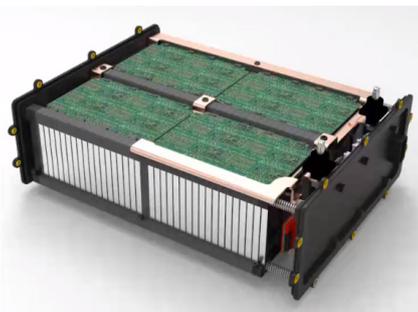
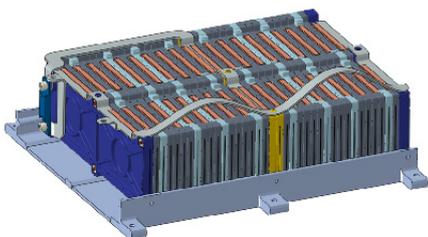
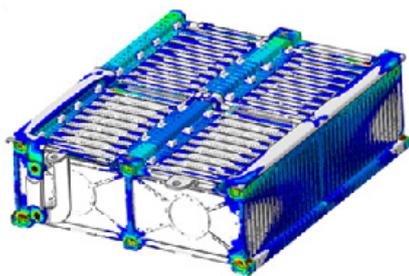


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**Ultra-fast Battery Charging**



Optimised lithium-carbon battery pack with Allotrope energy cells



Detailed analysis of cell arrangement

**Lithium Carbon Battery Cell Technology**

MAHLE Powertrain and Allotrope Energy are investigating a concept for an ultra-fast charging battery system optimised for urban delivery vehicles. The target is to enable a full battery recharge to be achieved in a similar time to refuelling an internal combustion powered vehicle - this equates to 90 seconds for a moped and 2 - 5 minutes for a van. The battery is based on Allotrope Energy's lithium-carbon battery technology, which has similarities to supercapacitors, but with a greater energy storage capacity.

Allotrope Energy's novel lithium-carbon battery cell technology combines the benefits of super capacitors with the energy storage capacity of lithium-ion cells which enable ultra-fast charging rates to be achieved. MAHLE Powertrain have used Allotrope's technology to design an ultra-fast charging, aggressively downsized battery pack for urban delivery eMoped and eVan applications. The battery pack concept design has been extensively analysed to ensure thermal stability and mechanical integrity.

Property	Units	EDLC	Lithium Carbon	Lithium-ion Capacitor
Power Density	kW/kg	70	15	8
Energy Density	Wh/kg	22	60	105
Energy Density	Wh/litre	26	80	200
Cycle Life	Cycles	>1 M	~100 K	1 - 2 K

Allotrop cell characteristics summary

> **Ultra-fast charging capability**  
**No rare-earth or exotic materials**

## eMoped Charging System

To enable the eMoped pack to be charged rapidly, from a domestic supply, a bespoke charger concept has been developed.

The charger system contains in-built energy storage, using Allotrope's lithium-ion capacitor technology for ultra-long lifetime. This enables the vehicle to be charged at power levels of up to 20 kW, necessary to achieve the very fast target charging times (about 90 seconds), from a 7 kW domestic supply...

Parameter	Units	eMoped	eVan
Pack Capacity	kWh	0.50	10.5
Maximum Voltage	V	58	400
Minimum Voltage	V	38	280
Output Power	kW	1.5	100
Charging Power	kW	20	210
Charging Time	Seconds	90	180
Cell Mass	kg	9.5	120
Configuration	-	18S-4P	128S-2P

eMoped & eVan pack specifications



Bespoke charger with lithium-ion capacitors

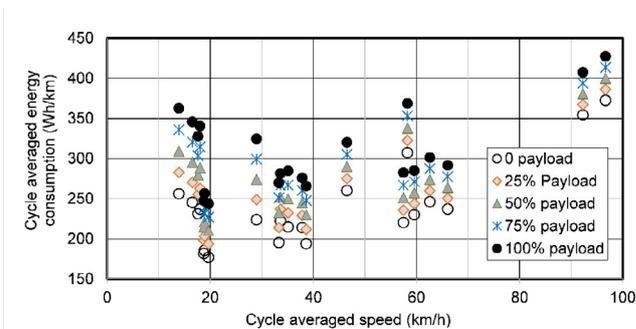


Modular test rig

## Summary

Allotrope Energy's novel lithium-carbon battery cell technology combines the benefits of super capacitors with the energy storage capacity of lithium-ion cells which enable ultra-fast charging rates to be achieved.

MAHLE Powertrain have the engineering capability to design and develop optimised battery packs and supporting systems.



Battery energy consumption versus vehicle speed