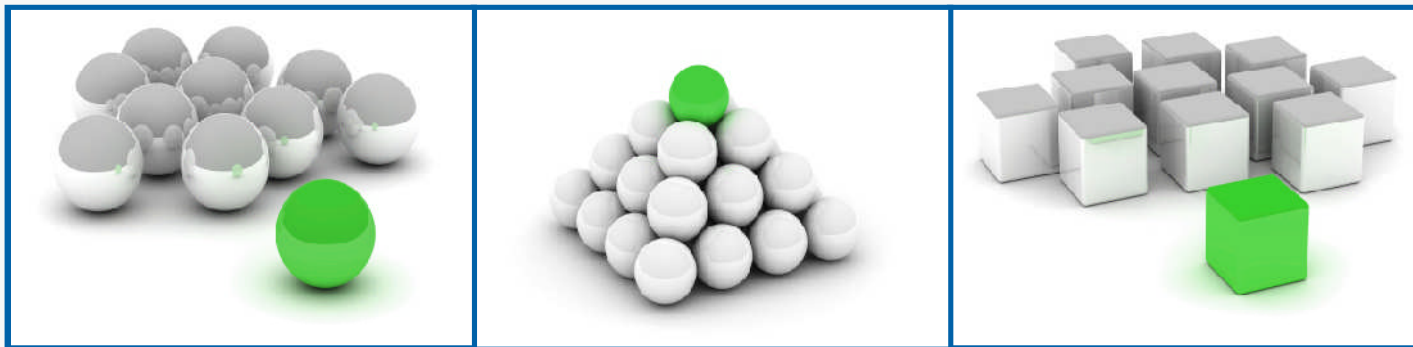
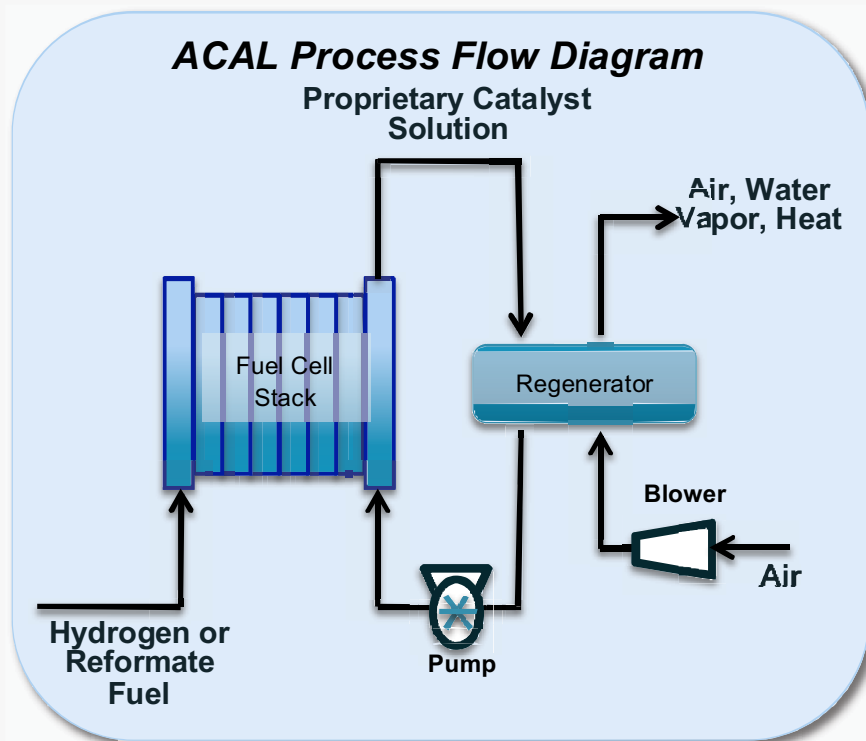
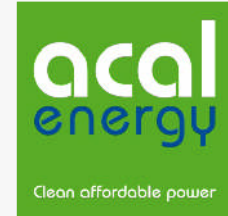


