

Stationary Fuel Cells:

How can they help California achieve its goal of clean, reliable electricity?



California Public Utilities Commission

California Public Utilities Commission
October 1, 2012

Participants:



Bloomenergy

A  Sempra Energy utility®



AGENDA

1:00 PM	Welcoming Remarks	<ul style="list-style-type: none">• Timothy Alan Simon - <i>Commissioner</i>, California Public Utilities Commission
1:10 PM	Keynote: An Introduction to Stationary Fuel Cells	<ul style="list-style-type: none">• Scott Samuelsen - <i>Director</i>, National Fuel Cell Research Center
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3:00 PM	Industry Panel Discussion	

CALIFORNIA STATIONARY FUEL CELL COLLABORATIVE

California **Stationary Fuel Cell Collaborative**



Co-Chairs

Mary Nichols, Chair
California ARB

Dr. Scott Samuelsen, Director
National Fuel Cell Research Center

Executive Director

Mike Tollstrup

Industry Advisory Panel

Matt Heling
PG&E

www.stationaryfuelcells.org

Established 2001

CA Air Resources Board
CA Department of General Services
CA Energy Commission
CA Environmental Protection Agency
CA Public Utilities Commission
CA Resources Agency
CA Trade and Commerce Agency
CA Transportation and Housing Agency
CA Food and Agriculture

U.S. Department of Energy
U.S. Department of Defense
U.S. General Service Administration
U.S. Environmental Protection Agency

National Fuel Cell Research Center
LA Department of Water and Power
South Coast Air Quality Mgt District
Bay Area Air Quality Mgt District



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CA F

Bloom Energy
FuelCell Energy

UTC Power

ClearEdge

Idatech

Chevron

Air Products

Johnson Matthey

Southern California Gas

Pacific Gas & Electric

U.S.

U.S.

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South Coast Air Quality Mgt District

Bay Area Air Quality Mgt District



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An Introduction to Stationary Fuel Cells

