



FuelCell Energy

Ultra-Clean, Efficient, Reliable Power

Clean Power from Commercial Stationary Fuel Cell Systems using waste-derived Fuels

**Bill Foster,
VP Federal Business Development**

**IPHE Briefing –
Joint 12th IPHE Implementation and Liaison
(ILC) & Steering Committee (SC) Meeting**

**Washington, DC
December 2, 2009**

reliable, efficient, ultra-clean



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FuelCell Energy Operations

Torrington - Technology Manufacturing

- Stack Production
- Module Assembly
- 65,000 ft² facility
- Opened in 2001



Danbury – Corporate, Engineering and R&D

- Research Labs
- Design Center
- Operations and Service Support
- Conditioning

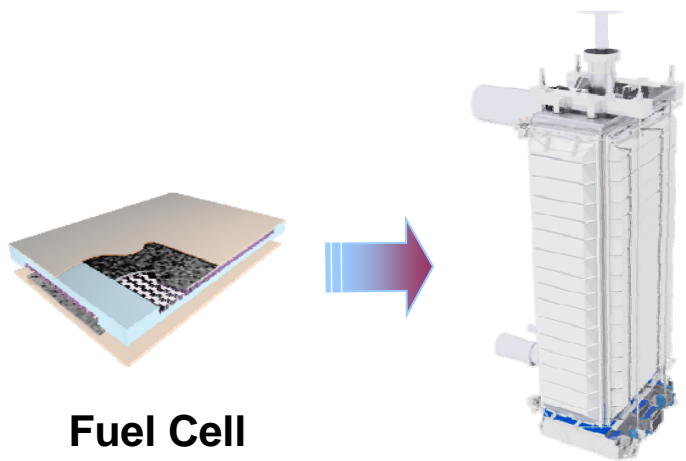




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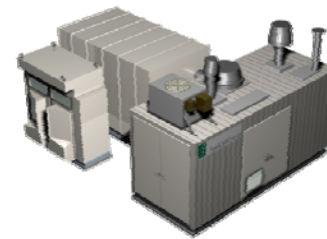
FuelCell Energy Products



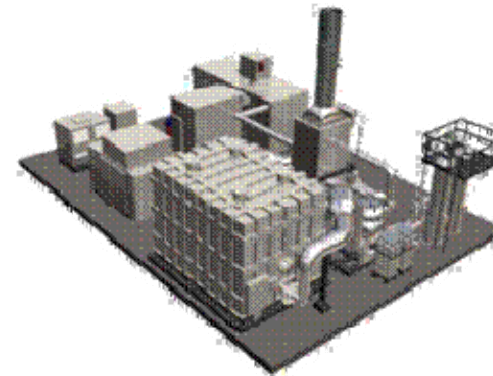
Fuel Cell

Stack

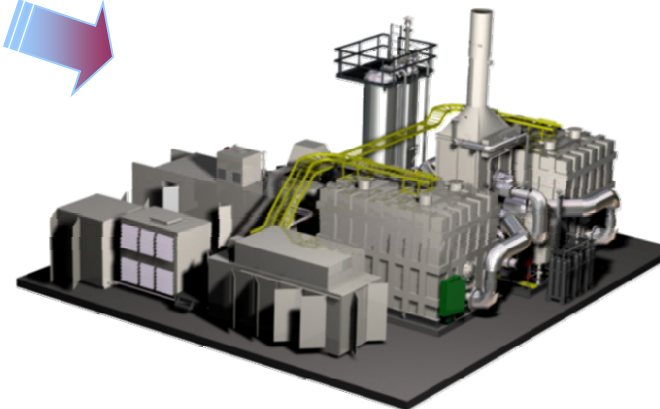
Building block approach
provides scalability and
a common cell/stack
component across
product lines



DFC300
Single Module
Power plant



DFC1500
Four Module
Power plant



DFC3000
Two 4-Stack
Modules

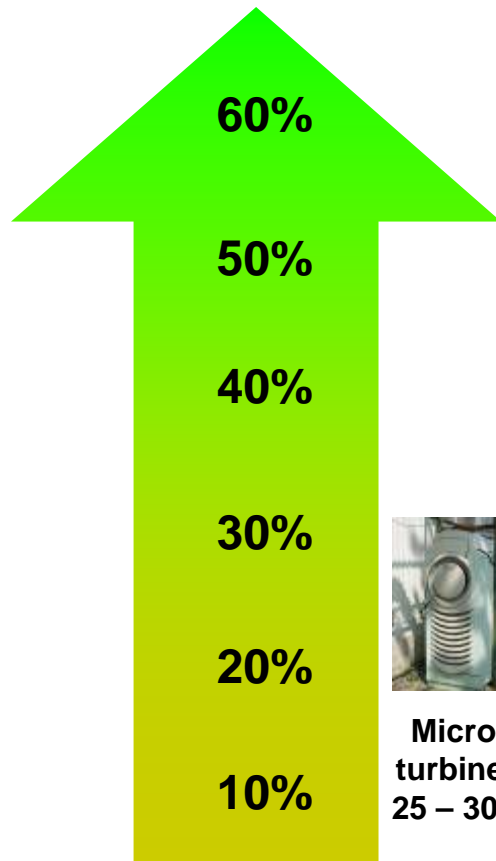


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High Electrical Efficiency

DFC power plants offer the highest efficiency of any distributed generation technology

