Tecogen
Advanced Modular CHP Systems

SMALL CHP SYSTEMS FOR PUBLIC, NONPROFIT, & COMMERCIAL FACILITIES

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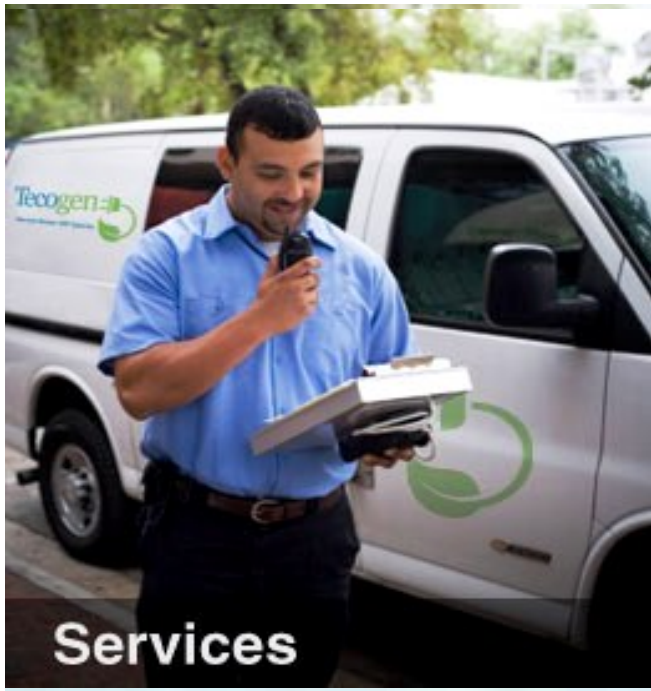
Company Background – TECOGEN Inc.

- Founded 1982, as division of Thermo Electron Corp., with headquarters in Waltham, MA
- A leading manufacturer, installer, & servicer of small gas engine-driven CHP systems, including cogen modules (60-100 kW) & chillers
- Thousands of systems in operation, some for 25+ years



Tecogen
Advanced Modular CHP Systems

Combined Heat & Power (<500 kW)

Definition: The simultaneous production of two useful outputs (electricity + heat) from a single fuel source

100.0%

Gas in

1,263,000 Btu/hr

27.0%

Electricity out

100 kW

55.4%

Thermal out

700,000 Btu/hr

TOTAL EFFICIENCY

> 82.4%
(HHV basis)

> 92.8%
(LHV basis)

<u>2-for-1</u>: "A generator that makes free hot water"

or

"A boiler that makes free electricity"

