

9.1 Engine cooling water system

Engine cooling water system	Value
Coolant temperature (in / out), design	**171 / 198 °F**
Coolant flow rate, constant (13) (14)	**321.1 gal/min**
Pressure drop, design (14)	**40 psi**
Cv value (13) (15)	**196.9 gal/min**
Max. operation pressure (coolant before engine)	**87.0 psi**

9.2 Exhaust gas heat exchanger (EGHE)

Exhaust gas heat exchanger	Value
Exhaust gas temperature (out)	—
Coolant temperature (in / out), design	—
Coolant volumetric flow, constant (13) (14)	—
Pressure drop, design (14)	—
Cv value (13) (15)	—
Min. coolant flow rate / min. operation gauge pressure	—
Max. operation pressure (coolant water)	—

Notes

- No exhaust gas heat exchanger is configured on this data sheet. Recoverable exhaust heat is listed as an option in section 2.

9.3 Mixture cooler 1st stage, external

Mixture cooler 1st stage, external	Value
Coolant temperature (in / out), design	—
Coolant volumetric flow, design, constant (13) (14)	—
Pressure drop, design (14)	—
Cv value (13) (15)	—
Min. coolant flow rate / min. operation gauge pressure	—
Max. operation pressure before mixture cooler	—

Notes

- No external 1st-stage mixture cooler is configured on this data sheet. First-stage mixture cooling is carried within the engine circuit — see the engine thermal output row in section 2, which is stated for block, lube oil and 1st stage mixture cooler together.

9.4 Mixture cooling 2nd stage, external

Mixture cooling 2nd stage, external	Value
Coolant temperature (in / out), design	**136 / 141.0 °F**

Mixture cooling 2nd stage, external	Value
Coolant volumetric flow, design, constant (13) (14)	**150.8 gal/min**
Pressure drop, design (14)	**7 psi**
Cv value (13) (15)	**222.8 gal/min**
Max. operation pressure before mixture cooler	**87 psi**

9.5 Heating circuit interface

Heating circuit interface	Value
Engine coolant temperature (in / out), design	—
Heating water temperature (in / out), design	—
Heating water flow rate, design (14) (16)	—
Pressure drop, design (14)	—
Cv value (15) (16)	—
Max. operation gauge pressure (heating water)	—

Notes

- No heating circuit interface is configured on this data sheet.

10 Room ventilation

Room ventilation	Value
Genset ventilation heat (17)	**478 kBTU/hr**
Inlet air temperature (min. / design / max.)	**86 / 95 / 40.0 °F**
Min. engine room temperature (18)	**59 °F**
Max. temperature difference ventilation air (in / out)	**36 °F**
Min. supply air volume flow rate (combustion + ventilation) (19)	**16,186 ft³/min**

Notes

- The maximum inlet air temperature is published as 40.0 °F, which is below the stated minimum of 86 °F. The sibling metric sheet gives 40.0 °C at this position, so the value appears to be an unconverted Celsius figure. Confirm with the OEM before designing to it.

11 Starter battery and filling quantities

11.1 Starter battery

Starter battery	Value
Nominal voltage / power / capacity required	**24 V / 2 × 9 kW / — Ah**

11.2 Filling quantities

Filling quantity	Value
Lube oil for engine	**87 gal**

Filling quantity	Value
Coolant in engine	**71 gal**
Coolant in mixture cooler	**7 gal**
Heating water for plate heat exchanger (20)	**—**
Lube oil for gearbox	**24 gal**

12 Gas regulation line

Gas regulation line	Value
Nominal size	**NPS 4**
Gas pressure min. – max. (at gas regulation line inlet)	**2.19 – 3.63 psi**

13 Sound levels

13.1 Engine sound level

1 meter distance, free field.

