



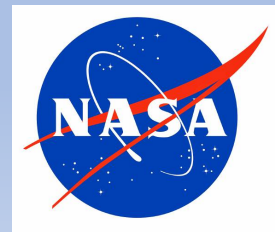
U.S. DEPARTMENT OF
ENERGY

Fossil
Energy

22nd SOFC Project Review Meeting

Aris Energy Solutions – DE-FE0031978

“Modular Fuel Cells Providing Resiliency to Data Centers and Other Critical Power Users”



Gaia Energy
Research Institute

Background

- SolidPower SOFC technology (Germany/Italy) offers
 - 57-60% electrical efficiency, 25+% thermal efficiency
 - 5-7 year stack life
- European operating SOFC fleet
 - 2000+ installations with 40+ Million cumulative operating hours
 - 10-year O&M service agreements
 - Ongoing deployment and cost reduction via Europe's "PACE" mCHP fuel cell program
- Aris Energy Solutions – SOLIDpower's US Distribution, Sales, Service and System Integration Partner
 - Founded in 2013 in Mt. Vernon, NY. Lead by executives with decades of experience in the utility, engineering, construction and fuel cell industries
- Key Market Drivers: Resiliency, De-Carbonization, Cost Reduction
 - Aris (as complement to SOLIDpower) is developing "Always On" Resiliency functionality in the integration of the fuel cell to the client's facility.
 - There are cost reduction opportunities with larger/modular installations and the forthcoming 6kW single fuel cell
 - This DoE program is well matched to those two goals
 - In parallel, the BlueGEN's inherent ability to reduce GHG emissions today, has been enhance with testing on a 20% H₂/Natural Gas feed (earlier industry funded work at BNL)
- The proposal team of Aris, NETL, WVU/NASA, Gaia Energy Research is uniquely capable to meet the program goals

Technical Approach and Project Participants

1) NETL

- A. Demonstrate the BlueGEN's ability to reliably disconnect from the grid to power a simulated critical load in "Island Mode" with the Year 1 6kW Quad product
- B. In Year 3 replicate that work on the 6kW BG-60 product

2) WVU/NASA

- A. Demonstrate a modular approach to scaling to higher kW range via a 24kW prototype system of BG-15 units, in service to power building loads at the NASA/Fairmont WV data center facility for 12 months, and integrate multiple AC coupling systems
- B. In Phase 2 at NASA, incorporate lessons learned to complete second part of the NASA data center installation, with an additional 16.5kW BG-15 capacity to operate for 12 months

3) 12 Month Demonstration of 6 kW BG-15 Quad in "Mainstream" Critical Power Application

- A. Install/operate a 6kW BG-15 Quad for a 12 months demonstration at the site of a commercial partner who requires reliable "Always On" electric power.
- B. Candidate sites include national retail bank branch, major urban hospital, and a cable industry/telecom consortium.

4) Techno Economic Assessment

Over the 3 year program, Gaia Energy Research Institute, who has an intimate understanding of fuel cell technologies and economics, will chart a path towards the cost and market goals.

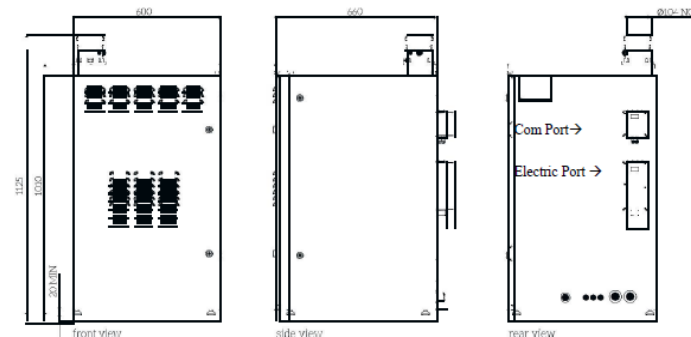
SOLIDpower BlueGEN 1.5kW BG-0



1. Concentric flue adapter (60/100 mm)
2. Fuel Cell Module
3. Waste heat recovery unit (hidden from view)
4. Gas safety double block valves
5. Condensate tank (hidden from view)
6. Air delivery system
7. Water treatment system
8. Power system
9. Gas desulphuriser

