Testimony of Energy Systems Group
Energy Mandates Study Committee
April 16, 2015

Good morning, my name is Greg Collins, I am the President of Energy Systems Group, a wholly owned subsidiary of Vectren Corporation. ESG is headquartered in Indiana and has employees throughout the country including in Dublin, Ohio. ESG is an energy services company, also referred to as an "ESCO", that specializes in providing energy infrastructure solutions to customers in a broad array of sectors throughout the U.S., including privately owned commercial and industrial companies, state and local governments, K-12 schools, higher education facilities, and the Federal government. We are also an active participant in the combined heat and power market, which will be the focus of my comments today. My comments will build upon the presenters who have already addressed the basics of CHP and the deployment of small scale CHP projects. Specifically, I will focus on larger CHP projects, generally those 10MW and greater, given our company's experience in the development of projects of this size.

First, let me explain how large projects differ from smaller installations, both from a technical and a cost perspective. For projects above a few megawatts, two primary power generation technologies dominate the market; Internal Combustion Engines (ICE) and Combustion Turbine Generators (CTG). Each technology has its place and distinct advantages. Internal combustion engines have higher electrical generation efficiencies, but as a result have limited ability to produce high grade thermal energy. Combustion turbines have lower electrical efficiencies, but are very good at producing medium to high grade thermal energy, and typically have lower maintenance costs. A properly designed CHP system takes the end user's electric and thermal needs into consideration. Additionally, the avoided cost of electricity and thermal energy value tend to dictate an optimal CHP plant design. As an example, ICE technology likely makes more sense for a university that heats water to 180°F for space heating and domestic water use, vs. an industrial energy user that needs a continuous amount of 400°F high pressure steam, in which case, a combustion turbine is likely the better fit.

From a cost perspective, generally the larger the CHP system, the lower the overall cost per kW. As the size of the plant increases, the cost will decrease from approximately $4,000 per kW to approximately $1,500 per kW. Project complexity, reutilization of existing assets, fuel delivery infrastructure and customer requirements can drive pricing up or down.

It is important to note however, that larger projects also provide more than just reduced demand and reduced consumption from the "traditional grid." Larger combined heat and power installations can also provide support for the grid in the event of unforced reductions in supply. These types of units can also be utilized as "Black Start" units. A black start unit is defined by PJM as a generator that can start operations without outside electrical supply. This is important because in the event of a significant outage, the grid is brought up slowly and requires "black start" units to be able to put power on the grid in order to start other units that do not have the ability to return to operation without outside sources of power. Because co-generation and CHP units typically can operate in this way

they can seek black start status from PJM and, if selected, receive compensation from PJM for that capability. Because units like this can receive compensation for having black start capability, the overall project economics improve.

In addition to the benefits black start capability offers, larger combined heat and power plants, can help to alleviate grid congestion and bring benefits such as voltage support and frequency stabilization to the system.

ESG has constructed two such units in Illinois, which is a part of the PJM interconnection. For example, ESG built and operates the North Chicago Veterans Affairs (VA) Energy Center at the Great Lakes Naval Training Center. The 12MW plant improves energy reliability and reduces costs by providing electricity, steam and chilled water for the VA's 40 building, 400 bed campus. Part of routine operating practices include dispatching excess generation capacity into the PJM based on the day-ahead Locational Marginal Price (LMP).

The reality is economics drive virtually all decision makers on the question of whether to move ahead on a CHP project. While CHP is consistently an attractive option to large energy users, there remain internal financial evaluation standards that can take a CHP project from feasible to not viable. This is because many companies, particularly manufacturers and large industrials, both of whom are ideal candidates for CHP projects, are often seeking high internal rates of return and very short payback periods. While a CHP installation may make sense when evaluated over a 48-60 month period, many companies are requiring paybacks of 12-18 months making deployment of these types of projects a significant challenge.

As an example here in Ohio, ESG is working to secure the go ahead on a 30 MW project and the economics of the project play a large role in the decision making process. The project generates approximately $10M in annual benefit to the company, creates jobs during the construction phase, and reduces CO_2 emissions by more than 130,000 tons annually which would assist in any state plan to comply with the proposed 111(d) requirements. This CHP project would also make this company's Ohio plant more competitive in the international market ensuring manufacturing jobs stay in Ohio. However, the size of the capital investment at $50M coupled with a 60 month payback period makes it difficult for the customer to move forward.

In short, it is our role to help large energy users identify ways they can cost effectively manage their energy consumption, mitigate risk when it comes to price fluctuation, and help them improve the efficiency of their operations. CHP does all of those things. However, CHP is many times caught in the potential customer's cost-calculation dilemma. Insufficient internal rates of return or payback periods outside the company's established guidelines often are the roadblocks that stall otherwise attractive projects.

Ohio is a leader in CHP potential. At a time when energy costs may be rising due to federal environmental regulations taking effect and others still to be finalized (111(d)), the time to encourage CHP development and deployment is now. At the Energy Symposium in 2011, Governor Kasich spoke to the importance of and his support for CHP and co-generation.

Subsequently that support was demonstrated by the members of the legislature including an expanded definition of renewable energy to capture and reward more of these efforts in SB 315.

This Energy Mandates Study Committee should continue to support the deployment of CHP projects in Ohio. The efficient, cost effective use of existing energy currently being lost should not continue. If Ohio wants to continue to see development of CHP initiatives here, steps can be taken to help improve the calculation of internal rates of return and reduce the payback period.

