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Charting a Course to Energy Independence

Providence, RI

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Charting a Course to Energy Independence

Technology Track

What's New in Combined Heat & Power Session

August 10, 2009

2:00 PM - 3:30 PM

Energy Systems Group

What's New in Combined Heat & Power

Organization of Presentation

- Introduction
- Overview
- Basics
- Benefits
- Metrics
- Case Studies
- Permitting
- Economic Stimulus
- Summary

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Technology Track

What's New

In Combined Heat & Power Session

Energy Systems Group

D.W. Sanders (ESG)

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What's New in Combined Heat & Power

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What's New in Combined Heat & Power

Overview

What's new in combined heat & power is renewed interest in its benefits relative to the demands of Renewable Portfolio Standards (RPS), Energy Efficiency Resource Standards (EERS), and greenhouse gas (GHG) emissions. CHP is the concurrent generation of multiple forms of useful energy through an integrated system from a single fuel source. CHP, which is characterized by the type of prime mover that drives the overall system, typically includes internal combustion engines, combustion turbines, microturbines, steam turbines, and fuel cells. CHP offers energy, environmental, and cost benefits relative to separate heat and power (SHP) applications. CHP applications can be located at the point of use and avoid the T&D losses associated with SHP applications. CHP deployment is versatile and can be coupled with existing and planned technologies for many different applications in the industrial-commercial-institutional sectors.

What's New in Combined Heat & Power

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What's New in Combined Heat & Power

Basics

- **CHP** is the concurrent (sequential) or simultaneous generation of multiple forms of useful energy through a single system from a single fuel source.
- **CHP** consists of a number of individual components – *prime mover* + *generator* + *heat recovery* + *electrical interconnection* – configured or coupled into an integrated whole.
- **CHP** is characterized by type of equipment (prime mover) that drives the overall system: internal combustion engines (ICE or IC engines), combustion turbines (CT) and microturbines, steam turbines, and fuel cells.
- **CHP** prime movers are capable of burning a variety of fuel forms: fossil and alternative fuels.
- **CHP** typically involves the production of electricity or mechanical power and useful thermal energy.

What's New in Combined Heat & Power

Basics

- **CHP** is not one technology; rather, a suite of technologies that together generate electricity and recover thermal energy that would normally be lost in the power generation process.
- **CHP** offers energy & environmental benefits over SHP applications in either central or distributed generation forms.
- **CHP** has the potential for a wider range of applications and higher efficiencies result in lower air emissions than SHP.
- **CHP** advantages include the simultaneous production of useful thermal and electric energy that lead to increased fuel efficiency. Applications can be strategically located at the point of energy use (on- or near-site location) and avoid the T&D losses associated with electricity purchased via the grid.
- **CHP** deployment is versatile and can be coupled with existing and planned technologies for many different applications in the ICI sectors.

What's New in Combined Heat & Power

Basics

- **CHP** improves overall fuel efficiency with concomitant benefits of lower capital and O&M costs and a lower air emissions.
- **CHP** typically requires ¾'s of the primary energy that SHP applications require.
- **CHP** provides operating flexibility in that it can be modified in accordance with the needs of the end-user.
- **CHP** provides on-site generation of electrical and/or mechanical power, waste-heat recovery for heating/ cooling/dehumidification/process needs, and seamless system integration for a variety of technologies, thermal applications, and fuel types into existing building infrastructure.

What's New in Combined Heat & Power

Basics

- **CHP** is amenable to industrial (large and small), commercial, and institutional applications.
- **CHP** is a specific form of distributed generation (DG) which involves the strategic placement of electric power generating units at or near customer facilities to supply on-site energy needs. CHP enhances the advantages of DG by simultaneous production of useful power and thermal output and thereby increasing the overall efficiency.
- **CHP**-power can be provided by on- or near-site generators using boilers, combustion turbines, and internal combustion engines.

