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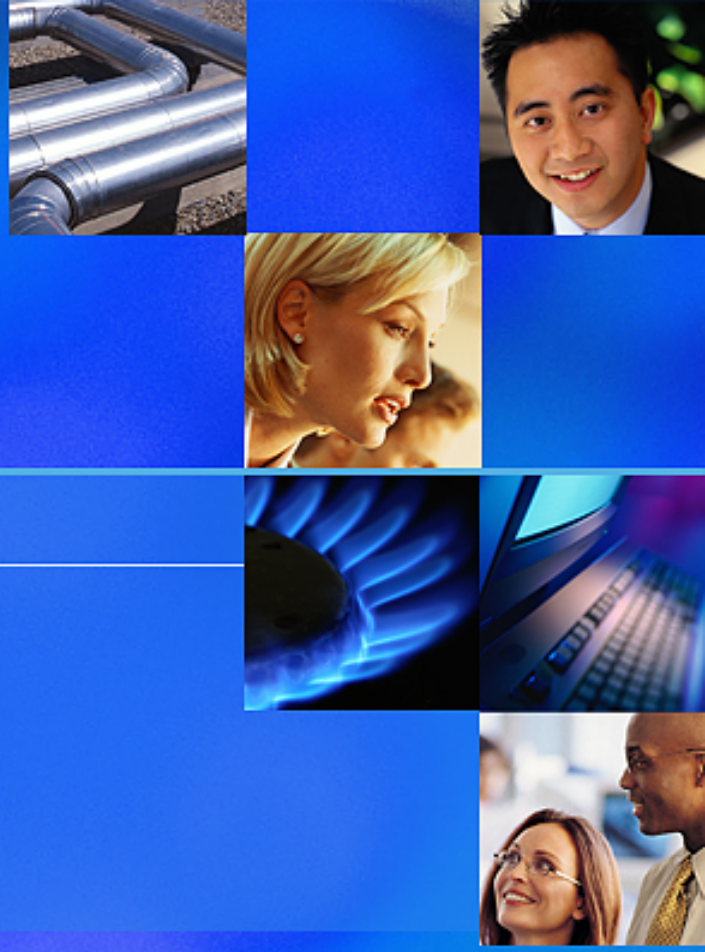

Gas Utility's Perspective on Small Scale Distributed Generation

ARPA-E Distributed Generation Workshop
June 1, 2011

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Technology Development Manager

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Presentation Outline

- Introduction
- Regulatory & Policy Drivers
- Technology Overview/Challenges
- Future Needs

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Southern California Gas Co. Overview

- Largest natural gas utility in USA
- 12 counties and 231 incorporated cities
- 20.9 million consumers
- Over 6 million natural gas meters
  - 875 large business/industrial customers
  - 207,000 small business customers
- 20,000 square mile service territory
- 100,000 miles of pipes
- 134 billion cubic feet of gas storage capacity (3% of national storage capacity)

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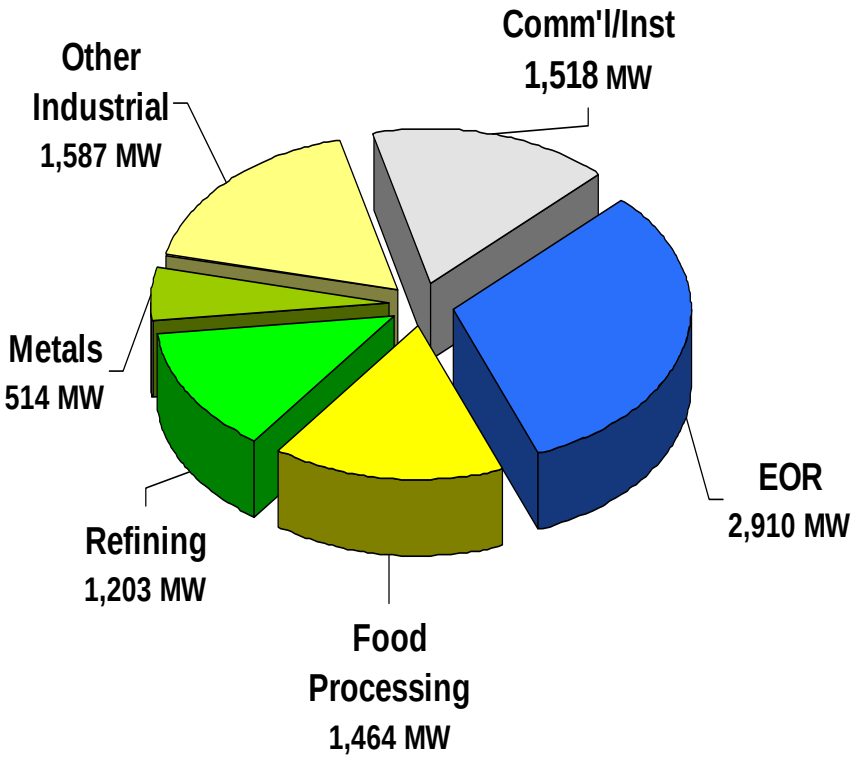
Status of CHP in California

- 9,200 MW of total DG/CHP capacity installed at over 1,100 sites (~ 17% of California's generation)
- Average capacity is 10 MW
- 88% of installed capacity is in systems greater than 20 MW
- Existing CHP saves over 300 TBtu of fuel each year (~ 14% of total gas use in CA)
- Existing CHP eliminates over 20 million tons of CO_2 emissions each year



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Remaining CHP Opportunity in California

- Technical potential of over 30,000 MW at industrial and commercial facilities – significant resource for California
- Two-thirds of the opportunity is in commercial and institutional applications
- Primary opportunity is within-the-fence systems sized for thermal loads
- 90% of the potential is in systems below 20 MW
  - Industrial – fabrication and assembly
  - Commercial – hotels, schools, office buildings
  - Residential – MicroCHP