Professor Scott Samuelsen
National Fuel Cell Research Center



University of California, Irvine
<http://www.nfcrc.uci.edu>

October 1, 2012

POWER GENERATION

- **COMBUSTION**

FUEL/AIR

COMBUSTION CHEMISTRY

THERMAL ENERGY

EXPANSION

PISTON or TURBINE

GENERATOR

ELECTRICITY

LIMITED EFFICIENCY

POLLUTANT EMISSION

- **FUEL CELLS**

FUEL/AIR

ELECTROCHEMISTRY

ELECTRICITY

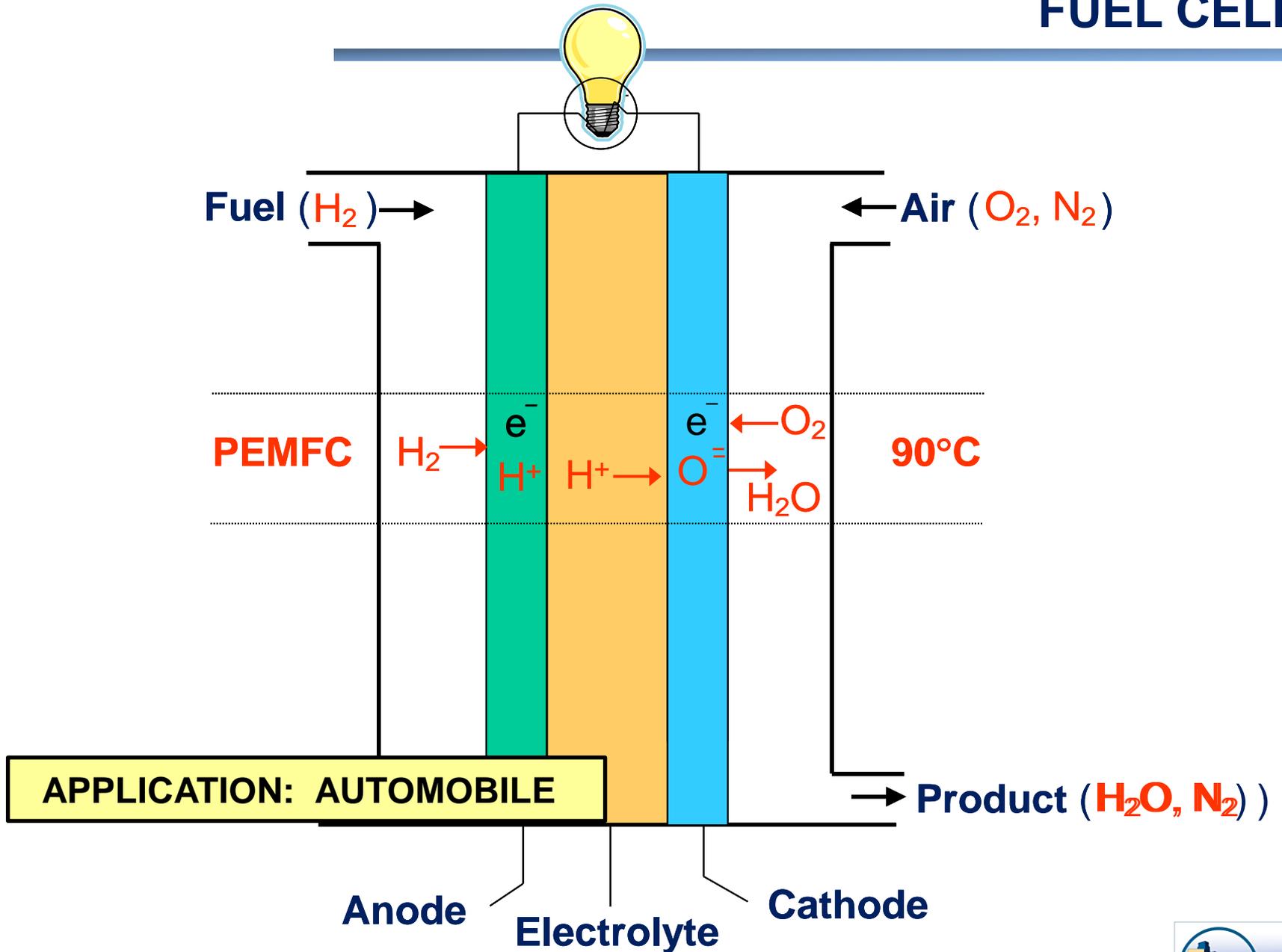
HIGH EFFICIENCY

NO POLLUTANT EMISSION

HIGH QUALITY HEAT

ACOUSTICALLY BENIGN

FUEL CELL



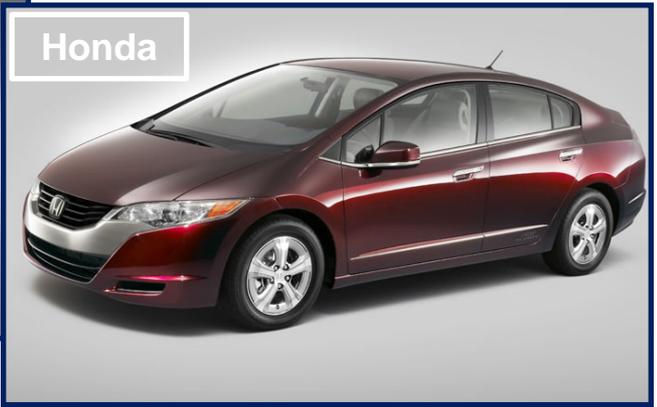
GM



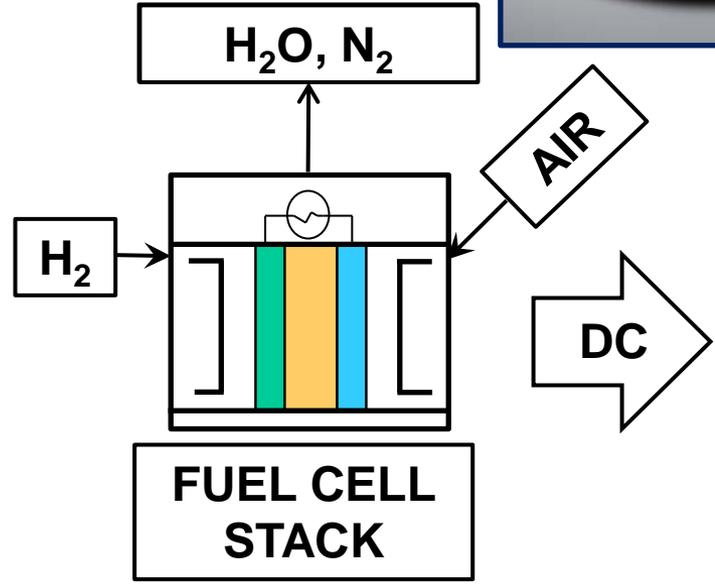
Toyota



Honda



MOBILE FUEL CELLS



UTC Power

APPLICATION: AUTOMOBILE

APPLICATION: BUS

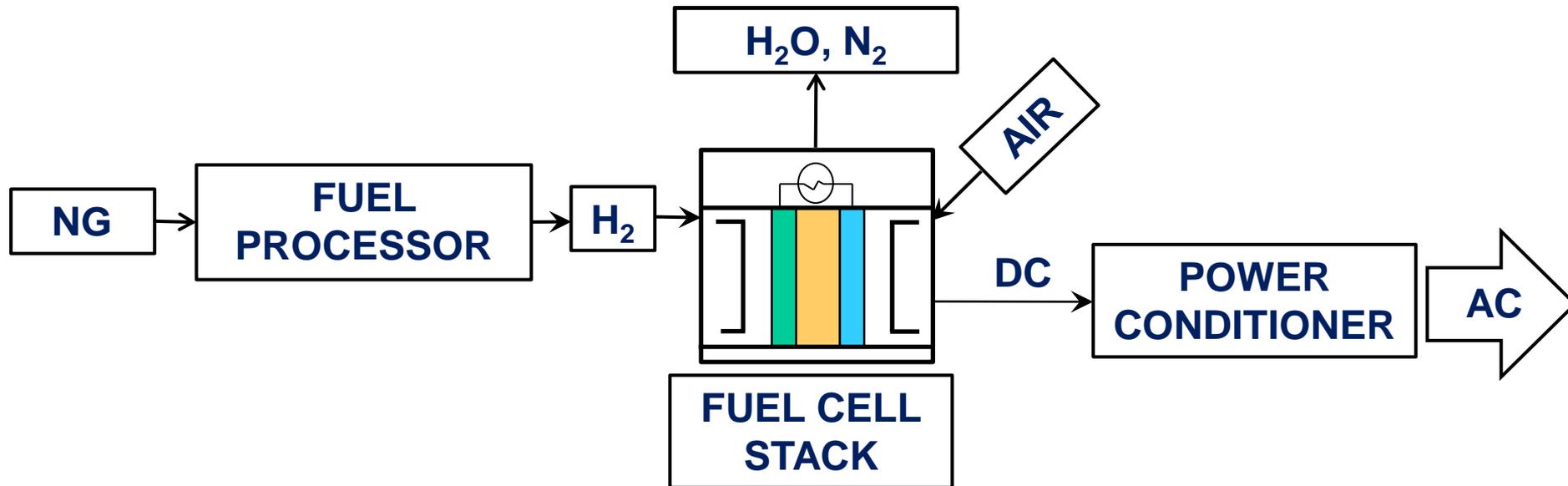
APPLICATION: LIFT TRUCK



Plug Power



FUEL CELL POWER PLANT



APPLICATION: STATIONARY

STATIONARY FUEL CELLS



APPLICATION: STATIONARY

STATIONARY FC DEPLOYMENTS

- WASTEWATER TREATMENT 9.10
- MOBILE RENEWABLES 3.90
- HOTELS 2.75
- GOVERNMENT 2.25
- HOSPITALS 1.00
- COMMUNICATIONS 0.50
- GROCERY STORES 1.00
- UNIVERSITIES 5.00
- BREWERIES 1.00
- INDUSTRIAL 4.20
- MANUFACTURING 0.50
- FOOD PROCESSING 0.50
- UTILITIES 0.25

