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**CHP 2008** 

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# Presentation Overview

- ⇒ Some Initial Thoughts
  - How CHP Works, Why is it "Good"
- ⇒ Primer on CHP/DG Configurations
  - Prime Movers, Heat Recovery
- ⇒ Factors for CHP/DG Decision Makers
  - Load Coincidence, Spark Spread
- ⇒ Regulatory History
- ⇒ Categories of NYSERDA Tech Transfer Studies
  - Market Potential
  - Environmental Issues
  - Reliability / Maintainability / Security
  - Regulation and Regulatory Effects
  - Guidebooks & Tools
- ⇒ Resources





## How CHP Works

- Combined Heat and Power (CHP) uses the heat energy from a heat engine cycle that would otherwise be wasted as low-grade energy and stack gasses.
- ⇒ The available heat energy can be used for space heat, process heat, absorption cooling, or bottoming cycles.





# Why is CHP "Good"?

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- ⇒ Reduced energy costs
- ⇒ Reduced life-cycle costs
- ⇒ <u>Attractive return on investment</u>
- ⇒ Improved power reliability
- ⇒ Improved economics for enhancing indoor air quality
- ⇒ Improved environmental quality
- ⇒ Reduced energy consumption

(http://www.chpcentermw.org/03-00\_chp.html#basic)





# Primer on CHP/DG Configurations



- ⇒ The Acronyms Tell the Story...
- ⇒ CHP Combined heat and power (or Cooling, heating, and power)
- ⇒ DG Distributed Generation
- ⇒ Cogen Cogeneration
- ⇒ CHPB Cooling, heating, and power for buildings
- ⇒TES Total energy systems
- ⇒...and on and on....





# Prime Movers

#### **Reciprocating Engines:**

- Applications usually under 1 MW
- Heat recovery: supplemental heat and hot water

#### **Gas Turbines:**

- Applications usually over 1 MW
- Heat recovery: process steam and heat

#### **Micro-turbines:**

- Applications usually under 1 MW
- Each unit provides between 30-60 kW (dated)
- Can be linked (parallel/series) for greater output

# Heat Recovery

Heat is low-grade energy: it is hard to capture, hard to usefully employ, and hard to move.

#### **Space Heating:**

- Must have an "immediate" need
- Domestic hot water is also an option

#### **Process Heating or CIP:**

- Good for pickling or plating baths or
- Food processing and equipment cleaning

#### **Boilers, HRSG's, or Bottoming Cycles:**

- This is what CHP is really all about

# Absorption Refrigeration

Heat used to "make" cold.

When one has a source of "free" waste heat it can be used to "power" an absorption machine to provide moderate cooling. A good application when the available heat is at lower temperatures.

You won't freeze meat, but you can easily keep the beer cold.

Good for cold warehousing and grocery/produce applications, as well as comfort cooling in the right climate.

(a good reference: Dorgan, Leight, Dorgan, Application Guide for Absorption Cooling/Refrigeration Using Recovered Heat, ASHRAE, 1995.)

### Factors for Decision Makers - 1



### ⇒ Coincidence of Need

It is important that a facility require BOTH thermal energy and electrical power, at some level of balance, AND at the same time.

This also insures that there is some level of need/load for the second commodity.





## Factors for Decision Makers - 2



## ⇒ Spark Spread

This is the differential between the *cost* of grid power and the cost of natural gas. (Cost of electric power can be a nebulous parameter.)

Spark Spread: Higher is Better





### Factors for Decision Makers - 3



## ⇒ Turnkey Cost Differential

The differential between turnkey costs of CHP vs. conventional systems:

Lower is Better

Is REDUNDANCY Important?
At what level?





# Legislation Review



- ⇒ Rule 12 (~1997)
  - Imposed a penalty charge for on-site self generation
  - Charged per kWh
  - Made CHP impractical for smaller applications
- $\Rightarrow$  SC 7 (2002)
  - Instead of penalty charge, standby (backup) charges are incurred
  - Backup equipment unnecessary at location
  - Two charges:
    - As-Used demand typical demand charges
    - © Contract demand standby service demand charge, based on facility's max load
  - SC 7 makes CHP much more financially attractive

Source: Hugh Henderson, P.E.

CDH Energy Corp, Cazenovia, NY





## **NYSERDA Project (Study) Categories**

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We opted to divide the collection of studies into the following categories:

- ⇒ Market Potential
- ⇒Environmental Issues
- ⇒ Reliability/Maintainability/Security
- ⇒ Regulation and Regulatory Effects
- **⇒Guidebooks and Tools**

There may be, however, some overlap.