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CA Policy Drivers

- CA Loading Order - EE/DR, Renewables, DG, Conventional
- Governor's Plan for DG/CHP
  - 12,000 MW of additional DG by 2020
  - 8,000 MW of additional central station renewable generation by 2020
  - 6,500 MW of additional CHP by 2030
- Feed-in-Tariff: Encourage the utilization of waste heat in CHP
- GHG Legislature mandate - reduce GHG's to 1990 levels by 2020
- RPS: 33% by 2020
- Self Generation Incentive Program: focus on wind & fuel cells
- California Solar Initiative – incentives for PV and solar thermal
- Net Zero Energy
  - All new residential construction in California will be NZE by 2020
  - All new commercial construction in California will be NZE by 2030

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Policy Driver - CA Loading Order

- California is the sixth largest economy in the world
- Demand for electricity is growing
- Loading order to meet growing demand:
  1. Energy Efficiency and Demand Response
  2. Renewable: wind, solar, small hydroelectric, geothermal, biomass
  3. Distributed Generation
     - Fuel cells,
     - Rooftop photovoltaic systems
     - CHP systems that simultaneously produce electricity and heat or steam for on-site use
  4. Clean fossil-fueled generation

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Governor Brown's Initiative for DG/CHP

- Propose to build 12,000 MW of distributed generation out of 20,000 MW of new renewable generation by 2020
  - 8,000 MW of additional central station renewable generation by 2020
  - 6,500 MW of additional CHP by 2030
- Introduce feed-in tariffs to accomplish this task
- 12,000 MW of new DG could produce 15-25 TWh of generation, or about 5%-8% of current consumption
- Accelerate the development of energy storage capacity

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Policy Driver – Feed-In-Tariff (AB 1613)

- Directs the CPUC to require IOUs to establish Feed-In Tariff for CHP systems <20 MW for sale of electricity to the grid
  - Proposed tariff between 8.33 and 10.57 cents/KWh
- It also directs the ARB to report on the reduction in emissions of GHG
- Section 2843 of the Act provides guidelines require that CHP systems:
  - Designed to reduce waste energy
  - Have a minimum efficiency of 62%
  - Have NOx emissions of no more than 0.07 Lbs/MWh
  - Sized to meet the eligible customer generation thermal load
  - Operate continuously in a manner that meets the expected thermal load and optimizes the efficient use of waste heat
  - Cost effective, technologically feasible, and environmentally beneficial

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Policy Driver – RPS (SB X 1-2)

- In April 2011, The State of CA obligated all CA electricity providers to obtain at least 33% of their energy from renewable resources by the year 2020
  - Interim targets: 20% by 2013; 25% by 2016
  - A renewable electrical generation facility must meets *all* of the following criteria:
    1. The facility uses biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 MW or less, digester gas, municipal solid waste conversion (not utilizing combustion), landfill gas, ocean wave, ocean thermal, or tidal current. *And*
    2. The facility satisfies *one* of the following requirements:
       - The facility is located in California or near the border of California with the first point of connection to the transmission network of a balancing authority area primarily located within California; *or*
       - The facility has its first point of interconnection to the transmission network outside California, but within the Western Electricity Coordinating Council (WECC) service area, and satisfies certain other conditions

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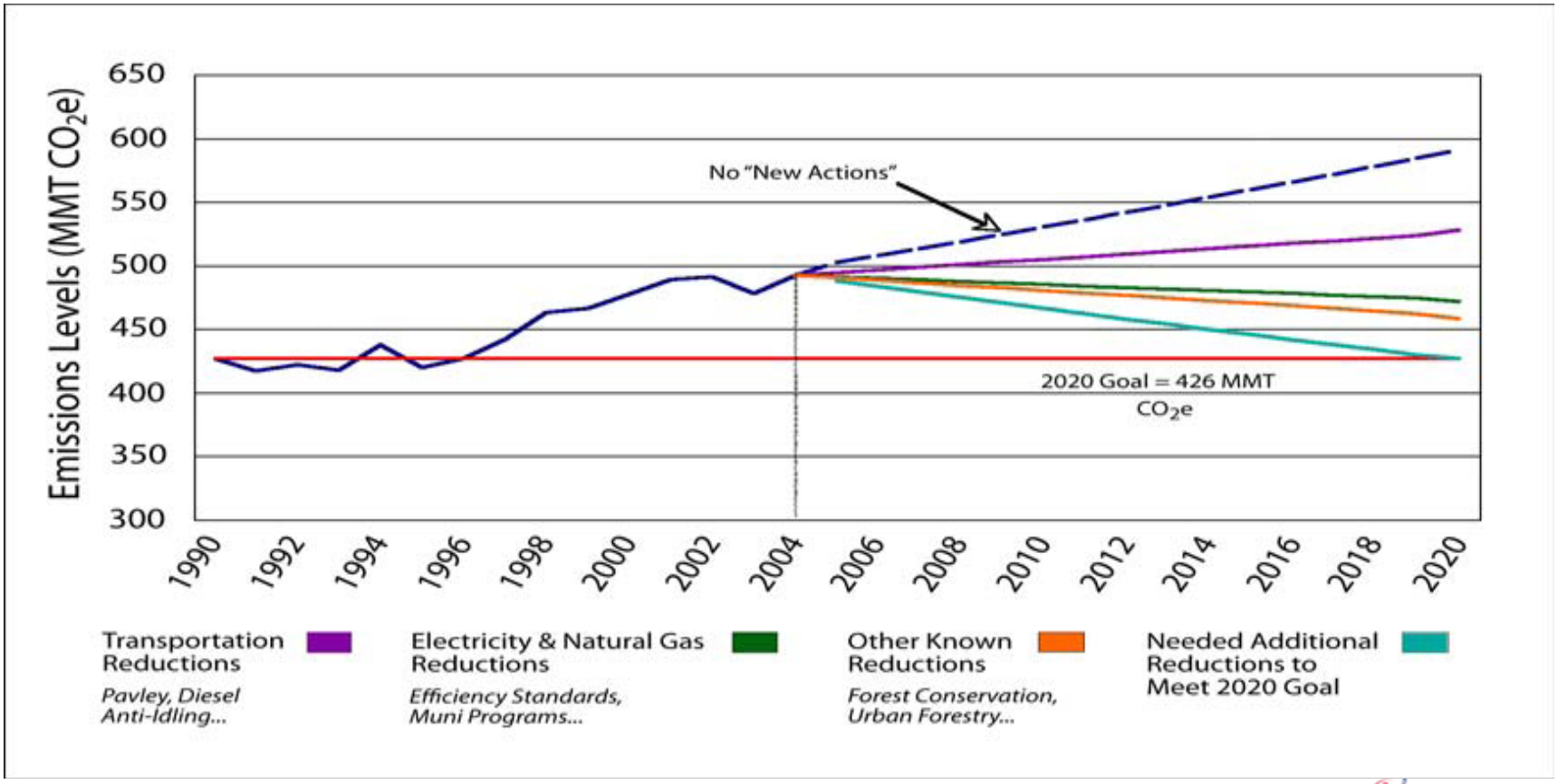
Policy Driver – GHG Reduction