In conclusion, CHP is a well-established and understood technology that offers benefits to large energy consumers, the regional grid in some circumstances, and can be an economic development driver for local communities. CHP projects already have strong interest from potential customers. Successful deployment of CHP is good for Ohio because it helps manufacturers and also can help reduce the cost of operations in government and academic settings as well. What is missing is that small boost of support that positively alters the economics to improve return rates and payback periods. Any number of approaches could be utilized, some of which were included in today's presentation. We appreciate the opportunity to testify before you today and are happy to answer any questions you might have.

IGS GENERATION
ENERGY SOLUTIONS OFF THE GRID

Good morning, my name is Patrick Smith and I am Vice President of IGS Generation, a turn-key provider of onsite distributed generation solutions, including combined heat and power systems. IGS Generation is an affiliated company of IGS Energy, which has been providing Ohioans innovative energy solutions for over 25 years. My comments today will build and expand upon what you have already heard from the other presenters regarding the benefits of CHP and the deployment of small-scale systems in Ohio.

IGS Generation develops and installs CHP projects with a focus on those sized 2 MW and smaller. Most recently, we finalized construction on a 248 kW system at the Dublin Community Recreation Center.

As an active participant in Ohio's CHP market, IGS Generation develops, owns, operates, and maintains energy generation assets. Our solutions give customers a long-term plan for responsible energy consumption with an ongoing opportunity to save with no upfront capital costs. By removing the capital costs, equipment responsibility, and managing system operation, we're actively eliminating what were previously considered barriers to CHP system adoption.

IGS Generation is dedicated to creating a sustainable energy future by installing CHP systems which provide:

- Efficiency, by operating at fuel efficiency levels of up to 90%
- Reliability, by providing backup capabilities in the event of power loss
- Sustainability, by using local resources and decreasing greenhouse gases and other pollutants
- Grid stability, by limiting grid congestion and reducing peak demand
- Cost-effectiveness, by allowing businesses to use more of the power they generate onsite

As I previously mentioned, the Dublin Rec Center is a recent IGS Generation client who is benefitting from a CHP system. We installed a 248 kW system, which was designed to meet about 60% of the electrical and heating demands of the Rec Center's 110,000-square-foot facility. Their savings are expected to be significant over the course of our 15-year agreement with them. In fact, we have projected utility-related cost savings of over $200,000. The Rec Center has also been able to avoid the costly replacement of one its boilers as a result of this installation. The system will also provide backup power in the event of a grid outage, and provide the Rec Center with the ability to continue operations with limited interruptions.

Recent extreme weather events and increasing strains on the grid are making onsite generation more appealing than ever to residents and businesses throughout the country. However, while the technical potential to develop CHP systems here at home is significant; our primary focus isn't on the Buckeye State for a few reasons. We have found that the conditions in other states (primarily in the Northeast and the Mid-Atlantic regions) offer a more favorable environment for CHP development. Those conditions include, state and utility incentives for CHP, fair net metering and interconnection rules and strong legislative support of CHP.

As we look into the future, IGS Generation is committed to leading the acceleration of CHP implementation throughout the state of Ohio. We look forward to supporting the state's efforts to renew its focus on energy efficiency, promote opportunities for education and awareness of the benefits of CHP, and improve opportunities for development through various incentives. Through the spirit of collaboration, IGS Generation is dedicated to helping the state further spur job growth and economic development associated with this promising and proven energy solution for Ohioans.

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GE Power & Water
Distributed Power

Ohio Energy Mandates Study Committee
Committee Hearing on Combined Heat and Power (CHP)
April 16, 2015
Testimony of Bala Naidu, Technology and Strategy Leader, General Electric

Co-Chairman Balderson, Co-Chairwoman Roegner and Members of the Energy Mandates Study Committee – thank you for the opportunity today to provide testimony on Combined Heat and Power (CHP). I am Bala Naidu, Technology and Strategy Leader for GE's Distributed Power business.

Combined heat and power (CHP) is the simultaneous production of electricity and heat from a single fuel source, such as: natural gas, biomass, biogas, coal, waste heat, or oil.

For example, a typical industrial facility will require electricity and heat or steam for its internal process needs. If this facility were to rely on conventional means to satisfy this demand, it may choose to buy electricity from the grid and use fossil fuel in a boiler to generate heat or steam for its internal heating needs. Typical efficiencies (both electrical and thermal) that are achieved in this conventional application are in the 40-55% range.

Alternatively, in a Combined Heat and Power application, this industrial facility can install either a turbine or a reciprocating engine coupled to an electric generator and a heat recovery system at the exhaust to capture the exhaust heat. Thus, electricity generated by the generator and the waste heat recovered from the exhaust of the turbine or reciprocating engine is utilized efficiently for the facility's internal needs. This ensures that efficiencies higher than 75% can be achieved leading to savings in fuel cost and reductions in environmental emissions. The most common CHP systems are built with reciprocating engine or a gas turbine running on natural gas, biogas, landfill gas, or liquid fuels.

There is large, untapped potential for the development of highly-efficient combined heat and power (CHP) and waste heat to power (WH2P) in the United States, and specifically in Ohio. CHP has been employed for decades in the United States, Europe and elsewhere and there is now growing interest in emerging markets.