ACAL Energy

www.acalenergy.co.uk



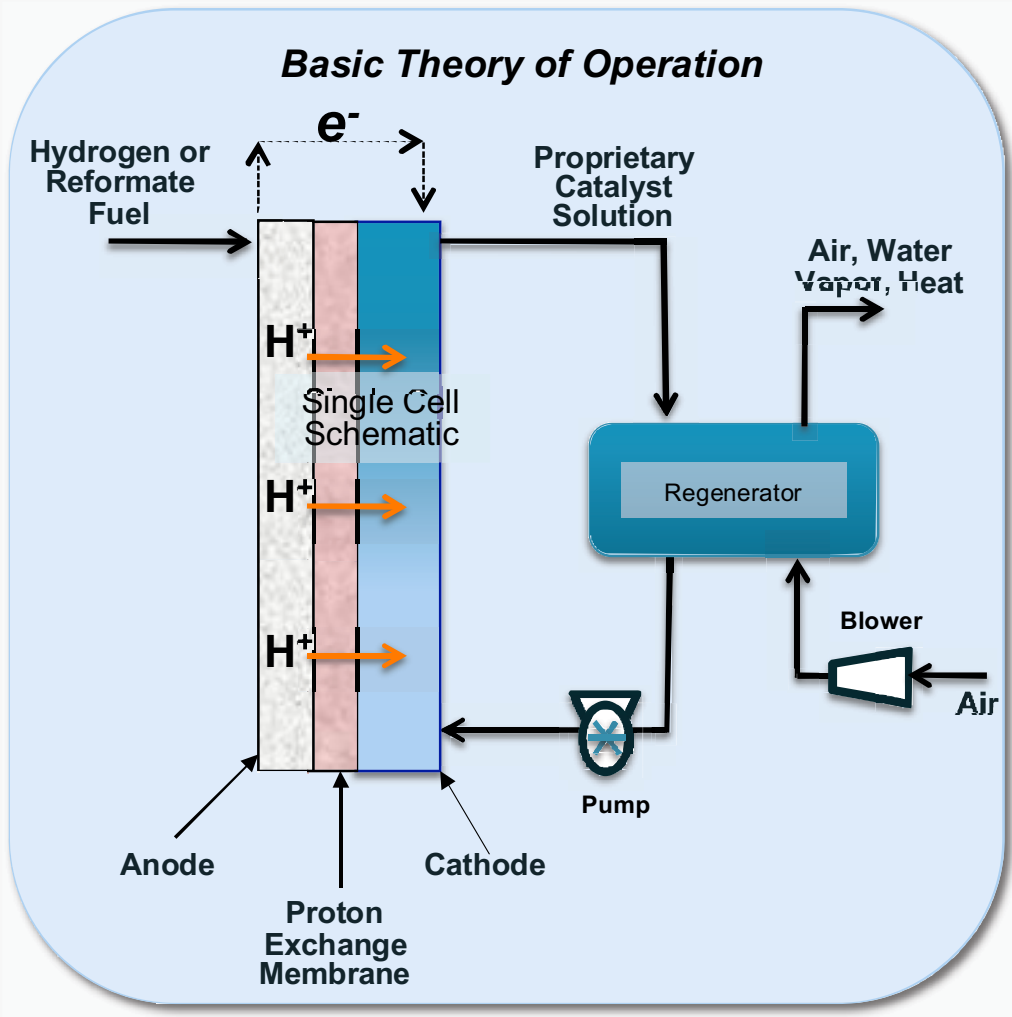
ACAL Technology Will Enable Clean and Affordable PEM* Fuel Cell Products



** PEM Fuel cells are proton exchange membrane fuel cells which are most the commonly used type for automotive and stationary power applications*

