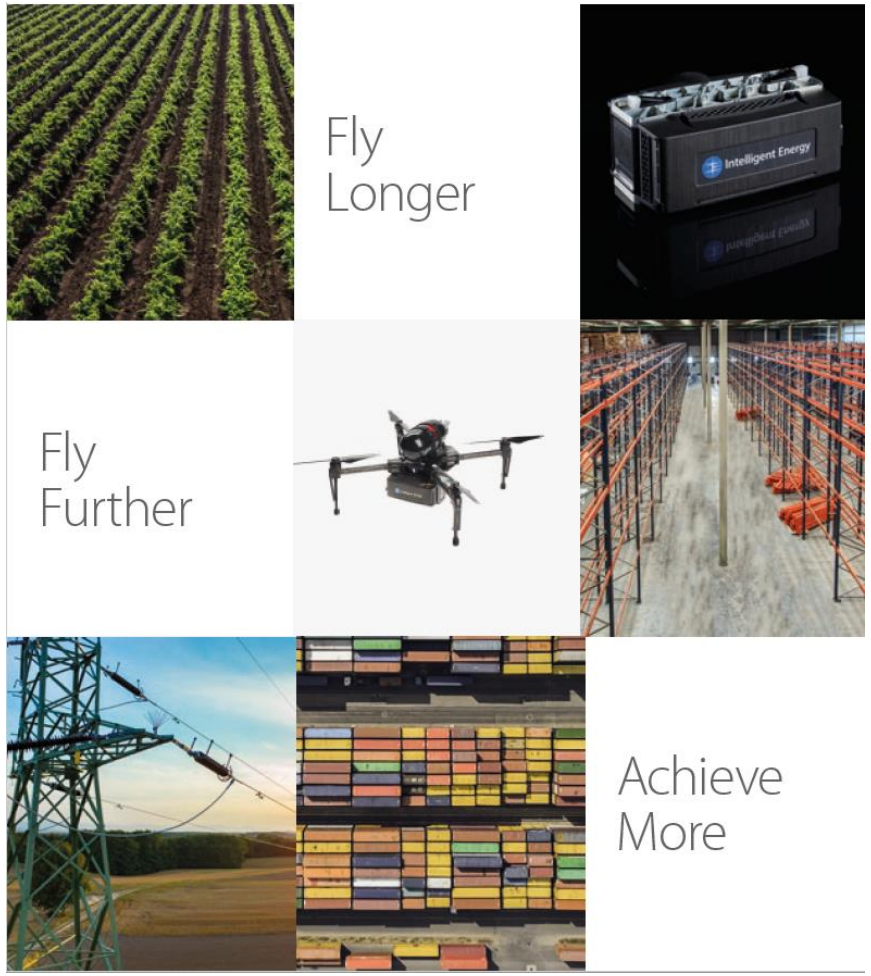
Intelligent Energy

Fuel Cell UAV Introduction

Applications where Intelligent Energy is engaged

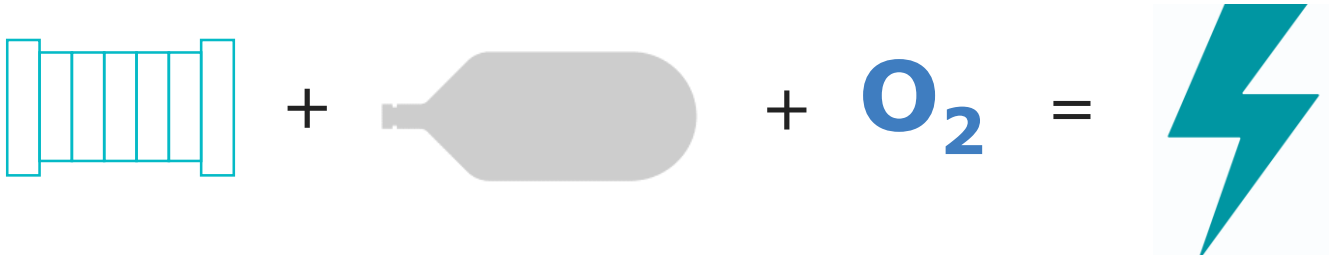
- ✓ Pipeline inspection
- ✓ Overhead power line inspection
- ✓ Surveying and mapping
- ✓ Inspection
- ✓ Motion picture, filming, television and broadcast
- ✓ Agriculture
- ✓ Parcel delivery
- ✓ Specialist/military



Key facts about fuel cells

A fuel cell is not a battery!

