



◀ The Power of Nature ▶



Advanced Power And Energy Transportation (HK) Co., Ltd. (A Member of the **APES** Group)  
[www.salamanderian.com](http://www.salamanderian.com)



ZINC OXYGEN ENERGY





# Metal Air Fuel Cell Revival

Zinc Air Fuel Cells are no news to the technology society. Previous versions of ZAFC had very high production costs, restricted to military use, and had not been properly promoted.

We invented new ways to harvest the energy from Zinc, by using low cost materials, fully open cell design, without any screws and glues, allowing re-usage of the cells casing for hundreds of times.

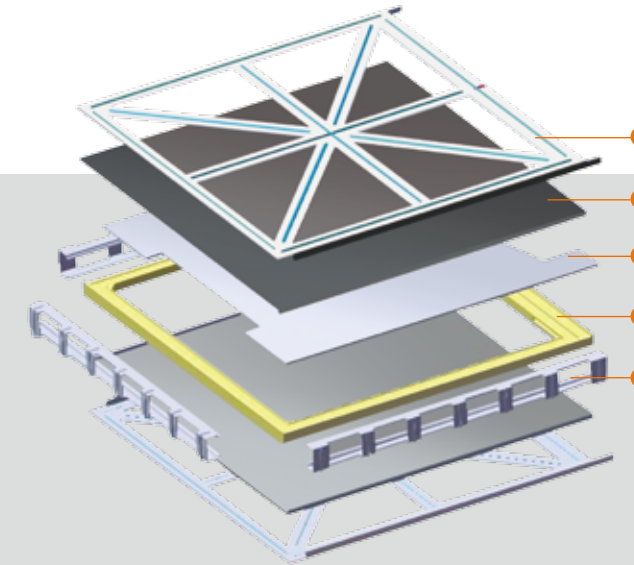
The commercialization of ZOE is based on the principles of:

1. Not changing habits
2. Maintaining existing convenience level
3. Quantifiable economics in kg of Zinc
4. Environmentally friendly
5. Zero carbon emission, thus enhancing human health
6. A true Product of Consideration



A portable Zinc Oxygen Energy fuel cell developed by APES. With cutting edged Metal Fuel technology, ZOE provides high capacity, a high energy density power source anytime, anywhere on Earth's surface.

1. Oxidation of metal to give electricity, with zero emission, non-toxic by products, and fully reusable/recyclable parts – a truly **GREEN** product.
2. Safe, Environmentally friendly, Portable, Easy to use, and Economical, making it a favorable alternative power source for EV



## Specifications

### Properties

Dimensions per cell: 205 x 195 x 11 mm  
Air Electrode surface area: 203 x 188mm  
Weight (full system cells): 630g  
Zinc weight: 210g  
Electrolyte weight: 160g  
Casing + electrodes weight: 260g

### Output (per cell)

Open circuit at 1.30V ~ 1.45V  
Operation voltage at 1.1V nominal  
Output power range at 20A  
Capacity: 140Ah  
Total energy: 154Wh  
Specific Energy Density: 244Wh/kg  
Operational Temperature: -20 °C ~ 60 °C  
(lower/higher temp formula can be tailored)

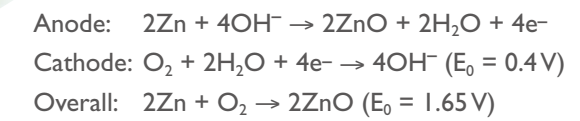
- A Metal Frame for structural support and current collector
- B Air Electrode for Oxygen diffusion and current collector
- C Power Pack with Zinc and separator, to hold electrolytes and generate electricity

- D Plastic Frame for structural support and insulator
- E Metal Clips to hold all components in position without any screws and enhance connectivity

