Industrial Technologies Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Industrial Utility Webinars:

Combined Heat and Power (CHP) Case Studies

June 9, 2010

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Speakers

- **R. Neal Elliott**, PhD, PE, Associate Director for Research, American Council for an Energy Efficient Economy (ACEEE)
- **Edward B. Kear III,** Senior Project Manager for the Combined Heat and Power Demonstration Program, New York State Energy Research and Development Authority (NYSERDA)
- **Brian O'Donnell,** Professional Engineer, Southwest Gas Corporation

Areas Covered in this Webinar

- Combined Heat and Power (CHP) implementation trends
- How state and utility programs are helping industrial customers implement CHP
- CHP Case Studies

Sponsors

- DOE Industrial Technologies Program
- American Public Power Association (APPA)
- APPA, Demonstration of Energy-Efficient Developments
- Western Area Power Administration (WAPA)

Questions?

Email: mdunkle@bcs-hq.com

Presentations: http://www1.eere.energy.gov/industry/utilities/tools_and_resources.html

Status of CHP: Market Barriers and the Relationship to Utilities

R. Neal Elliott, PhD, P.E.

Associate Director for Research

American Council for an Energy-Efficient Economy

Washington, DC

www.aceee.org

ACEEE 30 Years of Energizing Efficiency

The American Council for an Energy-Efficient Economy (ACEEE)

Nonprofit 501(c)(3) dedicated to advancing energy efficiency through research, communications, and conferences.

35+ staff in Washington DC, + field offices in DE, MI, WA and WI.

Focus on End-Use Efficiency in Industry, Buildings, Utilities, and Transportation; Economic Analysis & Human Behavior; and State & National Policy

Funding:

- Foundations (34%)
- Federal & State Grants (7%)
- Specific Contract work (21%)
- Conferences and Publications (34%)
- Contributions and Other (4%)

History of CHP:

Edison Pearl Street Station

PURPA

EPAct 1992

CHP Challenge

EPAct 2005

EISA 2007

Bailout Bill (2008) with Investment Tax Credit

Where Has Policy Brought Us Today:

CHP about 85 GW (compared to about 46 GW in 1996)

About 10% of US electric generation

Potential is huge—240 GW by 2030

Four Key Barriers to Expanded Installation of CHP:

- Uncertainty related to technical and procedural interconnection to utility
- Unfavorable utility tariffs related to supplemental, standby and backup power
- Uncertainty associated with air quality permitting
- Uncertainty of project's economics

Size Does Matter:

Smaller systems more affected by state utility regulations/incentives

Permitting costs more a barrier to small systems

Smaller system can benefit from net metering—if available

Larger systems more affected by air regulations—New Source Review (NSR)

Larger systems can by-pass state utility barriers using PURPA Sec. 210

State CHP Policies:

ACEEE State Policy Scorecard

& CHP Scorecard

http://aceee.org/pubs/e097.htm

http://aceee.org/energy/state/index.htm

2010 Edition Available in Fall together with dedicated CHP Scorecard

Different CHP Business Models

Two general models:

- PURPA QF-Wholesale model
- Displaced retail electricity model

Uncertainty is generally the key barrier to the implementation of CHP projects

Electric Utility Perspectives on CHP:

Utility Goal reliable and affordable electricity

Generally neutral to negative, unless CHP owned by utility

CHP represents a loss of revenue to the utility and can result in deferral of investment

May be motivated by EERS or RPS targets that include CHP as qualifying

Decoupling is Not Enough:

While decoupling makes utilities indifferent to changes in sales, does not provide an incentive

Need some incentive structure that rewards utility shareholders:

Lost revenue & cost recovery

Higher rate of return for investments

EERS or RPS targets with incentives upon meeting or exceeding targets

CHP Resource Targets

Fuel Choice Matters:

- Uncertainty in natural gas prices discourages CHP—inability to lock in long-term price
- Inverted “spark-spread” with gas
- Opportunity for use of opportunity fuels—waste fuels, landfill gas, digester gas
- Renewables make a sound choice—potential for Green Tags and better price stability

Future of CHP:

ITC will be available through 2016

CHP increasingly included in EERS and RPS at the state level—under consideration at the Federal level

Potential for inclusion in Climate Legislation

ACEEE 30
30 Years of Energizing Efficiency

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NYSERDA
New York State Energy Research and Development Authority

NYSERDA CHP Programs

June 9, 2010

Presented By: Edward Kear P.E.

NYSERDA
New York State Energy Research and Development Authority

Evolving Programs for an Evolving Market

Think back 10 years:

Most “Cogen” systems were large >> 5 MW
About 210 sites in New York State
5,000 MW installed (25 MW average)

Utilities were still trying to figure out how to make money in a deregulated environment, and were apprehensive about “small” on-site generation.

No standardized stand-by tariff structure or interconnect requirements.

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Evolving Programs for an Evolving Market

Offered 1st program in 2000.

- $2,000,000 total
- Up to $400,000, or 50% of cost per site
- Received about 15 proposals, selected 8, 6 were built about 4 still running.

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Evolving Programs for an Evolving Market

In 2001 we expanded the program:

- $15 million, up to $1 million per site.