- California Global Warming Solutions Act of 2006 (AB 32), mandates that California reduce its greenhouse gas emissions to 1990 levels by 2020.
- To meet AB 32 goals will require approximately a 29% cut in emissions below the levels the state is currently projected to produce in 2020.



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Self Generation Incentive Program (SGIP)

- Ratepayer funded incentives for Self Generation created through AB970
- Created in 2001 to increase generation capacity in California in response to Electricity Crisis.
- One of the largest DG programs in the United States
- By end of 2010 over 1300 projects online providing online capacity of 373 MWs statewide
- Original program provided incentives for all generation technologies
  - Renewables - photovoltaic, fuel cells, wind turbines
  - Fuel cells on natural gas utilizing waste heat
  - Turbines and IC Engines utilizing waste heat
- Current program provided incentives for the following technologies:
  - Wind Turbines
  - Fuel Cells- Operating on either Renewable or Non-Renewable Fuels
  - Advanced Energy Storage- If installed with either of above technologies

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Self Generation Incentive Program (SGIP)

Incentive Levels	Eligible Technologies [1]	Incentive Offered ($/Watt)	Minimum System Size	Maximum System Size [2]	Maximum Incentive Size
Level 2 Renewable	Wind Turbines	$1.50	30 kW	5 MW	1 MW
	Renewable Fuel Cells	$4.50	30 kW	5 MW	1 MW
Level 3 Non-Renewable	Non-Renewable Fuel Cells [3]	$2.50	None	5 MW	1 MW
Advanced Energy Storage	Coupled with eligible self generation technology and four hour discharge period at rated capacity	$2.00	None	5 MW	1 MW

[1] An additional incentive of 20% will be provided for the installation of eligible Distributed Generation (DG) technologies from a California Supplier

[2] Maximum system size is 5.0 MW, however, output capacity above the first 1.0 MW is not eligible for incentives.

[3] System must utilize waste heat recovery meeting Public Utilities Code 216.6

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CA SGIP Results (2001-2010) (All Utilities)

Technology	Amount Paid Out	KW Output	Ave. KW/Site	$/Watt Installed
Fuel Cell	$70,622,873	21,485	512	8.06
Gas Turbine	$6,564,285	26,451	2,645	2.35
IC Engine	$92,011,411	153,445	619	2.38
Microturbine	$20,542,026	23,527	167	3.34
Photovoltaic	$478,052,658	144,272	157	8.92
Wind	$5,494,971	3,948	564	3.53
Total	**$673,288,224**	**373,128**	**273**	**(Average) 5.31**

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Self Generation Incentive Program (SGIP)

- The Proposed SGIP for 2011 (final decision could be different)
- Gives major consideration to:
  - GHG reductions
  - Cost-Effectiveness
  - Need for Financial Incentive
- Proposed incentives for 2011:
  - Natural Gas Fuel Cells using waste heat - $500/kW
  - Natural Gas Turbines above 3.5 MW - $500/kW
  - All Technologies using on-site biogas - $1,250/kW
    - Gas turbines
    - Microturbines
    - IC Engines
    - Fuel Cells
  - No incentives for electric only fuel cells

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CA Solar Initiative (CSI)

- CSI offers cash back for installing solar PV and Solar Thermal in homes or businesses
- The CSI program has a total budget of $2.167 billion between 2007 and 2016
- Goal to install approximately 1,940 MW of new solar generation capacity and to install 200,000 new solar hot water systems that displace 585 million therms
- The CSI-Thermal portion of the program has a total budget of $280 million between 2010 and 2017
  - $180 million is allocated for natural gas-displacing SWH systems
  - $100.8 million for electric-displacing systems
  - Offers cash rebates of up to $1,875 for SWH on single-family homes
  - Multifamily and Commercial properties qualify for rebates of up to $500,000

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Net Zero Energy (NZE)

- CA launched NZE as one of the Big Bold Energy Efficiency Strategies (BBEES) to save an estimated 2,056 MW, avoiding the need for four new 500-MW power plants
- The plan designed to help commercial building owners take advantage of the latest technologies and financial incentives to reduce energy use to `net-zero.'
- NZE buildings have a net energy consumption of zero over a typical year
  - On-site solar, wind, and other renewable energy resources generate the amount of energy used by the building
- The three major BBEES are:
  - All new residential construction in California will be ZNE by 2020
  - All new commercial construction in California will be ZNE by 2030
  - HVAC will be upgraded to ensure that its energy performance is optimal for CA

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Technology Challenges

- Emissions Regulations
- CHP vs. Renewables
- Energy Rate Structure

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CARB & SCAQMD DG Emission Limits

	NOx(*) ppm @15%02	CO (*) ppm @ 15% 02
CARB Limit (with no Heat Recovery)	1.7	4.0
CARB limit (with 60% Heat Recovery)	3.5	8.1
SCAQMD Limit (with no Heat Recovery)	1.7	8.0
SCAQMD Limit (with 60% Heat Recovery)	3.5	16.2
BACT Limit	11	70
SCAQMD BARCT Limit	11	250

(*) SCAQMD Actual Emissions Requirements are: NOx <0.07lbs/MWh, CO < 0.2 Lbs/MWh

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CHP vs. Renewables – Regulatory Treatment

Example of how renewable, CHP generation, and efficiency technologies are treated unequally, under current regulations