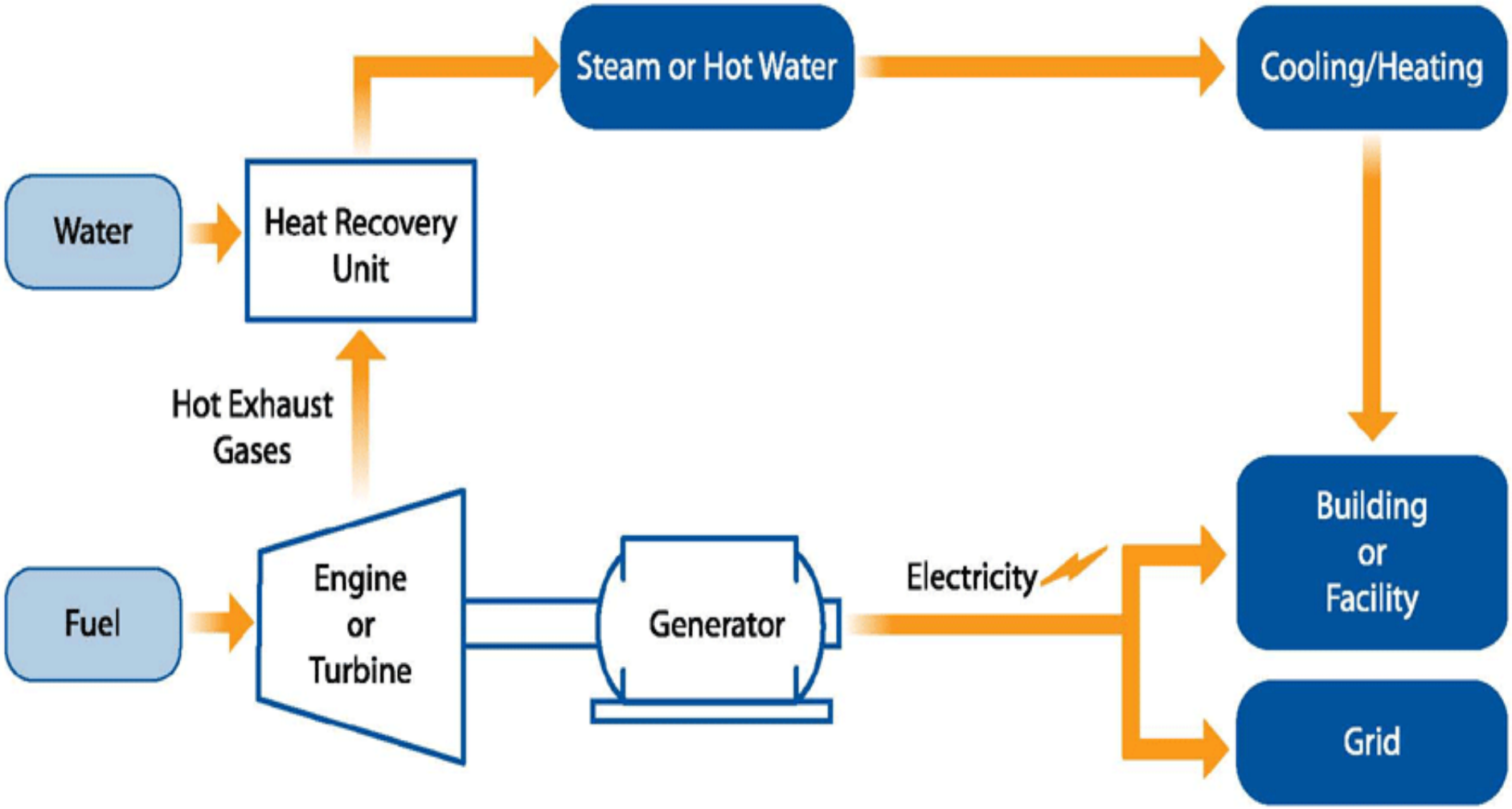
What's New in Combined Heat & Power

Basics

- **CHP**-thermal can be recovered as steam, high-temperature hot water, drying, process cooling, chilling, and dehumidification.
- **CHP** applications and designations come in numerous garden varieties: simple combined heat & power (CHP); cooling, heating, & power for buildings (CHPB); combined cooling, heating, & power (CCHP); buildings cooling, heating, & power (BCHP); integrated energy systems (IES).
- **CHP** two most common system configurations: CT or IC engine coupled to a heat recovery unit or steam boiler with turbine-generator that recovers steam or high-temperature hot water (HTHW).