Sample Tecogen InVerde CHP system

6 INV-100's

Sample Tecogen CHP System

AT LOCAL BAY AREA SITE

Best Applications…

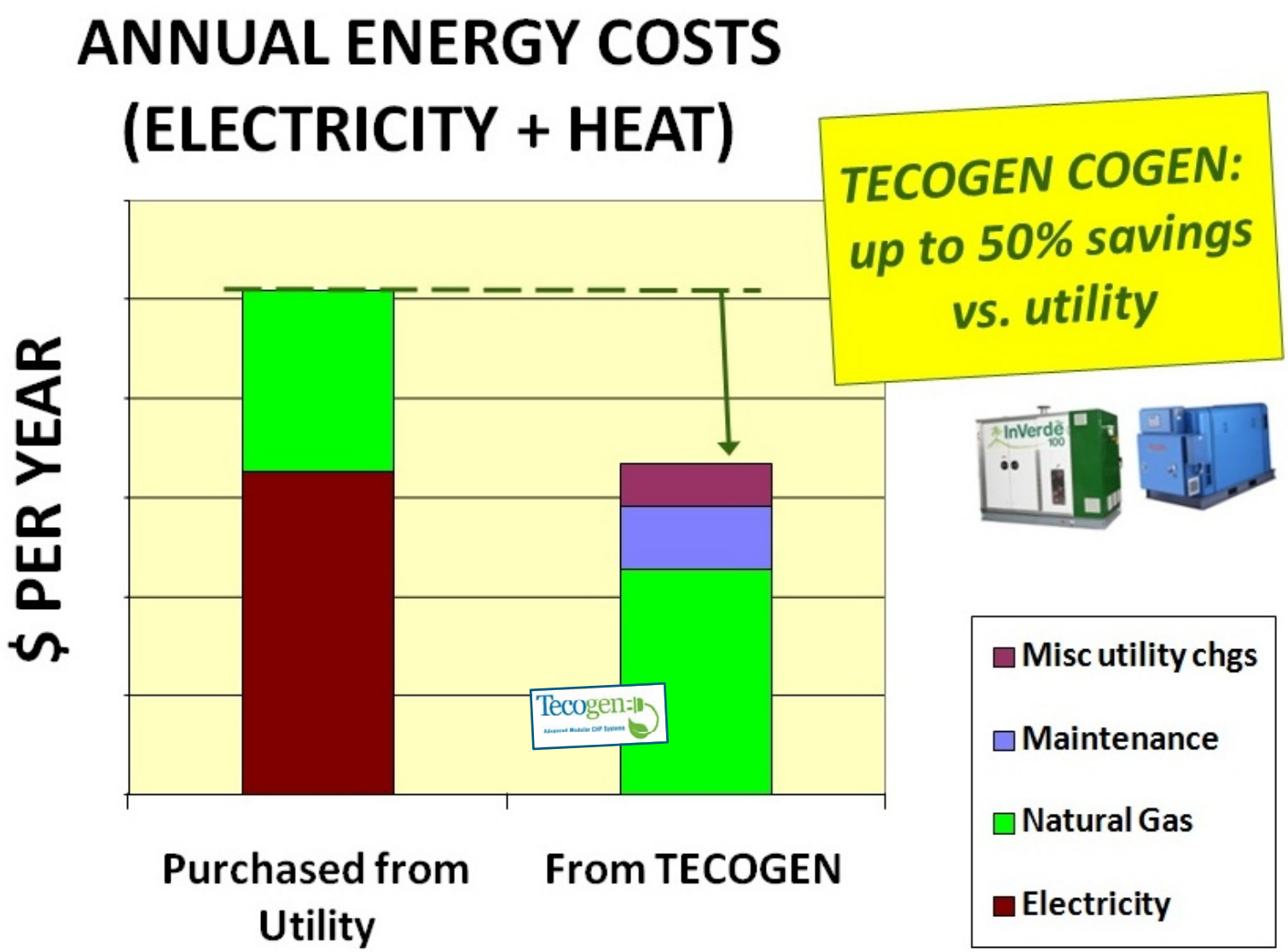
- Hospitals
- Schools
- Community Colleges
- Nursing Homes
- Retirement Residences
- Apartment Buildings/ Condos
- Athletic Clubs
- YMCA's
- Municipal Pools
- Jewish Community Centers
- Jails

Small-CHP Technology Breakthroughs

- Recent Small-CHP technical advances:
  - California Rule 21/ UL/ ETL/ NYSIR/ CE certifications *
  - InVerde CERTS Microgrid-compatible, inverter-based module *
  - Advanced engine *
  - Ultra-low emissions *