CPUC Regulations	Renewables (Solar PV, Wind, Hydro)	Biogas-Fired Fuel Cells	Biogas-Fired Turbines, or IC Engines	Natural Gas Fired Fuel Cells	Ultra-Efficient Clean Natural Gas-Fired CHP	Other Energy Efficiency (Lighting, etc,.)
Exempt from having to pay Stand-By-Charge	Yes	Yes	Yes	Yes	NO	Yes[2]
Exempt from having to pay all **"departing load" charges ("exit fees")**	Yes	NO	NO	Yes	NO	Yes[2]
Eligible for **"Net Energy Metering (NEM)"**	Yes	Yes	Yes	Yes	NO	(n/a)
Eligible for **Feed In Tariff (FIT)**	Yes	Yes	Yes	Yes	NO[1]	(n/a)
Eligible to receive utility **incentives**	Yes	Yes	Yes	Yes	NO	YES
Utility **interconnection application & study fees** waived	Yes	Yes	Yes	Yes	NO	YES[2]
"Net Generation Output Meter" waived	Yes	Yes	Yes	Yes	NO	YES[2]

1. Some kind may be implemented in future.
2. When EE measures are implemented, no standby fees, departing load charges, grid-impact studies, or meter requirements are assessed by the utility, despite the measures causing identical kW/kWh reductions.

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CA Legislation and Regulations Sideline CHP

- AB2778 kicked fossil CHP (excluding fuel cells) out of Self-generation Incentive Program
- CA Investor Owned Utility rate structures discourage CHP
  - High demand, facility & standby charges
  - Steep non-by-passable surcharges (exit fees)
  - No feed-in tariffs
  - No monetary recognition for T&D and/or capacity benefits
- CARB regulations do not recognize tradeoffs between GHG emissions & criteria air pollutant regulations for natural gas- driven CHP
  - unlike the balanced treatment given for landfill gas and digester gas systems
- Lack of increase awareness of cost and efficiency advantages of CHP

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Technology Update - SCG

- NOx & CO Emissions
  - Rich Burn Engines
  - Lean Burn Engines
- Fuel Cell
- MicroCHP
- Waste Heat Recovery

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DG Emission Limits

	NOx (*) ppm @15%O2	CO (*) ppm @ 15% O2
CARB Limit (with no Heat Recovery)	1.7	4.0
CARB limit (with 60% Heat Recovery)	3.5	8.1
SCAQMD Limit (with no Heat Recovery)	1.7	8.0
SCAQMD Limit (with 60% Heat Recovery)	3.5	16.2
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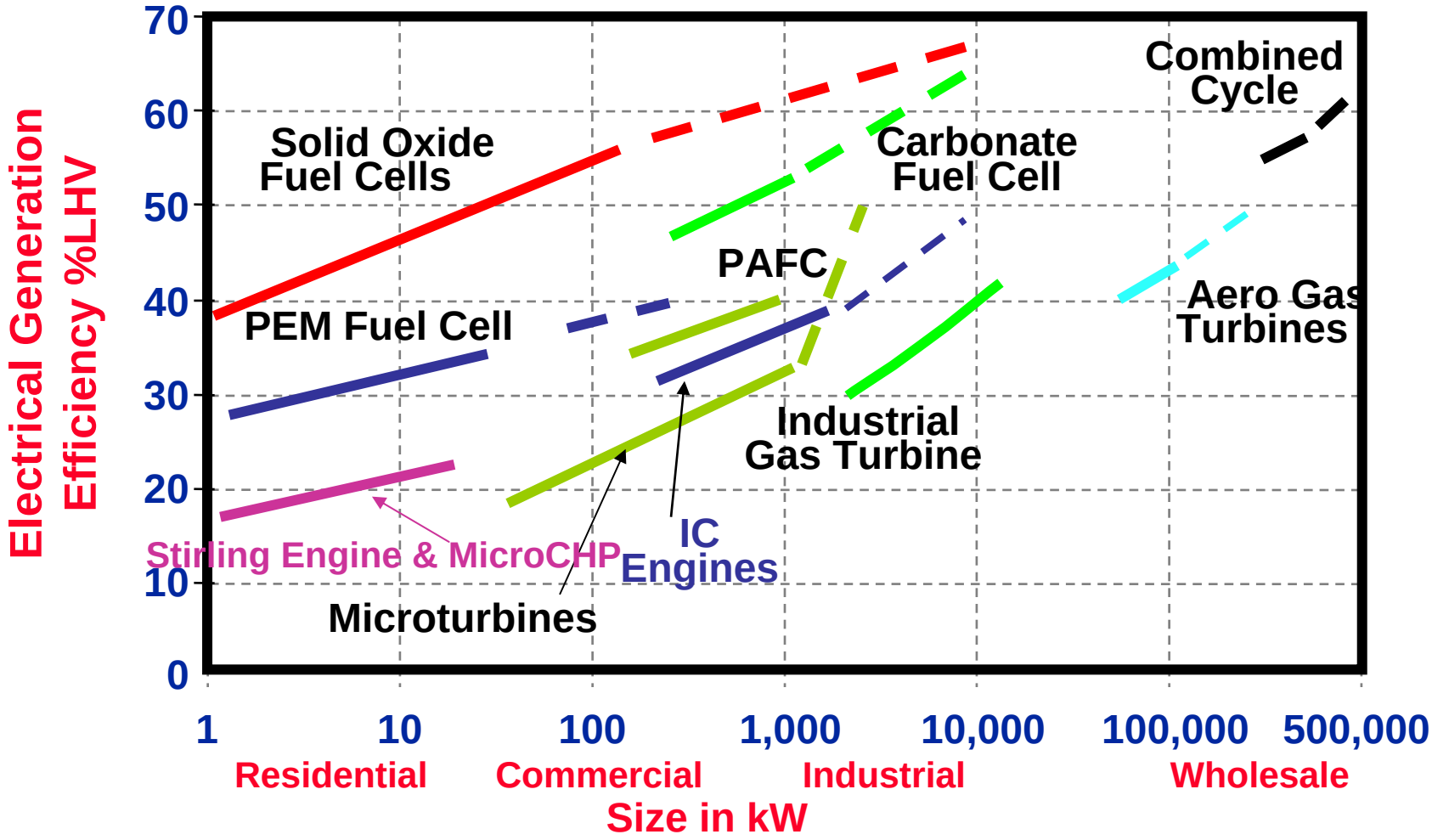
DG technologies