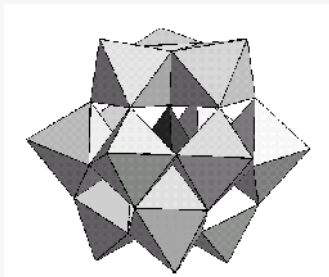
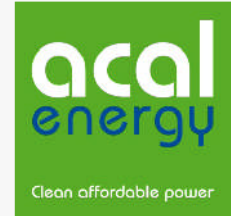
- ACAL replaces 90% of the expensive platinum catalyst in a PEM Fuel Cell with a safe, low cost, water-based catalyst solution.
- ACAL system also eliminates the need for humidification, air and fuel pressurization, and a separate cooling system.
- Cost savings of 40% and greater over conventional PEM Fuel Cell systems.
- Improved reliability and robustness.
- Technology can be applied to PEM Fuel Cells from 1 to 200kW+ in size.

Basic Concept: Better Fuel Cells From Breakthrough Chemistry

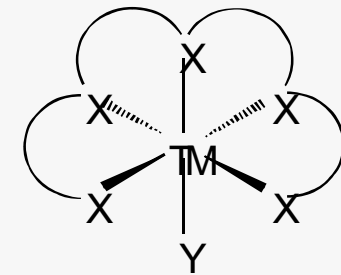
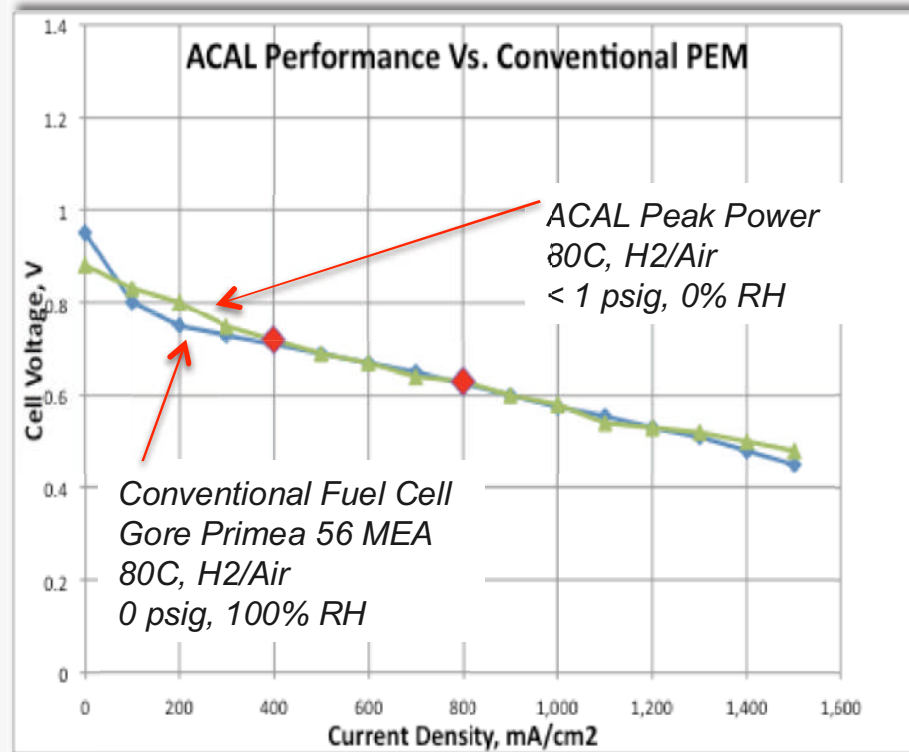


- Hydrogen enters the anode, dissociates into a proton and an electron. Protons flow through the membrane to the cathode, electrons flow through the external circuit.
- ACAL's catalyst solution flows through the cathode and accepts the protons and electrons.
- Mixture flows into small external reactor where the protons and electrons contact air and form water which is released as vapor.
- 'Regenerated' solution flows back to the fuel cell.
- Air never enters the fuel cell.