Fuel to Electrical Efficiency



Micro-turbines
25 – 30%



Small Gas Turbines
25 – 35%



Natural Gas Engines
30 – 42%



Direct FuelCell (DFC)
47%



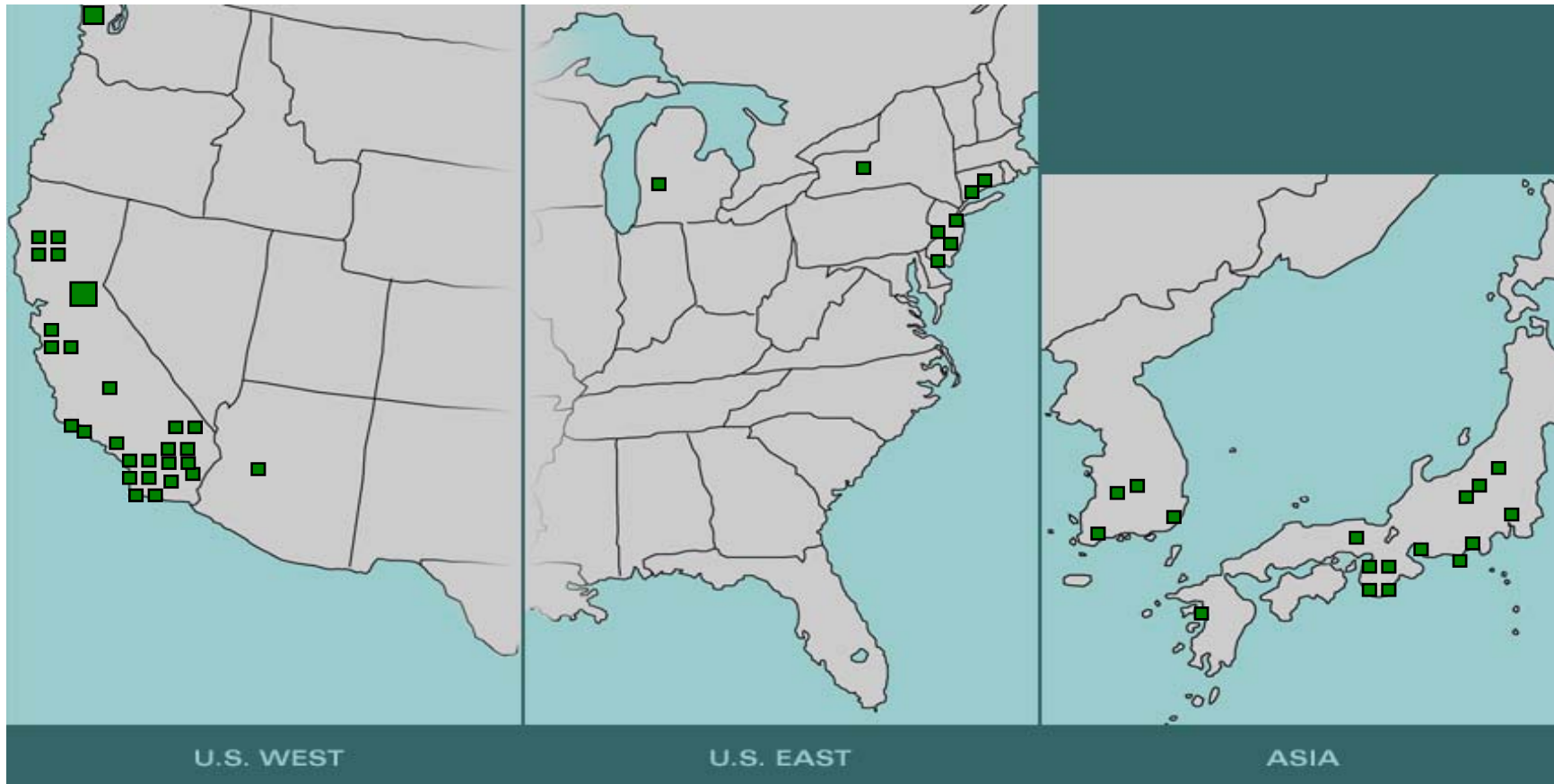
DFC-ERG
DFC/Turbine
58 – 65%



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FuelCell Energy Power Plant Locations