Got a lot of interest, but we started noticing problems:

- Almost everyone in Niagara Mohawk territory wanted to cut the wires

- Interconnection issues became common place

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Evolving Programs for an Evolving Market

•Early programs had very few requirements. CHP systems had to be "appropriately sized"

• 2003 Started "encouraging" CHP to stay connected to the grid, a 60% efficiency and "clean operation"

• 2004 Required 60% efficiency and asked for 15 minute operational data – Started encouraging backup power operation

• 2006 Added "mature" CHP technology to what's now Existing Facilities Program - performance based incentives

• 2007 Introduced performance programs for ADG and Fuel Cell

• 2007 Started requiring "grid independent operation during grid outage", sites must stay grid connected, $2M/site max

• 2008 Introduced the multi-site "Fleet Demonstration Program", started encouraging "prepackaged systems"

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Evolving Programs for an Evolving Market

We also saw a need for information

•Funded over 30 technology transfer studies

•Helped develop a national standard for measuring CHP system performance

•Made CHP system performance data publicly available at **http://chp.nyserda.org**

And a need for new technology

•Energy Efficient Power Systems Program

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Where are we now?

We have – the good things:

•Rational and consistent stand-by tariffs

•Standardized interconnect requirements and procedures, at least at the smaller sizes

•Utilities and local governments are becoming comfortable with CHP

•There are a number of experienced developers active in the market

•New technologies are becoming more attractive

•There are a number of solutions that provide back-up power

•Pre-engineered, prepackaged systems are starting to become available

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Where are we now?

BUT….

2002 study showed:

• "Technical Potential" of 8,500 MW of new CHP at 26,000 sites (mostly < 5MW each)
• Predicted 764 MW of CHP by 2012 for the "base case" and
• 2,200 MW for the "accelerated case"

How are we doing?

•NYSERDA has 200 MW under contract with about 100 MW installed

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Where are we now?

The Challenges:

•Most CHP installations are one-of-a-kind resulting in high fixed costs

•O&M services are not widely available

•CHP is still an early adopter market

•Most of the systems available today have not been around very long

•With today's energy market it's hard to estimate the ROI

•"I'm not in the business of making power"

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What's the future?

We need small CHP systems to move towards "catalog" items

•Pre-engineered, prepackaged systems
-Reduces engineering, assembly and sourcing costs

We need lots of installed systems

•Lots of identical systems serving similar loads in similar buildings (fleets)
- Reduces site-specific engineering, permitting, installation and maintenance costs

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Current Programs

New Product Development
-Environmentally Preferred Power System Technology (SBC)

Feasibility Studies
-Technical Assistance (SBC, EEPS)

Demonstration Program
-DG as CHP (SBC)

Performance Programs
-Existing Facilities (SBC)
-ADG to Electricity (RPS)
-Fuel Cell (RPS)

1 866 NYSERDA (1 866 697-3732)

NYSERDA CHP Programs

DG/CHP Program

- Competitive selection
- Up to $2M ($4M multi-site)
- 30-50% of project cost
- Project cost includes thermal systems
- Award based on total project cost
- All fuels (except ADG)
- All technologies (except some FC)
- No size limits
- 4 year data reporting
- Best-effort milestone payments

Existing Facilities Program

- First come – first served
- Up to $2M
- Up to 50% of project cost
- Project cost does not include thermal systems
- Incentive based on peak reduction and electric generation
- Natural Gas only
- ICE and large gas turbines only
- Systems >= 250 kW only
- 2 year reporting
- Performance based payments

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Thoughts on the future

CHP systems are proving themselves to be safe, reliable and beneficial, but …

CHP is still in the early adopter phase and still needs support

We will continue to push for pre-engineered, prepackaged, “system-in-a-box”

The Demonstration program will focusing more and more on fleets

More technology will be moving into the Existing Facilities Program

There may be a micro-CHP program

http://chp.nyserda.org

NEW YORK STATE




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DG/CHP Integrated Data System

Home | Facilities | Reports | Links | Help | Login

Welcome to the NYSERDA web-based DG/CHP data system. This system includes monitored performance data and operational statistics for NYSERDA's Distributed Generation (DG)/Combined Heat and Power (CHP) demonstration projects.

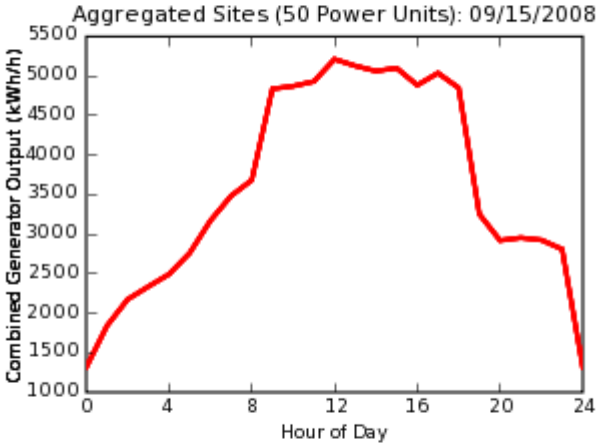
The integrated database includes the following:

- Monitored Hourly Performance Data
- Operational Reliability and Availability Data
- Characteristics of Each Facility and its Equipment

DG/CHP systems offer the potential to reduce operating costs for end users as well as to improve reliability of the electric distribution and transmission system. NYSERDA's objective is to accelerate the deployment of these technologies in the market to create benefits for the state of New York. To accelerate market acceptance, NYSERDA is supporting efforts to demonstrated DG/CHP systems that show the economic, technical, and environmental benefits of these systems in a variety of commercial, institutional, and industrial applications. This database provides access to the measured performance and reliability data collected on NYSERDA's demonstration sites.

