

# World's Longest Endurance Power Solutions for Electric UAS

## AEROPAK 450-700Wh/kg high performance fuel cell energy storage systems

### H<sub>2</sub> GAS (G-SERIES)

#### Composite Vessels



1

Up to 550 Wh/kg

- Lowest fuel cost (\$1/hr @ 200W)
- Simple plug & play system
- Excellent choice if space is available
- Best option for commercial UAV
- Lightweight and high efficiency

### LIQUID CHEMICAL (L-SERIES)

#### H<sub>2</sub> on-demand



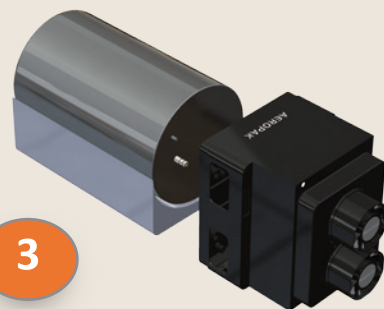
2

Up to 675 Wh/kg

- Controlled hydrogen on demand system
- Smaller size and lighter than gas option
- Non-gaseous fuel / easy to handle
- Better choice for remote area operations
- Progressive fuel weight reduction in flight

### SOLID CHEMICAL (S-SERIES)

#### H<sub>2</sub> on-demand



3

Up to 750 Wh/kg

- Controlled Hydrogen on demand system
- Smallest size, lightest of all options
- No catalysts required
- Infinite fuel storage life before use
- No waste fuel

## Fly small aerial drones at low altitude UAVs FOR HOURS AT A TIME



**NEW** – real-time system interface compatible with any device.  
Data via CAN, Bluetooth, IP, Serial  
Real time diagnostics and monitoring



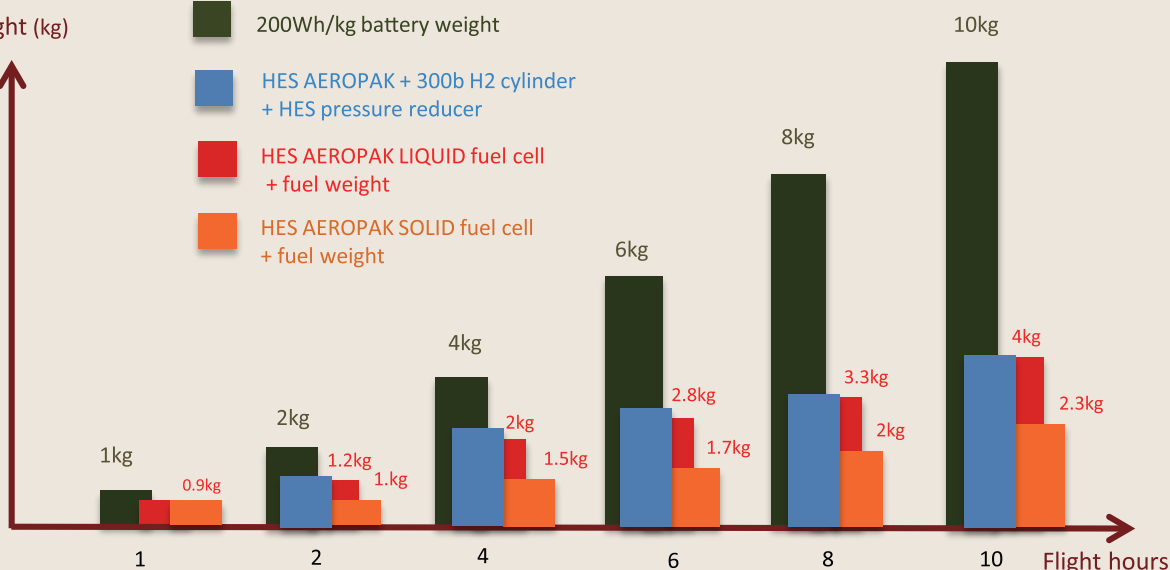
Weight (kg)

200Wh/kg battery weight

HES AEROPAK + 300b H<sub>2</sub> cylinder + HES pressure reducer

HES AEROPAK LIQUID fuel cell + fuel weight

HES AEROPAK SOLID fuel cell + fuel weight



HES is regarded as the most advanced fuel cell technology systems developer in the world, with energy densities already exceeding the 2015 performance targets set by US DOE in 2015. The company works mostly under confidential on-going contracts with several leading OEM customers around the world, while offering off-the-shelf versions of its special grade fuel cells.