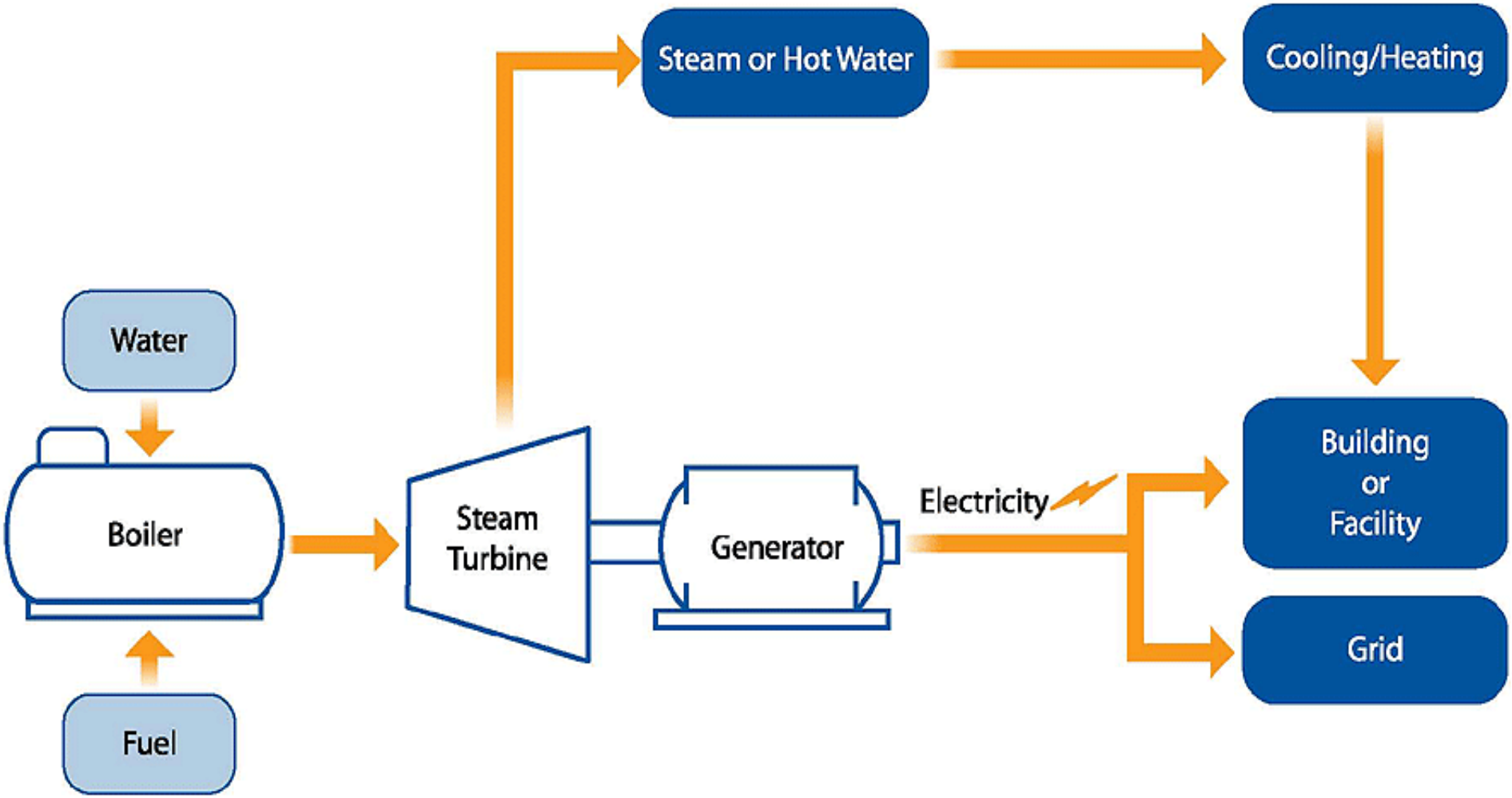
Common CHP System Configuration

Combustion Turbine or IC Engine w/ Heat Recovery Unit



Common CHP System Configuration

Steam Boiler Turbine Generator w/ Steam or HTHW



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What's New in Combined Heat & Power

Benefits

CHP deployment offers benefits that span efficiency, reliability, environmental, and financial performance factors:

- ***CHP Efficiency Benefits***
- ***CHP Reliability Benefits***
- ***CHP Environmental Performance Benefits***
- ***CHP Financial Benefits***

What's New in Combined Heat & Power

Benefits

CHP deployment offers benefits that span efficiency, reliability, environmental, and financial performance factors:

- ✓ ***CHP Efficiency Benefits***
- ➢ *CHP Reliability Benefits*
- ➢ *CHP Environmental Performance Benefits*
- ➢ *CHP Financial Benefits*