Frequency	63	125	250	500	1000	2000	4000	8000
Sound pressure level (dB)	**84.8**	**90.5**	**90.0**	**93.0**	**92.5**	**91.8**	**99.2**	**101.4**

Engine sound level totals	Value
Linear total sound pressure level	**104.8 Lin dB**
A-weighted total sound pressure level	**104.4 dB(A)**
A-weighted total sound power level	**124.1 dB(A)**

Notes

- +3 dB(A) tolerance applies to the total A-weighted level; +5 dB applies to a single octave level.
- All sound pressure levels at nominal load, according to ISO 8528-10 and ISO 6798 — see note (21).

13.2 Undampened exhaust noise

1 meter distance to outlet within 90°, free field.

Frequency	63	125	250	500	1000	2000	4000	8000
Sound pressure level (dB)	**113.9**	**119.8**	**111.9**	**104.5**	**97.1**	**96.8**	**94.0**	**83.9**

Exhaust noise totals	Value
Linear total sound pressure level	**121.6 Lin dB**
A-weighted total sound pressure level	**108.0 dB(A)**
A-weighted total sound power level	**121.0 dB(A)**

Notes

- +3 dB(A) tolerance applies to the total A-weighted level; +5 dB applies to a single octave level.
- Levels are undampened. Resonance effects of the connected exhaust line can influence the exhaust noise sound pressure level. Exhaust silencing is a project-specific selection.

14 Dimensions and weights

Aggregate dimensions.

Dimension / weight	Value
Length	**~ 268 in**
Width	**~ 79 in**
Height	**~ 94 in**
Gross weight (dry weight)	**~ 45,636 lb (~ 44,092 lb)**

Notes

- Dimensions and weights are as published. Contact the OEM for certified drawings.
- Do not use these dimensions for installation purposes.

15 Technical framework

15.1 Power derating and boundary conditions

Configuration	Value
Power derating — elevation	**Specific to the project**
Power derating — combustion air temperature	**Specific to the project**
Power derating — mixture cooler coolant temperature (in)	**Specific to the project**
Power derating — methane number	**Specific to the project**
Boundary conditions and consumables	**Systems and consumables have to conform to the actual company standard A001072**

15.2 Notes

Ref.	Note
(1)	Normal cubic meter at 15 psi and T = 273 K.
(2)	Prime power operation will be designed specific to the project.
(3)	Generator gross power at nominal voltage, power factor = 1 and nominal frequency.
(4)	According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency.
(5)	Emission values during grid parallel operation.
(6)	Thermal output at layout temperature; tolerance +/- 8 %.
(7)	Power consumption of all electrical consumers which are mounted at the module / genset.
(8)	Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions.
(9)	Functional capability.
(10)	Reference value at nominal load (without amount of oil exchange).

Ref.	Note
(11)	Generator (at nominal power) max. 3281 ft height of location and max. 104 °F intake air temperature; else power derating.
(12)	Max. allowable cos phi at nominal power (view of producer).
(13)	Stated values for cooling fluid composition 65 % water and 35 % glycol; adaption for use of other cooling fluid composition necessary. The system design must consider the tolerance.
(14)	Pressure loss at reference flow rate.
(15)	The Cv value declares the volumetric flow in gal/min at a pressure drop of 1 psi. Min. and max. flow rate limits are defined.
(16)	Stated values for pure water; adaption for other cooling fluid composition necessary.
(17)	Only generator and surface losses.
(18)	Frost-free conditions must be guaranteed.
(19)	Amount of ventilation air must be adapted to the gas safety concept.
(20)	Assemblies including pipe work.
(21)	All sound pressure levels at nominal load, according to ISO 8528-10 and ISO 6798. Resonance effects of the connected exhaust line can influence the exhaust noise sound pressure level.
(22)	Max. admissible cos phi depending on voltage in accordance with the requirements of the valid "Standard specifications and regulations".
(23)	Non-certified engine. The owner/operator must comply with EPA 40 CFR 60 JJJJ, state and local requirements.
(24)	A catalyst may be required to meet applicable emission requirements. VOC emissions based on natural gas with C2+ < 4 %.