Integrated Electric, Fuel Cell and Hybrid Powertrain Components Powering Clean Mobility
US Hybrid Group

**US Hybrid**

*HQ: Torrance, CA*

- **Year Established**: 1999
- **Core Competency**: Electric Powertrain for Electric, Hybrid and Fuel Cell Heavy Duty Vehicles

**Magmotor Corporation**

*Worcester, MA*

- **Year Established**: 1876 (Acquired by US Hybrid in 2008)
- **Core Competency**: Servo Motors and Drives Automation, Robotic and Semiconductor Mfg.

**FC Engine Div.**

*South Windsor, CT*

- **Year Established**: 2013
- **Core Competency**: Fuel Cell Power Plant

**FuelCell Engine Div.**

- **Torrance, CA**
- **South Windsor, CT**
- **Honolulu, HI**

US Hybrid Business Focus is Medium & Heavy-Duty Commercial Vehicles
## Fuel Cell Electric Vehicles Experiences

<table>
<thead>
<tr>
<th>Hydrogen Fuel Cell Vehicles</th>
<th>Customer</th>
</tr>
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<tbody>
<tr>
<td>H₂Shuttle</td>
<td>Air Force, HCATT, 2002</td>
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<tr>
<td>H₂-StepVan</td>
<td>Air Force, HCATT, 2005, 60kW</td>
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<tr>
<td>H₂Tug</td>
<td>Air Force, HCATT, 2012</td>
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<td>H₂Fuler-R12</td>
<td>Air Force, HCATT, 2014</td>
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<td>H₂Ride</td>
<td>Air Force, 2015</td>
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<td>H₂ Weapon Loader</td>
<td>Air Force, HCATT, 2016</td>
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<td>H₂ SPOD</td>
<td>Air Force, HCATT, 2017</td>
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<tr>
<td>Hickam Renewable H₂ Fueling Station</td>
<td>150kW Solar PV, 480kg, H₂ storage, 350/700 bar 2002</td>
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<tr>
<td>H₂Truck</td>
<td>POLA/POLB</td>
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<tr>
<td>H₂Sweeper</td>
<td>Caltrans</td>
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<tr>
<td>H₂Ride</td>
<td>Hilo-MTA, National Park, Air Force, CSULA, Sunline</td>
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<tr>
<td>H₂Transit</td>
<td>Sunline/BAE</td>
</tr>
<tr>
<td>H₂-Van</td>
<td>SARTA, Para-Transit, Ford Transit</td>
</tr>
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</table>
Air Force Fuel Cell GSE (TUG U-30, R-12 Aircraft Refueler & Weapon Loader)

Fuel Cell Weapon Loader

Fuel Cell Plug-In Hybrid Electric Re-Fueler (R12)

FC R12 Fueler, fueling at H₂ station
Renewable Energy Hydrogen Station

Controller, PLC, GUI & Telematics

Power to GAS

Electrolyzer 65 kg/day

Compressors to 12,000 psi

H₂ Power 60 kW Generator

H₂ Low & High-Bar Storage 278 kg @ 6,500 psi & 30 kg @ 12,000 psi

Hydrogen DISPENSERS 350 and 700 BAR

H₂ LB Buffer Storage 57 kg @ 3,600 psi

Power Inverter

Solar Array 146 kW

Utility Grid

GAS to Power

FC Vehicles

65 kg/day

12,000 psi

3,600 psi

350 and 700 BAR

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Controller, PLC, GUI & Telematics
Hybrid, Battery & Fuel Cell Street Sweepers NY, CA, Tokyo

Diesel Electric Hybrid

Battery Electric

FuelCell Electric

Drives like Electric Fuels faster than CNG
Hybrid, Battery & Fuel Cell Electric Drayage Truck (POLA/POLB)

CNG/LNG Hybrid Electric

Battery Electric

Fuel Cell Electric
Drives like Electric Fuels like CNG

FC engine mounted under hood
FC engines are installed in the engine bay using OBDII CAN diagnostic tools.
Integrated Fuel Cell Engine
Most Efficient Zero emission engine for Transportation

Volume: 0.51 m³
Weight: 292 kg

Volume: 1.6 m³
Weight: 996 kg
Fuel Cell Engine Automotive Components (Qualified supply chain)

Hydrogen Fuel IN

Fuel Processing Unit “Injectors”

Fuel Cell Engine

OUTPUT
Electric Power

Air IN

Fuel Cell "Engine Block"

Air Processing Unit "Compressor"

Power Processing Unit “ECU”

Stack Assembly "Engine Block"

Cell Assembly "Cylinders"

Thermal Management System “Radiator”

Exhaust Water Vapor

Water Vapor

US Hybrid 2020 ©
Assembly and testing like conventional engine

FCe™80 FC engine

at the test-stand running Port of Los Angeles Drayage Truck Duty cycle.

Fuel Cell Engine test-stand
Temp; -40C to 80C, Humidity 30-90%,
Yaw, Roll and Pitch +/-18%
Programmed Drayage truck and Transit Bus Drive cycle load Simulator (AV900 Load)
Fuel Cell Engines enable;

1. 24/7 operation
2. No payload, productivity and range compromise
3. Most Efficient Zero Emission transportation engine
4. Faster fueling than CNG, higher productivity & performance than battery Electric

Fuel Type and Energy Content
- Diesel: 37.1 kWh/gal
- Natural Gas: 33.4 kWh/gge
- Hydrogen: 39.7 kWh/kg
- Gasoline: 32.9 kWh/gal
- Li-Ion Battery: (180 Wh/kg)

Net Engine Output (Drayage Cycle)
- Diesel: 2.7 kWh/kg (4 mpg)
- Natural Gas: 1.8 kWh/kg (3.1 m/gge)
- Hydrogen: 17 kWh/kg (8 mile/kg)
- Gasoline: 1.9 kWh/kg (3 mpg)
- Li-Ion Battery: 0.17 kWh/Kg (1/11 mile/kg)
Thank You

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