What's New in Combined Heat & Power

CHP Efficiency Benefits

- CHP is an efficient & clean approach for co-generating power and thermal energy from a single fuel source.
- The average efficiency of fossil fuel power generation in US is 32% (coal generation equivalent heat rate of 10,700 Btu/kWh net).
- This performance has not changed substantially during the last 50 years; rather, it has declined incrementally because of the parasitic energy demand associated with air emission control devices for PM (FF or ESP), SO_2 (FGD), NO_X (LNC & SCR) and HAP (co-beneficial) emissions.
- This efficiency performance means that ⅔'s of the chemical energy in fuel is lost through vented or rejected heat energy.

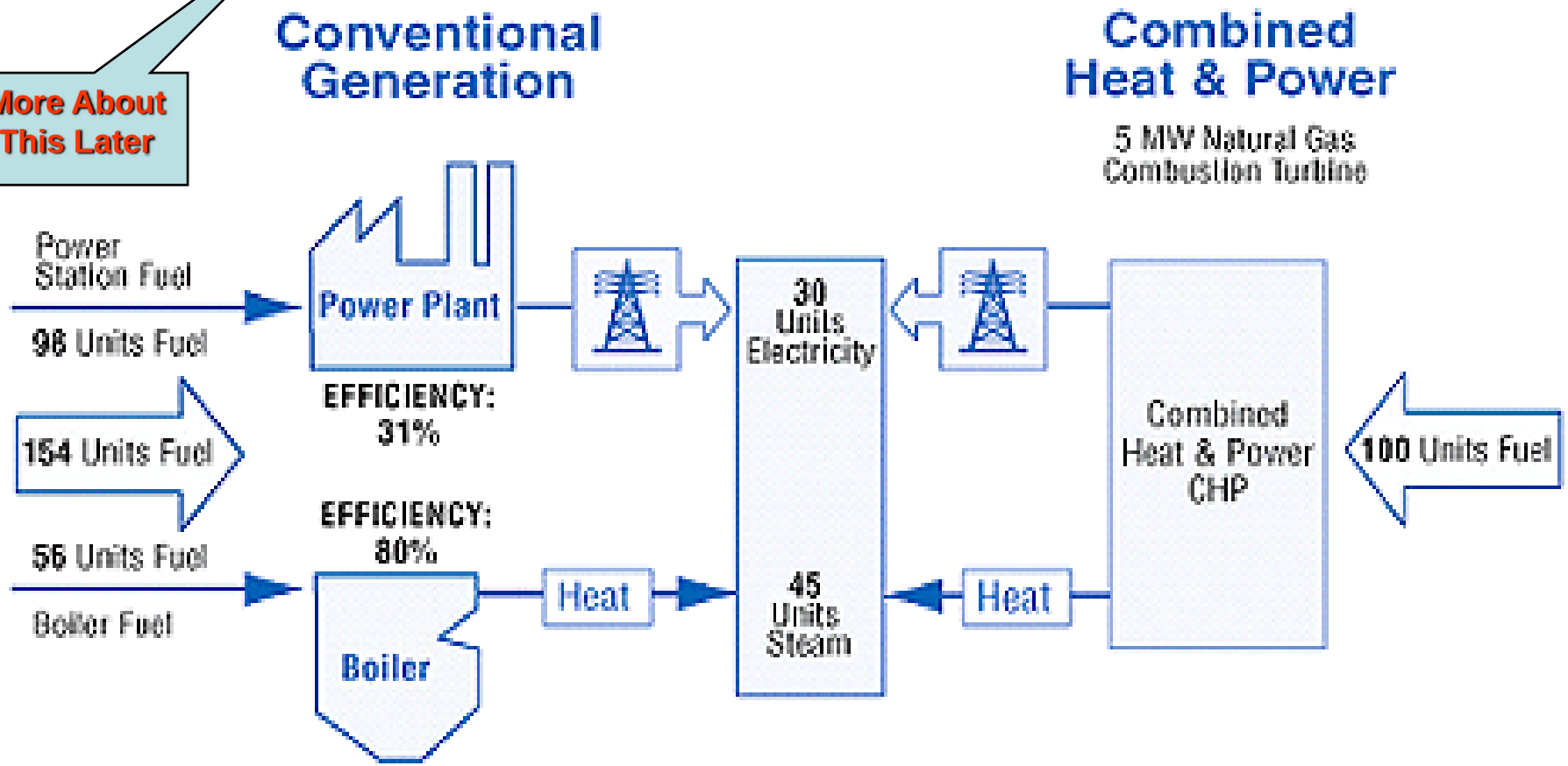
What's New in Combined Heat & Power

CHP Efficiency Benefits

- CHP can use waste heat recovery technology to capture a significant portion of this thermal energy to achieve overall efficiencies of 60% - 80%.
- CHP efficiency gains translate into less fuel used per unit of energy output with concomitant improvements in reliability (power quality, grid congestion, & T&D losses), environmental performance (lower air emissions), and financial (lower capital and O&M costs).
- Although the efficiency of a specific CHP application is site specific relative to the variables of technology selection, system design, and end-use activity, typical efficiencies for standard categories are steam boiler turbine: 80%, IC engine: 70 - 80%, CT: 70 - 75%, fuel cell: 65 - 80%.

Overall Efficiency Comparison

More About This Later



49% OVERALL EFFICIENCY

75% OVERALL EFFICIENCY

What's New in Combined Heat & Power

Benefits

CHP deployment offers benefits that span efficiency, reliability, environmental, and financial performance factors:

- *CHP Efficiency Benefits*
- ✓ ***CHP Reliability Benefits***
- *CHP Environmental Performance Benefits*
- *CHP Financial Benefits*

What's New in Combined Heat & Power

CHP Reliability Benefits

- CHP applications can provide critical service reliability while providing electric & thermal energy service on a continuous basis.
- Unreliable electricity service represents a quantifiable risk (business, safety, & health) to industry that is typically manifested in backup or emergency generators to protect against the risk of service failure.
- The first step in incorporating CHP into a business strategy to reduce risk is to calculate the monetary value of reliability and risk of outages by looking at alternatives with/without off-grid reliability benefit.
- Consider the added value of grid-independence: control, accessibility, and security.

What's New in Combined Heat & Power

Benefits

CHP deployment offers benefits that span efficiency, reliability, environmental, and financial performance factors:

- *CHP Efficiency Benefits*
- *CHP Reliability Benefits*
- ***CHP Environmental Performance Benefits***