Using compressed hydrogen vessels is the least complex solution at system level, and offers the lowest operational costs. It is possible to adapt small or large vessels to the front section of AEROPAK while using a specially designed pressure reducer developed for this purpose by HORIZON ENERGY SYSTEMS. Different vessel sizes offer more or less energy stored, and can be matched with smaller or larger stacks – standard or custom-designed for your needs.



Several configuration options are offered as standard items, HES also supplies CUSTOM solutions available on request. Just contact our engineering team on [sales@hes.sg](mailto:sales@hes.sg)

Horizon Energy Systems is also currently developing off-grid field refueling systems for hydrogen gas, using simple feedstock that are easy to handle such as river water. These novel systems should be available in late 2015 or 2016.

HORIZON ENERGY SYSTEMS makes the world's lightest titanium grade pressure regulators able to manage several hundred bars to 0.3 bar output pressure hydrogen delivery to the fuel cell stack.



### Two-step pressure regulator

Weight.....175g  
Size..... 42mm\*92mm  
Material..... Titanium  
Seal material..... Propionitrile rubber  
Screw type..... M18\*1.5  
Max. Input pressure..... 300 Bar  
Closing pressure..... ≤ 1.1 Bar  
Output pressure.....0.5 Bar  
if flow rate ≤ 7L per min



### Composite pressurized H2 vessels (0.5L to 12L)

- Certified and available now
- 300 bar pressure hydrogen
- Different sizes from 0.5L to 12L
- Lightweight and Handy
- High energy density

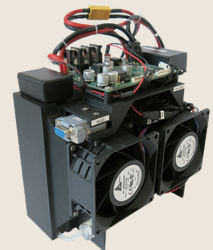


At just 570g for 200W rated (Inclusive of all peripherals) HORIZON ENERGY SYSTEMS supplies the world's lightest fuel cell systems.



### AEROSTAK 200W PEM FC

Number of cells .....35  
Rated power .....200 W  
Peak power .....220 W  
Stack weight(with fan & casing).....570 g  
Controller weight .....80g  
Stack size (with casing)...L 107 x W 126 x H 120 (mm)



### AEROSTAK 500W PEM FC

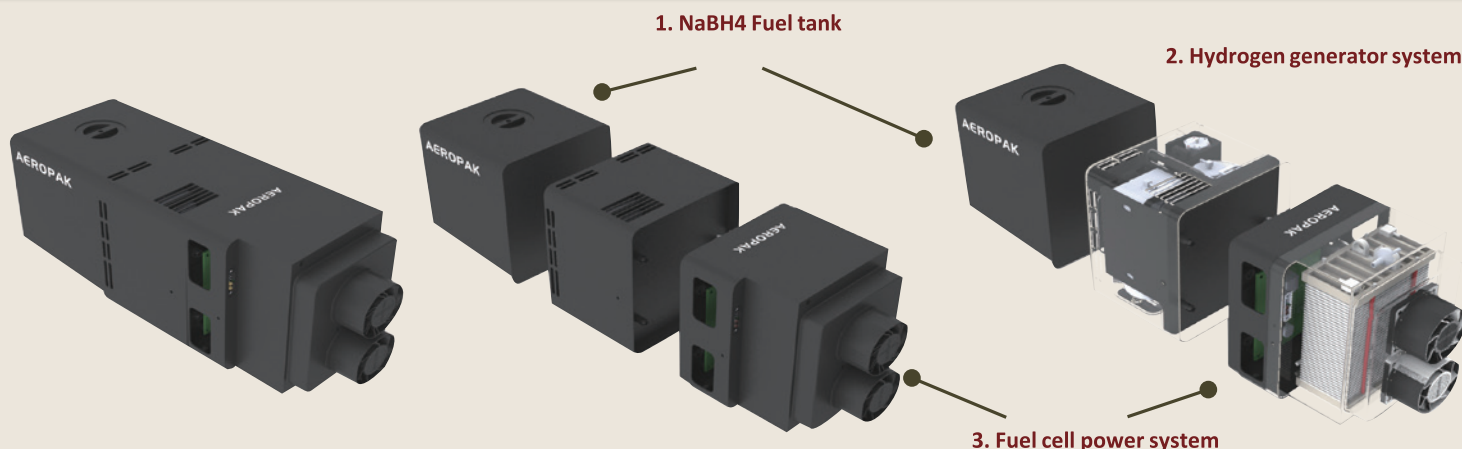
Number of cells .....45  
Rated power .....500 W  
Stack weight (with fan & casing).....1150g (±50g)  
Controller weight .....250g (±30g)  
Stack size (excl. electronics)...L 192 x W 107 x H 146