The Monitored Hourly Performance Data portion of the database allows users to view, plot, analyze, and compare performance data from one or several different DG/CHP sites in the NYSERDA portfolio. It allows DG/CHP operators at NYSERDA sites to enter and update information about their system. The

Monitored Power Generation Yesterday



Information Currently in the Database

Facilities:	98
Power Units:	271
Power Units With Monitored Data:	102

Results from Monitoring Yesterday

Power Units Monitored:	50
Energy Generated:	88043.0 kWh
Peak Power Generated:	5440.5 kW

Click Here for a complete summary

Information as of 09/16/2008 at 9:28 AM

NEW YORK STATE

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DG/CHP Integrated Data System

Home | Facilities | Reports | Links | Help | Login

The facilities shown below are currently in the database. Click on a column heading to re-sort by that column. Click on a facility name to view details about that facility. **Click Here** to see a map showing all of the facilities.

Filter the listing: Show All Apply Filter

Facility	Category	Developer	Primary Fuel	Units	Installed Capacity	Commission	Monitoring
10 West 66th Street Corp. New York, NY	Multi-Family Residence	DSM Engineering	Natural Gas	1	70 kW	07/01/2004	11/17/2005 - current
230 Park Avenue New York, NY	Office Building	Office Power	Natural Gas	16	960 kW		-
26th Ward Water Pollution Control Plant Brooklyn, NY	Wastewater Treatment	New York Power Authority	Digester Gas	2	400 kW	07/31/2003	-
4C Foods Brooklyn, NY	Food Processing	Energy Concepts	Natural Gas	3	450 kW	06/24/2004	05/22/2005 - current
A.A. Dairy Candor, NY	Dairy Farm	RCM Digesters	Digester Gas	1	130 kW	02/01/2000	04/25/2005 - current
Allenwaite Farms Schaghticoke, NY	Dairy Farm		Digester Gas	1	140 kW		-

NEW YORK STATE

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DG/CHP Integrated Data System

Return to Facility Listing

Grenadier Realty - AAF Sea Rise 1

3405 Neptune Ave
Brooklyn, NY 11224
Map It

DG/CHP Developed by DSM Engineering

Category: Multi-Family Residence
SIC: 65 - Real Estate
ISO Zone: J - New York City
Electric Utility: Consolidated Edison
Gas Utility: KeySpan East
Primary Fuel: Natural Gas
Number of Power Units: 2
Total Installed Capacity: 120 kW

Unit	Installation	Fuel	Prime Mover	Heat Recovery	Use	Technology Group	Installed Capacity (kW)
1	04/02/2004	Natural Gas	Reciprocating Engine	Hot Water	Domestic Hot Water	100-800 Reciprocating Engine (Lean Burn)	60
2	04/02/2004	Natural Gas	Reciprocating Engine	Hot Water	Domestic Hot Water	100-800 Reciprocating Engine (Lean Burn)	60

Facility Details
- Show Complete Details
- Sea Rise 1&2 CHP Site Fact Sheet

Facility Documentation
- Grenadier Realty 3405 Neptune NYSERDA CHP Details
- Sea Rise Online Database Notes

Project Webpages

Online Monitored Data Reports
- Monitored Data - Plots and Graphs
- Monitored Data - Download (CSV file)
- Utility Rate Calculation
- Monitored Data Quality

Standardized Monitored Data Reports
- Generator, Facility, and Meter Power
- Generator Status, Gas Use, and Heat Recovery

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DG/CHP Integrated Data System

Facilities Included:
Grenadier Realty - AAF Sea Rise 1 - Brooklyn, NY

Select the details for the report.