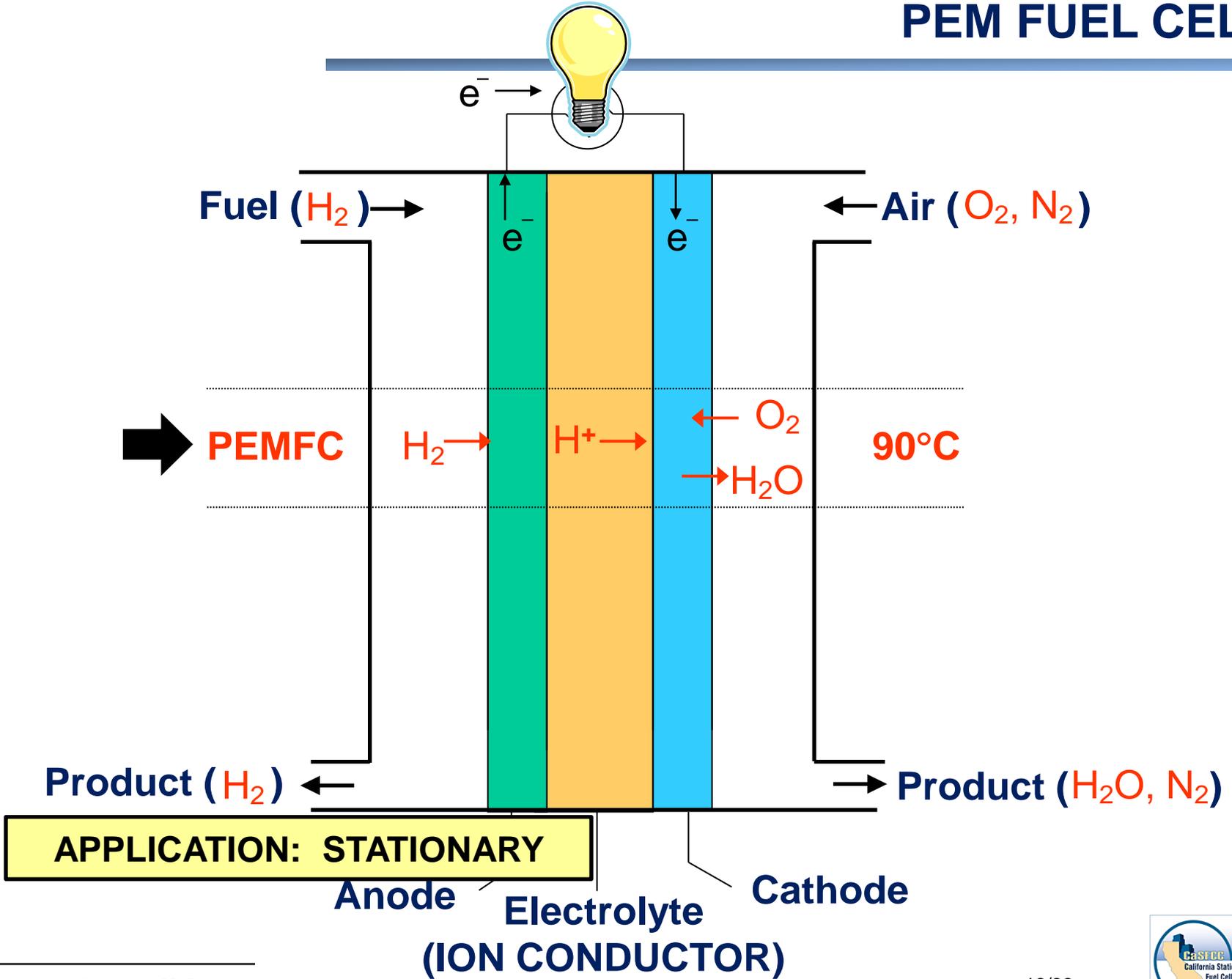
TOTAL = 33.00 MW



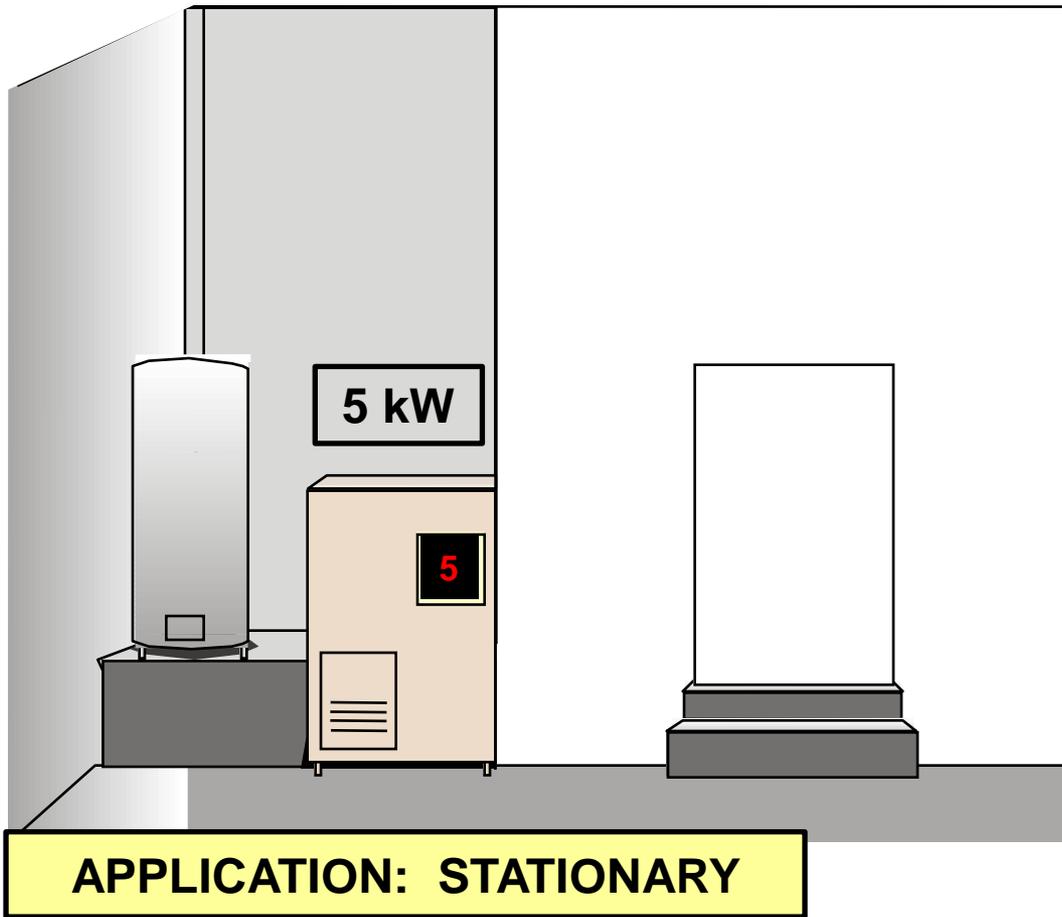
SOURCE: CASFCC.ORG



PEM FUEL CELL



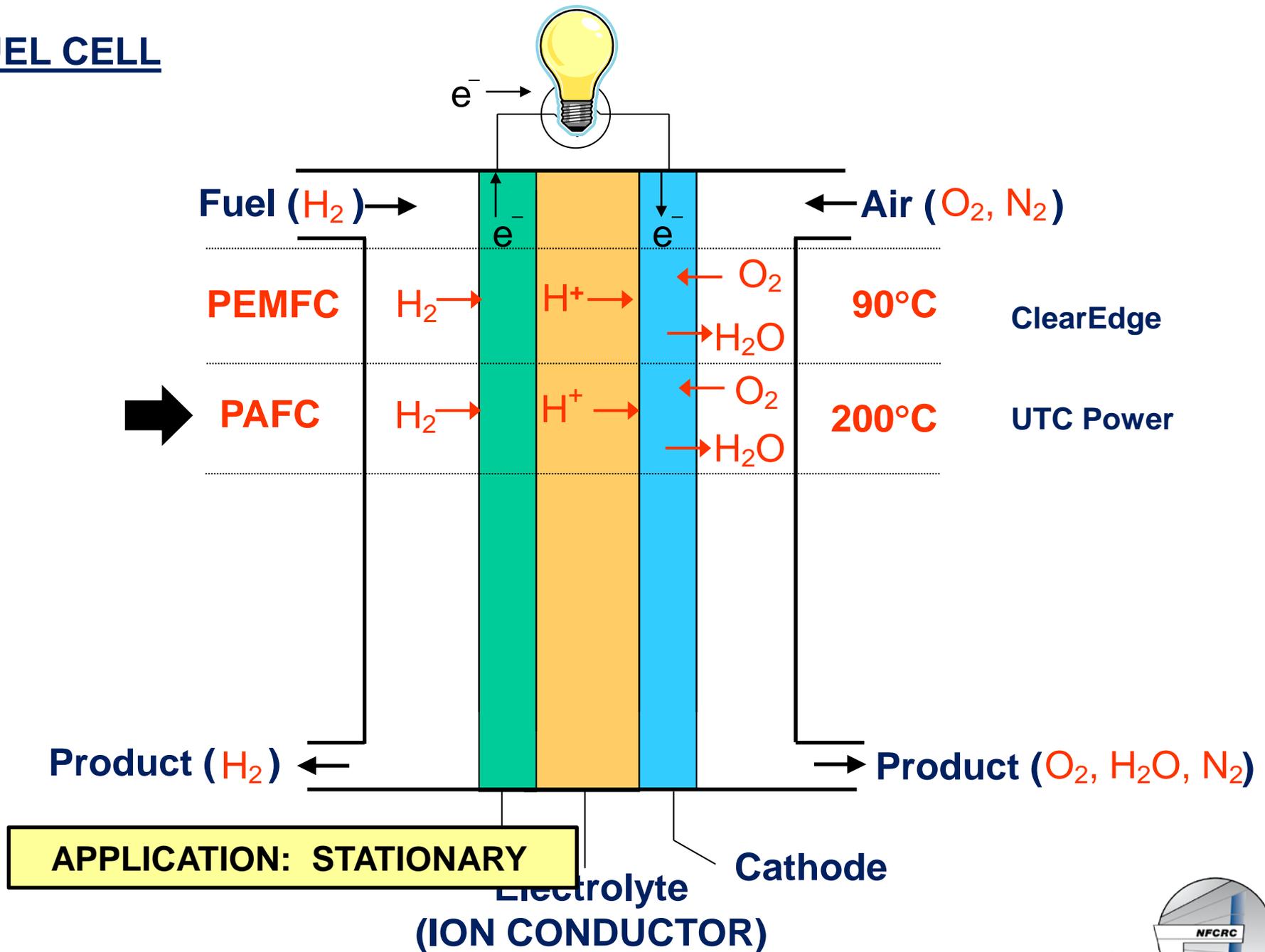
PEM FUEL CELLS



**EARLY
STAGE**



FUEL CELL



PAFC POWER PLANTS

STATIONARY FC DEPLOYMENTS



• WASTEWATER TREATMENT	9.10
• MOBILE RENEWABLES	3.90
• HOTELS	2.75
• GOVERNMENT	2.25
• HOSPITALS	1.00
• COMMUNICATIONS	0.50
• GROCERY STORES	1.00
• UNIVERSITIES	5.00
• BREWERIES	1.00
• INDUSTRIAL	4.20
• MANUFACTURING	0.50
• FOOD PROCESSING	0.50
• UTILITIES	0.25
TOTAL =	33.00 MW

APPLICATION: STATIONARY



SOURCE: CASFCC.ORG



PAFC POWER PLANTS

STATIONARY FC DEPLOYMENTS



Whole Foods Market
San Jose



Cox Communications
Orange County

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• MOBILE RENEWABLES	3.90
• HOTELS	2.75
• GOVERNMENT	2.25
• HOSPITALS	1.00
• COMMUNICATIONS	0.50
• GROCERY STORES	1.00
• UNIVERSITIES	5.00
• BREWERIES	1.00
• INDUSTRIAL	4.20
• MANUFACTURING	0.50
FOOD PROCESSING	0.50
UTILITIES	0.25
TOTAL =	33.00 MW



Albertson's
San Diego

1990



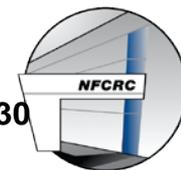
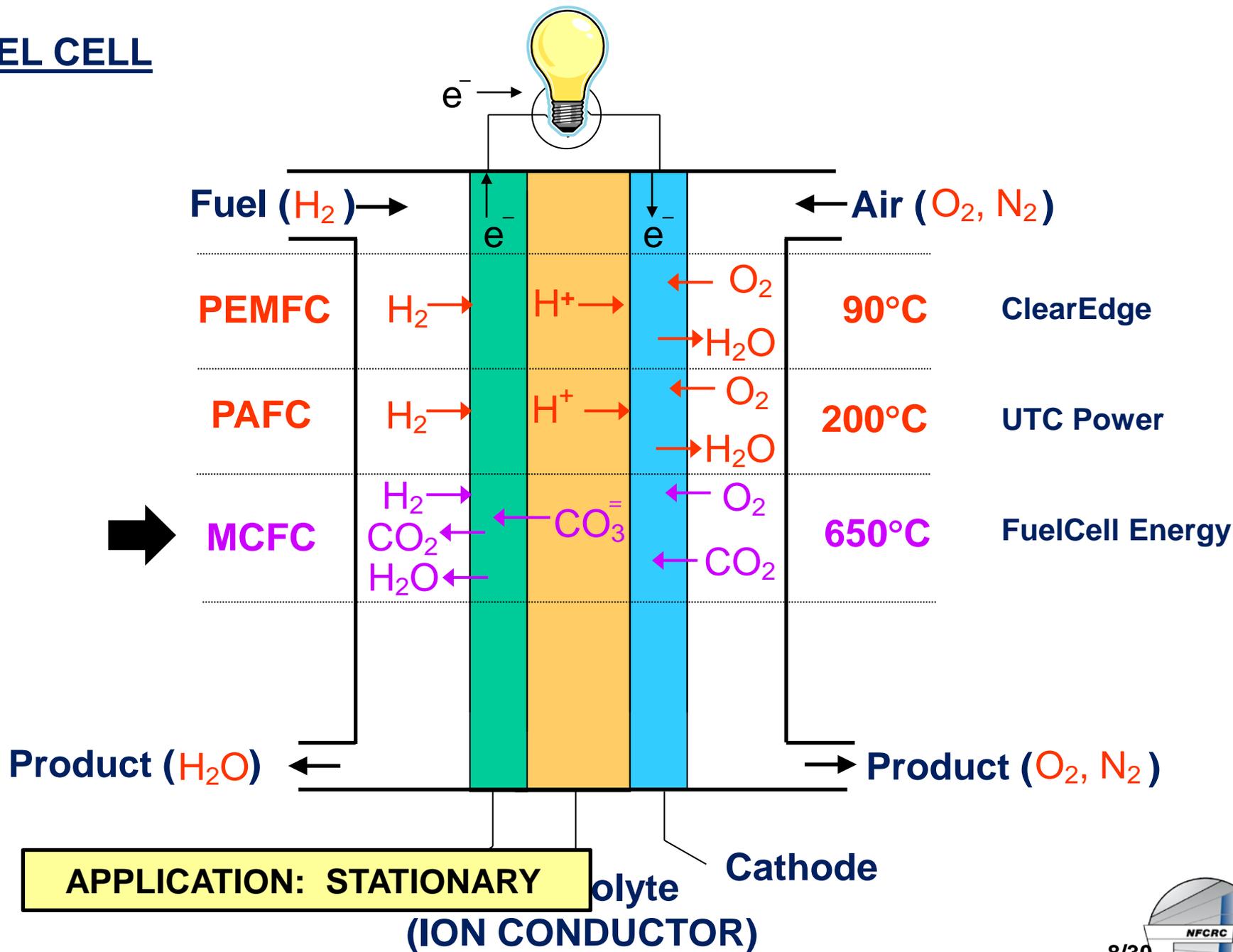
UTC Power