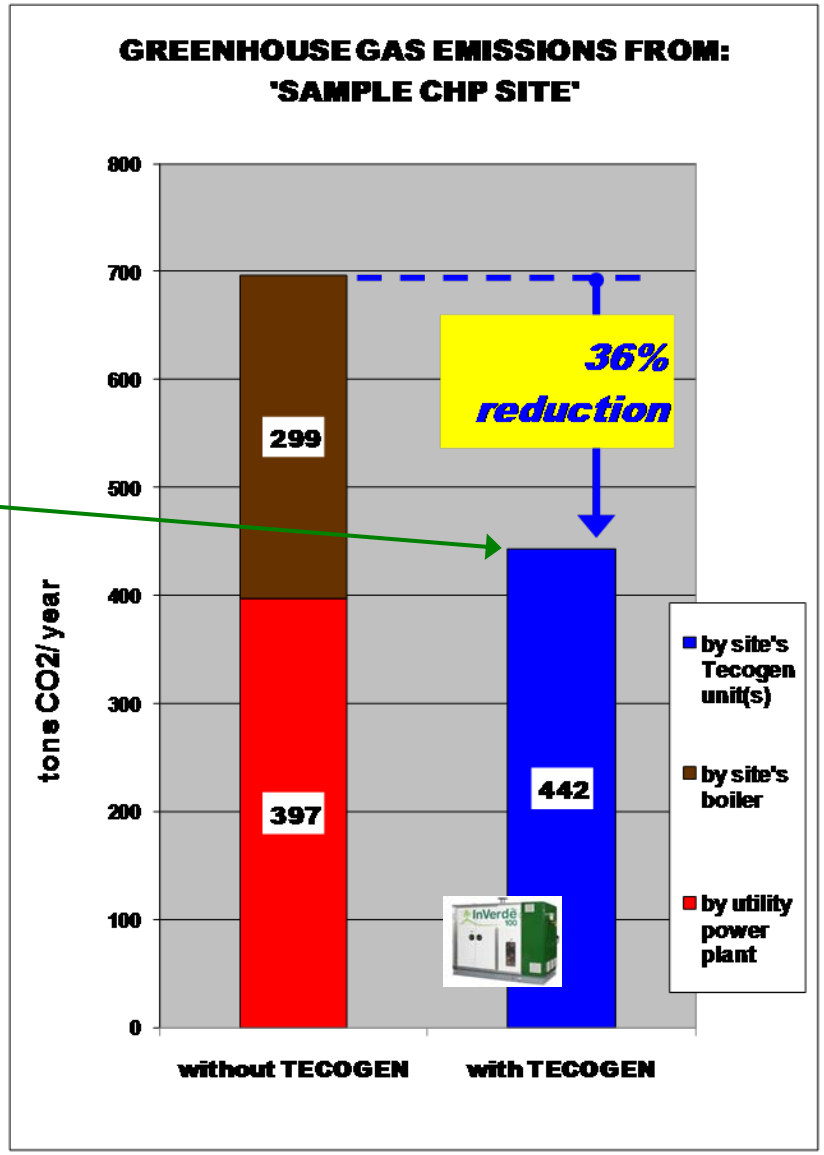
** All developed with CEC support*

Economic Benefits



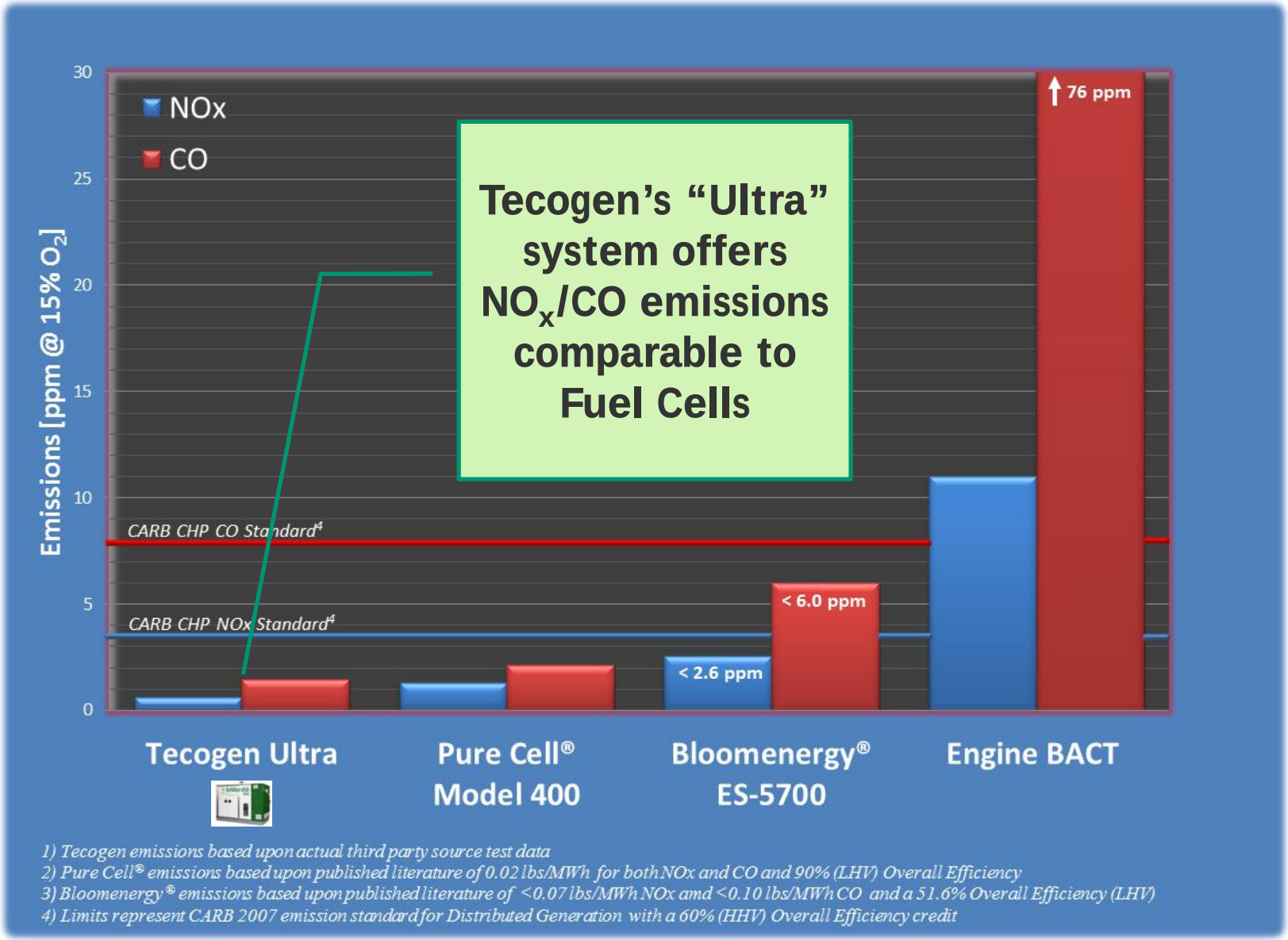
Environmental Benefits (GHG)