- Over 50 global units: mostly natural gas or biogas fueled
- More than 340 million kWh produced at customer sites
- More than 10,000 kg H₂/day being produced in CA alone



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Fuel Flexibility



Weston at SFO Airport
Nat Gas CHP



29 Palms Marine Corp Base
Nat Gas Secure CHP



Sharp Mfg Plant
Nat Gas Fuel Cell and Solar Power



Santa Barbara WWT Plant
BioGas CHP

**DFC Products are uniquely capable
of operating on many fuels**



Ford Paint Shop
Paint Solvent Fume Power



Sierra Nevada Brewery
Nat Gas and BioGas CHP



Kirin Brewery
BioGas and Propane CHP



Pacific Missile Range
Propane Secure CHP



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Wastewater Market

- Wastewater treatment facilities and food/beverage processors are growing source of renewable biogas
- Burning biogas in turbines and engines produces pollution
- Fuel cells produce ultra-clean electricity with biogas more efficiently than any other distributed generation solution their size
- Byproduct heat used in treatment process increasing system efficiency 80% and higher
- ~40% of FuelCell Energy's California installations and backlog are at wastewater and food/beverage facilities



1 MW DFC1500 at a wastewater treatment facility in southern CA



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**King County
Seattle**



**1 MW Municipal Wastewater Treatment Plant
First Site with Online Fuel Switching**



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Kirin Brewery Project



First SubMW Digester Gas Project, Running on Biogas from Beer Production



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Sierra Nevada Brewery



Site with Power Generation in excess of ADG Supply
First Site with Automated Fuel Blending



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Clean Energy
Credit: City of
Tulare, CA





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Gills Onion

Gills Onions wanted renewable power from its own operations

- Challenge:
 - Need for reliable, cost effective, ultra-clean power source from onion processing byproducts
- Solution:
 - 600 kW of fuel cells provide 24/7 power and high efficiency
 - Uses anaerobic digester gas produced from onion juice
 - Fuel cell waste heat used in anaerobic digester process
- Results:
 - Provides 35-45% of Gills Onions' electricity





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Kyoto Eco-Energy Project (KEEP)



- Fuel is Digester Gas from Food Waste
- Part of Mini-Grid with wind turbine, PV, & gas engines connected in parallel to the local electrical grid



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Multi-MW Scale Fuel Cells



4.8 MW Fuel Cell – Pohang, Korea



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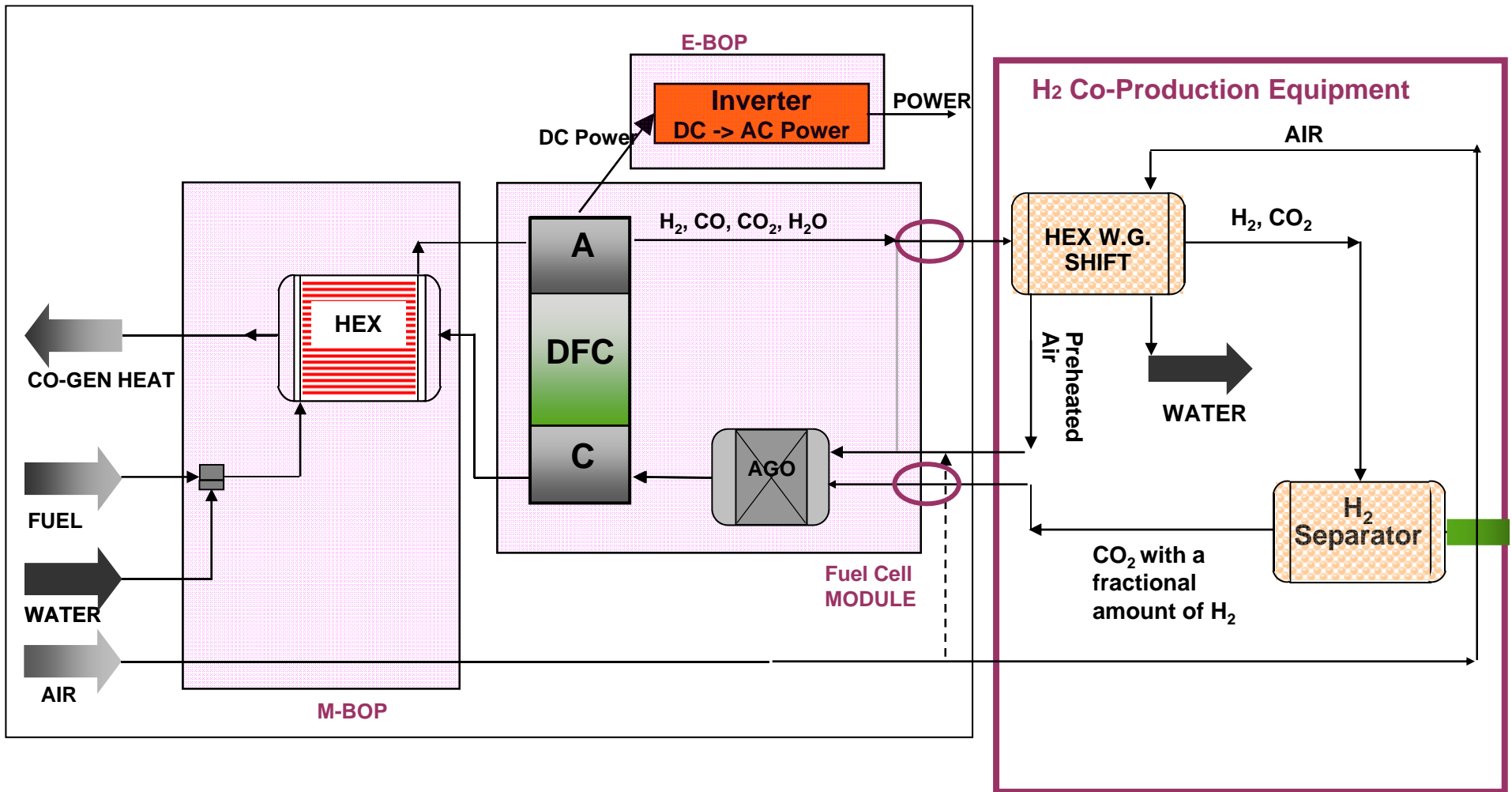
Hydrogen Co-Production