CHP projects are highly efficient and result in greater environmental benefits than if the heat and power were produced separately. These technologies are sometime misunderstood - and often overlooked - as a means to reduce primary energy input, optimize existing primary energy infrastructure, increase efficiency and reduce harmful emissions.

To further build on the benefits of CHP, we would like to highlight the following:

Efficiency Benefits
CHP projects require less fuel to produce energy. Producing electrical energy locally also avoids transmission and distribution losses that occur when electricity travels over power lines, thus enhancing the energy efficiency.

Reliability Benefits
CHP - designed to provide both high-quality electricity and thermal energy – decreases the impact of outages and improves power quality regardless of what may happen on the grid, thus demonstrating a high degree of reliability.

Environmental Benefits
CHP requires burning less fuel to produce a given energy output, thus reducing air pollution and greenhouse gas emissions.

Economic Benefits
CHP can provide cost savings to a facility due to its high efficiency, while also providing a solution to energy costs.

General Electric produces a variety of products and services that can be used in CHP applications. These include gas turbines (both Aeroderivative and Heavy Duty), reciprocating engines such as the Jenbacher and Waukesha engines, waste-heat recovery products, steam turbines, plant controls, and water technologies. CHP systems utilizing GE's products are installed in several CHP applications around the world. GE is committed to investment in critical technologies to improve the performance of these products to enable better CHP efficiency and reduced environmental emissions.

Policy and regulatory changes can dramatically increase CHP and waste heat to power (WHP) deployment, resulting in lower costs, increased energy security and improved environmental conditions.

Thank you for the opportunity to share GE's experiences on Combined Heat and Power (CHP) with you. We look forward to continuing to work with this Committee and our partners to support your ongoing efforts and determine how CHP can provide reliable, efficient, power to the state of Ohio.

Furthermore, we would welcome the opportunity to meet with each of you at a later date to address any questions you may have. Thank you.

CHP Coalition Presentation
Energy Mandates Study Committee
April 16, 2015

Today's Presenters

* Steve Giles, Hull & Associates

  &

* Bala Naidu, General Electric

  CHP 101

* Patrick Smith, IGS

  Small CHP Installations

* Greg Collins, Energy Systems Group

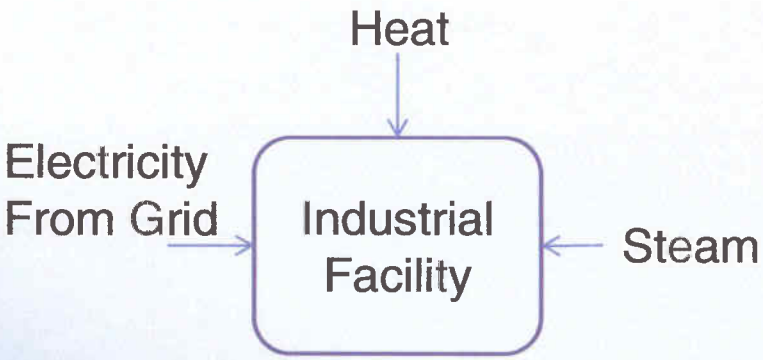
  Large CHP Installations


CHP 101
What is CHP?

Steve

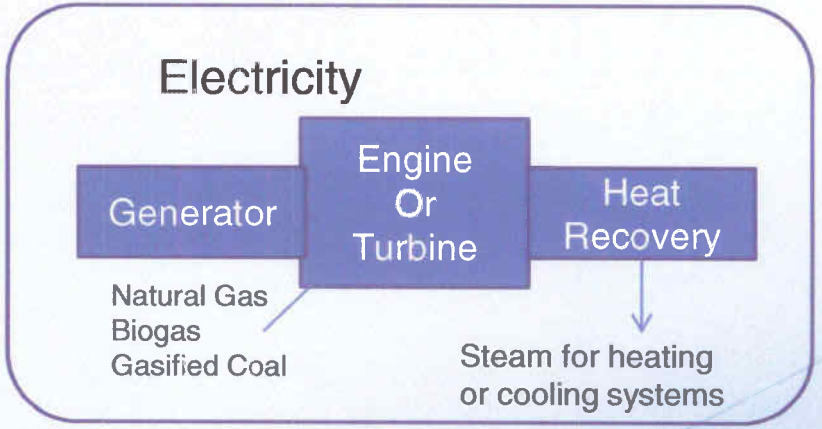
Combined Heat and Power (CHP)