Technical specifications

Operation mode	Power-led, continuous (approx. 8,700 h per year)
Fuel type	Natural gas, bio-methane
Fuel cell technology	SOFC (Solid Oxide Fuel Cell)
Fuel consumption ¹⁾	8.5 MBH
Electrical efficiency ¹⁾ (output)	Up to 60 % (1.5 kW)
Thermal efficiency ¹⁾ (output)	Up to 25 % (0.6 kW)
Overall efficiency ¹⁾	Up to 85 %
Electrical energy generated per year ¹⁾	~ 13,000 kWh _{el}
Thermal energy generated per year ¹⁾	~ 5,220 kWh _{th}
Control	Remote monitoring and control via Internet
Weight, Dimensions (H x W x D)	430 lb, 39.7 x 23.6 x 26 in
Noise level	< 47 db (A)
Service interval ²⁾	12 months
Full maintenance service	Yes (120 months)
Subsidies	Subsidy programmes differ by country. Please contact your local distributor to find out more.

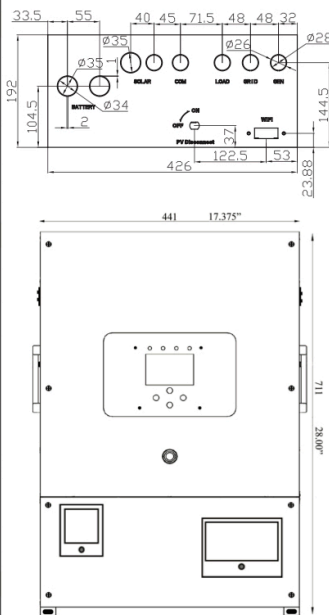


- 1) At maximum electrical efficiency, nominal output of 1.5 kW
 2) Replacement of filters depending on local water, air and gas quality