With TECOGEN, 254 fewer tons of CO2 are emitted each year, by 'SAMPLE CHP SITE'



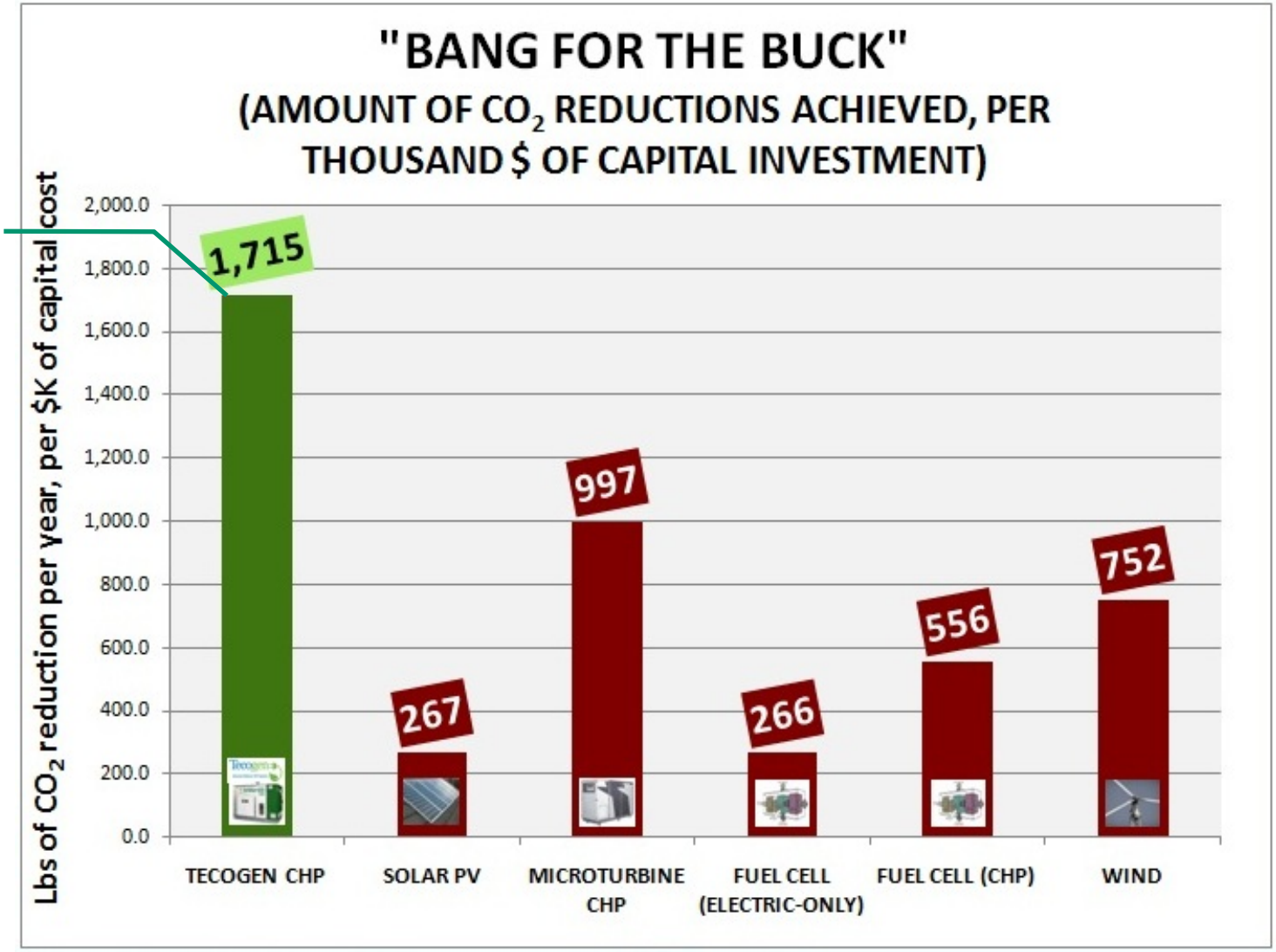
Assumes: 1 CM-75E

Environmental Benefits (NO_x/CO)