Rich-Burn Gas Engine RD&D Strategies

- Improved/Alternative Catalyst Materials and Suppliers
- Improved Control
  - Second Oxygen Sensor to Correct for Primary Sensor Drift
  - Wide-Band Sensors
- On-Board Diagnostics
  - Non Bypassable Controls
  - Alarm if Non-Compliant Condition Sensed
- Improved Engine Performance
  - Ignition Accessories (Upgrades)
  - Various Other
- Utilize Exhaust Gas Recirculation

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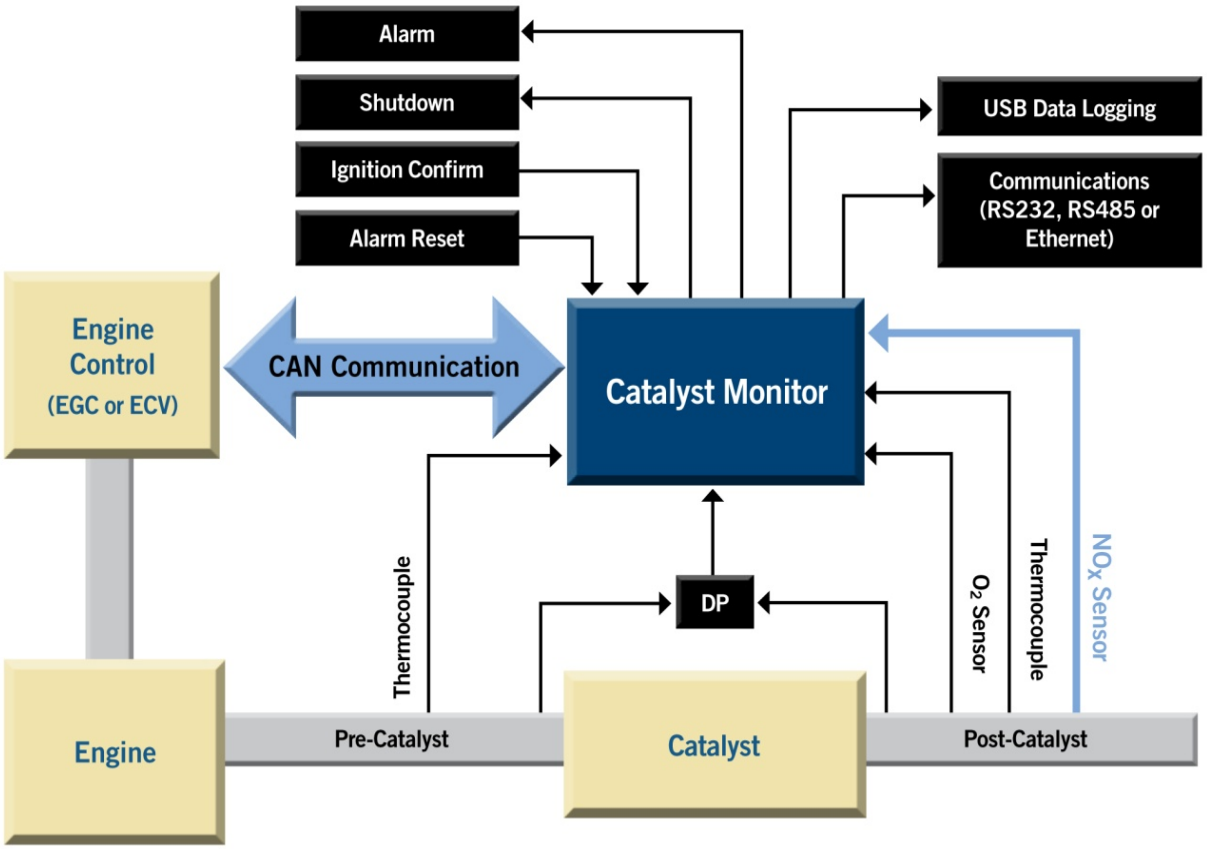
Rich-Burn Engine Emissions Control System – Continental Controls