Starting Date: 08/2006

Ending Date: 09/2008

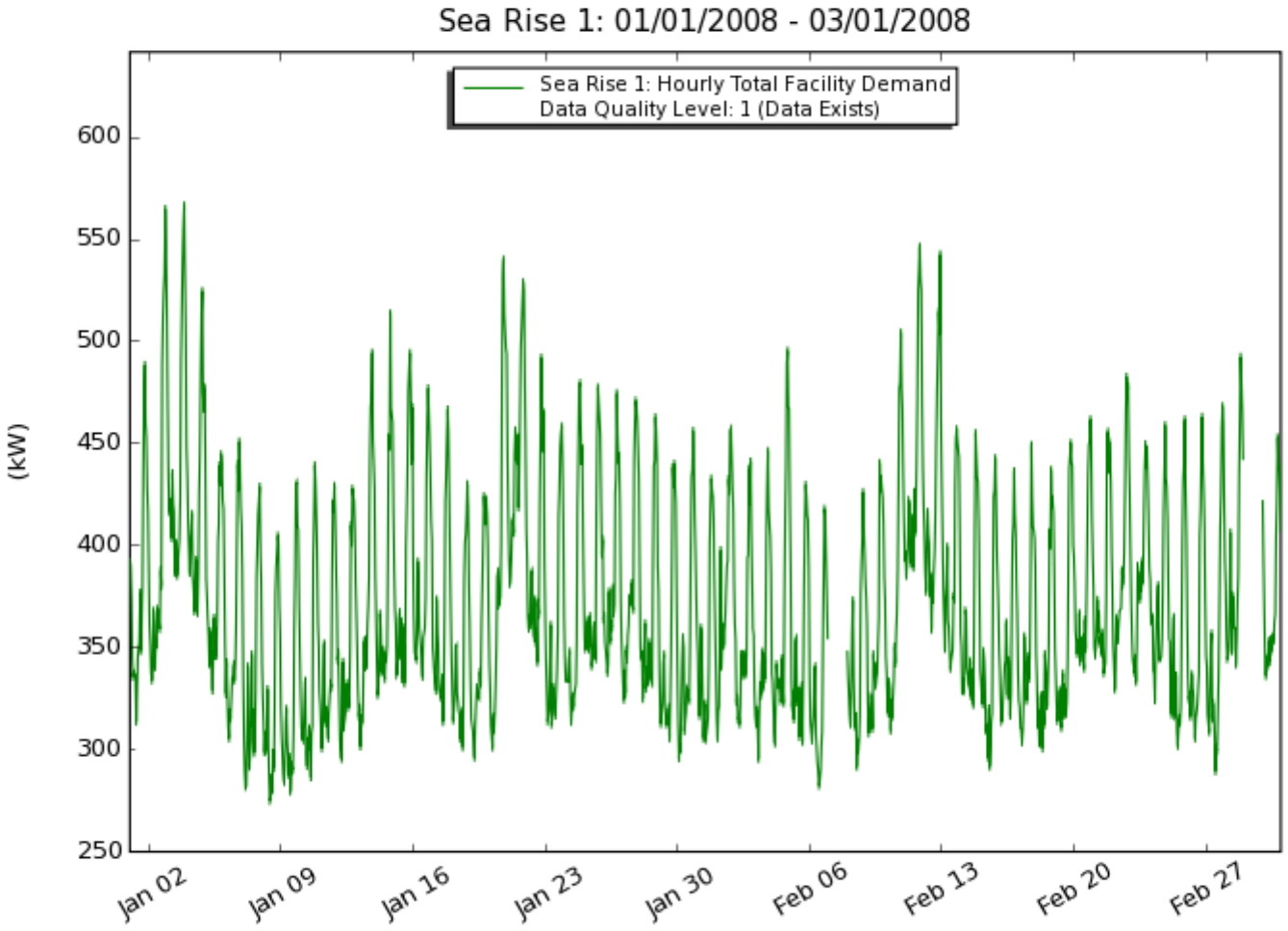
Data Channel: Total Facility Demand (kW)

Plot Type:

- DG/CHP Generator Output (kWh)
- DG/CHP Generator Output Demand (kW)
- DG/CHP Generator Gas Input (cf)
- Total Facility Purchased Energy (kWh)
- Total Facility Purchased Demand (kW)
- Other Facility Gas Use (cf)
- Total Facility Energy (kWh)
- Total Facility Demand (kW)
- Useful Heat Recovery (MBtu)
- Unused Heat Recovery (MBtu)
- Status/Runtime of DG/CHP Generator (h)
- Ambient Temperature (degrees F)
- Total CHP Efficiency (%)
- Electrical Efficiency (%)
- Two Points: Generator and Facility Energy (kWh)
- Two Points: Generator and Facility Demand (kW)

Facilities Included: Grenadier Realty - AAF Sea Rise 1 - Brooklyn, NY

Download CSV Data



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Case Studies

New York Presbyterian Hospital

17,000 employees
5 Hospital Centers
- 33 buildings
- 8.6 MM square feet

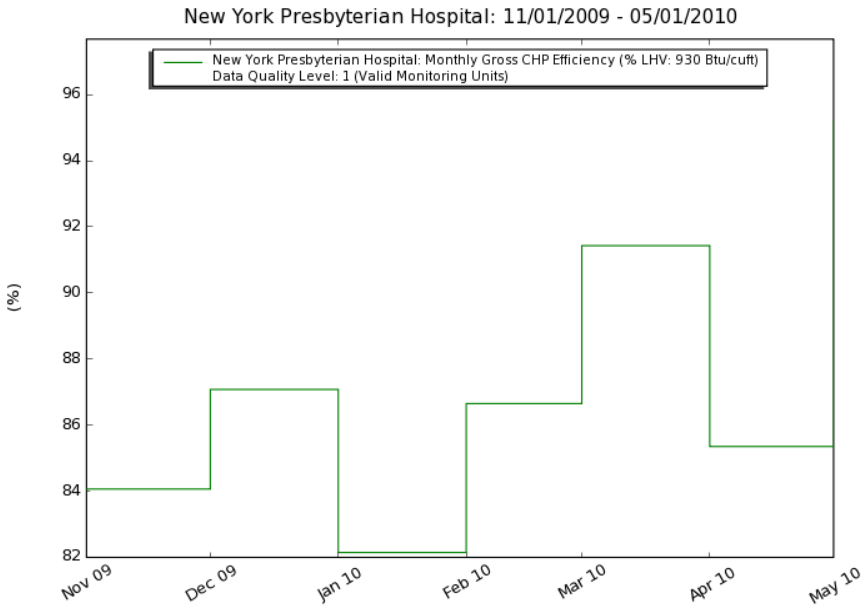
NYPH proposed

7.5 MW gas turbine

Heat Recovery Steam Generator

7.5 MW CHP System

- 50,000 MWhr/yr (75%)
- 600,000 MMBTU/yr (50%)
- 85% fuel energy utilization
- Reduce energy costs by $4M/yr