# **Market Potential (overview)**



- CHP Market Potential for NYS (Project #6133)
- Identifying Areas Where Distributed Resources are a Viable Alternative to Electrical System Upgrades (Project #7925)
- Inventory of Landfill Gas Potential in NY and Screening for DG-CHP Applications (Project #8602)
- Market Potential for DG Using Opportunity Fuels in NYS (Project #8605)





# **Market Potential II (overview)**



## ⇒ Studies (Continued):

- Distributed Energy Alternative to Grid Expansion in ConEd Territory (Project #9151)
- NYS District Energy Vertical Market Development (Project #9933)
- A Collaborative Approach to Advancing the Development of DG Systems in NYC High-Rise Buildings (Project #9934)





# **Environmental Issues (overview)**



- Environmental Performance of DG: Balancing Energy and Environmental Objectives (Project #4165)
- Emissions Allowance Market Opportunities for Small CHP Projects in NYS (Project #7165)
- Brownfield Tax Credits: An Incentive for Siting CHP (Project #9154)





## Reliability/Maintainability/Security (overview)

**CHP 2008** 

- Assessment of Industrial On-Site Generation
   Operational Reliability and Availability (Project #6477)
- Evaluation of the Cost Effectiveness, Constructability, and Replicability of DG-CHP Systems for Commercial Office Buildings within NYC (Project #9153)
- DG-CHP and Infrastructure Security (Project #9931)





## Regulation and Regulatory Effects (overview)

**CHP 2008** 

- Quantifying the Environmental Benefits of Increased Deployment of CHP Technologies in NYS and the Impact of Proposed Emissions Standards for Small DG (Project #7617)
- Mandatory Hourly Pricing and CHP (Project #9930)





# **Guidebooks and Tools (overview)**



- Promoting DG-CHP in NYS Industrial Sector (Project #6533):
  - **ODG-CHP** Siting and Permitting
  - Ouse of Geographic Information Systems (GIS) as a Siting Assessment Tool for DG-CHP Deployment
  - © Economic Valuation of Power Quality and Reliability
- Analysis of New Pollution Control Strategy Utilizing Emission Reduction Credits and Small-scale CHP Units (Project #7615)





# **Guidebooks and Tools II (overview)**

**CHP 2008** 

## ⇒ Studies (Continued):

- Multifamily CHP Screening Tool (Project #8600)
- Development, Demonstration, and Dissemination of a Web-based Interactive Standby Rate Estimator (Project #8601)
- Web-based Data Integrator (Project #8621)
- Development of Best Practices Guidelines and Handbook for Small CHP Project Development in NY (Project #9152)
- Reducing Market Development Hurdles to CHP in Hospital Applications (Project #8603)





- ⇒ Study: CHP Market Potential for NYS
- ⇒ Project #6133

- ⇒ Potential for 8,500 MW of new CHP over the next decade
- ⇒ 74% of remaining capacity is for smallmedium sized (below 5 MW) commercial and institutional facilities
- ⇒ Focus should be shifted away from very large industrial plants





- ⇒ Study: Identifying
  Areas Where
  Distributed
  Resources are a
  Viable Alternative to
  Electrical System
  Upgrades
- ⇒ Project #7925

- ⇒ Incentive of \$150 per kW slightly increased overall potential market, but substantially decreased paybacks
- Downstate counties had highest density of market potential (Bronx, Kings, Queens, New York, Richmond, Rockland, Westchester)





- Study: Inventory of Landfill Gas Potential in NY and Screening for DG-CHP Applications
- ⇒ Project #8602

- ⇒ Landfill gas is renewable opportunity and can be used for CHP
- Unfortunately, CHP is difficult at landfill sites due to lack of nearby neighbors and no needed thermal energy
- ⇒ Short-list of potential landfills that could be good CHP candidates is included





- ⇒ Study: Market
  Potential for DG
  Using
  Opportunity
  Fuels in NYS
- ⇒ Project #8605

- ⇒ Opportunity fuels (landfill gas, biomass, anaerobic digester gas, etc.) can be a price stable alternative to natural gas when operating CHP units
- ⇒ Report provides a full breakdown and analysis of potential market for NYS as well as an action plan for switching from natural gas





- Study: Distributed Energy Alternative to Grid Expansion in ConEd Territory
- ⇒ Project #9151

- □ Identifies critical circuits in Manhattan where DG-CHP could be a cost effective alternative to impeding grid expansion
- ⇒ Identifies possible candidate host sites for DG-CHP units on these circuits
- ⇒ Applicable to ConEd territory only





- ⇒ Study: NYS District
  Energy Vertical
  Market Development
- ⇒ Project #9933
- District Energy: Production of steam, hot water or chilled water, or any combination including all three, at a single central utility plant for distribution to other buildings through a network of pipes.¹