A United Technologies Company

APPLICATION: STATIONARY

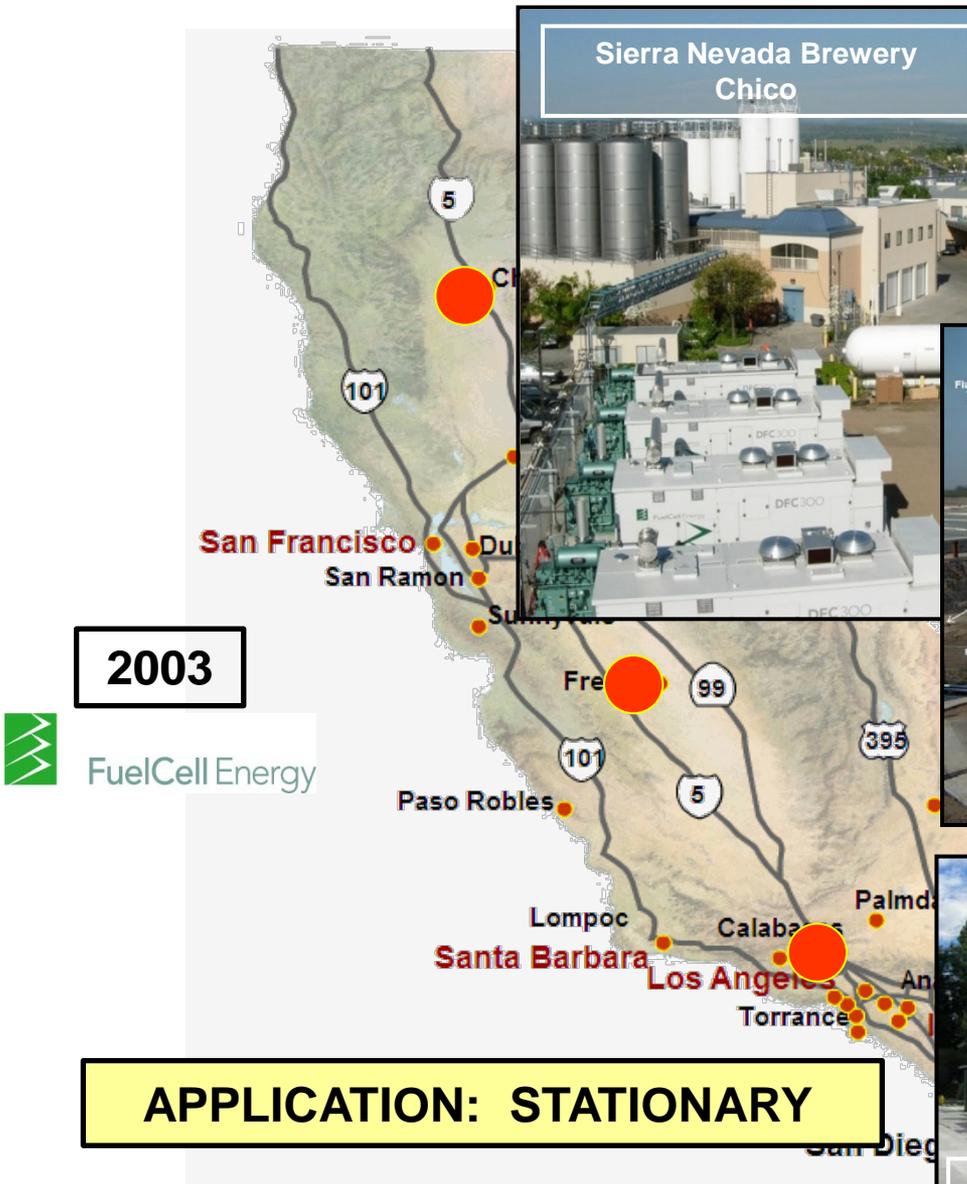


FUEL CELL



MCFC POWER PLANTS

STATIONARY FC DEPLOYMENTS

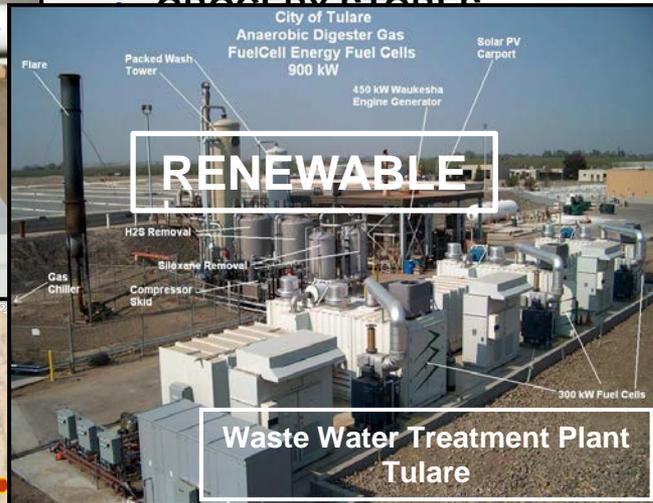


2003



APPLICATION: STATIONARY

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- MOBILE RENEWABLES 3.90
- HOTELS 2.75
- GOVERNMENT 2.25
- HOSPITALS 1.00
- COMMUNICATIONS 0.50



GROCERY STORES 1.00

5.00

1.00

4.20

0.50

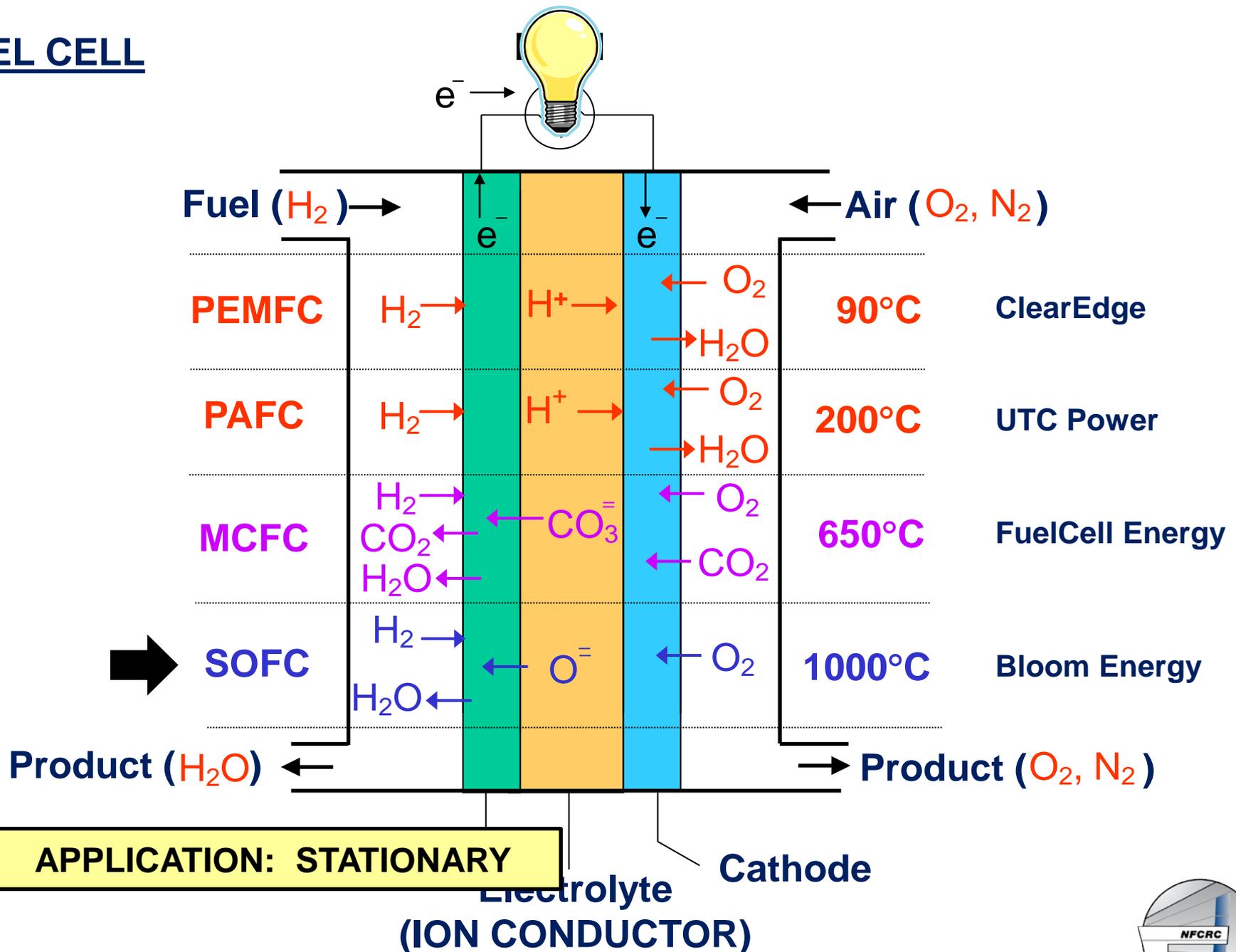
0.50

0.25

33.00 MW

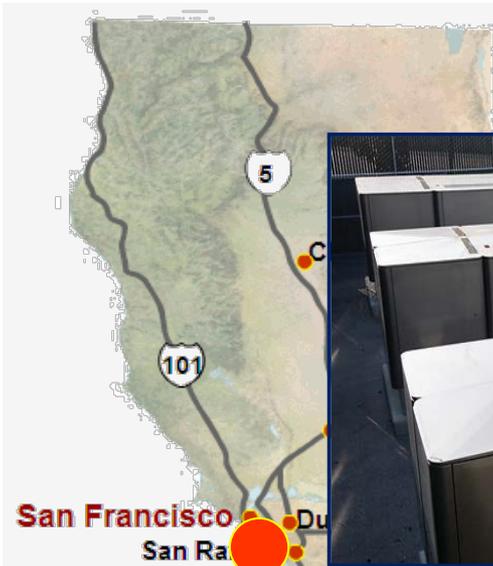


FUEL CELL



SOFC POWER PLANTS

STATIONARY FC DEPLOYMENTS



Google
Silicon Valley

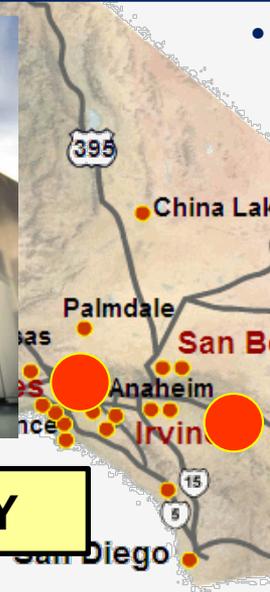
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• INDUSTRIAL	4.20
• MANUFACTURING	0.50
• FOOD PROCESSING	0.50
• UTILITIES	0.25
TOTAL =	33.00 MW