- Fuel cells **generate** electrical energy from chemical energy
- Energy is produced through an **environmental friendly** chemical reaction (it operates quietly and requires minimum maintenance)
- The fuel is **hydrogen**. It is combined in the fuel cell with oxygen from the air to produce electricity and pure water
- As long as you have hydrogen, you can keep generating **electricity**



Power vs energy

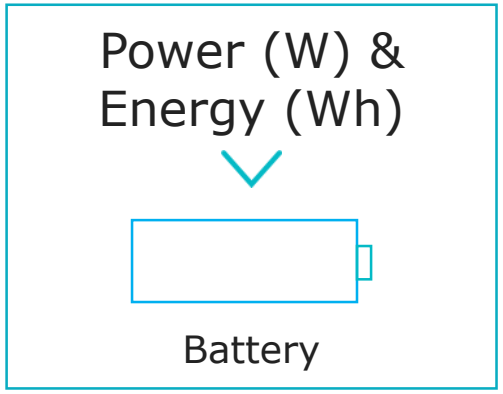
Power >

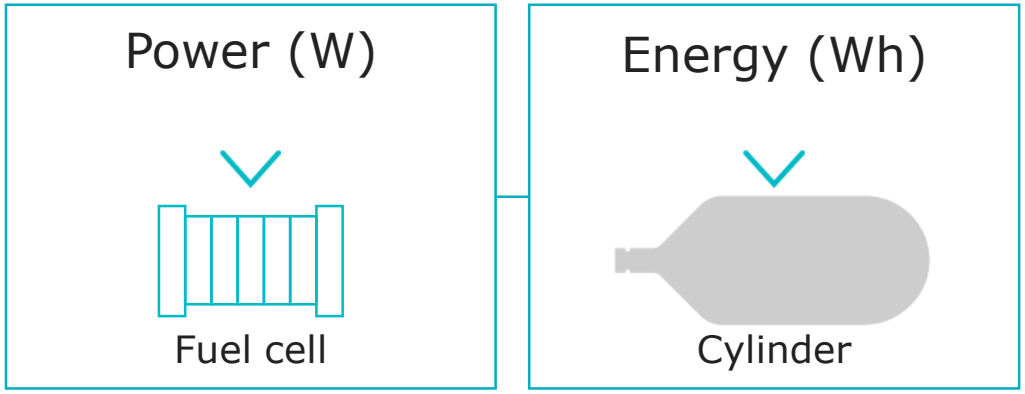
This relates to the lifting capability of the power system.
The battery equivalent is discharge rating (C-rating) or discharge current (A). A battery has a continuous discharge limit (peak power).

Energy >

This is how long you can stay in the air.
The battery equivalent is capacity, for example mAh or Wh.

A battery has both power and energy limits in the same hardware.
In a fuel cell system these are separate.