- **Hydrogen Co-Production Concept (DFC-H2[®])**
- **Hydrogen Co-Production Demonstration Status**
- **Advanced H₂ Separation Technology Development**
- **Renewable Fuel Capability**
- **Near-term Deployment Strategy**



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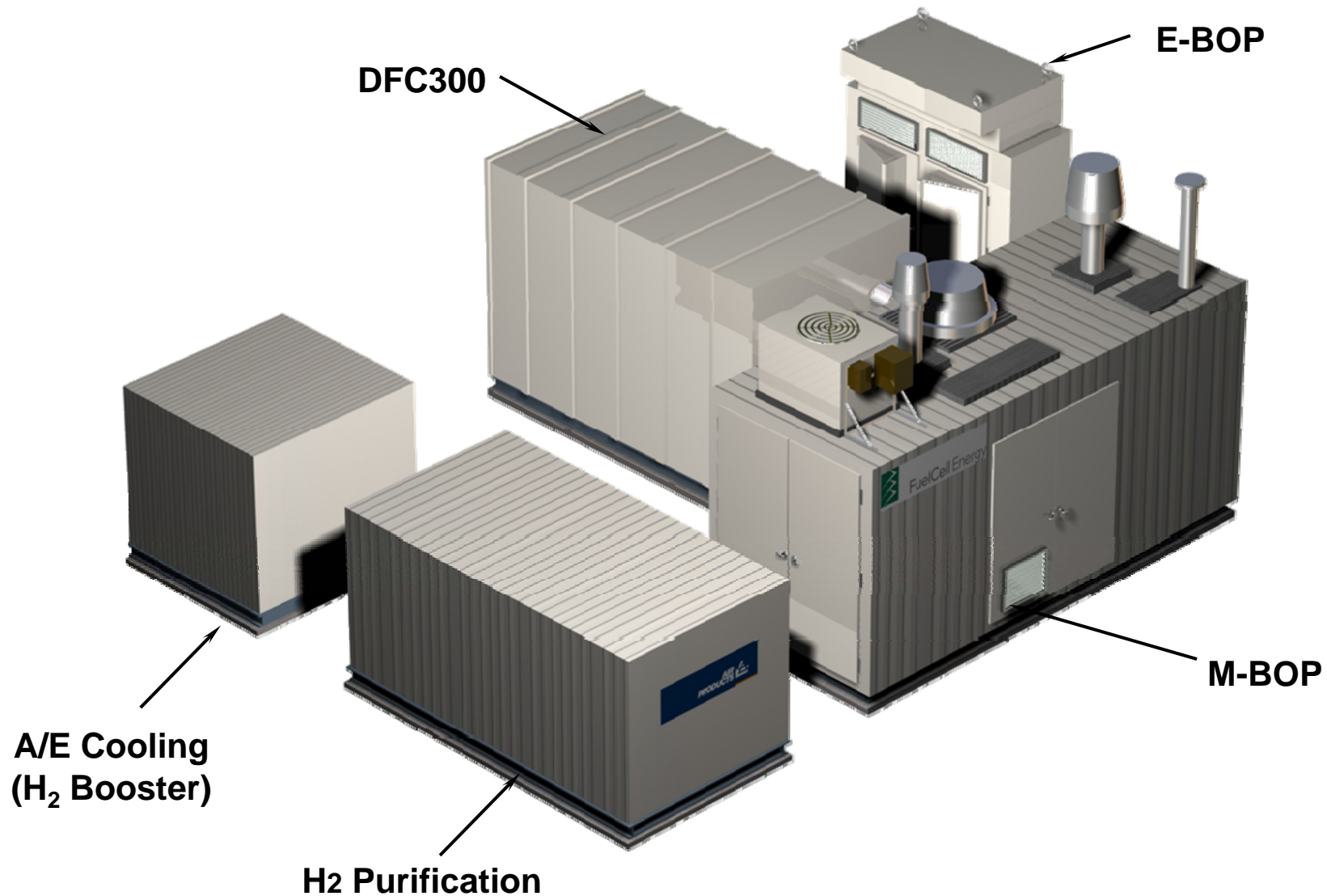
DFC-H₂[®] Configuration