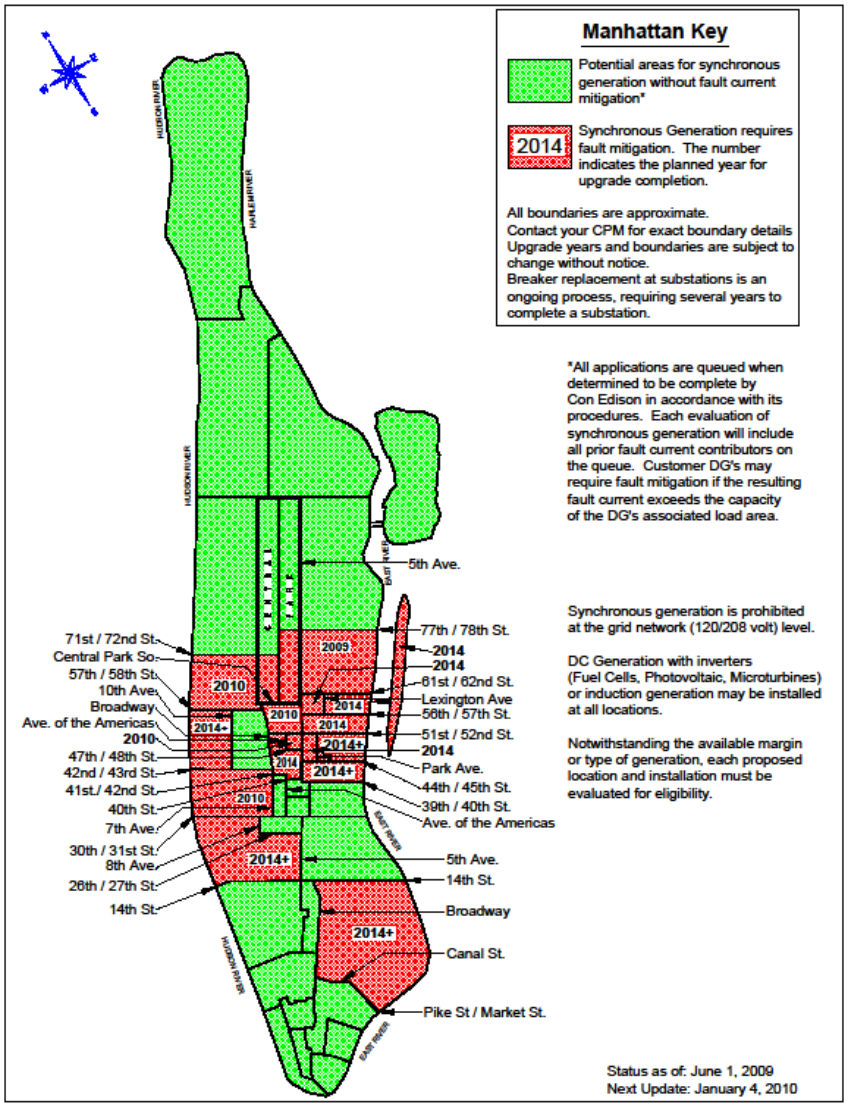


Other Benefits

- Provide back-up power to the 66% of NYPH's load that had no backup capability before.
- Reduce NOx emissions by 104,200 lbs/yr
- Reduce local NOx emissions by 25,000 lbs/yr
- Reduce CO2 emissions by 54,000 tons/yr

BUT

- Fault current limit at substation
- $8,000,000 to upgrade substation
- Or use an AC-DC-AC link



Commutating Current Limiter?

A device with a notched conductor and a small embedded explosive charge.

When a fault is detected, the charge explodes, cutting the conductor and re-routing the current to a fuse that melts, absorbing the energy.

It’s common in utility distribution systems, but not common in cogeneration applications.

CCL Results

- Factory tests showed a reaction time faster than 1/10,000 of a second.
- Installed to identify both incoming and outgoing fault currents.
- **Because of this project “Fast fuses” are now an approved method to connect synchronous generators to Con-Ed’s system**
- Shortly after installation, a fault in the utility system triggered the CCL – no damage to the CHP system or other equipment.


evapco
UTC Power
A United Technologies Company
PureComfort
UTC Power
PureComfort


Capstone
C65


x Absorption
the microturbines is sent to these
absorption chillers. The 585°F
haust evaporates a lithium
ooling the water being pumped
to 45°F (7°C). The water is
oduction Data Center to cool
ese two chillers—equivalent
produces approximately three
led by the data center. The
piped to the adjacent office
ning.


CENTRAL HEATING
PLANT


UTC Power
A United Technologies Company
BRUCE


UTC Power
A United Technologies Company
PureCell


VTC Power
VTC Power

Contact Info

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NYSERDA – CHP Performance data
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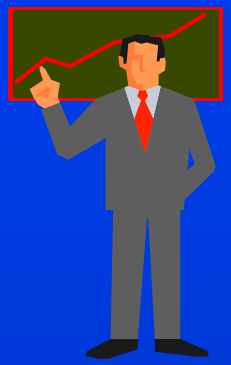