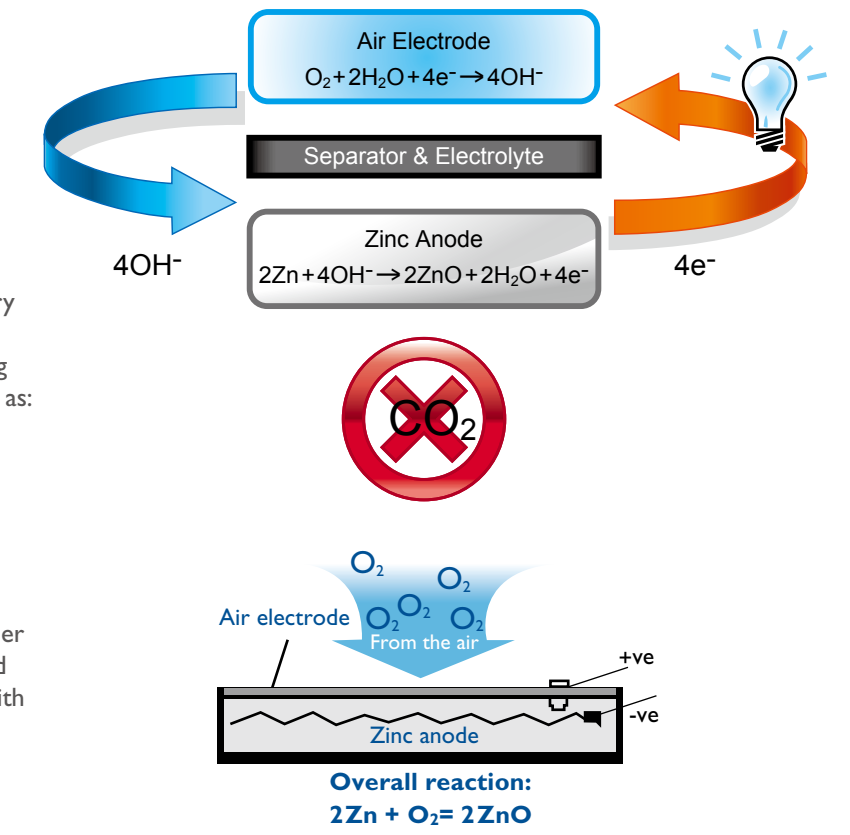


## Formation of Metal Air Fuel

ZOE - Zinc Oxygen Energy employs the basic electro-chemistry of a Zinc Air Fuel Cell, using Oxygen in the air to oxidize the metal Zinc, releasing two electrons from each Zinc atom during the process. The chemistry equation can be simply summarized as:



Batteries are made of two electrodes, one positive, and the other negative. ZOE uses Oxygen as half of the fuel, through Patented Air Electrode, Oxygen will be converted into fuels and react with Zn to generate electricity.



# Made to Measure

As the Zinc metal retains a very high specific energy density, a lot of electrical energy can be harvested from the oxidation process through absorbing Oxygen from air, hence reducing weight or increasing capacity of fuel cell, when comparing to other batteries.

## Use ZOE's capacity as an example:

ZOE has 140Ah per cell.

The weigh of each ZOE cell is 630g. A 12V 130Ah Lead Acid battery commonly used for existing EVs weighs 35kg, while ZOE 12. 1V 140Ah weighs 6.93kg only.

## Mileage comparison:

Take GEM, a very popular EV as an example, the battery is 72V 130Ah = 9.36kWh capacity and can go for 25-30miles or 40-48km. The batteries weigh 210kg (35kg x 6 units)!

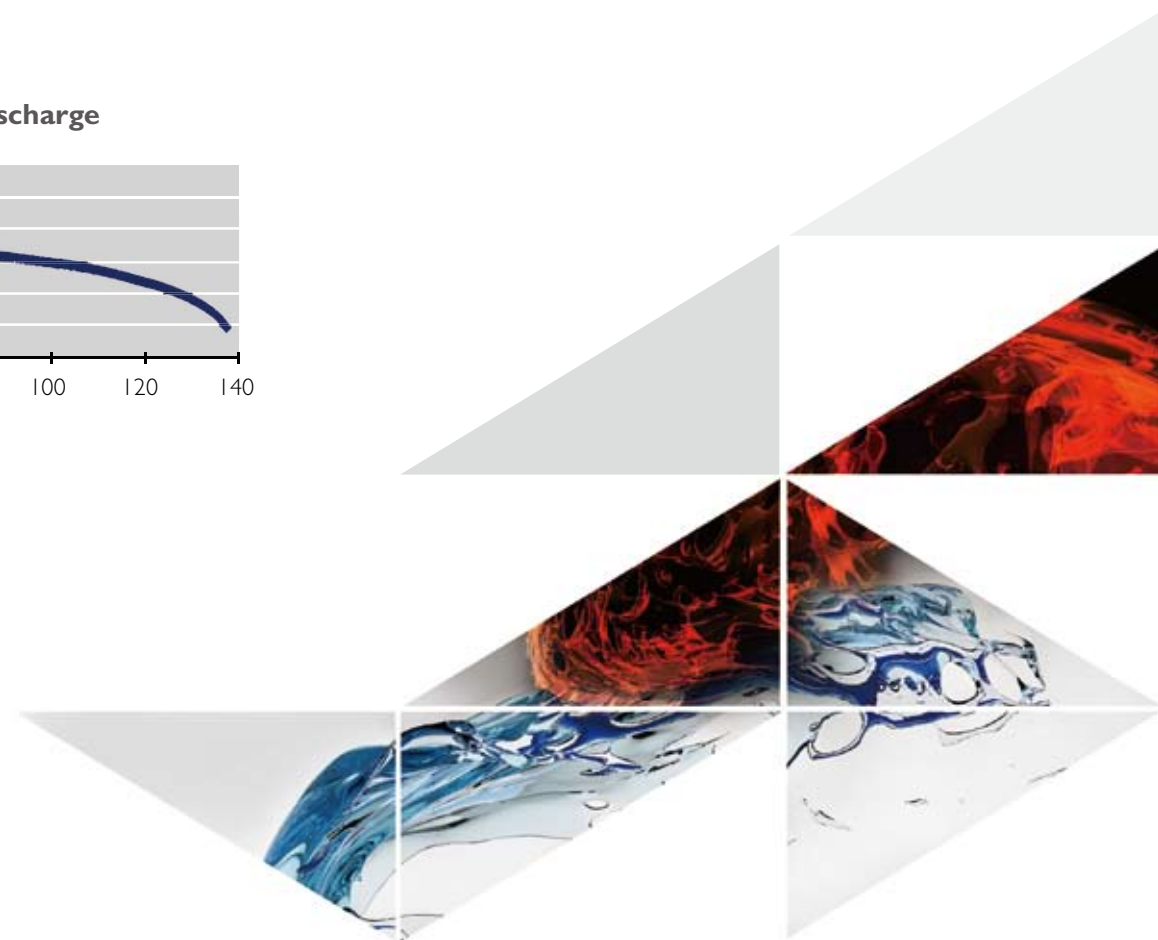
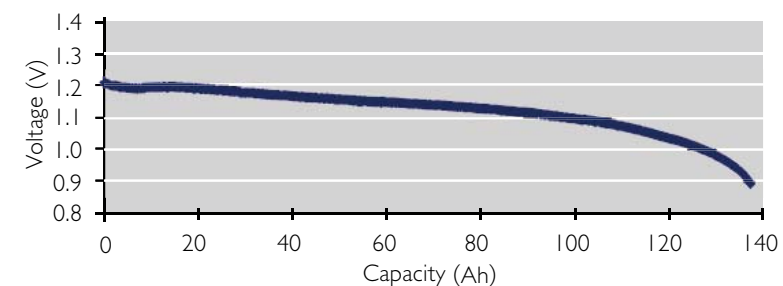
With 210kg, ZOE can pack 333 cells of over 51kWh of capacity, which could allow the existing GEM runs for a 260km at maximum, about 5 times more than that of Lead Acid batteries.