Fuel cells vs batteries

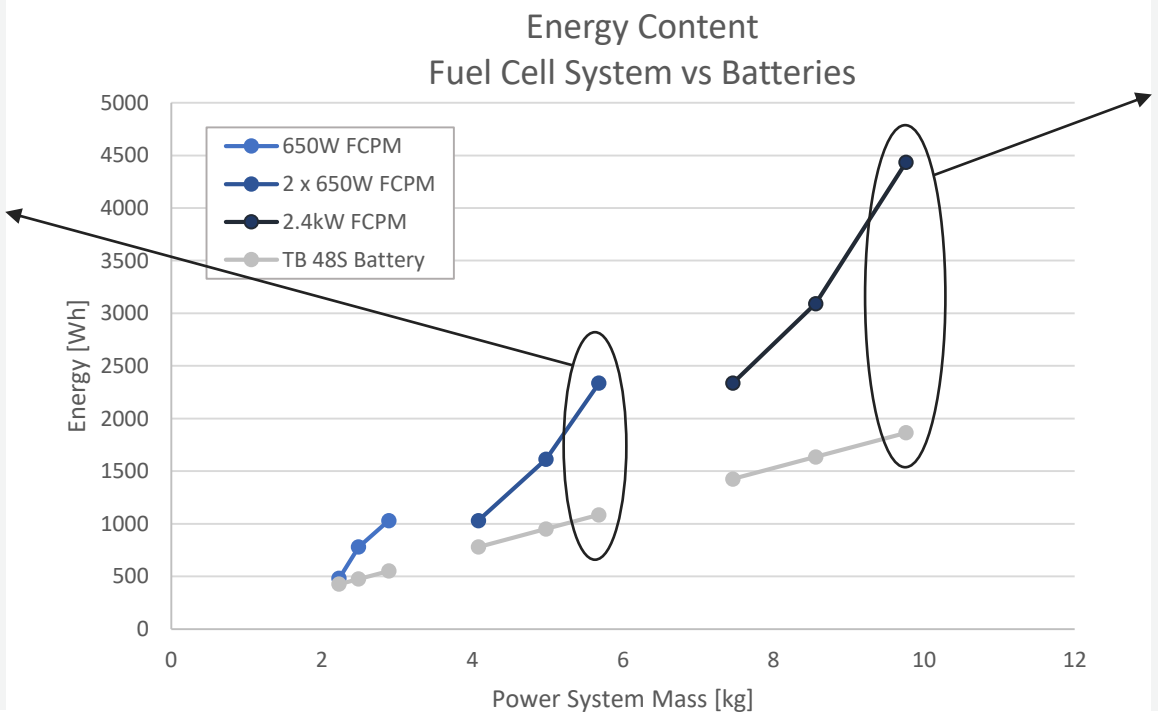
Compressed hydrogen contains more usable energy than a LiPo battery

Example fuel cell system

Fuel cell – 2.48kg
Battery – 0.46kg
Cylinder – 3.2kg

Total mass 6.14kg and contains 2336Wh
= 411Wh/kg

6.14kg of batteries contains 1085Wh
= 176Wh/kg



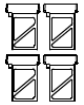
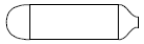
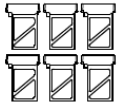
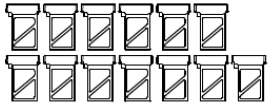
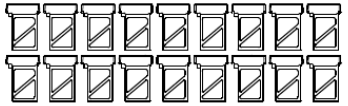
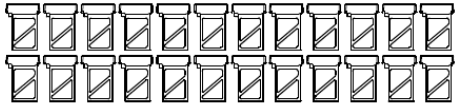
Example fuel cell system