Typical Industrial Facility



Industrial facility may self-generate either electricity **or** steam/heat

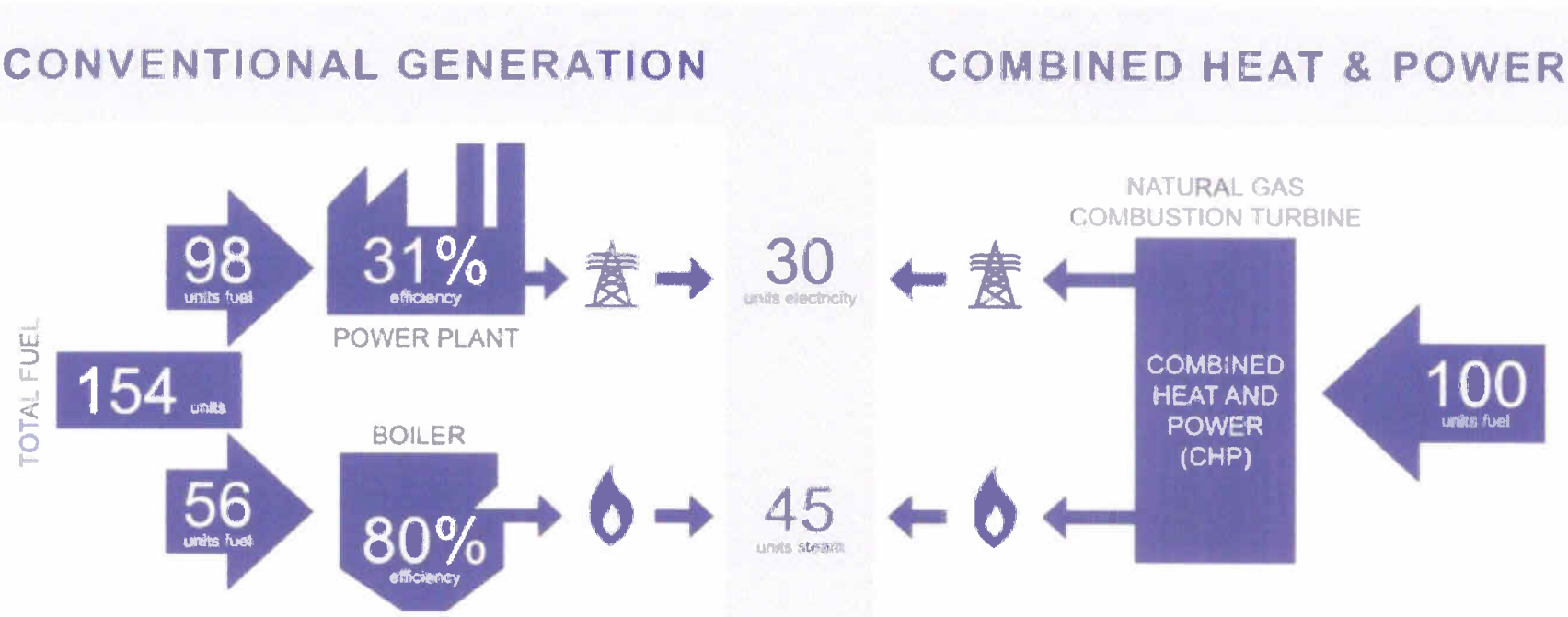
CHP Industrial Facility



CHP = Concurrent production of Heat and Electricity from a common fuel source

Steve

Why is CHP Compelling?



Steve

What are CHP benefits?

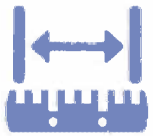
Energy cost savings
Less fuel burned per generated MW

Environmental sustainability
Lower emissions, enhanced cost effectiveness, excellent efficiency

Flexible power
Reduced system risk for grid instability, improved return on investment

Multi-fuel capability
CHP systems can be built using a Natural gas, waste gas, flare gas, biogas, and other lower cost fuels.

Resilient power
IBC compliance for additional energy security



Standardized design
Smaller footprint, scalable to your unique requirements, and easy to install

Reliability
More than 37,000 Distributed Power products proven in installations around the globe, in more than 170 countries

Simplified maintenance
Fast replacement and on-site maintenance is critical for continued operation

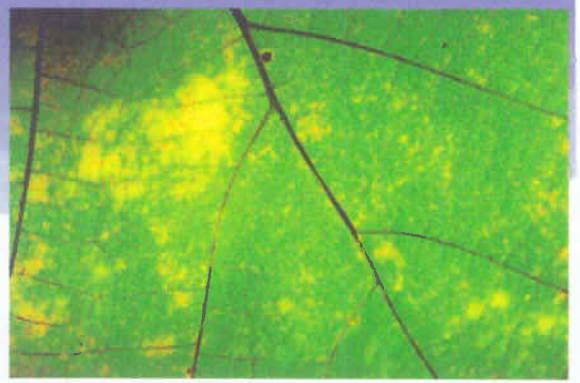
Steve

CHP TYPES AND SIZE RANGES

- District Heating – central plants that distribute power and heat to multiple facilities, such as municipalities, universities and industrial complexes
  - can range from 10 MW to 700+ MW; large systems are more common in European municipalities
- Large Industrial CHP – large scale system dedicated to a single industrial facility
  - can range from 5 MW – 300+ MW
- Commercial CHP – small to mid-size systems dedicated to commercial facilities
  - can range from 30 kW to 5+ MW

Steve

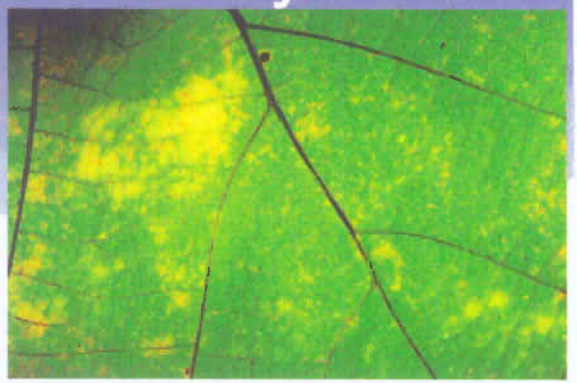
Island Mode versus Black Start



- **Island Mode** - Island mode operation relates to those power plants that operate in isolation from the local electricity distribution network
- **Black Start** - In general, all power stations need an electrical supply to start up: under normal operation this supply would come from the transmission or distribution system; under emergency conditions Black Start stations receive this electrical supply from small auxiliary generating plant located on-site.