- *CHP Financial Benefits*

What's New in Combined Heat & Power

CHP Environmental Performance Benefits

- CHP applications offer considerable environmental performance advantages relative to SHP applications.
- SHP applications can be represented by facilities comprising on-site standalone (separate) power and thermal (steam/HTHW) assets.
- Separate applications also can be represented by facilities comprising external (off-site) grid-purchased power and on-site thermal generation (steam/HTHW) assets.
- Regardless of approach, CHP applications consume less fuel than SHP applications to produce the same amount of energy.

What's New in Combined Heat & Power

CHP Environmental Performance Benefits

- Environmental performance can be represented by the air emission condition.
- Less fuel means proportionately less air emissions in terms of criteria ($PM/_{10}/_{2.5}$, SO_2, NO_X, CO, & VOC), hazardous, and GHG (CO_2) emissions.
- A typical CHP application requires ¾'s of the energy demand relative to SHP on-site configuration (standalone) power and thermal systems. It's air emission condition will also be ¼ less.
- CHP applications also provide additional air emission control placement flexibility because of integrated configurations (e.g., convenient placement of SCR and/or CO oxidation catalyst in exhaust gas path between CT and HRSG heat exchange elements).

What's New in Combined Heat & Power

Benefits

CHP deployment offers benefits that span efficiency, reliability, environmental, and financial performance factors:

- *CHP Efficiency Benefits*
- *CHP Reliability Benefits*
- *CHP Environmental Performance Benefits*
- ***CHP Financial Benefits***

CHP Financial Benefits

CHP offers various financial benefits for large applications that are site-specific to end-use activity, design, fuel selection, offset electricity cost, operating duty, and capital cost elements. The value of these benefits can be measured through the metrics of reduced energy costs, offset capital costs, protection of revenue streams, and hedge against volatile energy costs.

What's New in Combined Heat & Power

CHP Financial Benefits

- Reduced energy costs realized through high efficiency CHP applications can result in energy savings when compared to SHP: grid-purchased power & on-site thermal generation. The potential ROI of the alternative CHP application can be determined by comparing its costs (capital and O&M) relative to the costs of the alternative (purchased power and thermal energy).
- Offset capital costs are those realized for the CHP application that can be installed in place of assets (boilers or chillers) in new or retrofit construction projects.
- Protection of revenue streams can be achieved by captive on-site CHP generation because its associated improved reliability can allow entities to remain online regardless of external events.