Fuel cell – 3.25kg
Battery – 0.76kg
Cylinder – 5.5kg

Total mass 9.5kg and contains 4435Wh.
= 450Wh/kg

9.5kg of batteries contains 1800Wh.
= 189Wh/kg

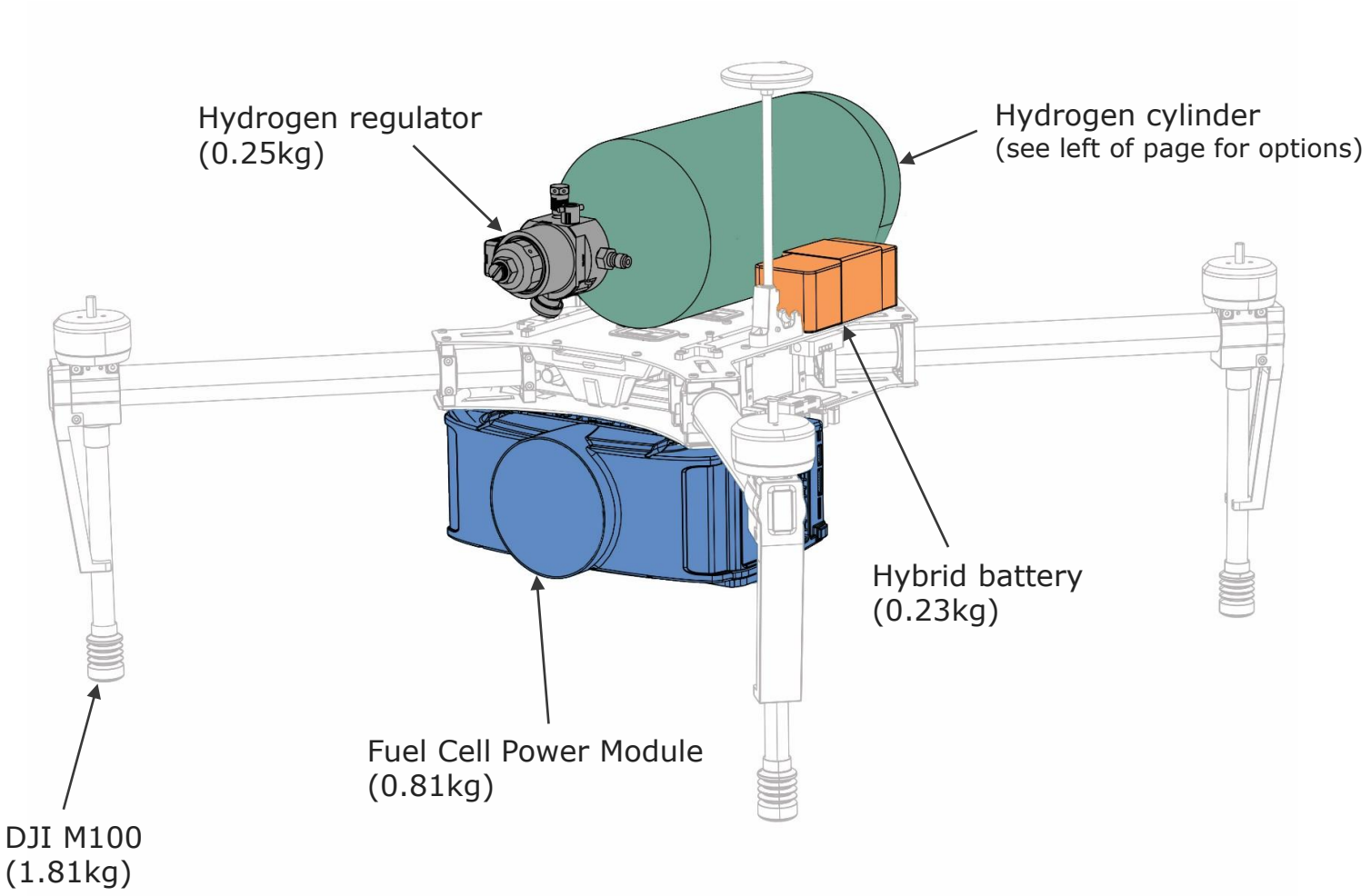
Cylinder energy vs TB48S battery equivalent

Cylinder Size [L]	Cylinder Mass	Usable Energy		DJI TB48S Wh Equivalent	TB48S Mass
1.5L	**0.97**kg	**482**Wh			**2.5**kg
2.0L	**1.25**kg	**780**Wh			**4.1**kg
4.7L	**2.56**kg	**1614**Wh			**8.4**kg
6.8L	**3.3**kg	**2336**Wh			**12.2**kg
9.0L	**4.45**kg	**3091**Wh			**16.2**kg
13.0L	**5.7**kg	**4435**Wh			**23.5**kg

DJI M100 + 650W Fuel Cell Power Module configurations

1.5L Cylinder
Mass: 0.94kg
Payload: 250g
Flight Time: 63mins
AUM: 4kg
System: **230Wh/kg**

2.0L Cylinder
Mass: 1.2kg
Payload: 0g
Flight Time: 85mins
AUM: 4kg
System: **276Wh/kg**