The key is the system integration



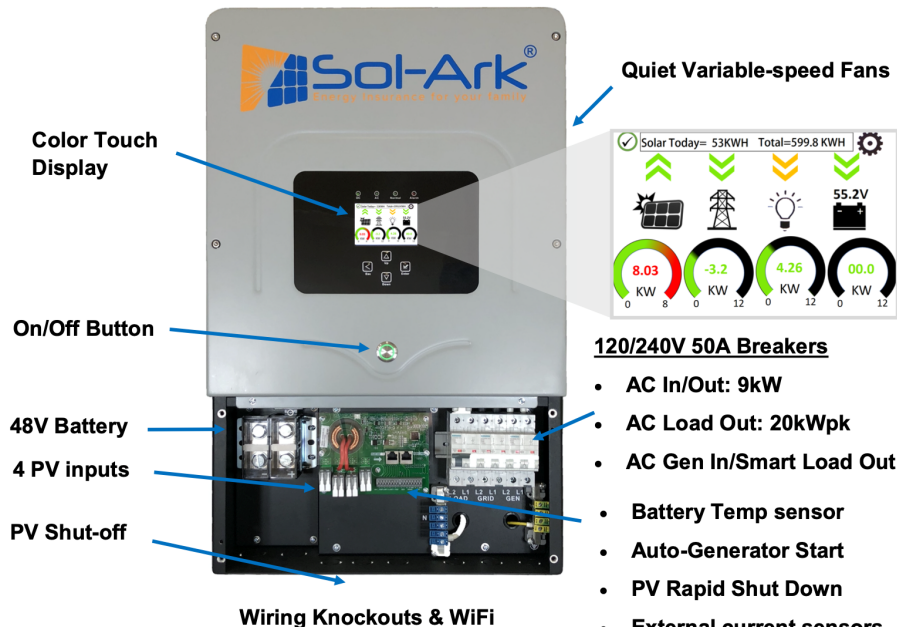
Sol-Ark-12K-P Specifications	
Solar Output Power 12000W	
Max allowed PV Power	9000W+9000W = 16,500W
Max PV power delivered to Battery & AC outputs	12000W
Max DC voltage	500V@18A, 450V@20A
MPPT voltage range	150-425V
Starting voltage	175V
Number of MPPT	2
Solar Strings per MPPT	2 w/o fuses, 3 w/ fuses
Max DC current per MPPT (self limiting)	20A@300V, 18A@400V
Max AC Coupled Input (Micro/String Inverters)	7,600W
AC Output Power 9600W On Grid & 8000W Off Grid	
Connections	120/240/208V split phase
Continuous AC power to Grid (On Grid)	9600W 40A L-L (240V) 4800W 40A L-N (120V)
Continuous AC power to Grid (Off Grid)	8000W 40A L-L (240V) 4800W 40A L-N (120V)
Surge AC power Ssec	20,000VA L-L (240V) 10,000VA L-N (120V)
Parallel Stacking	2-3 (240V), 3 or 6 (208V)
Frequency	60/50Hz
Continuous AC power with Grid or Generator	12000W 50A L-L (240V) 6000W 50A L-N (120V)
CEC Efficiency	96.0% (Peak 97.0%)
Idle Consumption typical – no load	60W
Sell back power modes	Limited to Household or Full Grid-Tied
Design (DC to AC)	Transformerless DC
Response Time (Grid-Tied to Off-Grid)	4ms
Power Factor	+0.9 - 1.0
Battery (optional) Output Power 8000W	
Type	Lead-Acid or Li-Ion
Nominal DC Input	48V
Capacity	90 – 2000Ah
Voltage Range	43.0 – 61.0V
Continuous Battery charging output	190A
Charging curve	3-stage w/ equalization
Grid to Battery Charging Efficiency	96.0%
External temperature sensor	included
Current shunt for accurate % SOC	integrated
External Generator Start based on voltage or % SOC	integrated
Communication to Lithium battery	CanBus & RS485
General	
Dimensions (H x W x D)	28.0" x 17.375" x 9.37"
Weight	77 lbs
Enclosure	NEMA type 1 (Indoor Use)
Ambient Temperature (3 variable speed fans)	-25 to 55C, >45C derating
Display	Color touch screen
Wi-Fi Communication (monitoring or SW updates)	included
Snap on sensors for limited selling to Household	included
Standard Warranty (verified by HALT testing)	10 years



Protection & Certifications

Electronics certified safety by SGS labs to NEC & UL specs – NEC 690.4B & NEC 705.4/6	Yes
Grid Sell Back – UL1741-2010/2018, IEEE1547a-2003/2014, FCC 15 class B, UL1741SA, CA Rule 21, HECO Rule 14H	Yes
PV DC disconnect switch – NEC 240.15	integrated
Ground Fault Detection – NEC 690.5	integrated
PV rapid shutdown control – NEC 690.12	integrated
PV Arc Fault detection – NEC 690.11/UL1699B	integrated
PV input lightning protection	integrated
AC input/output 50A breakers	integrated
Battery breaker / disconnect	integrated
User wiring enclosure w/ ½" & 1" knock-outs	integrated
Solar Flare/EMP Hardened to 2015 MIL-STD-461G (Independently tested June 2018)	optional

Battery Solar made Simple



- **Grid Tied Mode:** Sell your power to the Grid
- **Smart Load:** Programable Loads for high power off-grid items saves battery capacity
- **Meter Zero Mode:** Zero your whole home power
- **AC Coupling:** add backup to 7kW of existing Grid Tie installs
- **Time of Use:** Use batteries to avoid \$\$\$\$ power
- **Peak Shaving:** Reduces peak demand charges
- **120 / 240 / 208V**