- ⇒ District Energy (DE) is a very efficient and cost effective form of DG-CHP
- ⇒ DE systems underutilized in NYS
- ⇒ CUNY campus system used as DE assessment case study
- ⇒ Standard DE feasibility assessment and development processes, DE assessment tools, and training programs will be developed.

http://www.stanford.edu/group/Power-Systems/electrical\_technical\_glossary.htm#d





- ⇒ Study: A
  Collaborative
  Approach to
  Advancing the
  Development of
  DG Systems in
  NYC High-Rise
  Buildings
- ⇒ Project #9934

- ⇒ DG-CHP systems in commercial office buildings in NYC are underutilized and have considerable potential
- ⇒ As a result of a number of issues, very few systems have been developed
- ⇒ A NY Clean DG working group will be established to provide information to building owners





# **Environmental Issues 1**

- Study:
   Environmental
   Performance of
   DG: Balancing
   Energy and
   Environmental
   Objectives
- ⇒ Project #4165

- ⇒ Estimate of DG-CHP penetration in NYS over the next 20 years
- ⇒ Simple payback of DG technologies determined based on existing capacity
- ⇒ Technology forecast of DG estimated
- ⇒ DG-CHP inventory in NYS compiled from unit sales database





# **Environmental Issues 2**

- Study: Emissions Allowance Market Opportunities for Small CHP Projects in NYS
- ⇒ Project #7615

- ⇒ Report explores how CHP facilities below 15 MW can be included in EE/RE allowance set-aside provisions of "cap and trade" emissions rules for NO<sub>x</sub> and SO<sub>2</sub>
- □⇒ CHP facilities are not regulated sources, so any allowances given as an incentive can be sold and turned into cash





# **Environmental Issues 3**

**CHP 2008** 

- ⇒ Study: Brownfield Tax Credits: An Incentive for Siting CHP
- ⇒ Project #9154
- ⇒ Brownfield: abandoned, idled or under-used industrial and commercial site where expansion or redevelopment is complicated by real or perceived environmental contamination that can add cost, time or uncertainty to a redevelopment project²
- ⇒ CHP projects are eligible for the Brownfield Redevelopment Tax Credit (BRTC) and capital CHP costs on brownfield sites can be offset by 10-22%
- ⇒ Project will conduct analysis of sites with highest probability for brownfield CHP
- Provide business world with info on the economic feasibility of developing brownfields with CHP using tax credits



<sup>2</sup> http://www.ny-brownfields.com/index.htm



# Reliability/Maintainability/Security

- Study: Assessment of Industrial On-Site Generation Operational Reliability and Availability
- ⇒ Project #6477

- Operational reliability and availability database for industrial on-site generation technologies
- Data was assembled from DG facilities around the nation with a minimum of 75-100 in NYS
- DG system failures and outages identified and classified





# Reliability/Maintainability/Security 2

- ⇒ Study: **Evaluation** of the Cost Effectiveness, Constructability, and Replicability of DG-CHP **Systems for Commercial Office Buildings within** NYC
- ⇒ Project #9153

- ⇒ NYC is one of the largest DG/CHP opportunities in NYS
- ⇒ Pre-packaged CHP systems need to focus on user perspective instead of vendor perspective
- ⇒ Project established an advisory panel to determine design criteria for preengineered CHP system for NYC office buildings



# Reliability/Maintainability/Security 3

- ⇒ Study: DG-CHP

  and Infrastructure

  Security
- ⇒ Project #9931

- ⇒ In order to improve system ⇒ reliability, resiliency must be increased
- When a disturbance occurs, systems need high reliability in order to resume normal operation as soon as possible
- ⇒ Report pinpoints critical infrastructure sectors in NYS that have CHP potential





# Regulation and Regulatory Effects 1

- Study: Quantifying the Environmental
   Benefits of Increased
   Deployment of CHP
   Technologies in NYS
   and the Impact of
   Proposed Emissions
   Standards for Small
   DG
- ⇒ Project #7617

- ⇒ Project will assess the impacts of proposed DG emissions standards on:
  - Market penetration of CHP in NYS
  - Statewide emissions of critical pollutants
  - Mercury and CO<sub>2</sub>
  - NYISO electricity market parameters
- ⇒ Project will evaluate penetration and impact on air quality of CHP





#### Regulation and Regulatory Effects 2

- ⇒ Study: Mandatory
  Hourly Pricing and
  CHP
- ⇒ Project #9930

- ⇒ Hourly Pricing of electricity is a way to help reduce system peaks and improve efficiency of electric markets
- ⇒ Report contains a a quantitative analysis involving detailed modeling on an hourly basis of sample projects in NYS CHP markets to determine impact of Hourly Pricing on CHP adoption