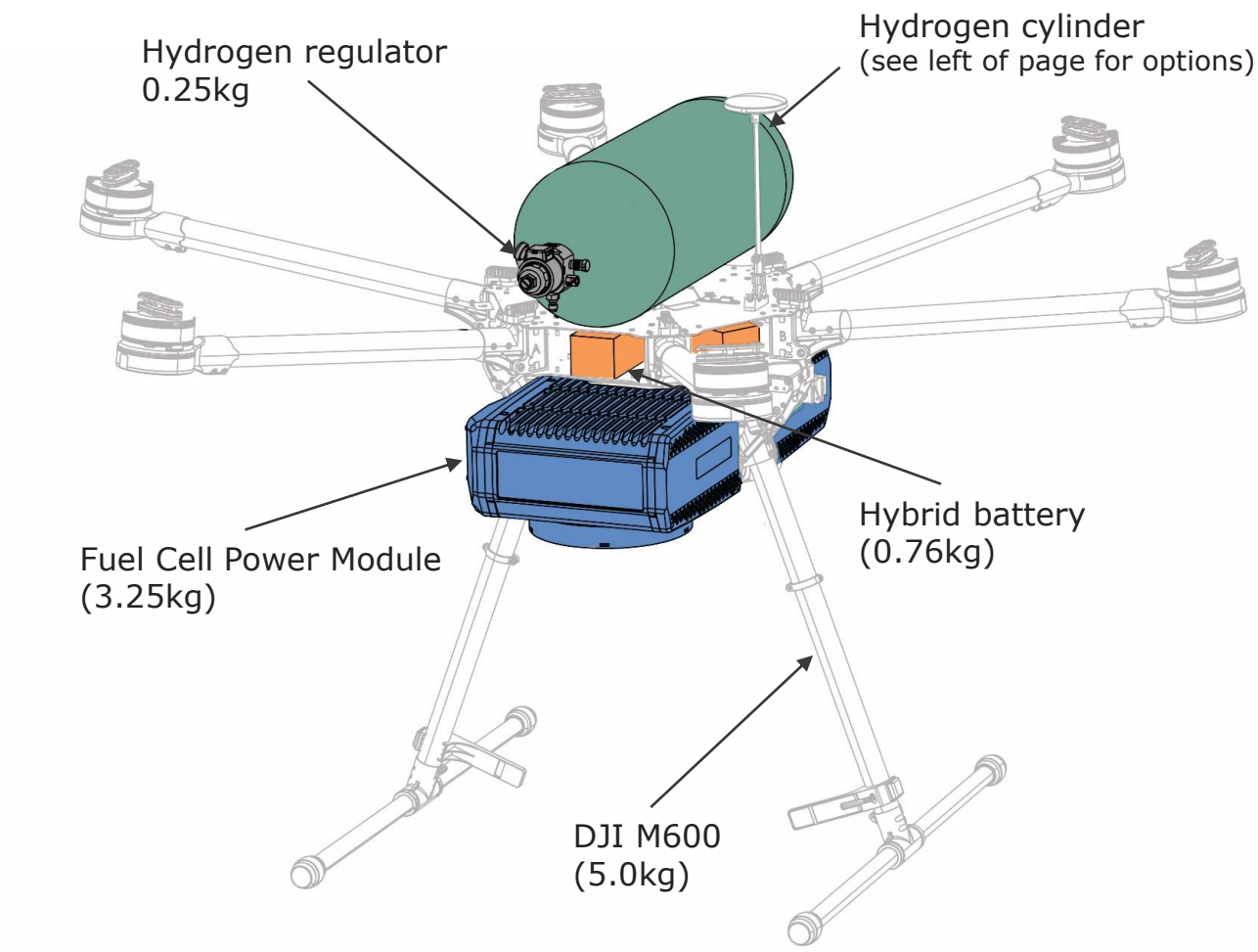
DJI M600 + 2.4kW Fuel Cell Power Module configurations

4.7L Cylinder
Mass: 2.5kg
Payload: 4.5kg
Flight Time: 38mins
AUM: 16.8kg
System: **232Wh/kg**

6.8L Cylinder
Mass: 3.2kg
Payload: 3.5kg
Flight Time: 57mins
AUM: 16.5kg
System: **305Wh/kg**