EMP/CME/LIGHTNING PROTECTION

- ♦ Protect your system and appliances from EMP/Solar Flare/Lightning at 2X military requirements

Wireless Monitoring & Remote Software updates

Four (4) x BG-0 Quad System at NETL Showing stack installation into BoP



Four (4) x BG-0 Quad System at NETL Showing Load Bank



BlueGEN Product Evolution

- BG-15 Model is successor to BG-0 Model
 - Both 1.5kw, BG-15 more manufacturing and installation friendly
 - BG-15 has better power density for higher kW levels via modular approach
- Modular Approach
 - “5 Pack” illustrated in next slide
 - WVU/NASA site will include 27 units (40kW)
- Standalone 6kW BlueGEN will supersede 4 x 1.5kW Quad approach at NETL (and BNL earlier)
 - Further improvement in power density
 - Significant “step change” in cost reduction

BG-0



BG-15



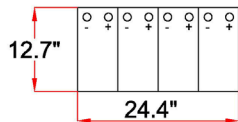
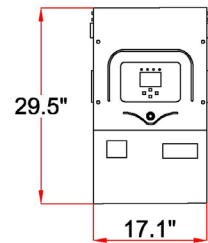
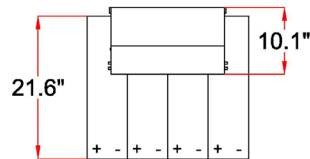
BlueGEN Product Evolution

BG-15 “5-Pack”



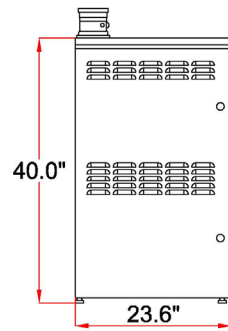
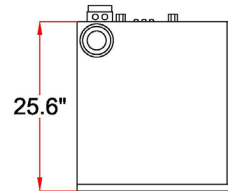
BlueGEN Product Evolution

SolArk:



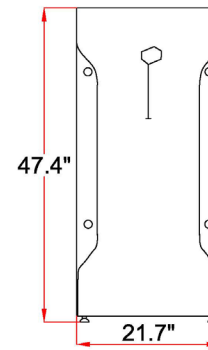
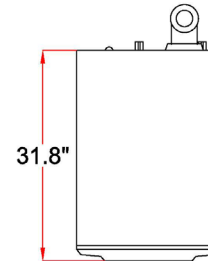
Weight: 718 lbs

BG-0:



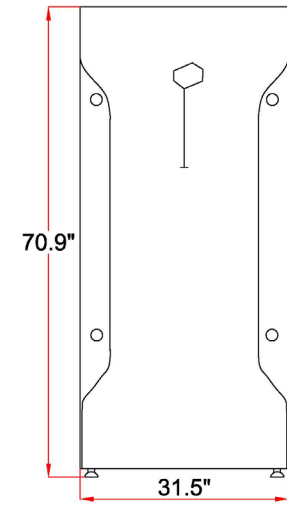
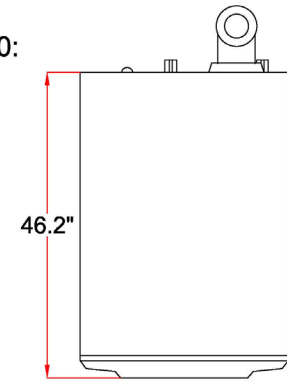
Weight: 507 lbs

BG-15:



Weight: 562 lbs

BG-60:



Weight: 1968 lbs

NO/REVISION				DATE		ARIS ENERGY SOLUTIONS_FUEL_CELL_MODELS	
						GENERAL_DIMENSIONS	
						BG-0,BG-15,BG-60	
DRAWN				DATE		DRAWING NO.	
CHECK						AES-21-0-04	
NOT FOR CONSTRUCTION						SHEET1OF1	
SCALE						REVISION	
CS				9/3/21		#1	



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