Record Performance Achieved, POM Material Ready for First Products



Current catalysts are based on inorganic polyoxometallate structures. Robust, long life, low cost materials. Now delivering same performance as platinum.



Higher performing metal-hybrid materials being developed. Will deliver performance higher than platinum.

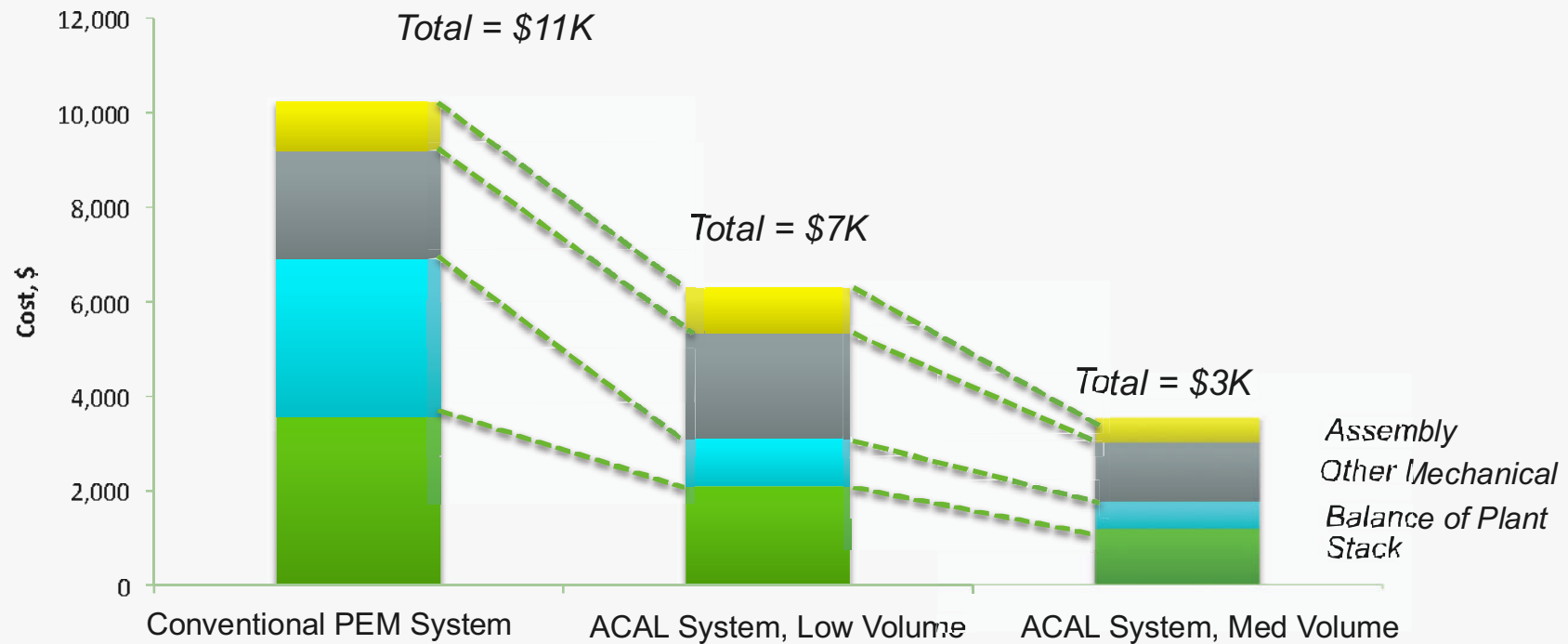
* Results are for a single cell running with hydrogen fuel, excludes regenerator performance. Conventional fuel cell is humidified while ACAL results use dry hydrogen and air.