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DFC-H2[®] Co-production Plant Major Subsystems





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Submegawatt DFC-H2[®] System Components – Testing at FCE (APCI-DOE Project)



**Hydrogen Ready Fuel Cell
Module**



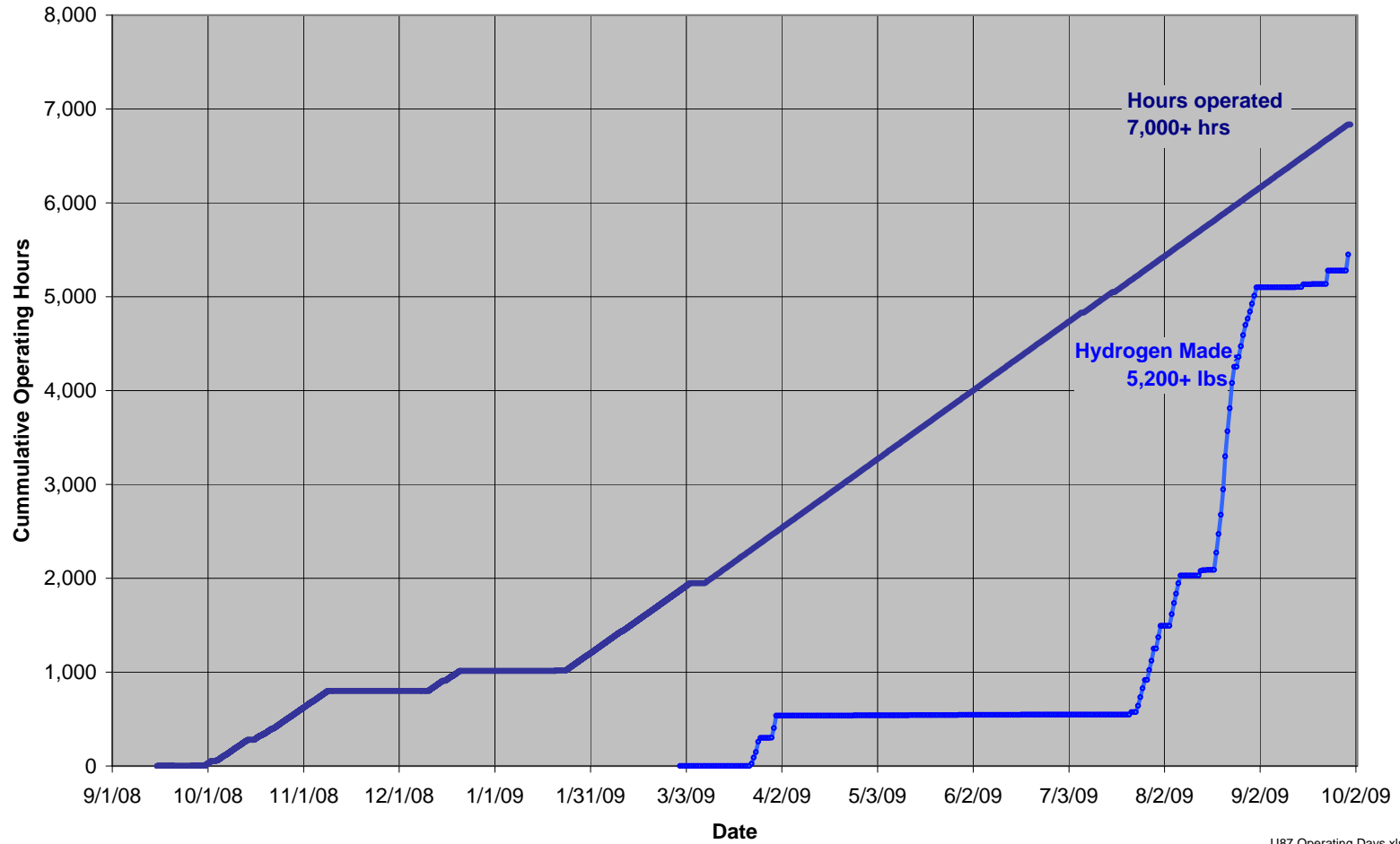
**Hydrogen Ready Fuel Cell
Module**

All Weather Design



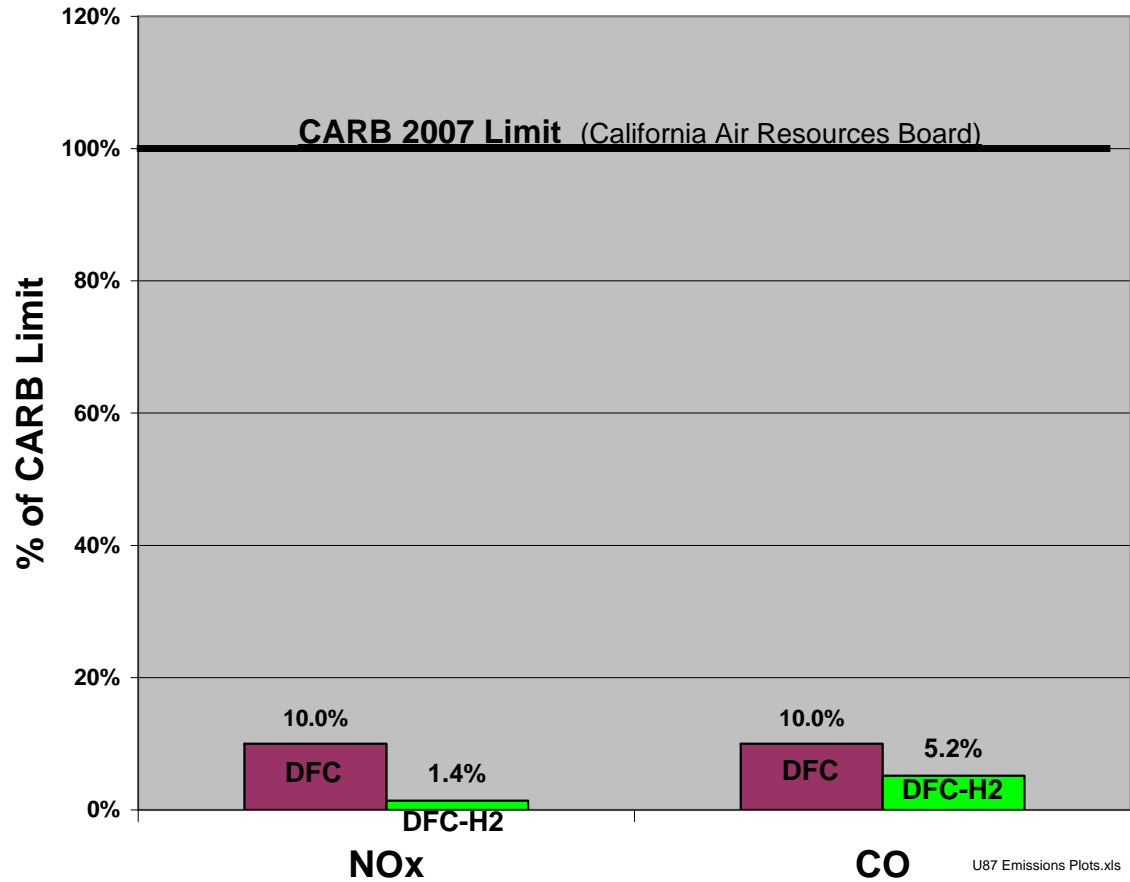
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DFC-H2[®] Operation Overview



U87 Operating Days.xls

Integrated Operation Successful



Significantly Lower Emission Than CARB2007 Limits



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Co-Production Capacity of DFC-H2[®] Power Plants

DFC-300[®]



DFC-1500[®]



DFC-3000[®]



Co-product

Power, kW	250	1,000	2,000
Hydrogen, kg/day	125	500	1,000
Heat, mmBtu/hr	0.5	2.0	4.0