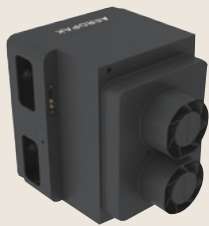
### AEROSTAK 1000W PEM FC

Number of cells .....50  
Rated power .....1000 W  
Stack weight(with fan & casing).....2200g (±50g)  
Controller weight .....250g (±30g)  
Stack size (excl. electronics)...L 252 x W 126 x H 190

The AEROPAK system is comprised of 3 sections: a fuel tank – where the hydrogen-rich NaBH<sub>4</sub> mix is poured, a reactor system that produces pure hydrogen gas with the help of a special catalyst, and a third section which integrates a fuel cell stack, electronics, and small peripherals. Electronics hybridize AEROPAK with an external battery for peak power.



### FUEL CELL SYSTEM



Continuous Output Power:	200W
Peak Power (hybrid battery):	600W for 2 min.
Continuous Output current:	10A
Output Voltage Range:	20V-32V
FC System Weight:	<b>570g</b>
Dimensions (mm):	107 X 126 X 120
Operating environment:	0C-40C / 0-95% humidity
Max altitude with no change:	3000m (can be adjusted)

### CARTRIDGE TYPE 1

(Includes H<sub>2</sub> generator + fuel tank)



#### TYPE 1 (can be customized)

Net Energy:	up to 900Wh
Dry Weight:	520g
Total Weight with 1L fuel:	1570g
Total Cartridge Volume:	2.3L
Size (mm):	180 X 106 X 120
H <sub>2</sub> flow rate:	0.3. L/min
Output pressure:	0.7 bar
Connection	quick-connector
Total FC + Cartridge Weight	2.1kg on take-off (landing weight is 1.5kg)
Total FC + Cartridge Volume:	2.2L
Total Specific Energy	<b>450Wh/kg (at take-off)</b>
Average Energy Density	<b>675Wh/kg</b> (landing Vs take off weight)

### CARTRIDGE TYPE 2

(Includes H<sub>2</sub> generator + fuel tank)