2009

Bloomenergy®



CalTech
Pasadena



Walmart
Hemet

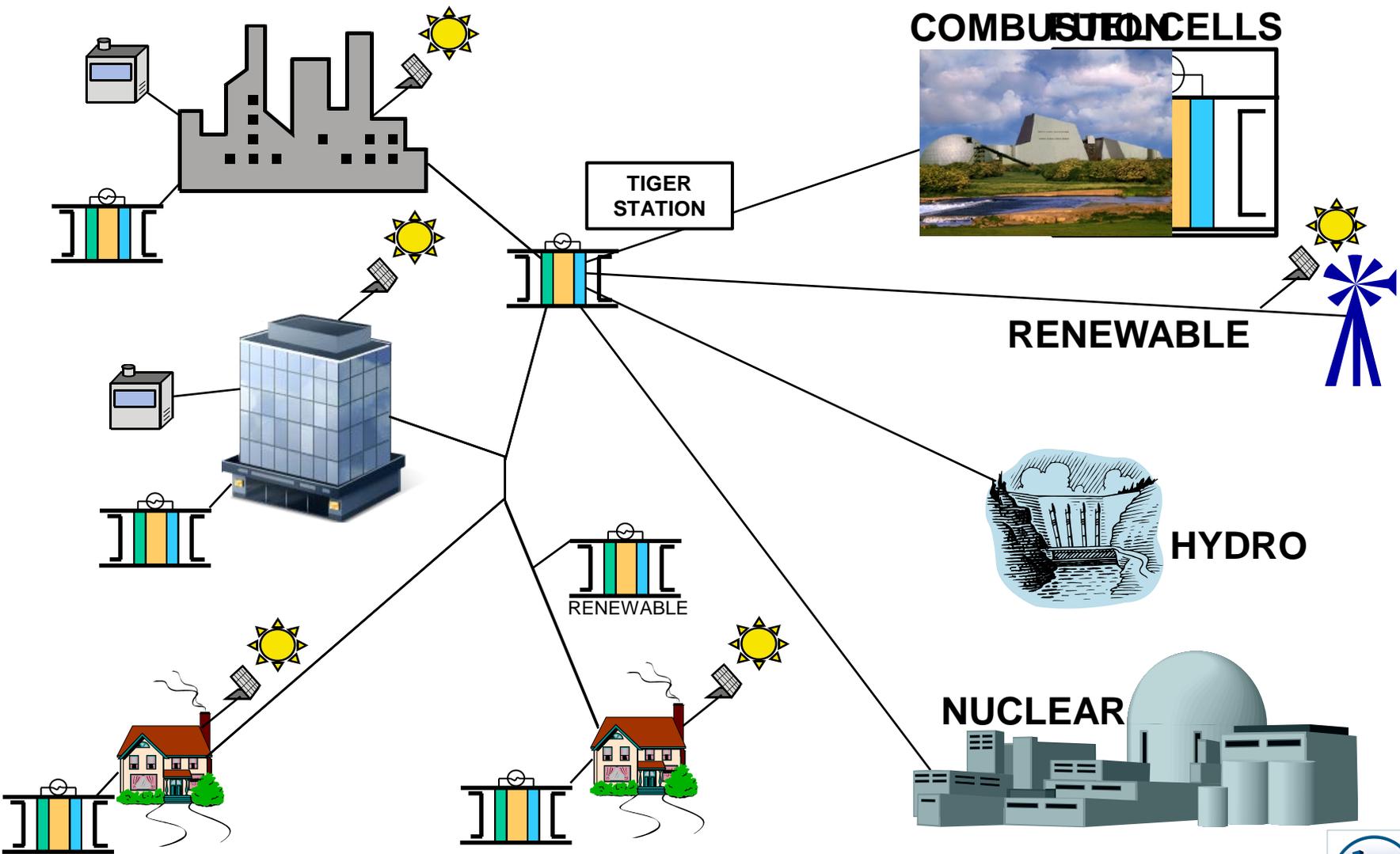
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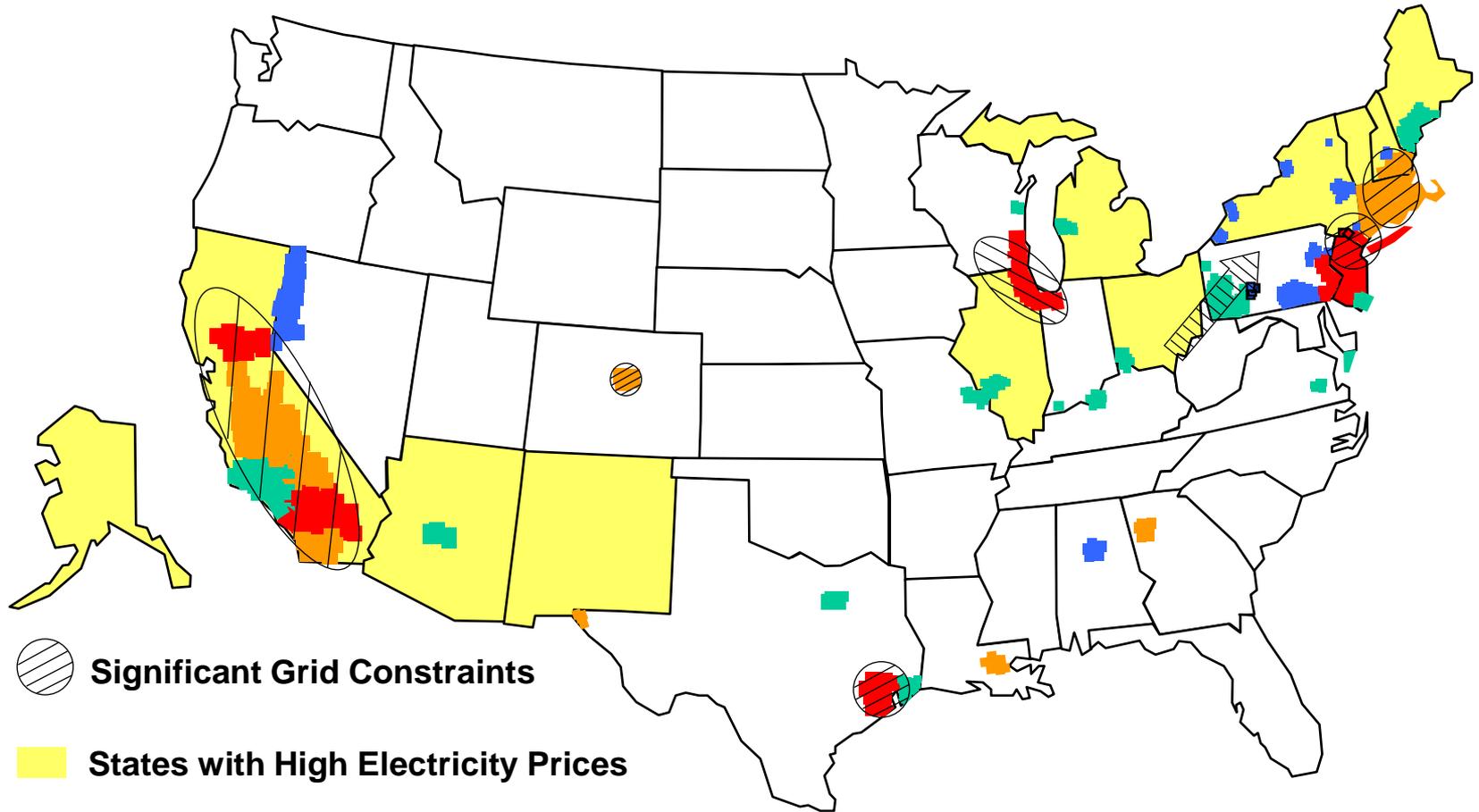
FUEL CELL MARKET

DISTRIBUTED GENERATION

CENTRAL GENERATION



MARKET DRIVERS



 **Significant Grid Constraints**

 **States with High Electricity Prices**

Ozone Non-Attainment Classifications

 **Marginal**

 **Serious**

 **Moderate**

 **Extreme (LA) & Severe**

Source: Energy Information Administration



- **Natural Gas Powered**

- Most Energy Efficient
- Most Environmentally Sensitive

- **Bio Gas Powered**

- 24/7 Renewable

- **GHG Reduction**

- High Efficient Fuel-to-Electricity
- High-Quality Heat

- **Criteria Pollutant Emissions Reduction**

- **Reliability and Power Quality**

- Enable Islanding

- **“Fortuitous Fit”**

- Distributed Generation
- RPS Partner for Renewable Solar and Wind
- Renewable 24/7 Baseload Power and Heat
- AB-32
- Market Demand

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Stationary Fuel Cells Briefing-CPUC Perspective: Fuel Cells in the Self-Generation Incentive Program