CATALYST MONITOR – SYSTEM LEVEL

Version 1	Catalyst Monitor
Version 2	Catalyst Monitor with Intelligent Feedback

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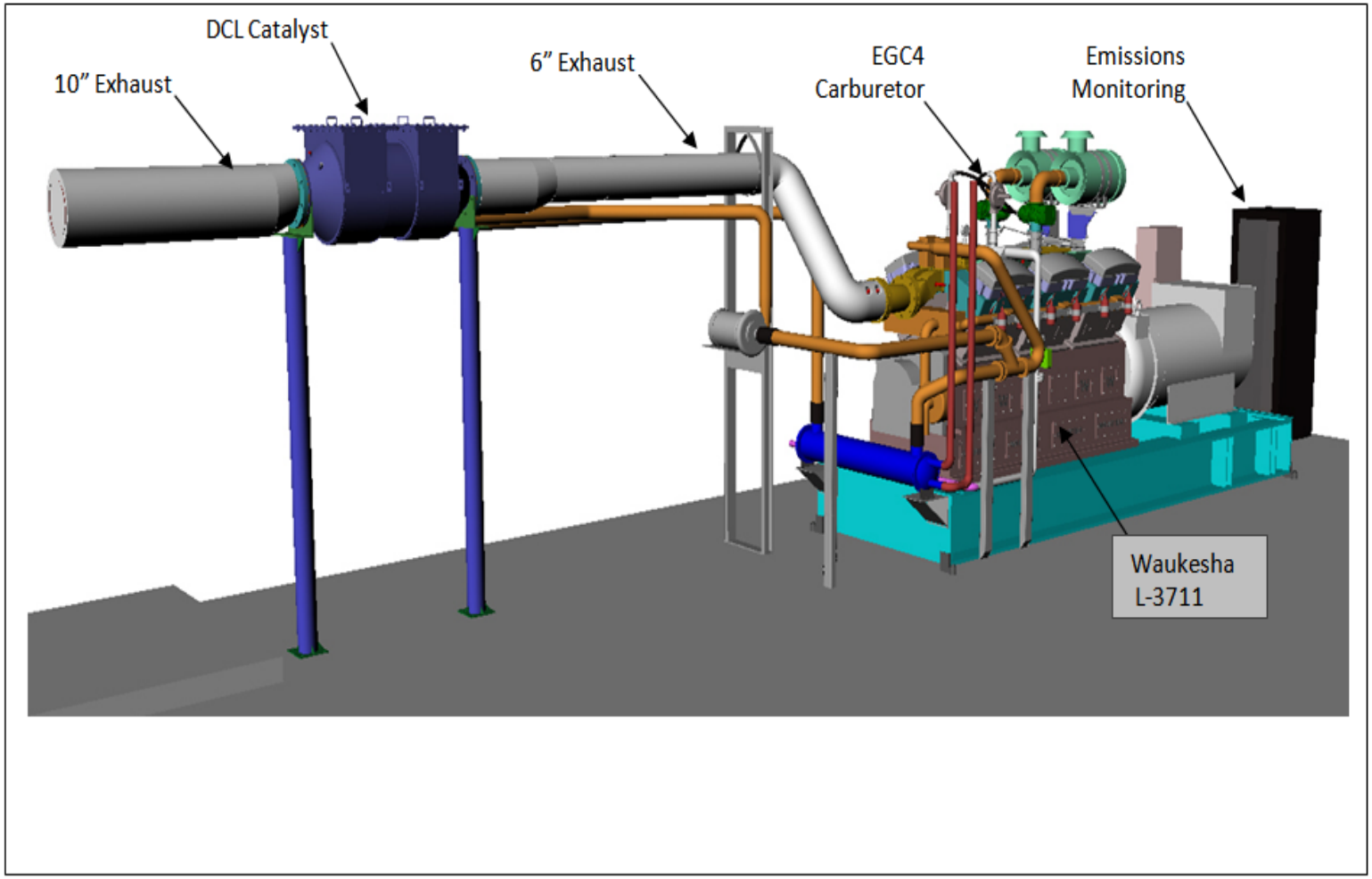
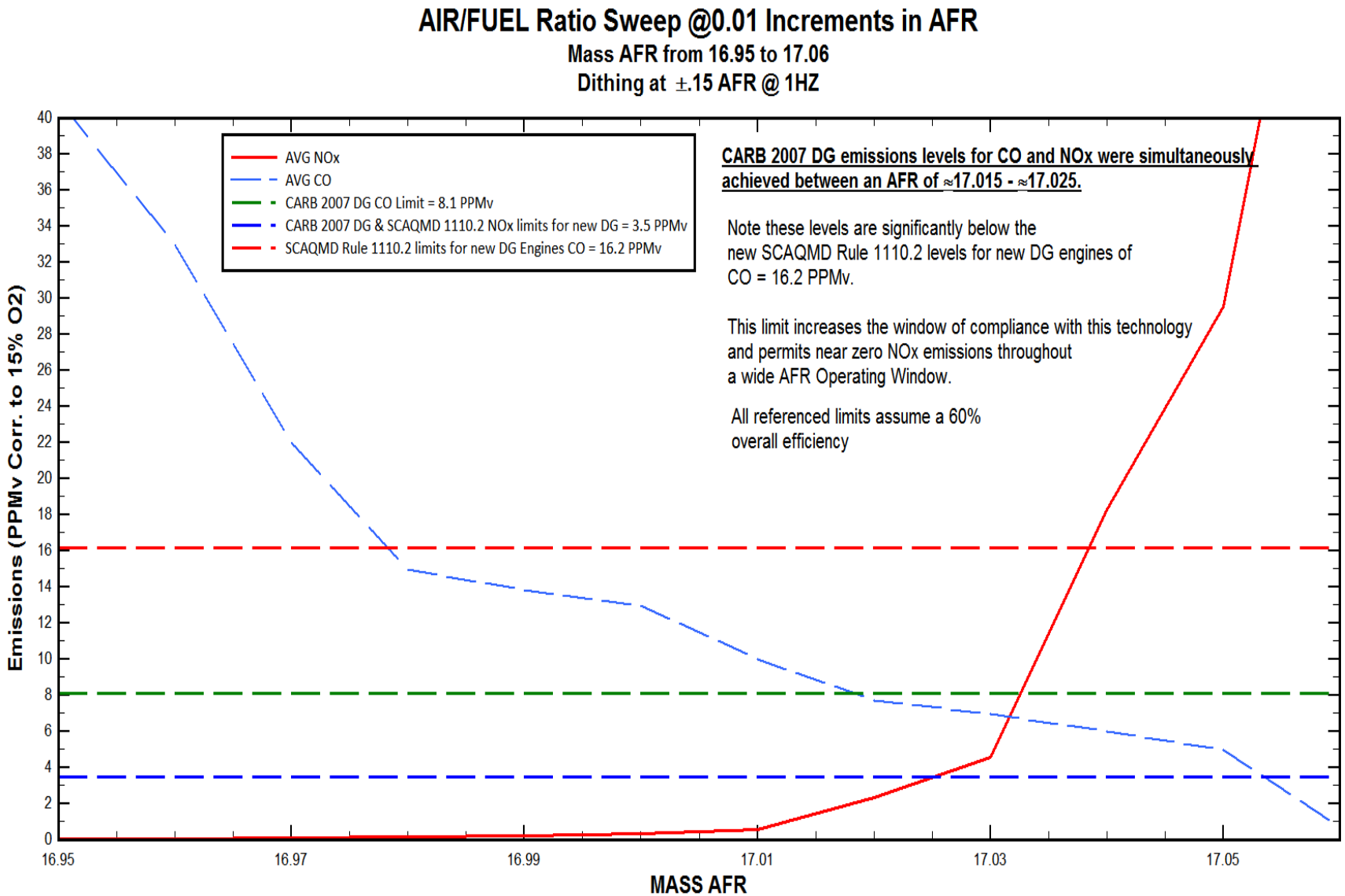
Rich-Burn Engine Test Site