Steve

CHP versus Waste Heat Recovery



- CHP differs from "waste heat recovery." In WHR, the waste heat is the fuel source to produce incremental power through a steam turbine or an Organic Rankine cycle engine

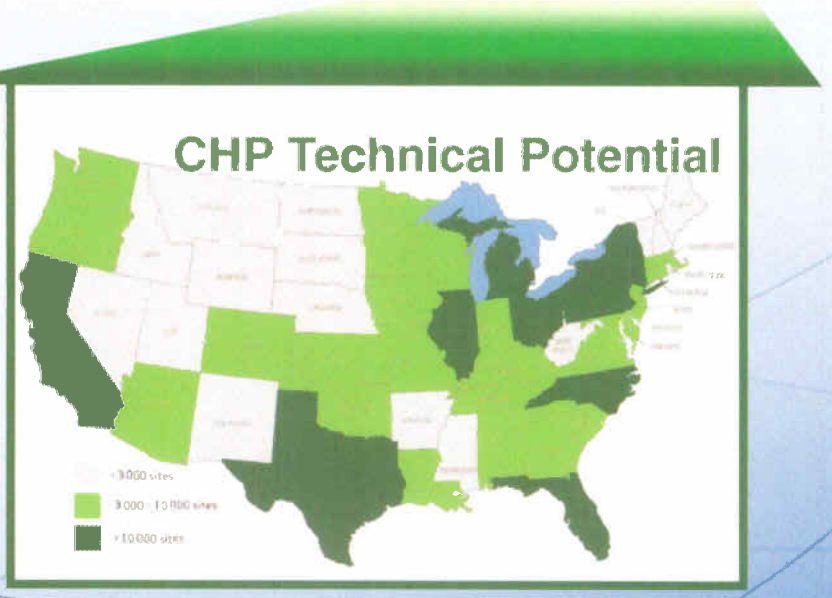
- Ohio, waste heat recovery systems are eligible technologies for renewable energy credits; CHP is not (with two exceptions)

Steve

SNAPSHOT OF OHIO CHP MARKET

	Current	Tech Potential
CHP Implementation in Ohio	566.6 MW	9,800 MW
CHP % of Total Ohio Electric Generation	1.7%	29.4%
Nationally, CHP % of Total Generation	*8.0%*	-

Market Sector	Gen. Potential (MW)
Paper	2,329
Chemicals	2,838
Primary Metals	430
Food	310
Other Industrial	767
Commercial/Inst.	3,082
Total	**9,800**



Ohio CHP Market Potential

* An interdependent study was performed to identify strong CHP candidates across 13 states
* Ohio represents the strongest potential of any state from a technical perspective
* **174 Total Sites**
* Over **3,100 MWe** of generation
* Industrial, Municipal, Healthcare and Universities

Where's the CHP Opportunity?

Tier 1 States

- IL – 5354 Mw (MIPD = 95 sites above 5 Mw)
- OH – 5951 Mw (147 sites above 5 Mw)
- MA – 2826 Mw (28 sites above 5 Mw)
- NJ – 3801 Mw (30 sites above 5 Mw)
- NY – 9360 Mw (79 sites above 5 Mw)
- PA – 6115 Mw (102 sites above 5 Mw)
- WI – 3973 Mw (71 sites above 5 Mw)
- MN – 2230 Mw (36 sites above 5 Mw)
- VA – 2570 Mw (41 sites above 5 Mw)
- MD – 1756 Mw (13 industrial sites above 5 Mw) (MD has technical potential of 1152 mw for commercial. # of Large commercial sites is greater than the # of industrials)

Total = 44 GW out of 130 entire US.

Bala

CHP Technologies

Gas Turbines

Aeroderivative and Heavy Duty

<10 MW to 100+ MW

Gas Engines

100kW to 10+ MW

Steam Turbines

1MW to 100+ MW

Boilers or Heat Recovery Steam Generators

Chillers for Cooling

Emissions Control Equipment

Waste Heat Recovery Systems

Investment in high tech CHP systems can deliver 80%+ CHP Efficiency
Reduced Environmental footprint – lower emissions

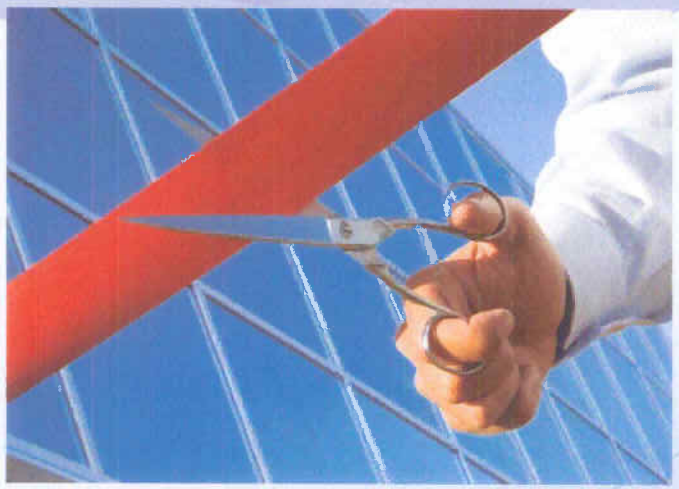
Bala

CHP is applicable in a wide variety of energy-intensive facilities

- **Industrial manufacturers** - chemical, refining, pulp and paper, food processing, glass manufacturing, cement, steel mills
- **Institutions** - colleges and universities, hospitals, prisons, military bases
- **Commercial buildings** - hotels and casinos, airports, high-tech campuses, large office buildings, nursing homes
- **Municipal** - district heating systems, wastewater treatment facilities
- **Residential** - multi-family housing, planned communities