October 1, 2012

Melicia Charles
California Public Utilities Commission
Energy Division

www.cpuc.ca.gov/PUC/energy/DistGen/





Self-Generation Incentive Program

SGIP provides incentives for DG technologies which have demonstrated a need for financial support in order to encourage customer adoption

Goals of SGIP

- Reduce greenhouse gas emissions (SB 412 in 2009)
- Reduce peak load demand (historical goal from inception in 2001)

Budget

- \$83 Million program budget per year
 - \$77 Million for incentives, \$6 Million for program administration
 - Incentive budget split 75% for renewable/emerging and 25% for non-renewable
- Budget Allocated across IOUs as % of electric and natural gas sales
- No new budget collection authorized after 12/31/2014 (AB 1150 in 2011)
- SGIP Program authorized through 2016 (AB 1150 in 2011)





Self-Generation Incentive Program History

History:

- Originally designed in 2001 as a rebate program focused on larger projects to complement CEC's Emerging Renewables Program (ERP), which focused on similar technologies, but at a smaller scale.
- Started in response to energy crisis in 2001

SGIP Policy Developments:

- *9/2006*: AB 2778 limits SGIP to fuel cells and wind
- *4/2008*: D.08-04-049 raises 1MW cap on incentives to a tiered 3MW
- *9/2008*: AB 2667 establishes 20% rebate incentive bonus for CA suppliers
- *1/2008*: D.08-11-044 makes storage coupled with DG eligible for \$2/W
- *1/2009*: SB 412 modifies SGIP goals to focus on GHG reductions
- *9/2011*: D.11-09-015 Includes wind, fuel cells, gas turbines, micro-turbines and internal combustion engines, waste heat capture, CHP, energy storage, and pressure reduction turbines.
- *9/2011*: AB 1150 extends SGIP through 2016





SGIP Program Incentive Structure

- SGIP offers incentives to offset the cost of capital investment
 - 50% upfront, 50% based on performance over 5 years

	Fuel	Incentive (\$/W)
Renewable Fuels and Waste Heat Capture		
Wind	n/a	\$1.25
Waste Heat or bottom cycle CHP	n/a	\$1.25
Pressure Reduction Turbine	n/a	\$1.25
Gas Turbine – CHP	Renewable	\$2.50
Microturbine – CHP	Renewable	\$2.50
IC Engine – CHP	Renewable	\$2.50
Non-Renewable fuels		
Gas Turbine– CHP	NG	\$0.50
Microturbine – CHP	NG	\$0.50
IC Engine – CHP	NG	\$0.50
Emerging technologies		
Advanced Energy Storage	n/a	\$2.00
Fuel Cell – CHP or electric only	NG	\$2.25
Fuel Cell – CHP or electric only	Renewable	\$4.25





Fuel Cells Installed by Year

Year	Renewable		Non-Renewable	
	Projects	Capacity (kW)	Projects	Capacity (kW)
2002			1	200
2004			1	600
2005	2	750	1	1,000
2006			7	3,950
2007			2	1,500
2008	3	2,700	3	1,200
2009	2	1,500	3	1,300
2010	7	2,900	5	1,260
2011	34	16,785	51	3,570
2012	20	8,085	41	13,250
Total	68	32,720	115	27,830

Date: September 27, 2012





Fuel Cells Installed by Territory

Program Administrator	Projects	Capacity (kW)	SGIP Incentives
California Center for Sustainable Energy	20	10,050	\$35,724,857
Pacific Gas and Electric	106	30,395	\$105,698,016
Southern California Edison	26	10,470	\$42,395,000
Southern California Gas Company	31	9,635	\$36,135,000
Total	183	60,550	\$219,952,873

Date: September 27, 2012





SGIP Installations by Technology Type

Technology	Projects	Capacity (kW)	SGIP Incentive
A.E.S.	2	1,600	\$3,200,000
Fuel Cell	183	60,550	\$219,952,873
Gas Turbine	10	26,451	\$ 6,564,285
Internal Combustion	252	154,554	\$93,018,411
Microturbine	143	25,029	\$22,117,026
Wind Turbine	12	8,563	\$11,666,847
Total	602	276,746	\$356,519,442

Date: September 27, 2012





Net Energy Metering (NEM)

- **Fuel Cell NEM**
 - Offers bill credits and the generation-only rate
 - Available to both fuel cells using renewable and non-renewable fuels
 - September 2012: Governor signed AB 2165 which raised the statewide cap for Fuel Cell NEM from 112.5 MW to 500 MW

- **Full-Retail NEM**
 - **Eligible Technologies:** Solar, wind, biomass, geothermal, **renewable fuel cells**, small hydroelectric generation, digester gas, municipal solid waste conversion, landfill gas, hydro technologies.

- **Onsite Load:** DG facility size limited to serve onsite electric needs.

- **Export/Import:** NEM customer-generator export to the grid, and import (consume) from grid → Only pay for the net on a billing period basis.

- **Credits:** NEM customers can rollover excess bill credits up to a year. Bill credits offered at the bundled full-retail rate.



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Industry Panel

- Lisa Ward - *Program Manager for Government Business Development, UTC Power*
- Robin Shaffer - *Vice President of Sales, ClearEdge*
- Matt Heling - *Expert Strategic Analyst for Distributed Generation, Pacific Gas & Electric*
- Jeff Reed - *Director for Emerging Technologies, SoCal Gas*
- Tracy Reid - *Vice President Western Region, FuelCell Energy*
- Erin Grizard – *Senior Manager for Regulatory and Government Affairs, Bloom Energy*

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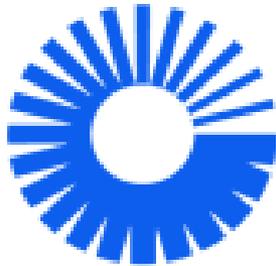
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Stationary Fuel Cell Markets

Lisa Ward

Government Business Development

UTC Power



UTC Power

A United Technologies Company

Fuel Cell Markets

Facilities with a 24/7 need for electricity and/or heat

Data Centers



Industrial/Life Sciences



Hospitals



Campus Environments



Office



Supermarkets



Mixed Use/Hotels



Utilities



Examples of Current California Installations

Market	End User
Commercial	Wal-Mart
	Staples
	CBS Studios
Industrial	The Coca Cola Company
Utility	PG&E – (2) University End Users
	SDG&E – Utility-side use
	SCE – University End User
Supermarket	Wholefoods Market
	Albertsons
Waste Water Treatment	Regional Treatment Facility (Tulare, CA)
Hospitals	St. Helena
Mixed Use/Hotels	Lafayette Hotel
Office Buildings	JMB MGM Towers, Century City
	Beckton Dickinson

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Utility Perspective on Stationary Fuel Cells

Matt Heling

Expert Strategic Analyst for Distributed Generation

Pacific Gas & Electric



***Pacific Gas and
Electric Company***[®]

Customer-Side Fuel Cells in PG&E Territory

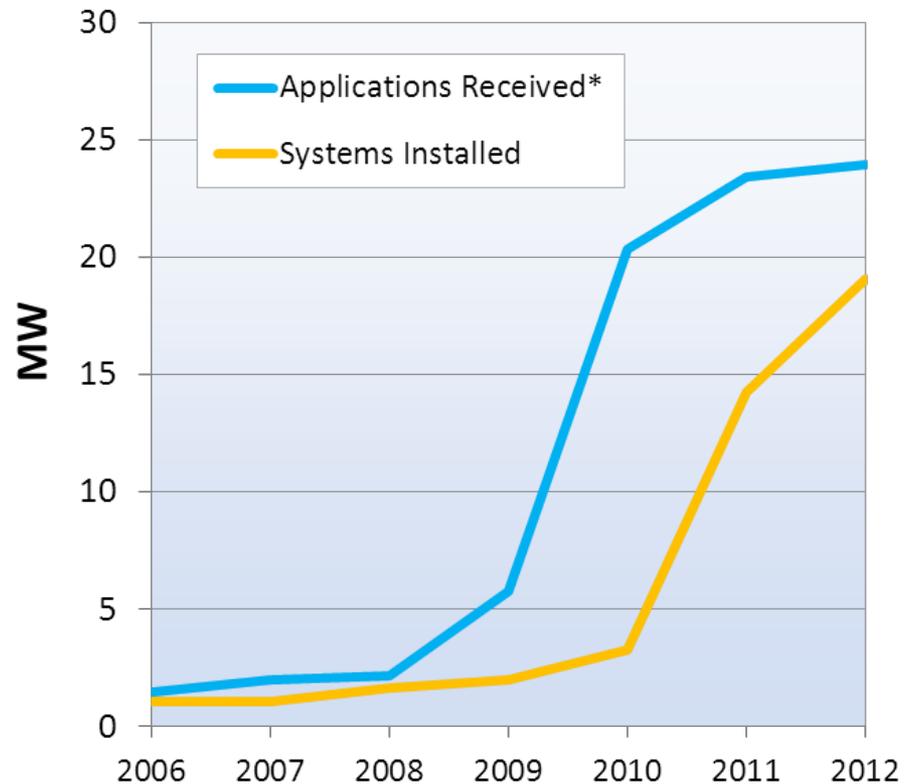
- Fuel cell **adoption is increasing**, particularly in past few years
- Policy drivers include:
 - **Self-Generation Incentive Program (SGIP)**
 - **NEM** (for renewable fuel cells), **NEMFC**
- Total customer-side fuel cell adoption approaching **20 MW**
- **Reduced GHG emissions by > 17 MMtCO₂ in 2011¹**

¹Source: CPUC 11th-Year SGIP Impact Evaluation, Table 6-11

October 1, 2012

Fuel Cells and SGIP: PG&E Territory

Cumulative fuel cell MW as of 9/26/12



* Excludes cancelled applications.