#### TYPE 2 (can be customized)

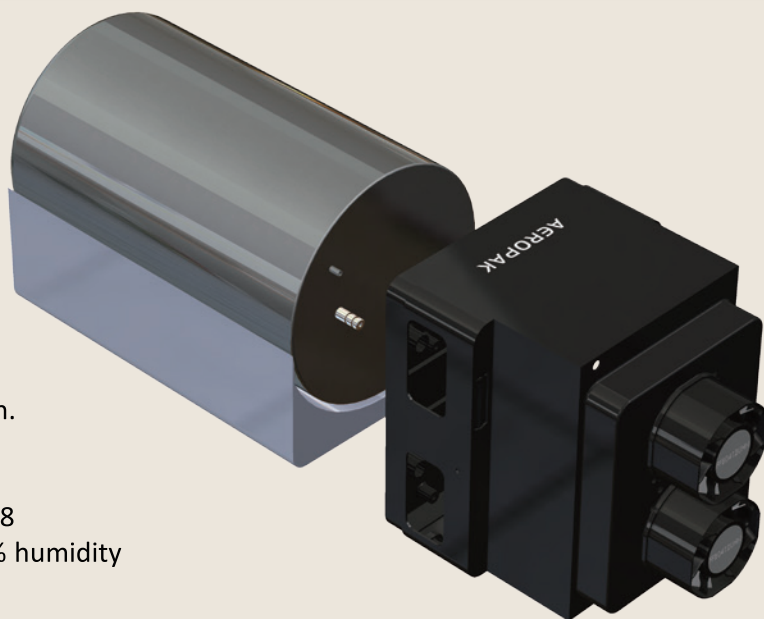
Net Energy:	up to 1700Wh
Dry Weight:	1200g
Total Weight with 1L fuel:	3100g
Total Cartridge Volume:	2.3L
Size (mm):	180 X 106 X 120
Total FC + Cartridge Weight	2.1kg on take-off (landing weight is 1.5kg)
Total FC + Cartridge Volume:	3.8L
Total Specific Energy	<b>550Wh/kg (at take-off)</b>
Average Energy Density	<b>700Wh/kg</b> (landing Vs take off weight)



Introducing a NEW, high performance SOLID hydrogen on demand cartridge system for its AEROPAK product line. This new SOLID system offers a theoretical 14% hydrogen storage weight content, and yields a practical 7%, placing at the performance edge of today's hydrogen storage technologies. In effort to continuously improve usability – this system is plug and play, with no complex reactor componentry, operates without any catalyst, and self-contains its waste by-product.

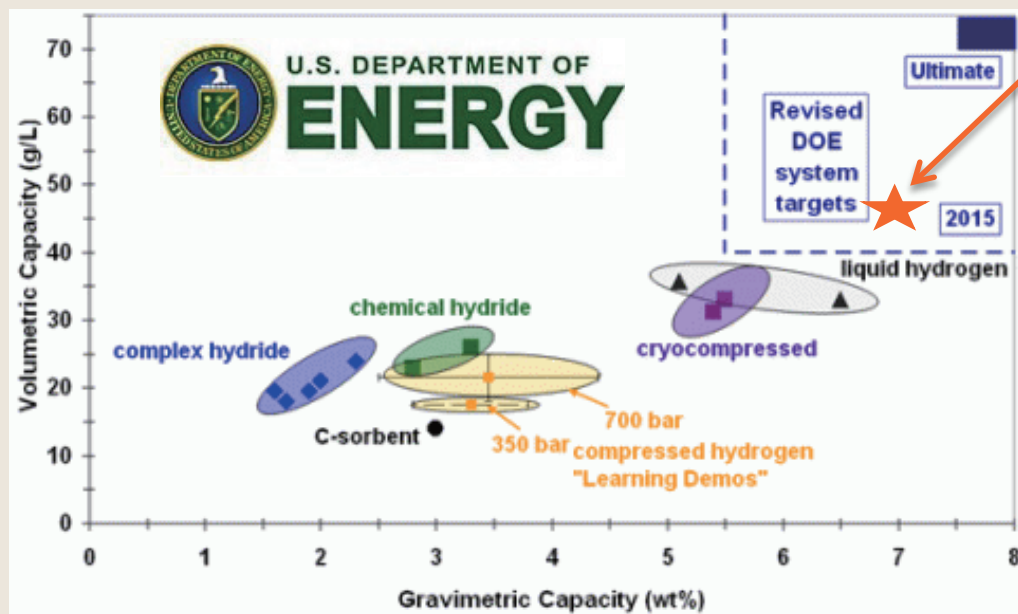


Continuous Output Power:	200W
Peak Power (hybrid battery):	600W for 2 min.
Continuous Output current:	10A
Output Voltage Range:	20V-32V
Dimensions (mm):	126 X 116 X 138
Operating environment:	0C-40C / 0-95% humidity



**CUSTOM SOLUTIONS AVAILABLE** - Please feel free to enquire with our team on development of systems based on available shapes/dimensions and other constraints, should our readily available COTS solutions fail to meet your specific needs. We'll design according to your needs.