REGULATORY/LEGAL CONSIDERATIONS

- Incumbent utility – regulated utilities, municipal electric companies and rural coops all have different rules regarding self-generation
- Net-metering rules and stand-by energy charges will impact project design and economics
- Power purchase contracts from alternative suppliers may restrict/prohibit self-generation



FINANCING ALTERNATIVES

- CHP paybacks that may range from 4- 8 years often due not meet internal capital allocation criteria
- Energy Supply Agreements put capital and operational risk on developers and can provide energy savings and a price hedge for customers
- Other financing arrangements such as long-term installment contracts and sale-leaseback structures can also be evaluated

Small CHP Installations

IGS GENERATION

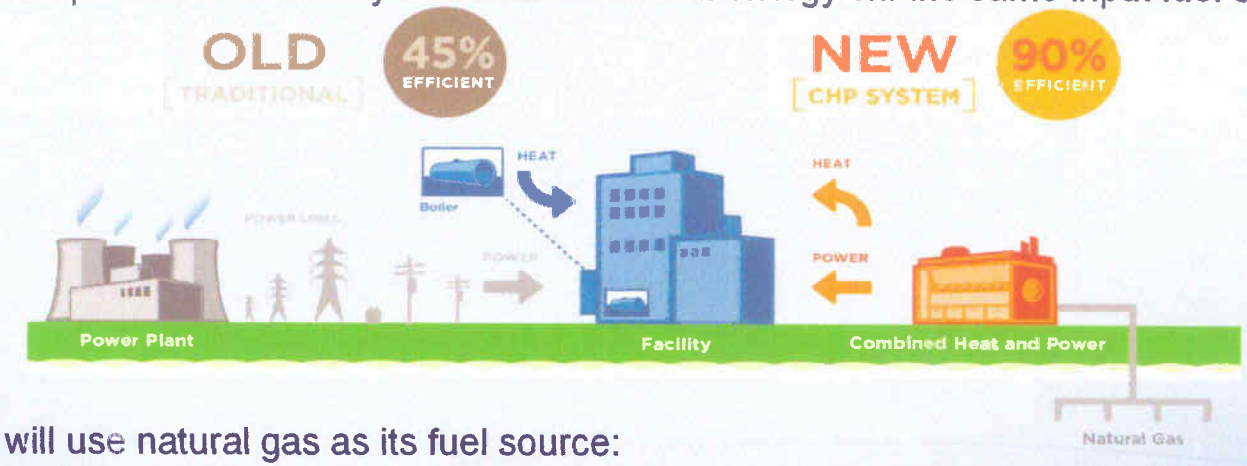
Project Summary: City of Dublin Combined Heat &Power System

CHP Project Summary

A Combined Heat & Power (CHP) System is being installed at the Dublin Community Recreation Center ("DCRC")

* IGS Generation, dba *Dublin Advanced Energy Partners* ("DAEP"), is responsible for the design, construction, and long-term maintenance of the new CHP facility.

* What is a CHP System?
  * System that produces electricity and usable thermal energy via the same input fuel source.



* The system will use natural gas as its fuel source:
  - Produce 248kW of electricity per hour, totaling 60% of the building's power needs.
  - Provide 1.5 million BTU of thermal energy per hour totaling 50% of the building's heating needs, primarily serving the heated swimming pools.
  - Total system efficiency over 90%.

Local Development Team

- IGS Generation – Project co-developer and system owner
- Hull & Associates – Project co-developer
- WW Williams – CHP system vendor (MTU) and maintenance provider
- Prater Engineering – CHP facility design/engineering
- AVT– CHP system enclosure
- Settle-Muter Electric – Electrical contractor
- Air Force One – Mechanical contractor

CHP Provides Backup Power

- The CHP system is enabled to run in "island mode"
- The system will be able to continue running when there is a loss of grid power
- This enables DCRC to continue using the building for emergency operations during power outages

Significant Value to the City of Dublin

Immediate cost savings

* Eliminates need for a boiler replacement, saving nearly $50,000
* CHP system installed and maintained by IGS at no cost

Protection against rising energy costs

* Long-term lease agreement provides price stability for 15 years.
* Projected to save DCRC over $200,000 in utility bills over 15 years