Test Results of New Air/Fuel Ratio Control



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Rich-Burn Engine – 75 KW Tecogen

- Objectives
  - Establish Long-Term Viability
  - Continuous Compliance (no Excursions)
- Use of 3-way catalyst and better controls
- Results Thus Far Highly Positive
  - Simultaneously Achieving Low CO/NOx
  - Wide Control Window
  - No Apparent Side Reactions
    - Hydrocarbons and Ammonia

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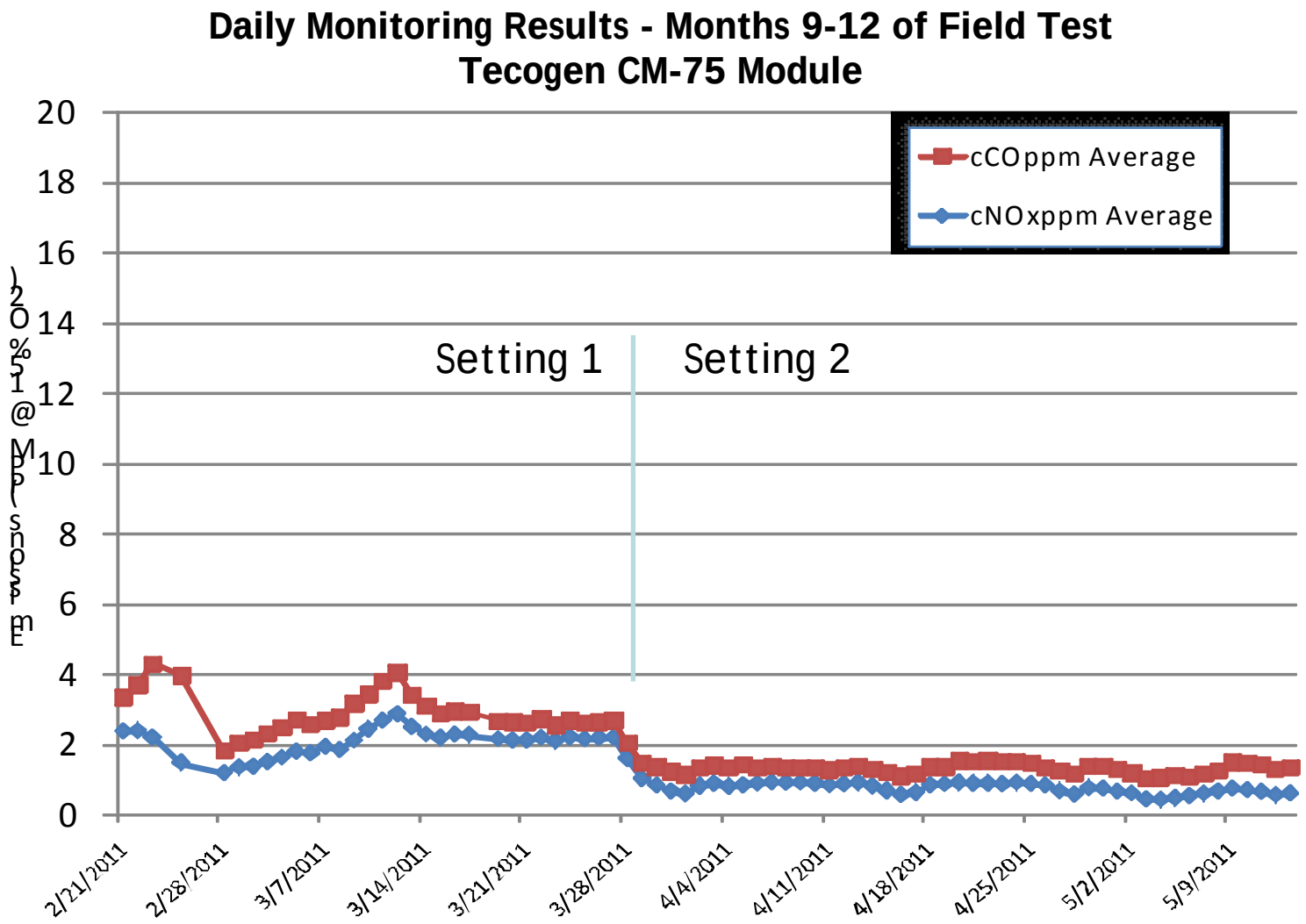
Rich-Burn Engine Results – Tecogen



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Lean Burn Engines

- Major OEM lean burn engine manufacturers are developing improved emission control technology based on selective catalytic reduction
- Several OEMs claim to be able to achieve SCAQMD DG emission levels including: MAN, Jenbacher, and Wärtsilä
- However, to date no lean burn engines have been installed / permitted in SCAQMD at more stringent emission levels

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Current SCG Fuel Cell activities

- SCG invested in Plug Power and ClearEdge Power
  - Demonstrating 5KW at SCG Energy Solutions Center
- Funding Plug Power advanced PEM demonstration
  - 6 units to be installed Q1/Q2 2011
- Funding 300 kW Fuel Cell Energy project at the Orange County Sanitation District.
- Funding National Fuel Cell Research Center (NFCRC) project to demonstrate a 300 kW FCE fuel cell coupled with a Yazaki chiller
  - Unit to be installed Q2 2011
- Funding Ceramic Fuel Cells demonstration
  - Unit has been installed at SCG Engineering Analysis Center