## At the edge of US Department of Energy targets

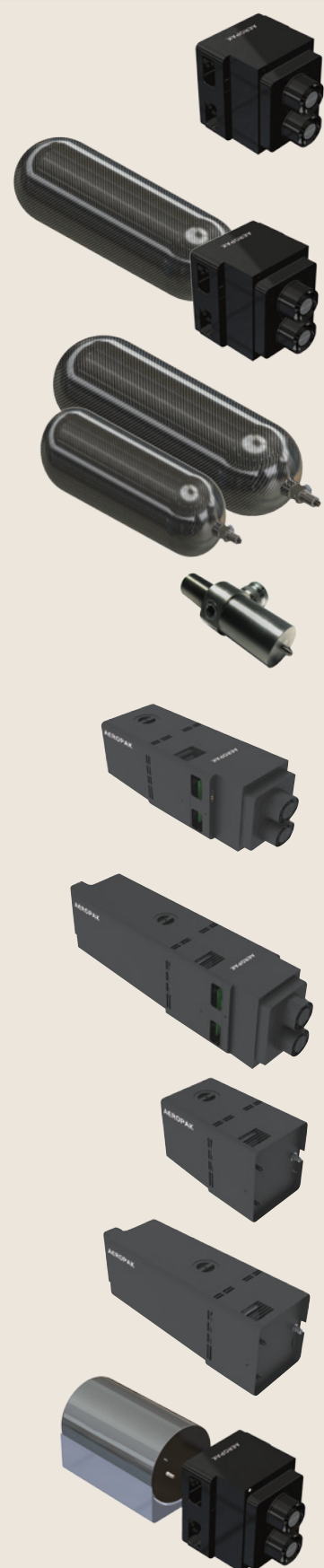


**Horizon**  
Energy Systems



# World's Longest Endurance Power Systems for Electric UAS

## STANDARD OFF-THE-SHELF kits - options & components



### AEROSTAK A-200: 500g/200W fuel cell system including peripherals

AST01-01

- Extremely compact and lightweight
- Built in controls and customizable housing
- Compatible with H<sub>2</sub>-generating cartridges or compressed H<sub>2</sub> tanks

### AEROPAK G-SERIES with compressed H<sub>2</sub> vessel (standard tank is 1.1L)

APCL01-01

- includes titanium pressure regulator
- Plug and play solution
- Refillable tanks, requires on-site filling capability

### AEROPAK G-SERIES compatible carbon-fiber reinforced composite H<sub>2</sub> vessel

CCL01-01

- compact and lightweight (*ask for our available sizes*)
- fast charging time
- hydrogen charging pressure up to 300bar

### AEROPAK G-SERIES compatible 2-step Horizon pressure regulator

APKCR01-01

- lightweight design
- designed for use with hydrogen gas
- reduces high pressure (300bar) to low consistent pressure (0.4 to 0.65bar)

### AEROPAK L-SERIES / Type 1 Cartridge : 450Wh/kg complete FC system

APK01-01

- Compact and ultra-lightweight system (2kg)
- Built in controls and customizable housing
- Comes with communication interface

### AEROPAK L-SERIES / Type 2 Cartridge: 550Wh/kg complete FC system

APK01-02

- Compact and ultra-lightweight system (3kg)
- Built in controls and customizable housing
- Comes with communication interface

### AEROPAK L-SERIES Cartridge Type 1: 900Wh H<sub>2</sub> generating cartridges

ASPR01-01

- Non-hydrogen gas storage solution
- Waste by-product is purged on the fly, reducing weight during flight
- In-situ hydrogen generation capability