Comparison

Battery	Spec / Weight	Module US\$/44kWh	Cost US\$/km/charge
<b>ZOE</b>	288 cells, 154Wh = 44.35kWh 181kg, 244Wh/kg	Projected \$3,600 for 288 cells	Replace only Zn \$0.215
Li-Polymer	408 cells, 3.6V, 30Ah = 44kWh 360kg, 122Wh/kg	\$35,200 (@\$800/kWh)	\$0.160
NiMH	2037 cells, 1.2V, 18Ah = 44kWh 723kg, 60Wh/kg	\$17,600 (@\$400/kWh)	\$0.223
PbAcid	37 batteries, 12V, 100Ah = 44kWh 1110kg, 40Wh/kg	\$8,800 (@\$200/kWh)	\$0.219

ZOE is being designed to fit mass market demand with acceptability and economy of scale in mind. The packaging of casing can be reused time and time again. Costs of the most expensive elements, such as casing and air electrodes, can be thinly amortized through our patent-pending methods. Without a screw or glue, the totally open-cell system allowing simple operation to change the power pack either manually or mechanically.

Single cell ZOE 20A discharge



# Ideal for Transportation

## For a vehicle application we need

1. Quantifiable fuel/range relationship to achieve commercialization structuring.
2. For a car runs 5 years, the replacement costs for other battery systems will be higher than the value of fuel. For example, Lithium polymer batteries take 2 sets to achieve a 5-year operation at high C rate under ideal scenario. Different charging/discharging habit and battery balancing methodology may result in damage or reduction of battery life.
3. Our calculation has yet to include the recycle program. Zinc is the 4th largest mineral reserve in the world, through carbothermal reduction Zinc can be a sustained energy carrier for all transportations.
4. Scarcity of Lithium remains to be the biggest concern of Lithium-based battery technology.
5. We are ready to license out ZOE technology and recipe for mass production.

# Versatile Energy Source

## For Mobile Energy = TRANSPORTATION

To be applied in cars, buses, trucks, ships, boats, airplanes, etc.

## For Emergency Energy

To be applied in back up facilities

## For Remote Energy

To be applied in distant locations without grid electricity supply e.g. fishing huts, skiing chalets, town centres of remote island villages, etc.



# Generation to Generation

ZOE is our solution to provide an alternative way to apply energy, to achieve a more efficient usage habit. It is important to start making changes today, for the health and well-being to ourselves and to our next generations to come. By replacing transportations with internal combustion engines – pollutions directly threatening everyone's health, ZOE can play a significant role in achieving an emission-free society in the near future.

ZOE is one of the only cost competitive, and sustained energy system that we can engage immediately. An energy generation system that breathes as human, receives and delivers energy as nature does. ZOE acts as a perfect balancer to this CO2 rich world, with direct encouragement for people to plant more trees and live green from the root.

**Salamander**  
Advance Green Power from Here



