

The many uses of fuel cells

1 Intelligent Energy Ltd fuel cell stacks



Fuel cells (1) are electrochemical devices that convert hydrogen and oxygen from the air into electricity, heat and water vapour. They were invented in 1839 by Sir William Grove, but the first use of fuel cells came over a century later, following the invention of the alkaline fuel cell by Francis Bacon in 1932.

These fuel cells were used in NASA space programmes from the mid-1960s to generate power for satellites and space capsules. They are now used in many more applications (2) and are being used to reduce carbon emissions, particularly in the automotive, aerospace and marine industries.

2 Kelluu airships powered by fuel cells enable larger areas to be covered in a single flight, with increased real-time monitoring and data capture



Stationary power applications, such as backup power for construction sites or hospitals that ensure continuous operation if the National Grid goes down, have less need for reduced mass, but a greater requirement to provide reliable power over many years in a variety of environments. Automotive applications, such as cars, trucks and buses, rely on both: mass impacts the range, and robustness impacts reliability (3). Engineering trade-offs provide the best of both.

In drone applications (4) the mass must be as low as possible, and the fuel cell must provide a high power density for short periods of time. This will enable the drone to fly for greater distances and carry heavier payloads, such as cameras or sensors.

Fuel cells compete with batteries and internal combustion engines currently being used by drones, but the weight of fuel cell equivalents is considerably less.

3 Transport applications require a balance between mass and reliability



4 Drones powered by fuel cells. (a) Aurora Flight Sciences choose fuel cell technology for extended range and improved operations. (b) Fuel cell-powered drone with LiDAR equipment installed



Commercial drone operators, such as those working in the inspection, mapping and cinematography sectors, are often limited by the flight time capabilities of battery-powered drones. The heavier the aircraft, the shorter the flight. Batteries require lengthy recharging times, increasing the time required to complete a job. Batteries can also be heavy, especially when increasing the power needed, thereby limiting any additional equipment that may be required.

5 Some advantages of fuel cells

	Low to zero emissions	Fuel cells provide zero emission power at point of use, and can be used as an alternative power source for batteries and diesel engines.
	Modular	Hydrogen fuel cell technology is both modular and scalable. Multiple hydrogen fuel cell modules can be connected in a single system, meaning that they can be easily scaled to achieve the desired power output.
	Refuelling	Fuel cells do not need electrical recharging because they can provide power for as long as hydrogen is supplied as a fuel. Fuel cell systems can be refuelled with hydrogen in minutes, compared with batteries, which can take several hours to charge.
	High efficiency	A fuel cell can be around twice as efficient as an internal combustion engine. Combustion engines typically have efficiencies of 33–35%, whereas fuel cell efficiency can be 60%.
	Reliability	Fuel cell technology is both reliable and durable. A fuel cell contains fewer moving parts than a combustion engine, reducing the likelihood of part failure and down time.
	Range	Fuel cell-powered drones can fly 3–5 times further than battery-powered drones due to lower weight and higher power density.

Fuel cells can improve the performance and efficiency of drone operations – such as longer flight time, quick refuelling and greater data capture – due to their lightweight nature and ability to refuel in minutes compared with heavy battery alternatives. As a result, fuel cells have become a popular power alternative for many commercial drone operators, who previously opted for battery power (5).

Thank you to Intelligent Energy for the information and images in this 'At a glance'.

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