Combined Heat and Power

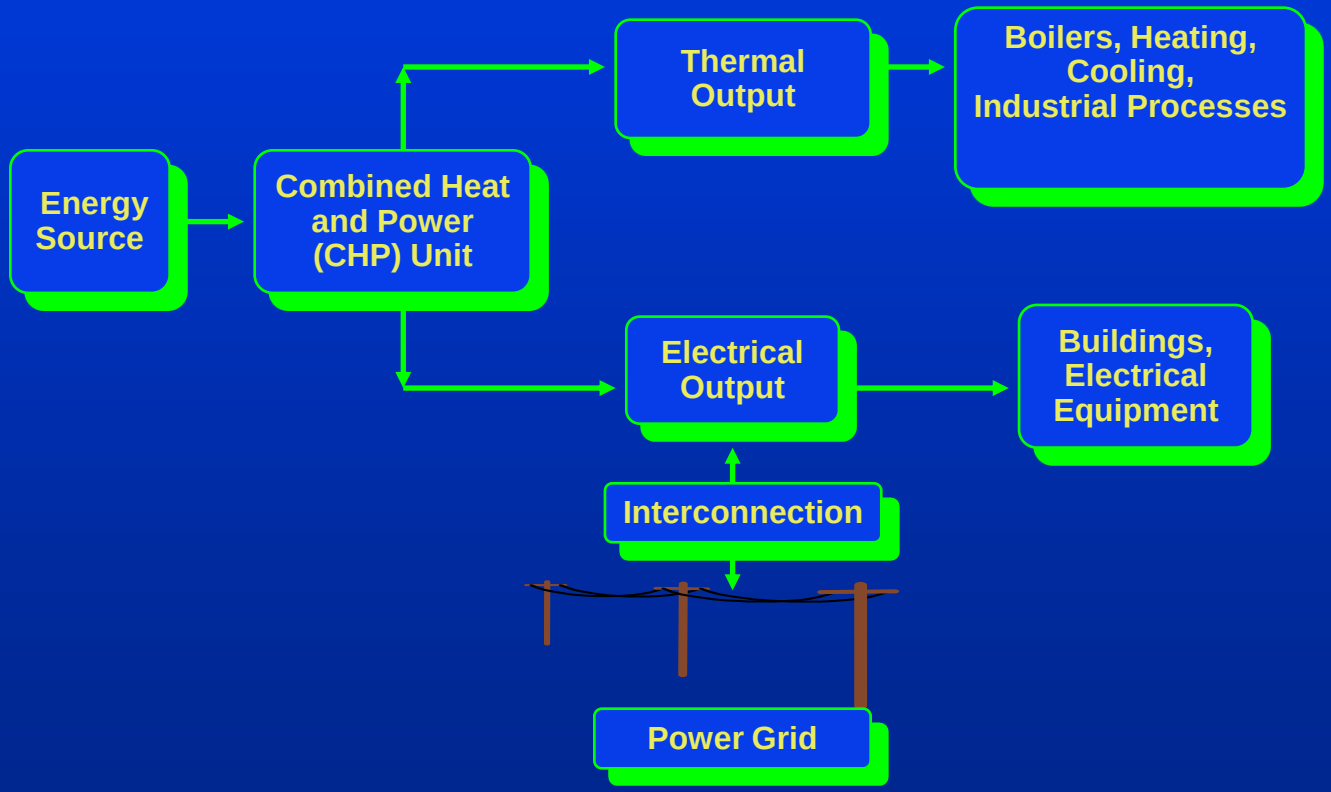
Southwest Gas Incentive Program

June 9, 2010

SOUTHWEST GAS®

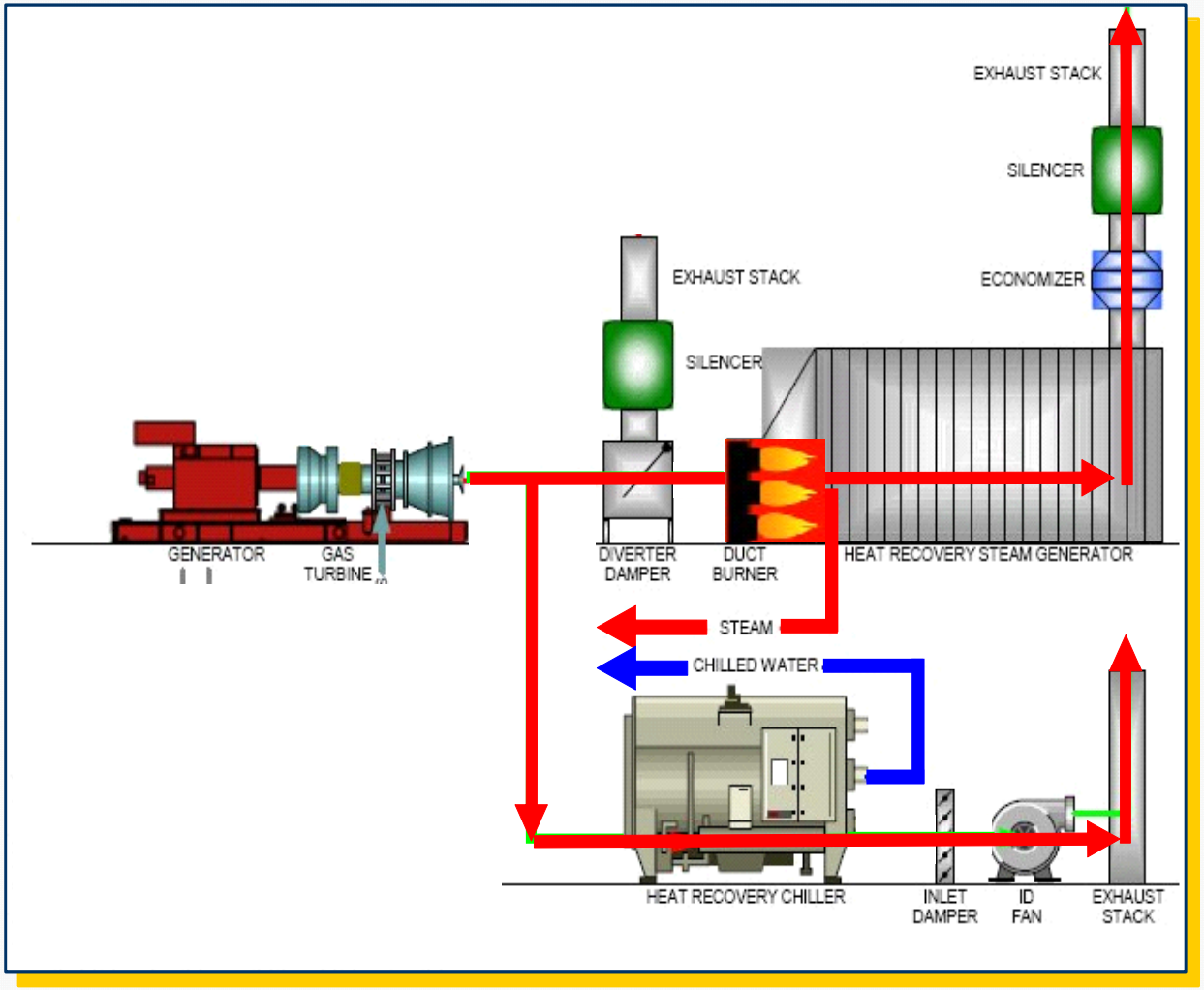
Brian O'Donnell, PE

Combined Heat and Power (CHP) Schematic

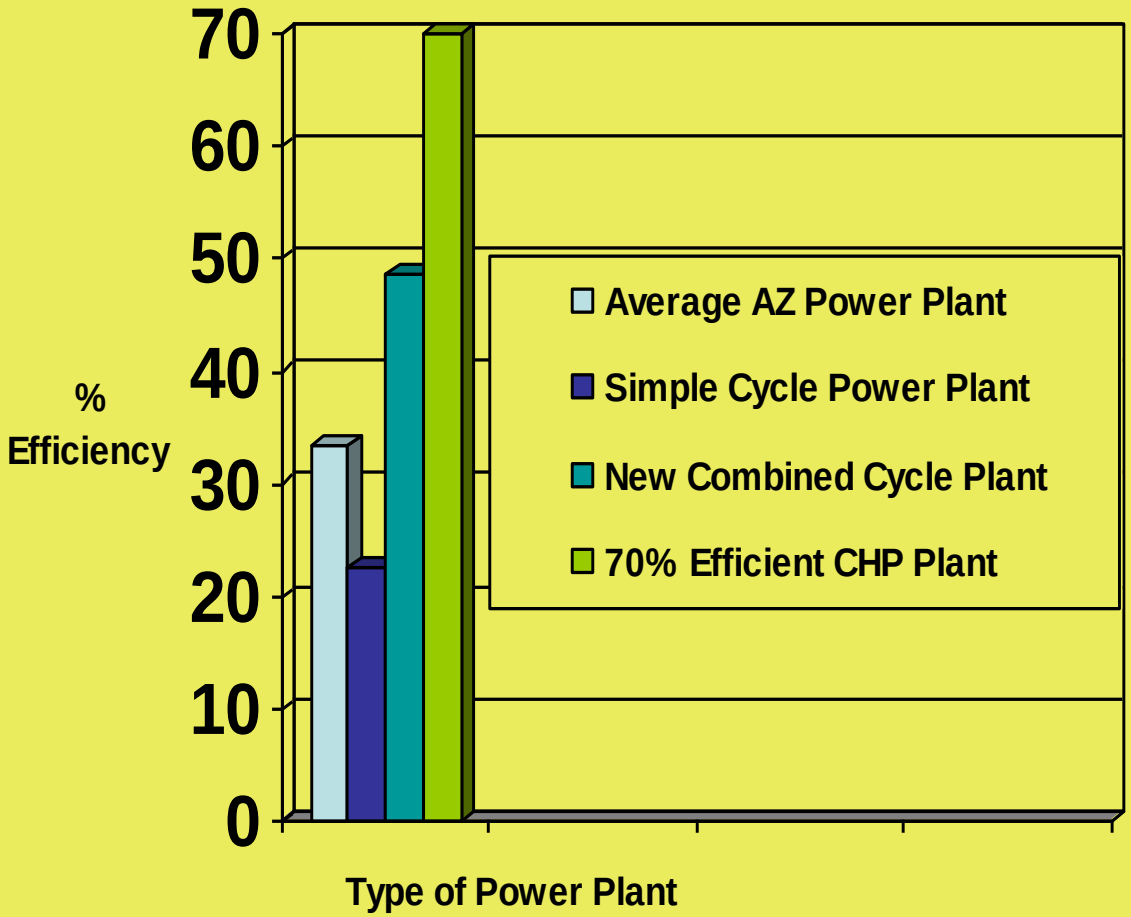


Solar® Turbines
A Caterpillar Company

Building Cooling, Heating and Power



ENERGY EFFICIENCY of POWER PLANTS



CHP or Buy From the Grid

- **Operate CHP**
  - Turbine or Engine Cost
  - Maintenance
  - Operations
  - Standby Charges
  - Finance Costs
  - Auxiliary Power Consumption
- **Buy From the Grid**
  - Electricity
  - Boiler Fuel
  - Boiler Maintenance
  - Operations