### AEROPAK L-SERIES Cartridge type 2: 1700Wh H<sub>2</sub> generating cartridges

APKCR01-02

- Non-hydrogen gas storage solution
- Waste by-product is purged on the fly, reducing weight during flight
- In-situ hydrogen generation capability

### AEROPAK S-SERIES: 1200Wh Solid Chemical H<sub>2</sub> generating cartridges

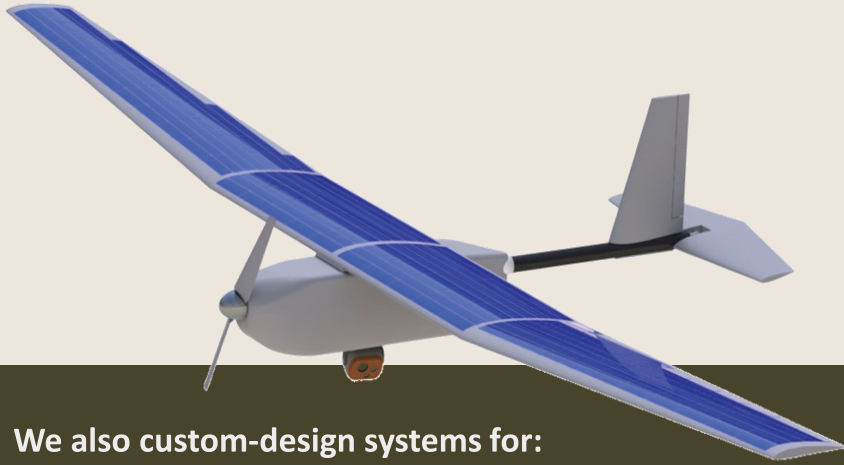
APKCR01-02

- Non-hydrogen gas storage solution
- Waste by-product is purged on the fly, reducing weight during flight
- In-situ hydrogen generation capability

# World's Longest Endurance Power Systems for Electric UAS

## Custom engineering services / endurance power for unmanned vehicles

Fuel cell solutions are typically much lighter, but also take up more space than batteries. To make the most of the endurance benefits, certain adjustments need to be made to the aircraft design. We can help the scientists and engineers on your team – to develop the most optimal solution.



HES systems are scalable and can be offered in various configurations, taking into account nominal, peak, and continuous power levels, as well as duration, or other data communication and software requirements. The systems can be designed to maximize weight efficiency by reviewing the power profile of a typical flight. These are all parameters we analyze together with our clients in great detail prior to engaging on custom designs.

### We also custom-design systems for:

- Mini-UAS (5-12kg TOW)
- Small Tactical UAS (12kg-80kg TOW)
- Unmanned Underwater Vehicles
- Ground Robot Vehicle systems
- Soldier Portable & Stationary Systems



SMALL DRONES, FOR **BIG** JOBS.

HES is regarded as the most advanced fuel cell technology systems developer in the world, with energy densities already exceeding the 2015 performance targets set by US DOE in 2015. HES has worked under a US DARPA program in 2010 and 2011, focused on novel power solution development in the field of micro-UAVs. Following a new world record flight distance set by NASA-backed teams and DLR engineers with our ultra-light fuel cell design, Horizon Energy Systems was formed in Singapore (2009), where it established its first laboratories. From Singapore, it has developed an international customer base in the field of unmanned aerial vehicles (UAV) in civilian and military applications.

In Singapore, Horizon Energy Systems (HES) develops ultra-light, high energy density power systems enabled by fuel cells and various on demand hydrogen supply solutions. Horizon's lightweight fuel cell systems stem from its **in-cell™** water management technology which avoids the use of heavy and bulky system peripherals. The HES engineering team and field experts work together to creatively solve the most challenging energy storage challenges. HES consistently innovates to create solutions that outperform, bringing out the best of fuel cells, solar, battery and capacitor technologies in optimally balanced hybrid systems.

### Global partners & clients



[www.hes.sg](http://www.hes.sg)