Cost-Effectiveness

Small "Microengine" CHP offers excellent "Bang for the Buck"



Q1: What Motivates Decision-Makers to Install CHP?

- **Economic benefits**
  - Payback (<4 years required)
  - Excellent use of waste heat & electricity onsite
- Power reliability/ quality
- *Perception* of:
  - Utility & governmental support
  - Consistency with state energy policies
  - Green benefits (e.g., reduce GHG & NOx emissions)
  - Be good citizen
- **Must be easy to implement**

Q2: Market/ Regulatory Barriers to Installing CHP

- Utility-related
  - **Excessive fees killing small-CHP economics:**
    - **departing load charges**
    - **standby charges**
    - **interconnection charges**
    - **SGIP metering & monitoring costs**

      Together, adding 2-3 years to payback, putting out of range of many users
  - Other tactics:
    - Complexity
    - Delays
    - CHP not eligible for Net Energy Metering (NEM)
    - No practical FIT contract yet for very small CHP systems (AB 1613)

Q2: Market/ Regulatory Barriers to Installing CHP

Complexity: Sample chart for determining applicability of various utility charges to different DG technologies

(about as simple as a third-world bus schedule!)

Please verify information as regulations frequently change and matrix may not be updated!!!!!!

IS THE TARIFF-RELATED COMPONENT BELOW APPLICABLE?