CHP ECONOMIC DECISION
USE SPARK SPREAD METHOD

Price for Electricity: X
Equivalent Price for Electricity with CHP: Z
Cost of Fuel to Make Electricity: Y

$$Z = \frac{Y}{\text{CHP Efficiency}} \text{ (Fuel Conversion Factor)}$$

Spark Spread = X - Z

Example
Electricity Price = $0.092/kWh
Fuel Price = $8.70/MMBtu (million Btu)
CHP Efficiency = 85%

$$\text{Equivalent Cost} = (\$8.70 \div 0.85) \times \frac{3412 \text{ Btu/kWh}}{1{,}000{,}000 \text{ Btu}} = \$0.035/\text{kWh}$$

Spark Spread = $0.092 - $0.035 = $0.057/kWh

Program Description

- **CHP systems can Help Arizona commercial and industrial businesses increase energy efficiency and save on energy costs**
- **Customers may qualify for financial support up to 50% of the installed costs for CHP systems that meet requirements and energy-efficiency standards**
- **Projects will be selected by Southwest Gas**

Program Limitations

This program will be limited to Southwest Gas Arizona customers who qualify under the program requirements.

Feasibility

Southwest Gas Key Account Management engineers or its contractors may work with the customer or customer's consultants to prepare preliminary economic studies and environmental assessments to determine the feasibility of CHP projects.

Eligibility for Incentives

To be eligible for funding, CHP technologies will be required to achieve a total fuel efficiency of 60 to 70% or higher.

This efficiency must be shown during standard operations as defined by the customer. Standard operations will vary depending upon the type of facility where CHP is being utilized.

Amount of Incentives

- **$500/kW for CHP systems with minimum fuel efficiency of 70%, up to a maximum of 50% of the installed cost of any project.**
- **$450/kW for CHP systems with minimum fuel efficiency of 65%, up to a maximum of 50% of the installed cost of any project.**
- **$400/kW for CHP systems with minimum fuel efficiency of 60%, up to a maximum of 50% of the installed cost of any project.**

Savings

CHP proposals must show savings in one or more of the following areas:

- **Energy usage**
- **Energy demand**
- **Emissions**
- **Water use**

These savings will be estimated by comparison to a baseline both with and without the measures.

Total Annual Program Funding

- **Incentives for CHP Units: $350,000 annually ($650,000 in 2011)**
- **Energy/design studies: $22,000 annually**
- **10% Investment Tax Credit from Energy Improvement and Extension Act of 2008 - separate**
- **CHP Stimulus Funding from American Recovery Act of 2009 - $825,000 ($300/kW)**

Application Dates for 2010

Opening	***Date for Applications***	***Deadline for Applications***
• **Cycle 1**	**To be established**	**To be established**

Application Requirements

- **Complete the program application form and supply additional documents as shown in the application**
- **Include 12 months of gas and electric utility bills**
- **Include a copy of a CHP preliminary project economic feasibility study.**
- **A final study stamped by an Arizona registered professional engineer (PE) will be required prior to award.**
- **Applicants may request partial funding for either the preliminary or final study depending upon the project circumstances.**

Project Evaluation and Selection

- **Southwest Gas will review applications on a first-come, first-served basis and select qualified projects, until all funding is used.**
- **Any project submitted will have a three year application life and will be considered prior to other projects submitted in later application cycles.**
- **The incentive program will continue until all funds are depleted. Any funding not used in one year cannot be carried over to the next.**

Owner Agreement with Southwest Gas

- **Southwest Gas may award only a portion of project funding or no project funding at all.**
- **All projects awarded will require that the facility owner sign an agreement with Southwest Gas. The agreement will specify verification of project costs, project fuel efficiency and ensuring that the project will remain in operation a minimum of three (3) years.**
- **The agreement will also specify when funding will be provided to the project as well as other pertinent information.**
- **After the CHP project is operational, Southwest Key Accounts Management will verify energy savings and demand reductions during normal operations.**

COMBINED HEAT and POWER
Southwest Gas Incentive Program Application
For questions regarding this application, please contact Key Accounts at (602) 395-4058

- **Project Name: _____Date: _____**
- **Project Address: _____**
- **Project Contact Name: _____ Title : _____**
- **Phone: _____Cell: _____E-Mail: _____**
- **<u>Section I. Proposed Project</u>**
- **A. Size of Project in kW (or Hp if not producing electricity): _____**
- **B. Project Description (e.g. 100 kW generator with waste heat to displace boiler load): _____ _____ _____**

C. Size and Description of Proposed Equipment (e.g: 100 kW Caterpillar model XXX natural gas generator, 600,000 Btu/hour heat exchanger, electric switchgear, concrete supporting structure, process piping, etc).

_____ _

For More Information

DOE Industrial Technologies Program (ITP) Utility Partnerships
www.eere.energy.gov/industry/utilities

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American Public Power Association (APPA)

Demonstration of Energy-Efficient Developments (DEED)
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For answers to additional questions, please email Myka Dunkle at mdunkle@bcs-hq.com.

Past and Present

Industrial Utilities Webinar Presentations are posted on the ITP Utility Partnerships Resources and Tools webpage:

http://www1.eere.energy.gov/industry/utilities/tools_and_resources.html