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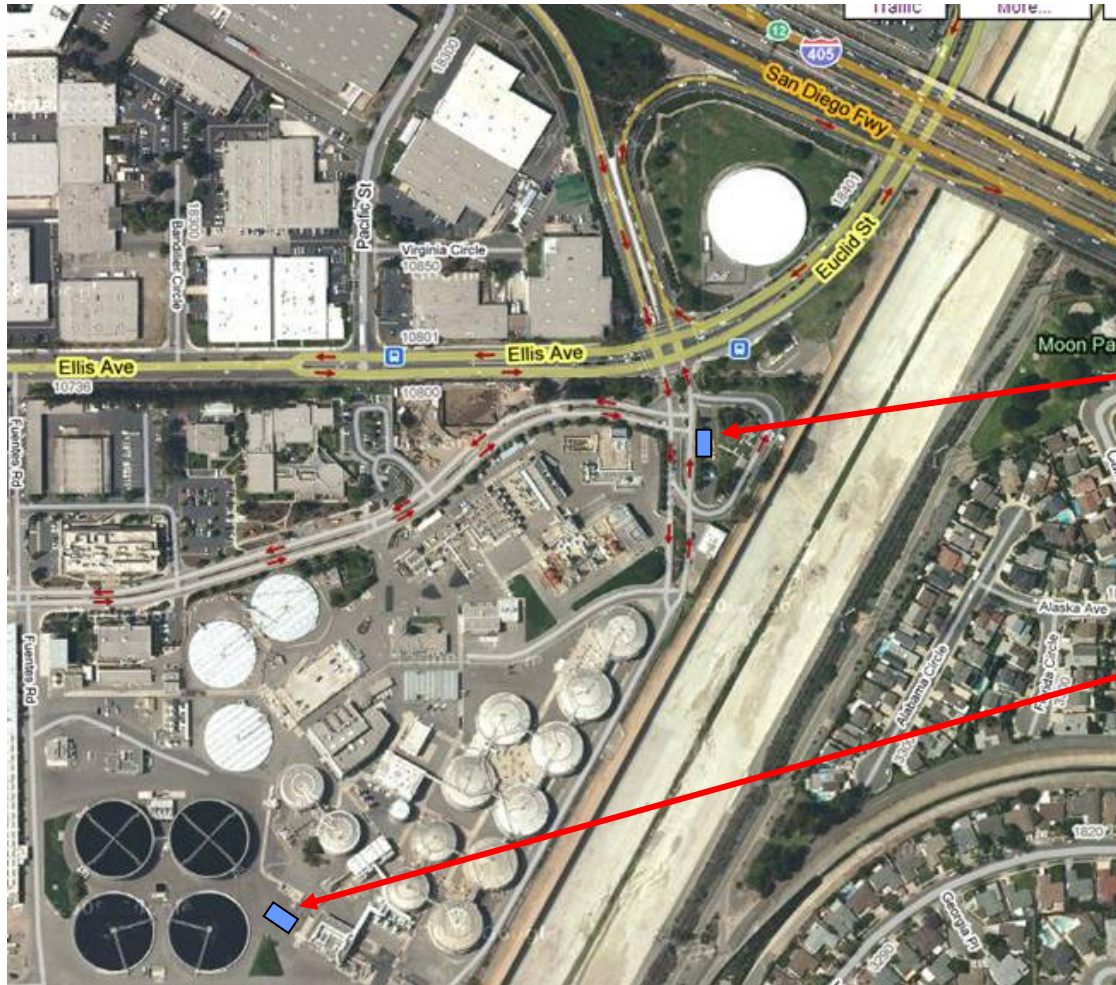
Refueling Capacity

Cars, 4.2 kg/day	30	120	240
Buses, 25 kg/day	5	20	40
Fork Lifts, 2.1 kg/day	60	240	480
Plugn Battery Hybrid, 12 kWh/day	500	2,000	4,000



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First DFC-H2[®] Prototype to be Demonstrated in California



Orange County
Sanitation
District
(OCSD)