PG&E-Owned Fuel Cells

- CPUC-approved project to own & operate fuel cells at **San Francisco State University (SFSU)** and **Cal State East Bay (CSU-EB)**
- Installed in September 2011 (Commercial operations)
- Multiple technologies demonstrated
 - **SFSU:** Molten Carbonate (FuelCell Energy; 1.4 MW) and Solid Oxide (Bloom Energy; 200 kW)
 - **CSU-EB:** Molten Carbonate (FuelCell Energy; 1.4 MW)
 - Operations & maintenance contracts with fuel cell vendors
- Electricity feeds directly into PG&E grid
- Waste heat is utilized by campus thermal loops

PG&E-Owned Fuel Cells (cont'd)



CSU-EB: 1.4-MW FCE unit



SFSU: 200-kW Bloom Energy unit



SFSU: 1.4-MW FCE unit

PG&E-Owned Fuel Cells – Learnings

Category	Detail
System performance	<ul style="list-style-type: none">• Electric efficiencies, uptimes generally as expected• For CHP technologies, overall efficiencies (and GHG impacts) depend heavily on utilization of waste heat
Thermal integration	<ul style="list-style-type: none">• Original design underestimated impact of campus thermal loop operational patterns; but overall thermal utilization high
Safety requirements	<ul style="list-style-type: none">• Needed alignment of safety expectations across PG&E, CSU, vendors

The project has provided – and will continue to provide – PG&E with:

- ***First-hand opportunities to learn about fuel cell capabilities***
- ***Practical experience in operating fuel cell technology***

PG&E Perspective on Fuel Cells

- Fuel cells can contribute to an environmentally responsible energy future
 - Clean, non-combustion generation process
 - Efficient operation
 - Can provide GHG benefits, depending on fuel source and operating efficiencies
- However, all else equal, less valuable than dispatchable generation given increases in intermittent renewables
- Fuel cell costs need to continue to decline to become competitive with “conventional” power generation
- As with other DG technologies, need to balance rate-embedded incentives with impact on non-participants’ rates

Utility Perspective on Stationary Fuel Cells

Jeff Reed

Director for Emerging Technologies
Southern California Gas Company



Southern California Gas Company

- Regulated subsidiary of Sempra Energy
- “Sister” utility of SDG&E
- North America’s largest natural gas distribution utility
- Serves 20.9 million customers through 5.8 million meters in more than 500 communities
- Service territory from Visalia to Mexican border – approximately 20,000 square miles
- One of leading RD&D programs among utility peers – focus on technology demonstrations technology forecasting



History of SoCalGas Fuel Cell Activities

SoCalGas has been involved in fuel cell and hydrogen RD&D for over 40 years, with total investment in excess of \$20 million

- Funded basic work in both stack and reformer technologies
- Participated in the International Fuel Cell (IFC) 12.5 kW and 40 kW demonstration programs in 1980's
- Purchased, installed, and operated 10 IFC 200 kW phosphoric acid units in early 1990's
- Demonstrated 250 kW molten carbonate system in early 1990's
- Invested \$9.7 million in Plug Power in 1999
- Purchased and installed three Plug Power 5 kW units (1 for test and evaluation at EAC, 2 for sustainable communities projects in San Diego)
- Founding Member – National Fuel Cell Research Center

SoCalGas Perspective -- Opportunity

- Fuel Cells represent a major opportunity to use an economical, clean, domestic fuel (natural gas) to meet the state's environmental goals
- This environmentally friendly new load on the gas system will enhance system utilization and benefit all ratepayers through environmental benefits and downward rate pressure
- Fuel Cell technology is on the cusp of widespread adoption to contribute to the State's goal of 4,000 MW of new CHP over the next ten years -- products are available and projects are being completed
- Programs are being put in place to enable CHP adoption (standard offers, feed-in tariffs etc.)

SoCalGas Perspective -- Challenges

- Although beginning to scale, the industry is at about 1% of economics scale based on DoE analysis (order of 100 units per year versus ~10,000)
- The SGIP is a key to achieving scale with some manufacturers anticipating non-incentivized deployment within three years
- Customer need to have confidence in the reliability and availability of the systems – more transparency on hard operating data is needed (10,000 hours or 40,000 hours)
- SoCalGas supports a utility role, including potential ownership of systems, to help the market scale

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1:10 PM	Keynote: An Introduction to Stationary Fuel Cells	<ul style="list-style-type: none">• Scott Samuelsen - <i>Director</i>, National Fuel Cell Research Center
1:30 PM	CPUC Program Perspective	<ul style="list-style-type: none">• Melicia Charles – <i>Customer Generation Supervisor</i>, CPUC Energy Division
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3:00 PM	Industry Panel Discussion	

Renewable Operation of Stationary Fuel Cells

Tracy Reid

Vice President Western Region

FuelCell Energy



FuelCell Energy

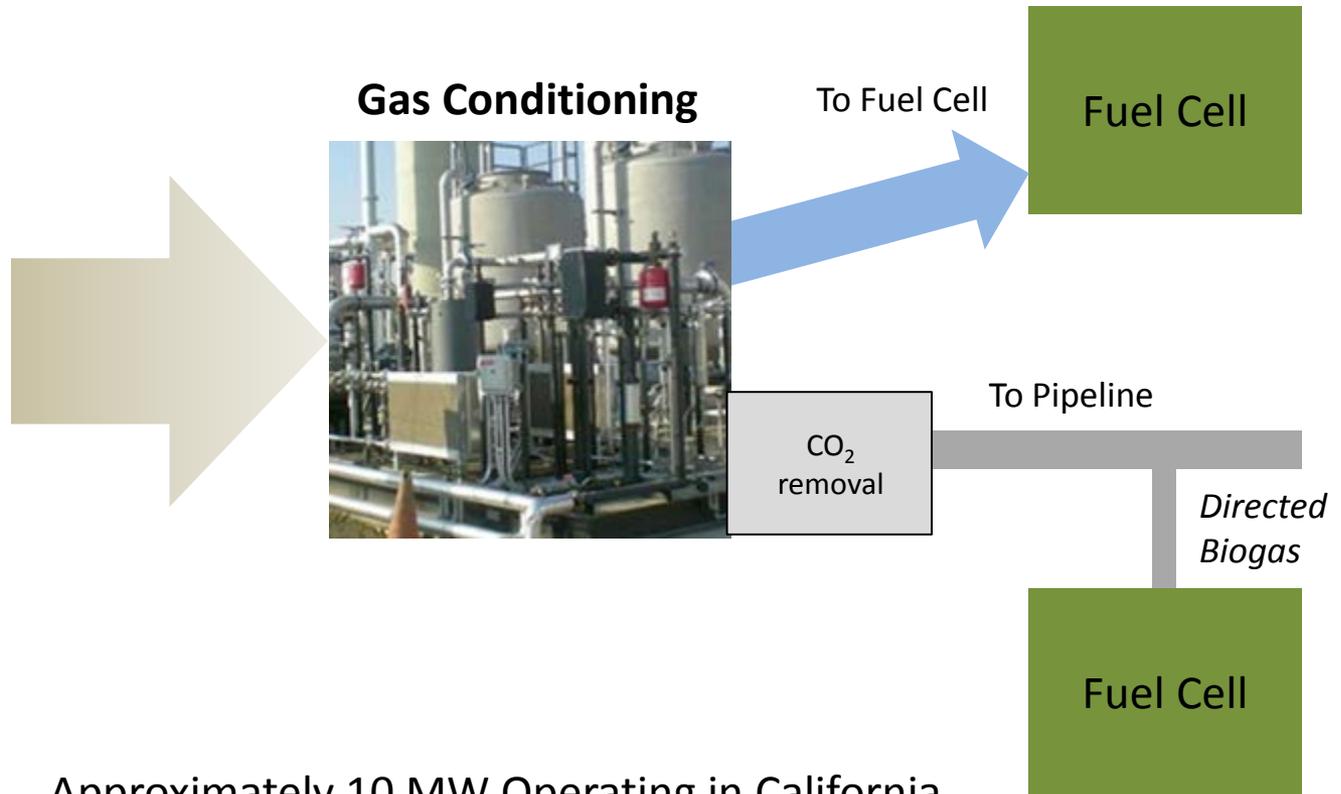
Renewable Operation of a Fuel Cell

Digesters



- Wastewater treatment plants
- Food & beverage processing
- Agriculture

Landfills



Approximately 10 MW Operating in California
California Addressable Market > 1GW

Renewable Operation of a Fuel Cell



Wastewater

Challenges:

- No change required

Potential Solutions:

- Value lower emissions



**Agriculture/Food
& Beverage**

- Dispersed fuel sources
- Limited need for kWh on site
- Perceived stability of host(s)

- FIT
- Directed biogas
- Project financing



Landfills

- Gas constituents
- Changes in gas makeup and amount over time
- Limited need for kWh on site

- FIT
- Directed biogas
- Natural gas blending

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Policies Related to Stationary Fuel Cells