#		standby exemption PU Code 353 exemptions expire 6/1/2011	Physical Assurance (see note 12)	Initial supplemental and review fees (see note 18)	$0.00505/kwh - DWR Bond Charge (See note 17)	G-EG (gas for electric generation)	$.00370 G-SUR (gas - franchise fee surcharge)	(See note 1 for details) Power Charge Indifference Adjustment[1]	($0.000555/kWh) Ongoing CTC expires 2024 (See note 16)	($0.00472/kWh) - expires 2012 - Energy Cost Recovery Amount[2]	(Sec- $0.014 ; Prim - $0.01312) Public Purpose Program Charge[3]	($0.00066/kWh) Nuclear Decommissioning Charge[3]	References
1	(On-line < DWR entry into the market 2/1/2001 Pre-DWR DG[4]	Yes only if it meets PU Code 353	Yes	Yes	No D.03-04-030	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No	Yes, unless net metered or per PU Code 372 cogeneration[4]	No[1]	Yes, unless not metered	Yes, unless not metered	D.01-07-027 D. 03-04-030 PU Code 2827.9
2	(On-line < 1/1/2003 ; ap for authority to const. <8/29/01 online<2/1/03 -3,000MW CG cap not applicable Grand fathered Customer Generation DG[5]	Yes only if it meets PU Code 353	Yes	Yes	Yes D.03-04-030 effective 10/03	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No	Yes, unless net metered or per PU Code 372 cogeneration[4]	No[1]	Yes, unless not metered	Yes, unless not metered	D.01-07-027 D. 03-04-030 PU Code 2827.9
3	Net metered projects ≤ 1 MW Except BIO GAS DIGESTER Customer Generation(CG)	Yes - no sunset date for standby exemption	N/A	No except reprogramming fee	No	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No	Yes except for first 1MW only if not cogen - all exempt if cogen - PU Code 372 cogeneration[4,5,6]	No[1]	No7	No7	D.01-07-027 03-04-030 PU Code 2827.9
4	BIO GAS DIGESTER CG Net metered projects ≤ 1 MW	Yes - no sunset date for standby exemption	N/A	No except reprogramming fee	No	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No	Yes except for first 1MW only if not cogen - all exempt if cogen - PU Code 372 cogeneration[4,5,6]	No[1]	Yes PU Codes 381-383 and 385	Yes PU Code 379	D.01-07-027 03-04-030 PU Code 2827.9
5	Non - Net metered projects ≤ 1 MW	Yes - no sunset date for standby exemption	N/A	No except reprogramming fee	No	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No	Yes except for first 1MW only if not cogen - all exempt if cogen - PU Code 372 cogeneration[4,5,6]	No[1]	Yes	Yes	D.01-07-027 (ICE-T) 03-04-030 PU Code 2827.9;
6	Solar projects under 5 MW ELIGIBLE for net metering, SGIP or CEC incentives. (ultraclean)[6]	Yes (standby agreement required for fuel cell/bio projects see Notes #13 and 14) and installed < 12/31/08	Yes	No charge up to $5,000 app fee waived but reprogramming fee may apply	No for the first 1 MW only	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (PU Code 379.8 - 45% min elec eff. For G-EG portion of gas and/or state facility)	No	Yes except for first 1MW only if not cogen - all exempt if cogen - PU Code 372 cogeneration[4,5,6]	No[1]	Yes	Yes	D.01-07-027; PU Code 353; PU Code 2827 03-04-030 PU Code 379.8; PU Code 8341 AB 1110
7	Solar projects under 5 MW NOT ELIGIBLE for net metering, SGIP or CEC incentives (ultraclean)[6]	Yes if < 5 MW and installed < 12/31/08	Yes	No charge up to $5,000 app fee waived but reprogramming fee may apply	Yes	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No	Yes, unless cogen per PU Code 372 cogeneration[4,5]	No[1]	Yes	Yes	D.01-07-027; PU Code 353; PU Code 2827 03-04-030
8	Biogas digester/fuel/wind cell projects under 5 MW ELIGIBLE for net metering,- NEMBIO expired 12/31/08 (No DA for NEMFC) SGIP or CEC incentives (ultraclean)[6]	Yes (standby agreement required for fuel cell/bio projects see Notes #13 and 14) and installed < 12/31/08	Yes	Yes	No for the first 1 MW only	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (PU Code 379.8 - 45% min elec eff. For G-EG portion of gas and/or state facility)	No	Yes except for first 1MW only if not cogen - all exempt if cogen - PU Code 372 cogeneration[4,5,6]	No[1]	Yes	Yes	D.01-07-027; PU Code 353; PU Code 2827 03-04-030 PU Code 379.8; PU Code 8341 AB 1110
9	Biogas wind/digester/fuel cell projects under 5 MW NOT ELIGIBLE for net metering, SGIP or CEC incentives(ultraclean)[6]	Yes (standby agreement required for fuel cell/bio projects see Notes #13 and 14) and installed < 12/31/08	Yes	Yes	Yes	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No[7]	Yes, unless cogen per PU Code 372 cogeneration[4,5]	No[1]	Yes	Yes	D.01-07-027; PU Code 353; PU Code 2827 03-04-030 PU Code 379.8; PU Code 8341 AB 1110
10	Category 1[8] (Clean under 1 MW) most SMALL IC engines fall in here	Yes - must be installed < 12/31/08	Yes	Yes	No[7]	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No[7]	Yes except for first 1MW only if not cogen - all exempt if cogen - PU Code 372 cogeneration[4,5,6]	No[1]	Yes, unless net metered or G-EG then exempt for GPPP	Yes, unless not metered	D.01-07-027 03-04-030
11	Category 2[9] (Ultra-Clean, over 1 MW and also non-net metered)	Yes if less 5 MW and installed < 12/31/08	Yes	Yes	Yes	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No[7]	Yes, unless cogen per PU Code 372 cogeneration[4,5]	No[1]	Yes, unless G-EG then exempt for GPPP	Yes	D.01-07-027; PU Code 353; PU Code 2827 03-04-030
12	Category 3[10] (Other DG meeting BACT)	Yes if meets PU Code 353	Yes	Yes	Yes	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No[7]	Yes, unless cogen per PU Code 372 cogeneration[4,5]	No[1]	Yes, unless G-EG then exempt for GPPP	Yes	D.01-07-027 03-04-030
13	Continuous DA with CG - DA thru period 2/1/01 and 9/20/01	Yes if meets PU Code 353	Yes	Yes	No	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No[7]	Yes, unless cogen per PU Code 372 cogeneration[4,5]	No[1]	Yes, unless G-EG then exempt for GPPP	Yes	PU Codes 381 -383; 385 and 379; D. 04-02-062
14	DA switching to CG - a non continuous customer switching to CG	Yes if meets PU Code 353	Yes	Yes	Yes unless exempted from category above D. 05-02-051	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	Yes for past charges not for prospective charges as long as cap not met eff. 9/21/01	Yes, unless cogen per PU Code 372 cogeneration[4,5]	Yes for past charges not for prospective charges as long as cap not met eff. 9/21/01	Yes, unless G-EG then exempt for GPPP	Yes	PU Codes 381 -383; 385 and 379; D. 04-02-062; D.05-02-051
15	Continuous DA - customers that remained on DA both before and after 2/1/01 including CARE and medical DA	Yes if meets PU Code 353	Yes	Yes	No	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No[7]	Yes, unless cogen per PU Code 372 cogeneration[4,5]	Yes (D.04-02-062)	Yes, unless G-EG then exempt for GPPP	Yes	PU Codes 381 -383; 385 and 379; D. 04-02-062; D.02-11-022
16	DA taking bundled service on or before 2/1/2001	Yes if meets PU Code 353	Yes	Yes	No Resolution 3813	Yes (must meet PU Codes 216.6 and 379.8 or gas transmission customer)	Yes (except for G-EG portion of gas and/or state facility)	No Resolution 3813	Yes, unless cogen per PU Code 372 cogeneration[4,5]	Yes (D.04-02-062)	Yes, unless G-EG then exempt for GPPP	Yes	PU Codes 381 -383; 385 and 379; D. 04-02-062; D.02-11-022; Resol. 3813
17	Diesel/Non-BACT DG[11]	No	Yes	Yes	Yes	n/a	n/a	n/a	n/a	Yes	Yes	Yes	D.01-07-027 03-04-030