- Study: Reducing Market Development Hurdles to CHP in Hospital Applications
- ⇒ Project #8603

- ⇒ Hospitals are a highpriority sector for CHP market
- ⇒ CHP siting and permitting is more complex in hospital environment due to Dept. of Health regulations
- Guidebook developed to explain role and benefits of CHP in hospitals





CHP 2008

## ⇒ Study: Promoting DGCHP in NYS Industrial Sector

- DG-CHP Siting and Permitting
- Use of Geographic
   Information Systems (GIS)
   as a Siting Assessment Tool
   for DG-CHP Deployment
- Economic Valuation of Power Quality and Reliability
- ⇒ Project #6533

- ⇒ Comprehensive study to review the existing NYS siting and permitting processes and streamline it for the future
- ⇒ Production of locationemphasized visual display of candidate CHP sites
- ⇒ Evaluation of the economic impact of variations in power quality and interruption in electrical service to industrial, large commercial, and institutional consumers





**CHP 2008** 

- Study: Analysis of New Pollution Control Strategy Utilizing Emission Reduction Credits and Small-scale CHP Units
- ⇒ Project #7615

⇒ Guidebook to document

potential and process for creating Emissions

Reduction Credits (ERCs) for permanent reductions from small-scale CHP applications in NYS





- ⇒ Study: Multifamily
  CHP Screening Tool
- ⇒ Project #8600

- ⇒ Design of a simple, effective screening tool for CHP in multifamily buildings that could be used by the existing energy auditor





- Study: Development, Demonstration, and Dissemination of a Web-based Interactive Standby Rate Estimator
- ⇒ Project #8601

- Developed in coordination with an Advisory Committee and demonstrated for NiMo and ConEd territories
- ⇒ Project will provide insight into standby rate tariffs with plain english explanations





- ⇒ Study: Web-based

  Data Integrator
- ⇒ Project #8621

- ⇒ Goal: acquire, store, analyze and present data from as many existing operational DG-CHP demonstration projects as practicable and each of the remaining projects as they come online
- Maintain a system to acquire data related to the performance of NYSERDA's DG-CHP demonstration projects
- ⇒ Present data using an internet website





- Study: Development of Best Practices Guidelines and Handbook for Small CHP Project Development in NY
- ⇒ Project #9152

- ⇒ Handbook will document:
  - Project development hurdles
  - Descriptions of project development requirements
  - Detailed guidance for successful project development approaches
  - Commonly-recognized pitfalls





#### Resources

# CHP 2008

### Syracuse University Industrial Assessment Center

















#### References (print)

- CHP 2008
- ⇒ Application Guide for Absorption Cooling/Refrigeration Using Recovered Heat, C.B. Dorgan, S.P Leight, C.E. Dorgan, ASHRAE, 1995.





#### **Related Websites**

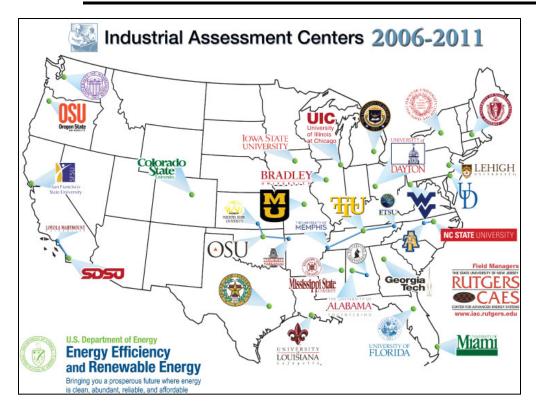
NVCEDDA

NIGERDA
<b>US Combined Heat and Power Association (USCHPA)</b>
US EPA CHP Partnership
Northeast CHP Application Center
World Alliance for Decentralized Energy (WADE)
US DOE Distributed Energy Program
NY Public Service Commission
NY Department of Environmental Conservation (DEC)
NY State
<b>Energy and Environmental Analysis Inc. (EEA)</b>
CDH Energy
<b>ASERTTI Distributed Generation Testing Protocols and</b>
Performance Database
(from http://chp.nyserda.org/links/index.cfm)

#### **Documents and Other Resources**

NYSERDA DG/CHP Integrated Data System User Guide
 (21 page PDF)
 Monitoring and Data Collection Standard for NYSERDA
 DG/CHP Sites (17 page PDF)
 Summary of Data Requirements for NYSERDA DG/CHP
 Sites (1 page PDF)
 Directions for Submitting Data to NYSERDA (2 page PDF)
 (from http://chp.nyserda.org/links/index.cfm)

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- Waste Minimization and Pollution Prevention
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