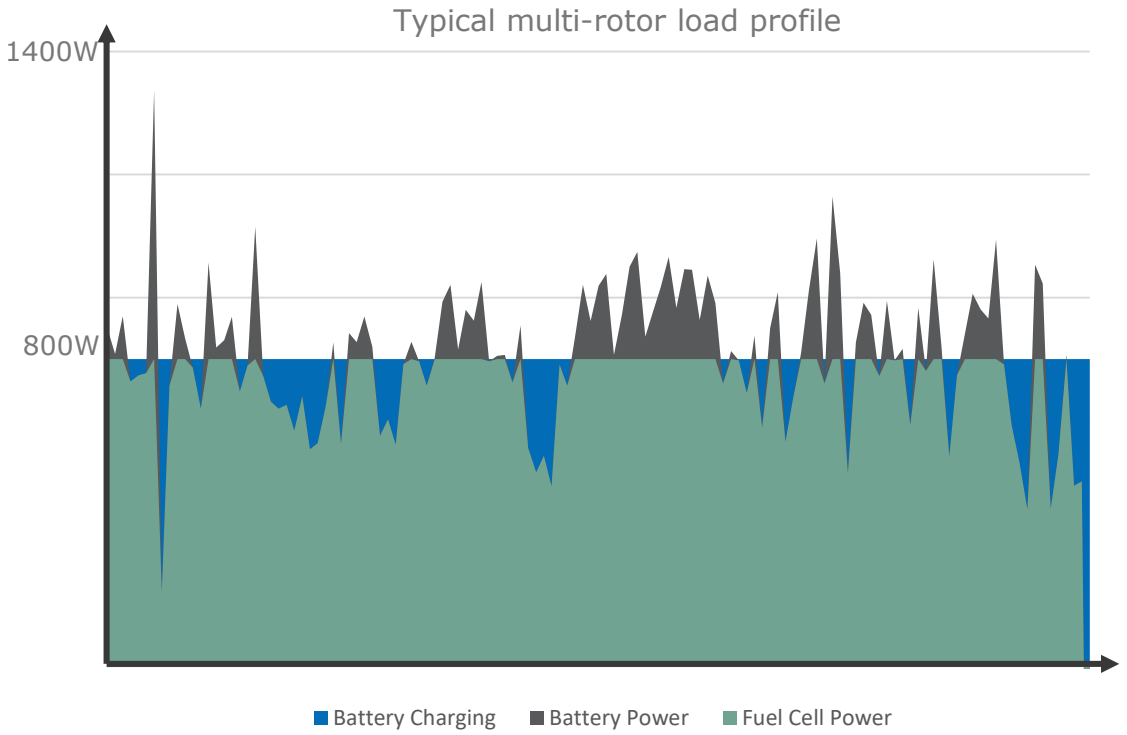
9.0L Cylinder
Mass: 4.3kg
Payload: 2.5kg
Flight Time: 75mins
AUM: 16.5kg
System: **353Wh/kg**

13L Cylinder
Mass: 5.5kg
Payload: 1kg
Flight Time: 111mins
AUM: 16kg
System: **446Wh/kg**



Peak power and battery hydridisation

Typical multi-rotor load profile is erratic and averages around a ‘power-to-hover’ level.
Throughout the flight, battery voltage is maintained at rated voltage.



800W Fuel Cell Power Module will provide power below 800W from fuel cell

‘Peak’ Power (>800W) will come from battery

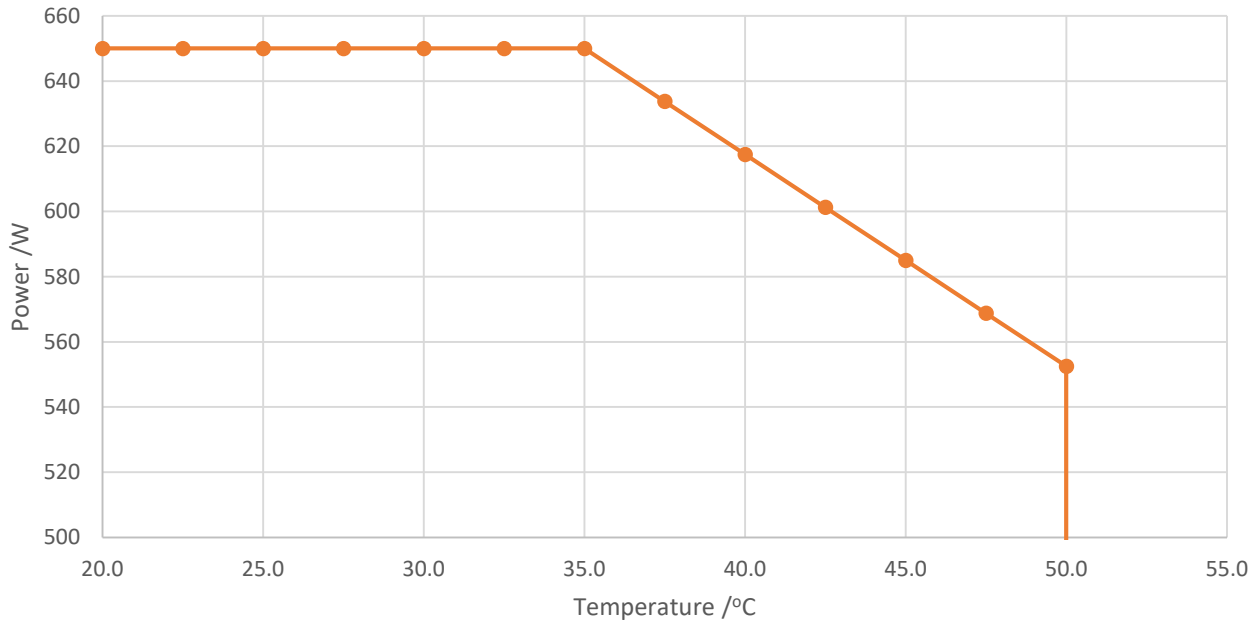
Battery will be charged while load is less than rated power (<800W)