Renewable H₂
Filing Station

ADG fueled
DFC-H2[®]
Production Unit

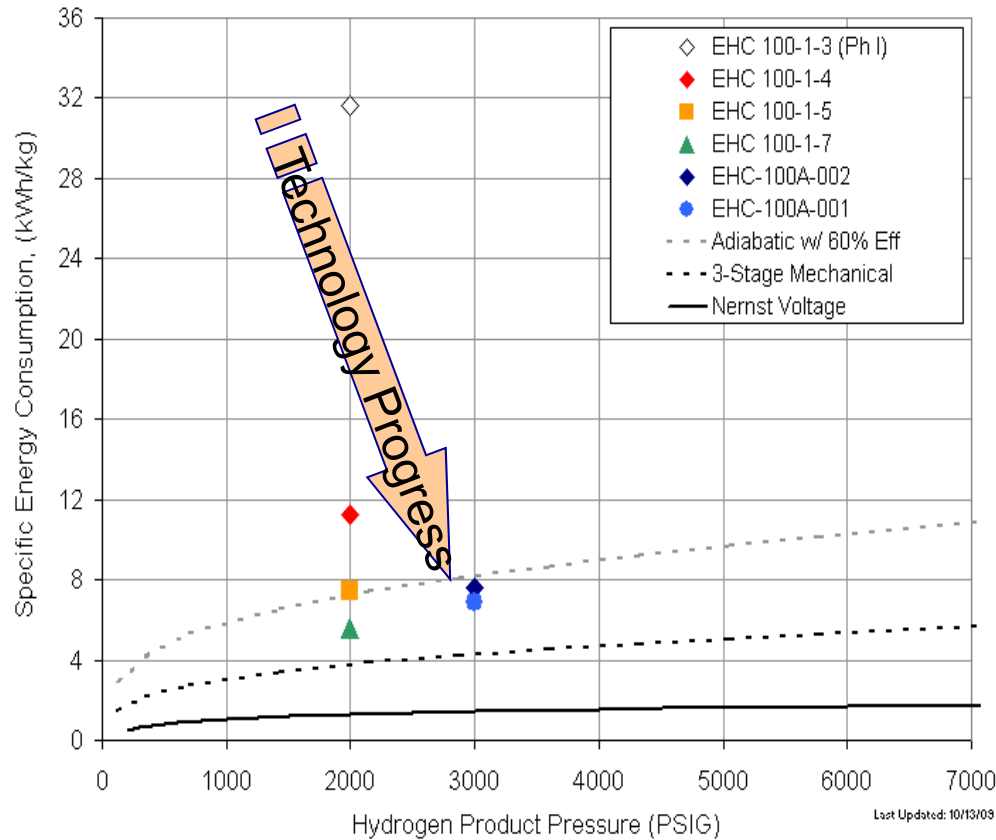




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Specific Energy Consumption of Various Compressors



Over 80% Reduction in Compression Energy

Electrochemical Hydrogen Compressor Development



Achieved 5,600 psi Compression in Single Stage



2009 DOE Hydrogen Program R&D Award



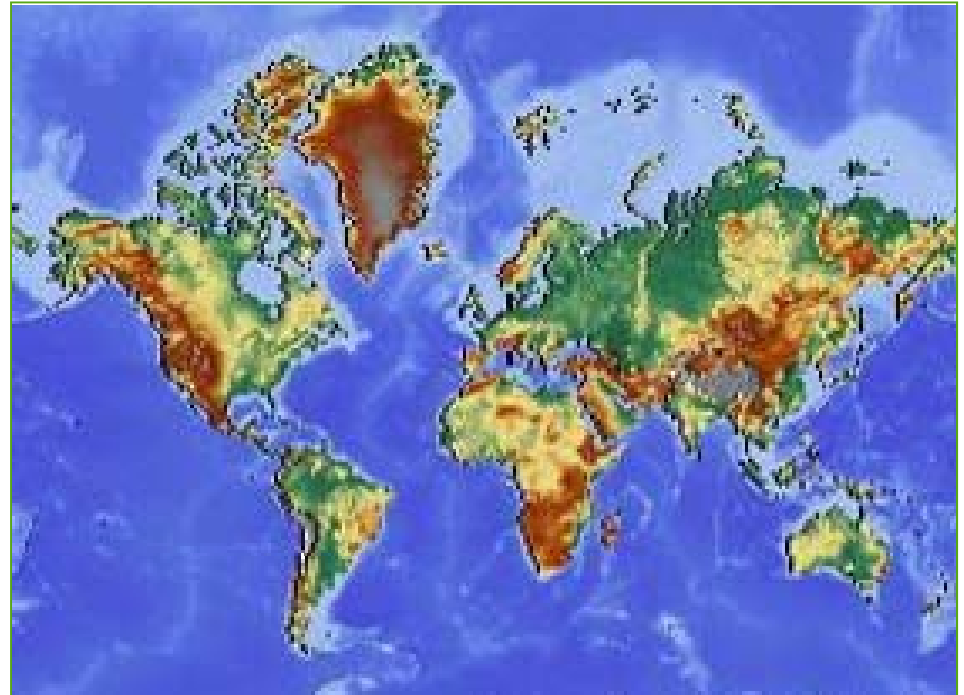
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Market
Leadership

Markets

- 95 MW installed/backlog
 - Japan/Korea: 72 MW
 - California/West Coast: 15 MW
 - Northeast/Canada: 5 MW
 - Europe: 2 MW
- Targeted applications
 - Grid Support: 69 MW
 - Renewable/Wastewater: 9 MW
 - Manufacturing: 7 MW
 - Hotels: 3 MW
 - University & Hospitals: 2 MW
 - Government: 3 MW
 - DFC-ERG: 2 MW





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Thank you

Questions?

**For more information please
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reliable, efficient, ultra-clean