Notes:
1. On July 1, 2006 the Power Charge Indifference Adjustment replaced the DWR Power Charge. PCIA established by Water Code Section 80110 PU Code 454.5 (above market costs for and new renewable energy resources) - Ranges from $0.00635 pre-2009 vintage DA to $0.0144/kWh 2010/2011 vintage DA.
2. On March 1, 2005, the Energy Cost Recovery Amount (adopted in D.04-11-015) replaced the Regulatory Asset Charge (adopted in D.03-12-035). Also codified in PU Code 841.1 ECRA and PCIA exemptions are identical. D. 04-02-062 reaffirmed CG and DA cost responsibility
3. The Public Purpose Program and Nuclear Decommissioning charges were established through PU Codes 381 and 379 respectively - ND shall be recovered as a NBC for biogas CG.
4. DG unit on-line before DWR's entry into the market (February 1, 2001, per AB 117).
4. To be considered "cogeneration" a DG unit must meet the efficiency standards in P.U. Code Sec. 216.6, and the service must be consistent with Sec. 216.6 as it existed on 12/20/95
5. Either: (a) on-line on or before January 1, 2003; or (b) permitted before August 29, 2001 and on-line on or before January 1, 2004.
6. Must be eligible for NEMBIO or NEMFC, i.e. must meet the requirements of P.U. Code Section 2827.9 (biogas digester) or P.U. Code 2827.10 (fuel cell).
7. Subject to the limitations of a statewide cap.
8. Under 1 MW and either: (a) net metered; or (b) eligible for financial incentives from PG&E's Self Generation Incentive Program or California Solar Initiative Program; or (c) eligible for financial incentives from the California Energy Commission.
9. 1 MW or above and "ultra-clean and low-emission" (defined by P.U. Code Sec. 353.2) Note - **No new applications after 12/31/08 under PU Code 353.2. - until CPUC extends deadline.**
10. DG not in Category 1 or 2, but meeting best available control technology standards (BACT).
11. Diesel or other DG units not meeting BACT standards set by local air quality management districts and/or the California Air Resources Board. Operating the DG unit during periods when the grid is unable to deliver power is not considered departed load. PG&E has requested clarification whether on-site generation operated in conjunction with a dispatchable load management program is considered departing load.
12. Physical assurance provides customers the ability to escape standby charges by installing a physical means which ensures that when the DG fails, the load served by the DG is instantaneously and automatically dropped from the grid.
13. P.U. Code 2827.9, section (e)(2)(A) for Biogas customer-generators states, "In the extent that charges for transmission and distribution services are recovered through demand charges in any particular month, no standby reservation charges shall apply in that monthly billing cycle."
14. PU Code 2827.10 - P.U. Code 2827.10, section (e) for Fuel Cell customer-generators states, "The net metering calculation shall be carried out in accordance with Section 2827.9."
15. PU Code 379.8 allows fuel cells meeting certain efficiency and emissions requirements to qualify for discounted G-EG gas transportation service (minimum electrical efficiency is 45%)
16. PU Code 372 (effective 12/20/95) - CTC Cogeneration exemption through special filing. PU Code 373 - Utilities may apply to the CPUC to allow additional exemptions for a particular class of customers or a particular consumption. D.02-11-022 reaffirms DA Customers' responsibility to pay CTC
17. DWR bond charge established through Water Code Section 80110 and D. 03-04-030 ; Pre-DWR CG departed load exempt; and Resolution E-3813. DA customers that remained on DA and did not take bundled service on or after 2/1/01 are exempt.