More improvements ahead, latest materials showing potential for 1W/cm² and higher

Significant Cost Reduction Possible Today



Cost Estimate for Water Cooled 5kW Stationary Fuel Cell System



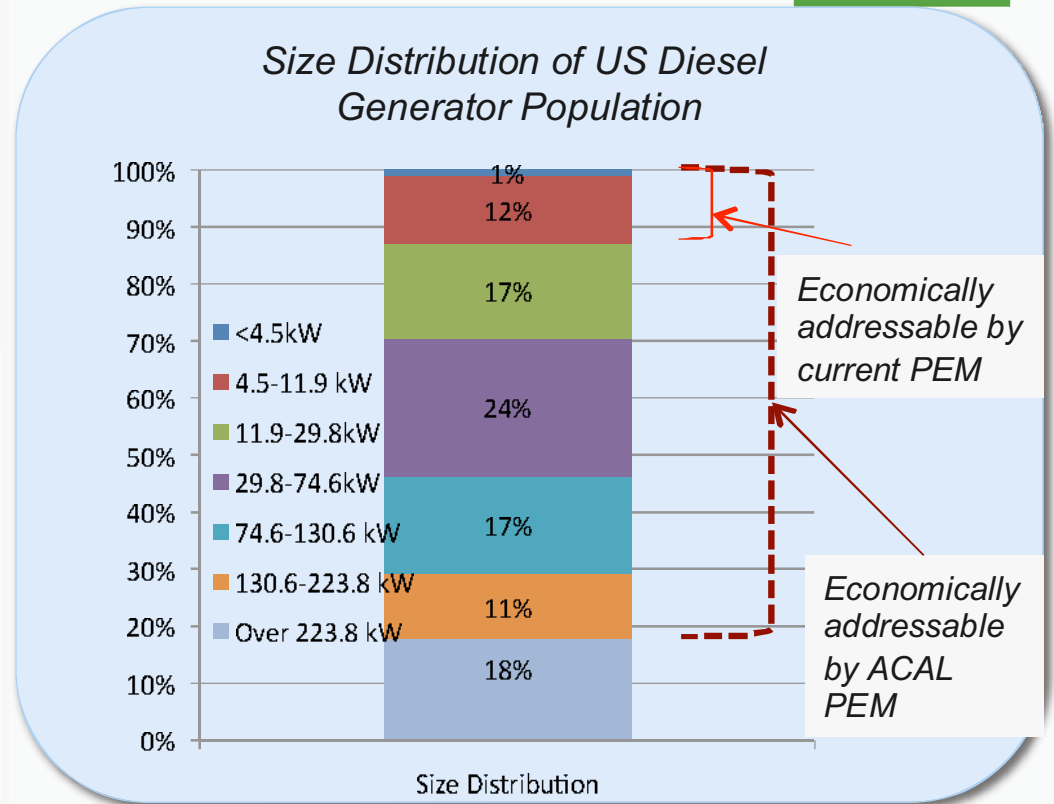
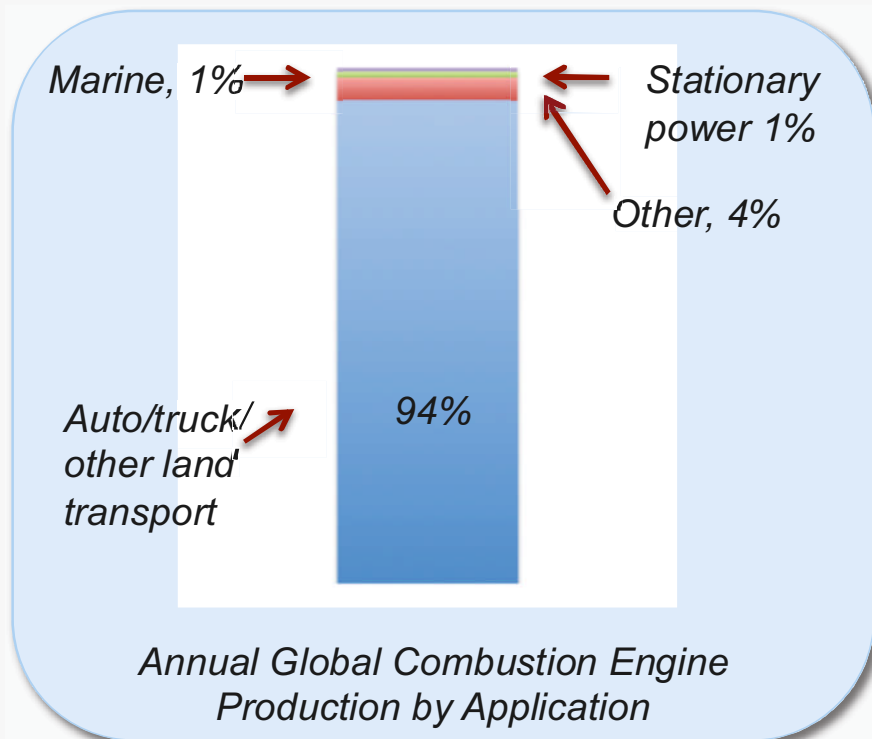
ACAL cost savings increase with increasing fuel cell size and Pt content