Grid Resiliency

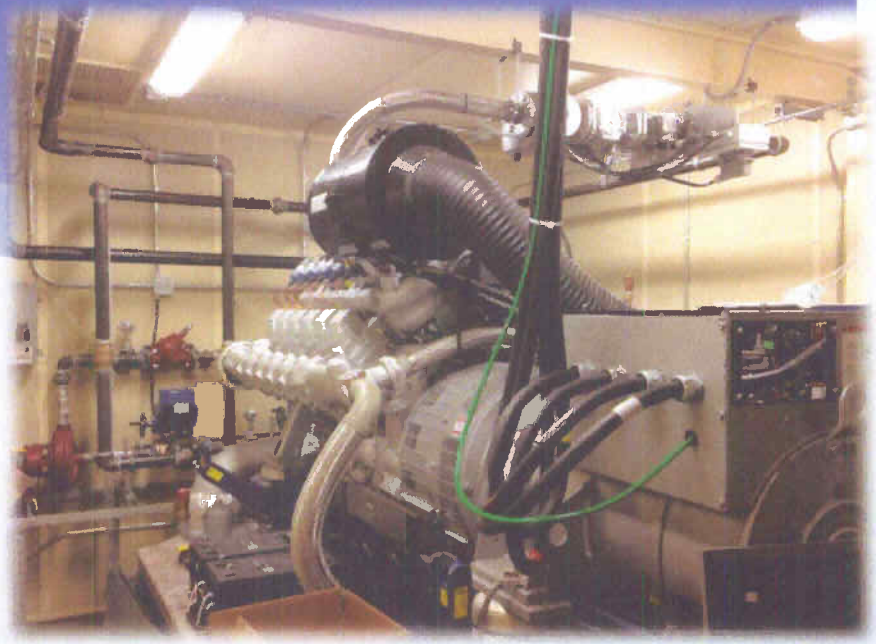
* System provides backup power during grid outage – saving $100,000 over installing a similar sized backup generator

Green energy solution

* Aligns with City's vision for the future: It's Greener in Dublin
* Annual Savings:
  - 187 cars taken off the road
  - 7 acres of forest preserved
  - 126 homes of CO_2 emissions
  - 900 tons of CO_2 removed

Details on CHP System

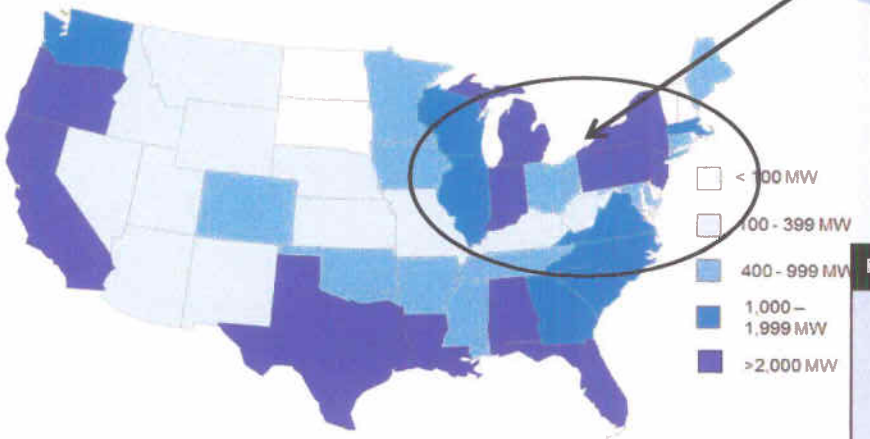
- Designed to integrate directly into existing HVAC and electrical systems
- Installed in noise-reducing enclosure to minimize sound to visitors.
- Information inside the Dublin Community Rec Center will provide education opportunities for visitors.

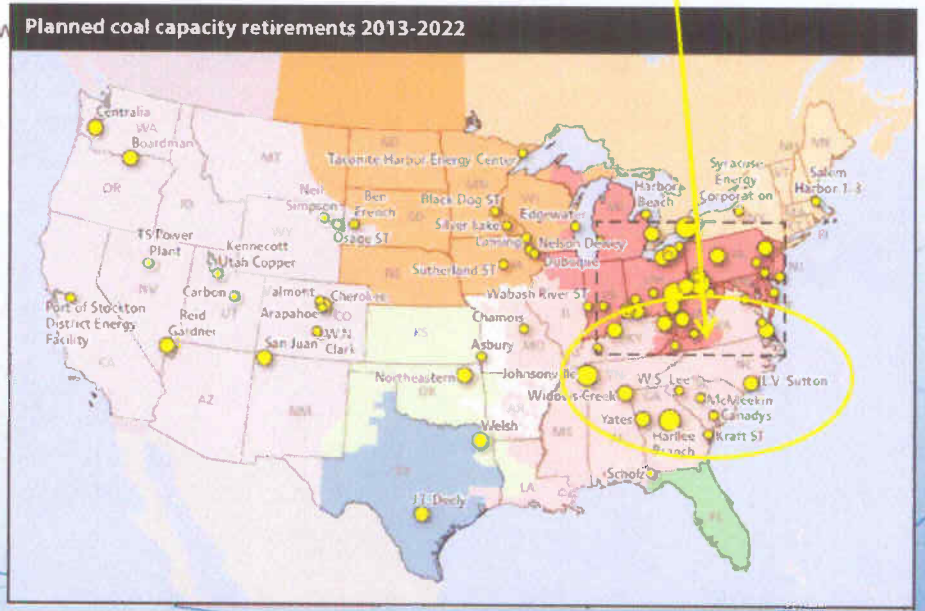


Larger CHP Installations

CHP 'Sweet spot' for ESG: 80% of our business will likely come from Tier 1 states located in these over-lapping ovals

- Existing **CHP** Capacity by State
- Highest Concentration of Planned **Coal** Retirements – Nearly **20%** **(28GW in PJM)** will go **offline by 2016**





North Chicago VA Energy Center

- 12 MWe of Generation Capacity
  - (1) 5MWe Combustion Turbine
  - (1) 7MWe Combustion Turbine
- 250,000 lb./hour Steam Capacity
- "Black Start" Capable
- 98% Uptime
- Excess Generation Dispatched into PJM Based on Day Ahead Locational Marginal Price (LMP)

Solar Taurus 60 – 5MWe Combustion Turbine Generator

60,000 lb./hour Heat Recovery Steam

What About in Ohio?

