Stationary Fuel Cells and California's Energy Puzzle

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California Environmental Protection Agency

AIR RESOURCES BOARD

http://www.arb.ca.gov/

Fuel cells can mitigate some of California's energy problems.

- Greenhouse gas emissions
  - ► High electrical efficiencies and CHP capabilities
  - ► Distributed Generation minimize distribution losses

- Ambient air quality
  - ►Negligible emissions of NOx, CO, VOC
  - ►No emissions of SOx, PM

- Energy Independence
  - ► Capable operating on a variety of renewable fuels including landfill gas and digester gas.

- Low nuisance
  - ► Virtually no noise and pollution compared to other DG.

Fuel cell attributes and benefits

High electrical efficiencies (>50%)

Virtually zero impact

- **Virtually zero emissions of criteria pollutants**
- **Virtually zero acoustic signature**

Well suited for distributed generation (DG)

Well suited for the recovery and use of waste heat

- **High efficiencies (>90%)**

Well suited for building integration

- **Variety of heating and cooling options**
- **DC distribution**

Most Common Fuel Cell Technologies

Type	Electrolyte	Operating Temperature (^{O}F)	Electrical Efficiency (%)	Total Energy Efficiency (%)	Transient Capability	Power
PEMFC	Ion exchange membrane	~120	30 – 35	50 – 60	High	Less than 30 kW
PAFC	Phosphoric acid	~390	36 – 42	85 – 90	Medium	More than 100 kW
MCFC	Molten carbonate	~1200	45 – 55	75 – 85	Low	More than 100 kW

Fuel Cell Sites in California

CaSFCC
California Stationary Fuel Cell Collaborative

http://casfcc.org/

PEM Fuel cells

- Battery Replacement
- Backup Power
- UPS

PAFC Fuel cells

- UTC POWER 200 kW
- PC-25® and PureCell®
- Prime power and CHP

POLICE STATION & LIBRARY
ANAHEIM

HYATT REGENCY HOTEL
IRVINE

FORD PREMIER DESIGN CENTER
IRVINE

MCFC Fuel cells

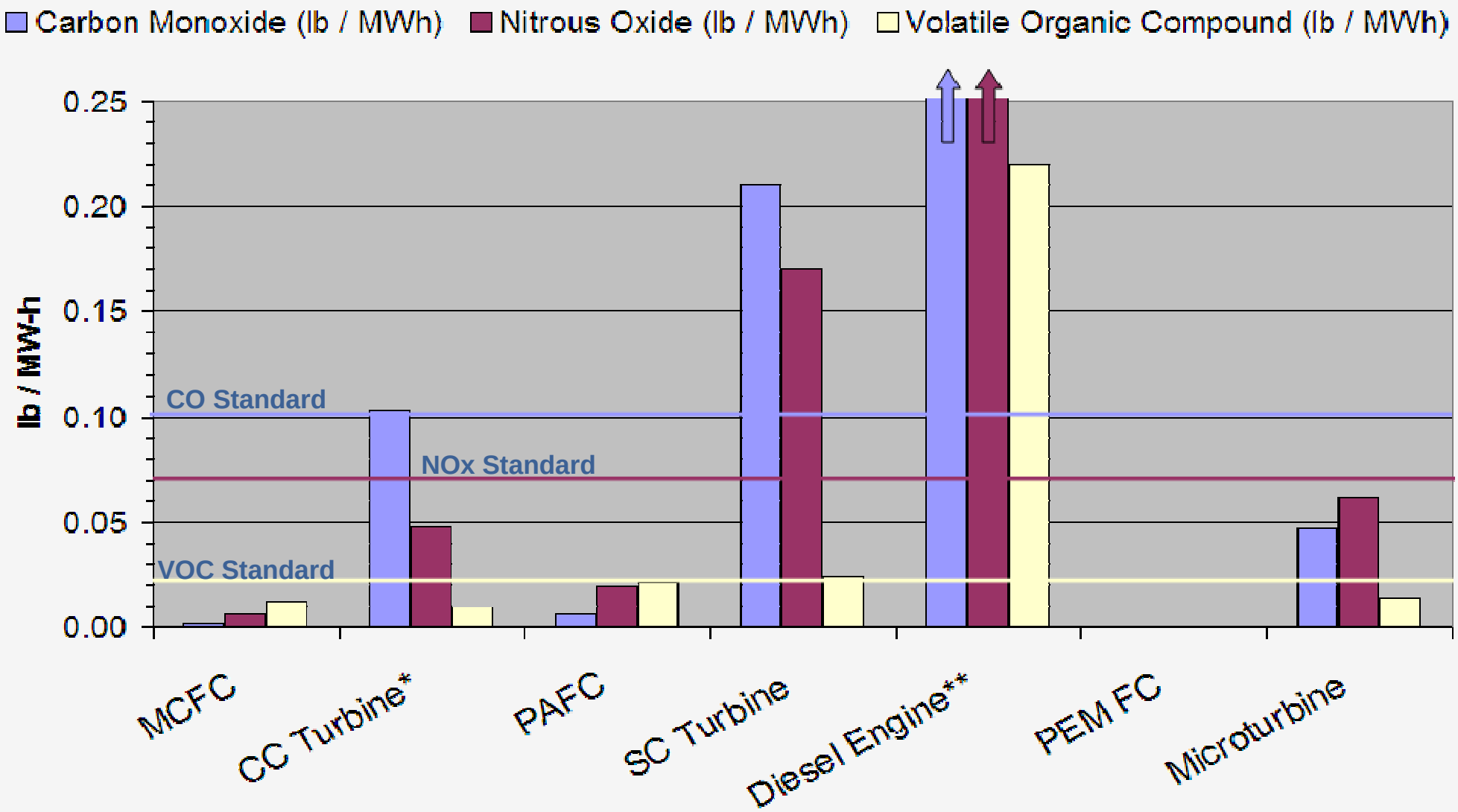
- Fuel Cell Energy: 300kW, 1.2MW, 2.4MW
- DFC300®, DFC1500®, and DFC3000®
- Prime power and CHP