System Cost (\$) for 5kW Back-up Power Application – Conventional System is non-pressurized liquid cooled system

ACAL Market Opportunity: Enable Fuel Cells to Replace Combustion Engines

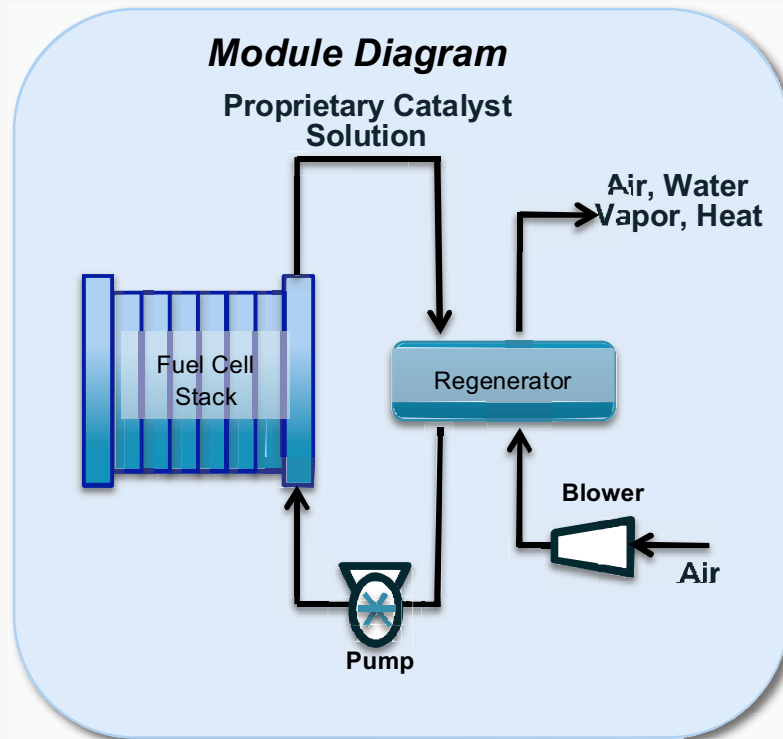


~75 Million combustion engines produced globally every year....