- Ohio industrial facility with existing coal-fired boilers to supply process steam
- Proposed 30 MWe natural gas-fired CHP plant to enable decommissioning of coal-fired boilers and provide much of the facility's electric supply (plant not sized to maximize export power)
- "Black Start" capability
- $50M investment
- $10M annual operating cost savings = 5 year simple payback
- 40-50 temporary jobs for design and construction
- 5-10 full time jobs
- 132,400 Ton reduction of source CO_2e
- Project put on hold due to customers ROI thresholds

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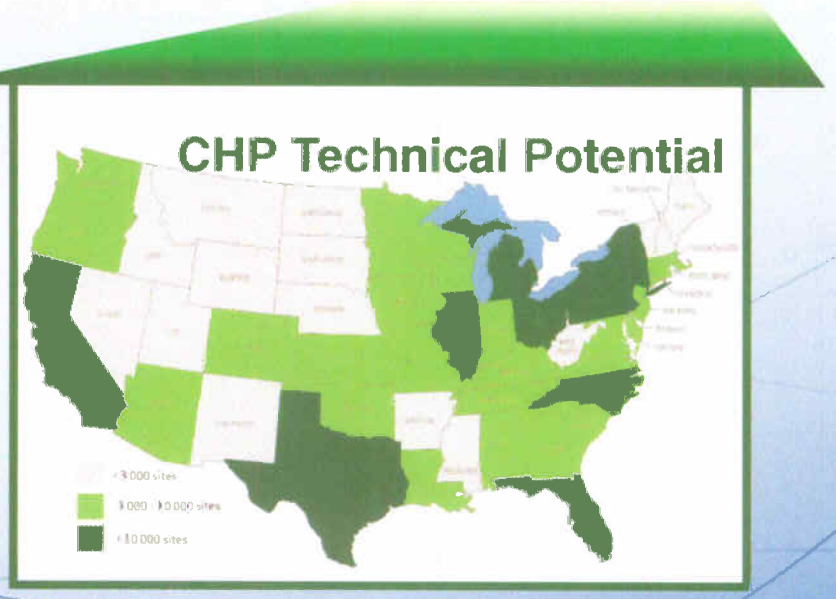

So What are Other States Doing to Incent CHP Deployment?

Tier 1 States with CHP Incentives

* New York, Massachusetts, Ohio, New Jersey and Maryland have initiated specific incentive programs for CHP.
* Supportive policies for industrial and large commercial CHP are anticipated to be forthcoming in IL (2014), and MN (TBD). DCEO in Illinois has initiated a 'pilot' program for CHP incentives for public and state institutions.
* Massachusetts Green Communities Act – The Green Communities Act includes a rebate incentive for efficient CHP systems ($750/kW up to 50 percent of total installed costs).
* Maryland's CHP pilot program for facilities within investor-owned utilities, implemented in 2013, offers $250/kW in upfront incentives and $0.07/kWh for the initial 18 months of operation.
* Federal Tax Incentive – 10% of total project cost (no limit) up to 50 MW and must be at least 60% efficient

NYSERDA CHP Acceleration Program

Program Mechanism:

- Create a catalog of "pre-qualified" system (reasonable component sizing, reputable components)
- Assign specific "rebate" to each system
- Customers select system from catalog

Qualification Requirements:

- Clean and Efficient CHP
- Integrated Controls Package
- Built-in Data Monitoring Features
- Bumper-to-Bumper Warrantee
- 5-year Service Plan
- Capable of "stand-alone" Operability

- Strategy #1: Simplicity
  - Small-to-medium (50 kW – 1.3 MW)
  - Identify replicable designs/opportunities
  - Promote standardization for streamlining
  - PON 2568 -- $60 million Incentive Pool Budget
  - Maximum $1.5 million per project

- Strategy #2: Customization
  - Medium-to-large (greater than 1.3 MW)
  - Promote custom design to maximize efficiency
  - PON 2701 -- $40 million Incentive Pool Budget
  - Maximum $2.6 million per project

Other State Incentives

- NJ Clean Energy
  - $0.35 - $2.00 / Watt depending on size
  - Cap at 30% of total project cost, or $2 - $3M
  - Cap at 40% for CCHP
  - 30% paid at purchase, 60% at installation, 10% after 12mo operation
  - Must be 65% efficient and run at full output for >5,000 hours per year
- Empower Maryland
  - Incentives up to $2M
  - $75/kW, $175/kW installation, $0.07/kWh for 18 m
  - Must be 65% efficient, and cannot export power to the grid
- PA ACT 129
  - Customized programs based on each utility