Q2: Market/ Regulatory Barriers to Installing CHP

- Government (Legislature/ CPUC/ CEC)
  - CEC inverter certification process no longer available for CHP
    - Bureaucratic Catch 22
    - Something the CEC can fix today

Q2: Market/ Regulatory Barriers to Installing CHP

Unequal CPUC treatment for various DG technologies:

CPUC Regulation:	Renewables (Solar PV, Wind, Hydro)	Onsite Biogas-Fired Fuel Cells	Onsite Biogas-Fired Turbines, or IC Engines	Natural Gas-Fired Fuel Cells (including "electric-only" fuel cells, and "directed" biogas fuel cells, which actually burr natural gas)	Ultra-Efficient, Clean Natural Gas-Fired CHP (Microengines, Microturbines, & Large Engines/ Turbines, all with Full Heat Recovery)	Other Energy Efficiency (causing identical kW/ kWh reductions; lighting, etc)
Exempt from having to pay **stand-by charges**	YES	YES	YES	YES	NO	YES
Exempt from having to pay all **"departing load" charges (aka "exit fees")**	YES	YES	YES	YES	NO	YES
Eligible for **"Net Energy Metering (NEM)"**	YES	YES	YES	YES	NO	(n/a)
Eligible for a practical **Feed In Tariff (FIT)**	YES	YES	YES	YES	NO	(n/a)
Utility **interconnection application & study fees** waived	YES	YES	YES	YES	NO	YES
"Net Generation Output Meter" requirement waived	YES	YES	YES	YES	NO	YES
Eligible to receive utility **incentives**	YES	YES	YES	YES	YES (but much lower incentive level)	YES

Q2: Market/ Regulatory Barriers to Installing CHP

Regulations are giving improper market signals:

		DG Technology 1	DG Technology 2
Characteristics			
	System size (kW)	100	100
	Fuel input	Natural gas	Natural gas
	NOx emissions	ultra low	ultra low
	Overall energy efficiency (HHV)	~49%	85%
	% GHG emissions reductions	0-10%	25-35%
	Module cost	$700,000	$130,000
Regulatory Treatment			
	SGIP incentive ($/kW)	$2,250	***$500***
	Federal tax credit	30%	***0-10%***
	Eligible for NEM	Yes	***No***
	Exempt from departing load charges	Yes	***No***
	Exempt from standby charge	Yes	***No***
	Practical FIT available	Yes	***No***
		oversubsidized	*undersubsidized*

Q2: Market/ Regulatory Barriers to Installing CHP

- Government (Legislature/CPUC/CEC)
  - Unlevel playing field has been created
    - Arbitrary and prescriptive biases for certain DG technologies has become the norm
    - "Picking winners" not working
    - "Special interest"-driven prescriptive approach conflicts with rational energy policy-making
      - Instead: Who has the best lobbyist?
      - Focus on regulators, rather than facilities and efficiency engineering

Q2: Market/ Regulatory Barriers to Installing CHP

- Government (Legislature/CPUC/CEC)
  - Yields a lower benefit ("bang for the buck"), in terms of the GHG reductions and project economics achieved.
    - Causes inefficient deployment of taxpayer & ratepayer resources.
    - Creates market distortions, confusion, unfairness
    - Excessively complex rules deter end-users from adopting CHP technology.

Q3: How can state support active CHP development?

- **Recommendations:**
  - Phase out **non-bypassable departing load charges**
  - Phase out **standby charges** (esp. if already paying demand charge on same kW)
  - Extend **Net Energy Metering (NEM)** to CHP
  - Extend **SGIP** (also make it simpler and more sensible)
  - Restore a simpler and more **level playing field** for all technologies.
    - More uniform regulatory treatment.
    - Legislators and regulators should resist the temptation to "pick winners" among various technologies. Let technologies' inherent characteristics, efficiencies, and advantages play out instead.
    - Yields best "bang for the buck" for customers, ratepayers, GHG.