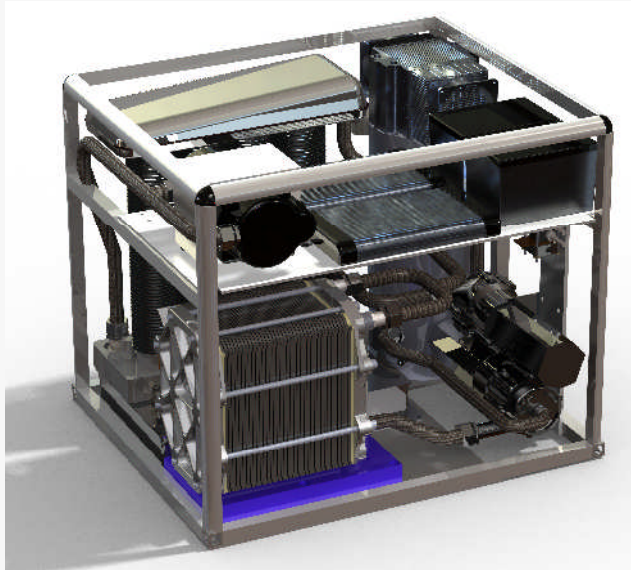
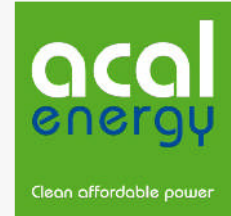
....first market target, \$10B stationary power segment, commercial CHP, auto/truck applications next

ACAL Business Model: Supply Modules & Chemicals to System Manufacturers



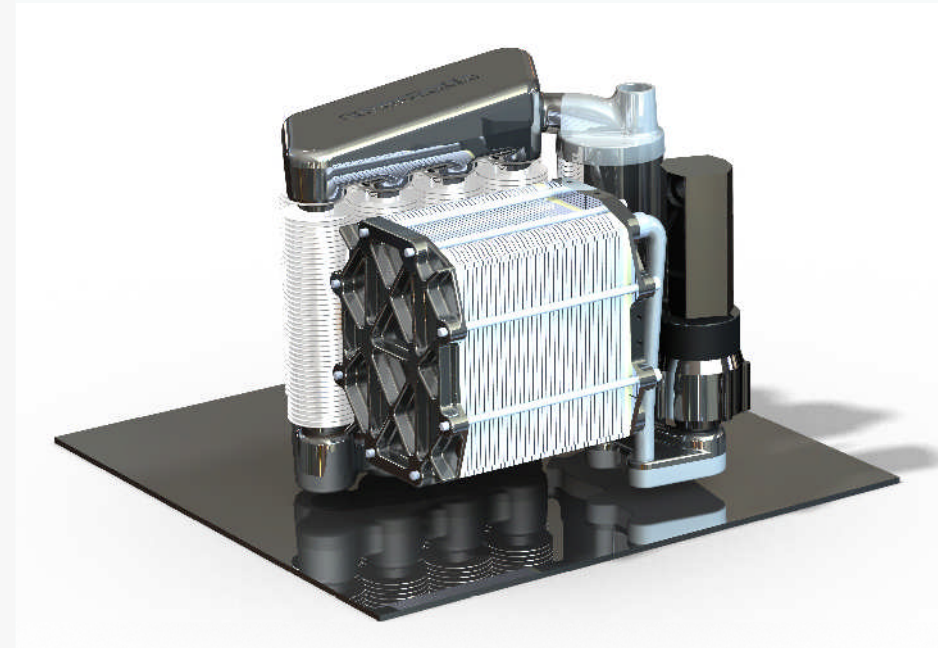
- ACAL primary business to provide hardware modules, chemicals and design expertise.
- Modules include stack and regeneration systems, ready to integrate into the manufacturer's system products.
- Will consider licensing and chemical supply arrangements in special circumstances

Beta Demonstration Unit: 3kW Output



5kW Module Platform Concept

Specification	Value
Module Scope	Stack, Regenerator, Control Electronics
Fuel	Hydrogen
Cathode catalyst	POM
Anode catalyst	Platinum, loading less than 0.3mg/cm ²
Module electrical efficiency	48%+
Parasitic power consumption	Less than 10% of gross stack output
Start-up time from to full power	10 minutes at room temperature
Stack operating temperature	80C
Operating temperature range	-10 to 40C
Air humidity range	0 to 100%
Lifetime	5,000 hours initial but increasing to 10,000



100kW module concepts in development for stationary power but auto/bus ultimately

www.acalenergy.co.uk