*max peak power duty cycle for Fuel Cell Power Modules is dependant on hybrid battery capacity. Default batteries provide peak power for 120 seconds

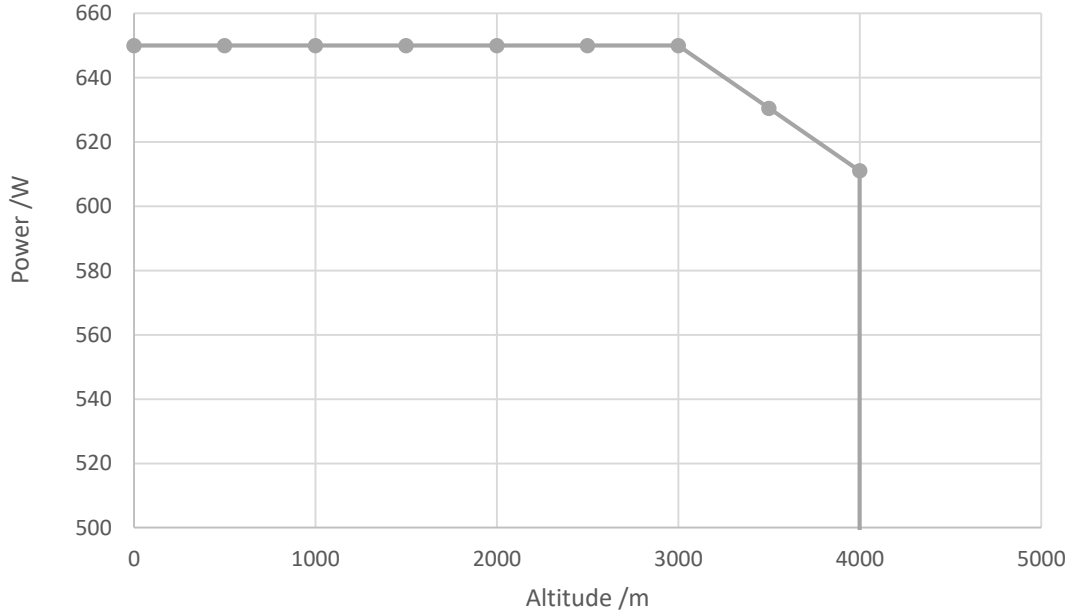
Temperature and altitude

Intelligent Energy's fuel cell systems can function at higher altitudes (>3000M) and higher ambient temperatures (>35°C)
Power output needs to be reduced as per the following de-rate curves

AC64 - temperature de-rate curve



AC64 – altitude de-rate curve



Disclaimer

This presentation was prepared on behalf of Intelligent Energy Limited (the "Company") for information and discussion purposes. No reliance may be placed for any purposes whatsoever on the information contained in this presentation or on its completeness. The Company is not under any obligation to update or keep current the information contained in this presentation. No representation or warranty, express or implied, is given by or on behalf of the Company or its respective subsidiary undertakings, affiliates, respective agents or advisers or any of such persons' affiliates, directors, officers or employees or any other person as to the fairness, accuracy or completeness of the information, or of the opinions, contained in this presentation and no liability is accepted for any such information or opinions.