SHERATON HOTEL
SAN DIEGO

CAL STATE UNIVERSITY
NORTHRIDGE

WASTEWATER TREATMENT
SANTA BARBARA

Fuel Cells Vs Conventional DG: Criteria Pollutants



Horizontal lines indicate the 2007 CARB DG Standards

*** Combined cycle turbine is grid power not DG.**

**** Diesel engines are for backup DG only.**

Funding

2008 SGIP Incentive Program				
Incentive Levels	1st MW ($/Watt)	2nd MW ($/Watt)	3rd MW ($/Watt)	Maximum Size
Level 2 (Renewable)	$4.50/W	$2.25/W	$1.125/W	5 MW
Level 3 (Non-renewable)	$2.50/W	$1.25/W	$0.625/W	5 MW
Funds up to $7,875,000 per project				

Southern California Gas Company

SDGE

Sempra Energy

PG&E Pacific Gas and Electric Company

SOUTHERN CALIFORNIA EDISON

An EDISON INTERNATIONAL Company

Center for Sustainable Energy CALIFORNIA

Fuel Cells in Municipalities: City of Tulare

Permit to operate (lb/MWh)

NOX: 0.02 SOX: 0.001 PM10: 0.01 CO: 0.05 VOC: 0.02

Comparison of Cogeneration Technologies Using Digester Gas

Comparison Criteria	IC Engines	Micro-turbines	Gas Turbines	Fuel Cells
Size Range (kW)	250 to 3,000	30 to 250	3,000 to 10,000	200 to 2400
Electricity Conversion Efficiency	25 to 35	25 to 30	30 to 40	35 to 50
Emissions	High	Low	Medium	Negligible
Experience on DG	Most	Limited	Significant	Limited
SGIP funding $/kW(1)	-	-	-	4,500
(1) Up to 1,000 kW, capped at 3,000 kW with declining incentive per KW				

The Future of Stationary Fuel Cells in California

Future Projects

- Folsom Prison and Corcoran Prison
- Stanford Mansion

Future Concepts

- Hydrogen Coproduction Stations
- Combined Cycle Fuel Cells
- Home CHP

Future Opportunities

- Waste Water treatment facilities
- Hospitals
- Universities
- Apartment Complexes
- Military
- Goods movements
- Manufacturing
- Industrial

Contact Information

Jonathan Foster
Air Resources Engineer
Air Resources Board
Stationary Source Division
jfoster@arb.ca.gov
(916) 327-1512