Erin Grizard

Senior Manager for Regulatory and Government Affairs

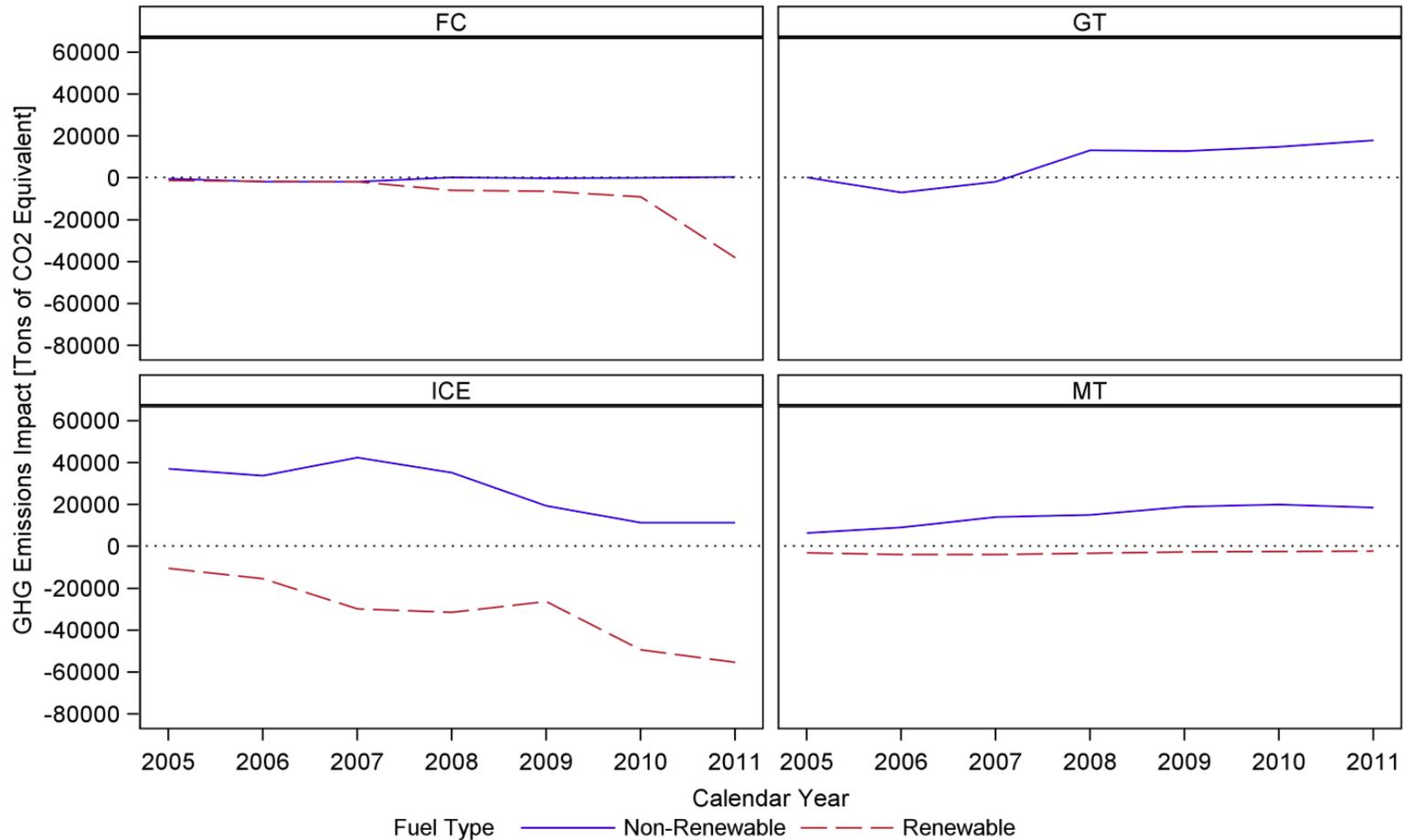
Bloom Energy

Bloomenergy®

Existing DG Programs and Policies

Program	Participating Buyers	Eligible Technologies
IOU Solar PV Programs Utility-owned generation (UOG)	3 large IOUs	Solar PV
California Solar Initiative (CSI)	Customers of <u>all POU</u> s and IOUs	Solar Photovoltaic and Solar Thermal
Feed-In Tariff (FIT)	All IOUs (inc. SMJUs) and municipal utilities	All RPS-eligible technologies (biogas)
Renewables Auction Mechanism (RAM)	3 large IOUs	All RPS-eligible technologies (biogas)
SCE Renewables Standard Contract Program (no longer offered)	3 large IOUs	All RPS-eligible technologies (biogas)
Qualifying Facilities (QFs)	3 large IOUs	All RPS-eligible technologies (biogas) and CHP
Renewable NEM	All IOUs and POUs	All RPS-eligible technologies (biogas)
Combined Heat and Power (CHP) Feed-in Tariff	3 large IOUs	CHP facilities certified as eligible by AB 1613 guidelines
CHP Competitive Procurement	3 large IOUs	CHP facilities meeting PU Code 216.6 definition of cogeneration
CHP As-Available Facilities	3 large IOUs	CHP facilities who are 60% efficient
Self-Generation Incentive Program (SGIP)	Customers of <u>4 IOUs</u> (SCG, PGE, SCE & SDGE)	As determined by the PUC
Fuel Cell NEM	Only IOUs	Fuel cells

Policy Objective- GHG Reductions

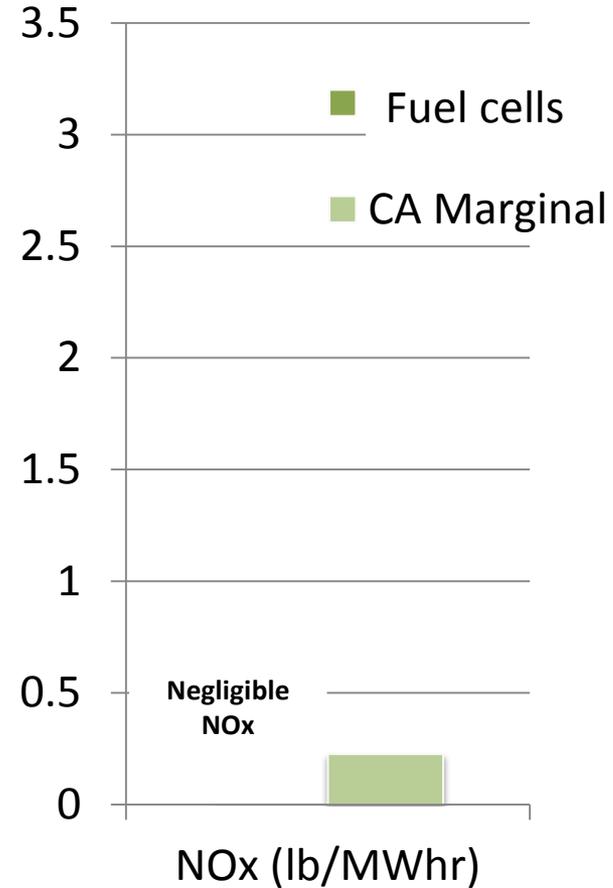
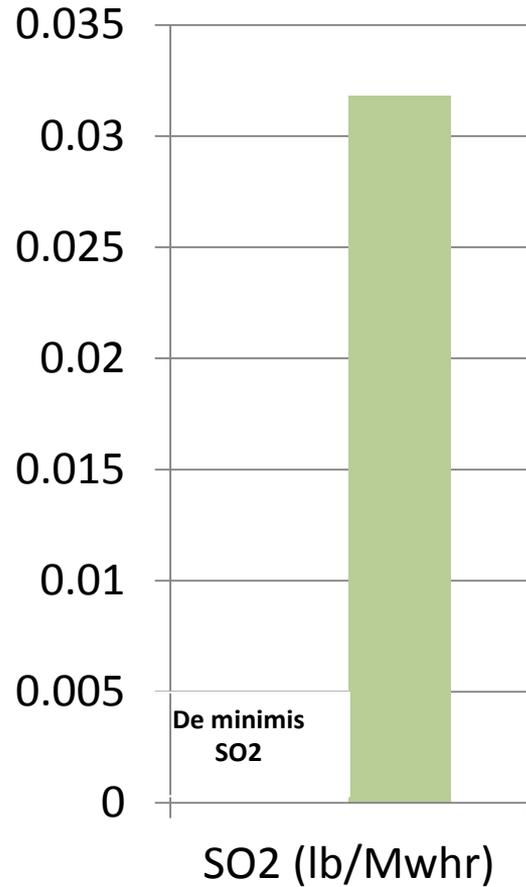


Source: CPUC Self-Generation Incentive Program—Eleventh-Year Impact Evaluation Report, Figure 6-9: Trends in CO₂ (and CO₂Eq) Emission Impacts by Technology and Fuel Type

October 1, 2012



Policy Objective –Air Pollution Reduction



Ultra low emissions profile allows for exemptions/streamlined air permitting in SCAQMD and other air districts.

Policy Objective- Water conservation

Generation Type	Gallons/kWh
UTC Power	N/A
FuelCell Energy	0.20
Bloom Energy	0.000037
ClearEdge	Negligible
Efficient Combined Cycle Nat Gas	0.37
Average US Coal Plant	0.61
US Grid	0.87

Future Policies- Why should policy makers support fuel cells?

- Fuel cells achieve existing policy goals (GHG, criteria pollutants, water reduction, etc)
- Reliable, Complimentary to intermittent tech
- The other 67%

Energy Infrastructure Transformation



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Industry Panel

- Lisa Ward - *Program Manager for Government Business Development*, UTC Power
- Robin Shaffer - *Vice President of Sales*, ClearEdge
- Matt Heling - *Expert Strategic Analyst for Distributed Generation*, Pacific Gas & Electric
- Jeff Reed - *Director for Emerging Technologies*, SoCal Gas
- Tracy Reid - *Vice President Western Region*, FuelCell Energy
- Erin Grizard – *Senior Manager for Regulatory and Government Affairs*, Bloom Energy

Stationary Fuel Cells:

How can they help California achieve its goal of clean, reliable electricity?



California Public Utilities Commission

California Public Utilities Commission
October 1, 2012

Participants:



Bloomenergy

A Sempra Energy utility