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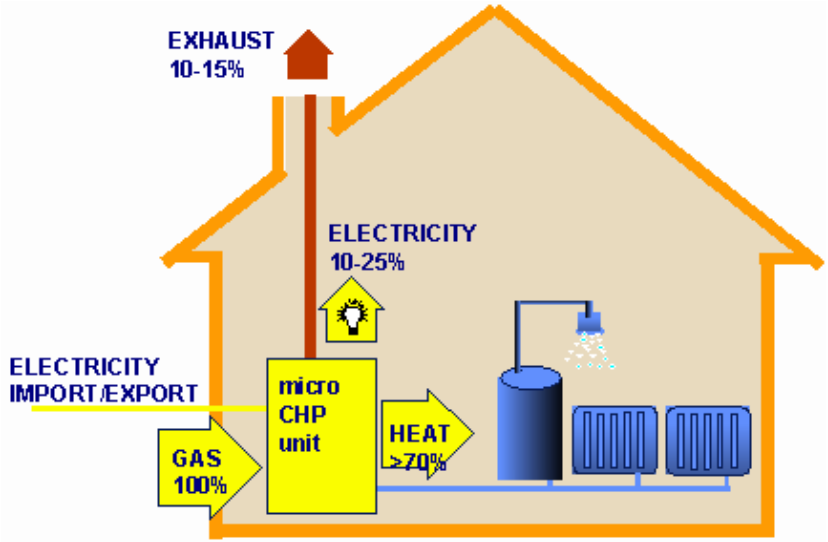
Micro CPH

- Definition:
  - Size less than 15KWe
  - Simultaneous production of heat and electricity in individual homes & small businesses
  - Replaces the gas central heating boiler and provides heat and hot water
  - Provides portion of electricity needs
- Most current Micro CHP systems are controlled by heat-demand and deliver electricity as by-product
- In CA most homes use forced air heating (not hydronic) and don't use too much domestic hot water
- Must have Net Metering to make these systems cost effective and achieve NZE targets



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Various MicroCHP Products

IC Engines	Stirling Engines	ORCs	Fuel Cells
EC Power	Baxi-Sener Tech	Cogen Microsystems	Acumentrics
Climate Energy (1.2 KWe – 3KWt)	Disenco (0.5-3 KWe – 12KWt)	Energetix (1 KWe)	Ceramic Fuel Cells Ltd (2 KWe – 3KWt)
Marathon Engine (4.5 KWe – 12KWt)	ENATEC micro-cogen		Ceres Power
VW - LichtBlick	Infinia		ClearEdge (5 KWe – 7KWt)
Yanmar	Whisper Tech (1 KWe – 7KWt)		Hexis
	Microgen Engine		Plug Power (5KWe – 8KWt)
			Vaillant

Available in the USA

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MicroCHP Challenges

- Many products are not commercially available in the US
- Existing product are too costly >$1,500/KW
  - Incentives can reduce cost premiums
- Ultra low emissions compliance in CA
- 1 – 2 kW best size for medium/large home market
- > 2 kW, market shrinks to XL homes, multi-family & light commercial
- Thermal CHP best suited as boiler enhancement in colder climates
  - A premium boiler that also produces some electricity (only) when there is a demand for hot water
- Electric CHP is residential option for warmer climates < 2 kW
  - Primary product is electricity but thermal use enhances economics and GHG reduction

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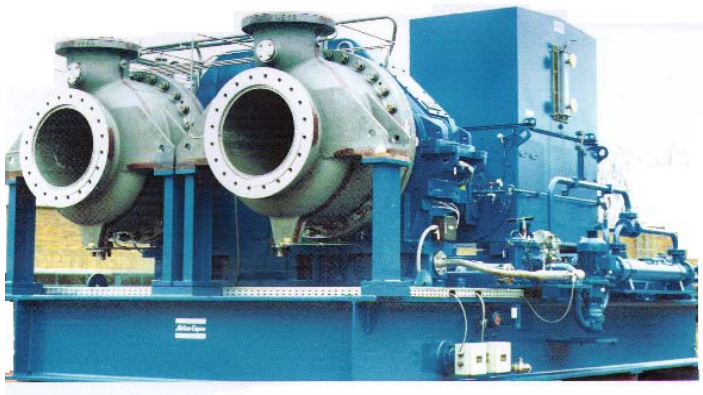
Waste Heat Recovery - WOWGen®

- Demonstrating WOWGen® technology to convert waste heat from Solar Mercury 50 to electrical power
  - Convert waste heat to power in the 300 °F to 900 °F temperature range efficiently
  - The cycle can operate as low as 200 °F when capturing heat from saturated steam or as high as 2000°F for high temperature gases
  - WOWGen® used a patented twin process loop recuperative-regenerative waste-to-power cycle.
  - Each loop utilizes a turbo-expander to convert energy from heat to mechanical power



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Future Needs

- Regulatory
- RD&D

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Policies to Enable Robust CHP Implementation

- Adopt a statewide CHP portfolio standard
- Recognize CHP as an efficiency measure
  - CHP should be explicitly included along with energy efficiency first in CA Loading Order
  - As currently practiced with efficiency, as well as most renewables and fuel cell, exempt CHP from departing load charges
  - Reward CHP GHG performance – GHG credits from CHP should be kept by facility for trading in California's cap and trade program
- Restore combustion technologies to the Self Generation Incentive Program
- Provide incentives to utilities to participate in CHP solution
- Payments for T&D and generation capacity value
- Shift weight in tariffs from fixed and demand charges to energy charges as is being done for renewables
- Institute Net Metering to take advantage of MicroCHP and meet NZE
- Promote acceptance and awareness of CHP technologies and benefits & reduce perception of CHP risk
- Demonstrate innovative technologies

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RD&D Needs

- CHP products that can meet CARB & SCAQMD emissions requirements
- Cost effective products (i.e., microturbine, MicroCHP and fuel cells)
- Micro CHP systems that are:
  - highly efficient (>40% electric),
  - Runs independent of electricity demands,
  - Provide hot water and space heating as needed,
  - If possible, provide space cooling
- Low-cost reliable absorption chillers, to broaden CHP applications potential into cooling markets
  - Combined Cooling Heating & Power (CCHP)
- Cost effective heat recovery technologies
- Hybrid & integrated with Renewable (Solar & Biofuels)

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Conclusion

- California needs robust implementation of CHP to realize energy and environmental policy objectives
- Remove barriers that continue to slow market progress of CHP
- Improve product performance and cost (learn from the PV industry)
- Incentives are vital, particularly for robust market adoption of smaller systems (< 5 MW), where the greatest remaining CHP potential resides
  - Until CHP is fully integrated into utility resource planning & procurement process
- Outlook for CHP is encouraging – but proactive CHP legislation and regulations that enables state energy policy is critical

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