What's New in Combined Heat & Power

CHP Financial Benefits

- A hedge against volatile energy prices can be created by CHP applications through protection against episodes of unstable energy prices because the end-user can supply its own power during times when prices for electricity are fluctuating.
- The CHP application can also be equipped to accept a variety of alternative fuel feedstocks that can provide fuel-switching capabilities to further hedge against high fuel prices.

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More About This Now

CHP Energy Efficiency Measures

System	Component	Efficiency Measure
Separate heat and power (SHP)	Thermal Efficiency	$EFF_Q = \frac{\text{Net Useful Thermal Output}}{\text{Energy Input}}$
	Electric-only generation	$EFF_P = \frac{\text{Power Output}}{\text{Energy Input}}$
	Overall Efficiency of separate heat and power (SHP)	$EFF_{SHP} = \frac{P + Q}{F_{Power} + F_{Thermal}}$
Combined heat and power (CHP)	Total CHP System Efficiency	$EFF_{CHP} = \frac{(P + Q)}{F}$
	FERC Efficiency Standard	$EFF_{FERC} = \frac{P + (Q/2)}{F_{Power} + F_{Thermal}}$
	Effective Electrical Efficiency (or Fuel Utilization Efficiency, FUE):	$FUE = \frac{P}{F - (Q/EFF_{Thermal})}$
	Percent Fuel Savings	$S = 100*(1 - (F_{CHP}/F_{SHP}))$

What's New in Combined Heat & Power

Metrics

- The major attribute of CHP is it's high efficiency relative to SHP.
- The efficiency of CHP is measured & expressed in a number of different ways because it co-produces the disparate energy forms of electricity and thermal energy (disparate in terms of "quality").
- Measures for SHP applications involve separate efficiency determinations for the thermal-only component (steam or HTHW boiler or heat recovery steam generator) and the power-only component.
- The efficiency of the thermal-only component measures the net thermal output (Btu) to the energy input (fuel heat input in Btu). This value is typically 80%.

What's New in Combined Heat & Power

Metrics

- The efficiency (η) of the power-only component measures the net power output (W expressed as kW or MW) of purchased-power to energy input (fuel heat input expressed in Btu as MM Btu). The power output value is converted to Btu and compared to fuel heat input. The index used to express fuel-to-power conversion efficiency is heat rate which measures fuel in (Btu) to power out (kWh) or Btu/kWh (net). Typical central station net heat rate values are 10,700 Btu/kWh, which is equivalent to an efficiency of 32%.
- The overall efficiency of SHP is quite simply the sum of the separate components thermal and power (EFF_{SHP}).

CHP Energy Efficiency Measures

System	Component	Efficiency Measure
Separate heat and power (SHP)	Thermal Efficiency	$EFF_Q = \frac{\text{Net Useful Thermal Output}}{\text{Energy Input}}$
	Electric-only generation	$EFF_P = \frac{\text{Power Output}}{\text{Energy Input}}$
	Overall Efficiency of separate heat and power (SHP)	$\mathbf{EFF_{SHP} = \frac{P + Q}{F_{Power} + F_{Thermal}}}$
Combined heat and power (CHP)	Total CHP System Efficiency	$EFF_{CHP} = \frac{(P + Q)}{F}$
	FERC Efficiency Standard	$EFF_{FERC} = \frac{P + (Q/2)}{F_{Power} + F_{Thermal}}$
	Effective Electrical Efficiency (or Fuel Utilization Efficiency, FUE):	$FUE = \frac{P}{F - (Q/EFF_{Thermal})}$
	Percent Fuel Savings	$S = 100*(1 - (F_{CHP}/F_{SHP}))$

What's New in Combined Heat & Power

Metrics

- $EFF_{SHP} = \left\{ \dfrac{P + Q}{F_{Power} + F_{Thermal}} \right.$
- Assume example of 100 MM Btu/hr of fuel heat input each to power-generator component and thermal-generator (steam boiler) component.
- Assume power-generator functions at η of 32% (heat rate = 10,700 Btu/kWh).
- Assume thermal-generator (boiler) functions at η = 80%.
- 100 MM Btu/hr in to PG yields 9.4 MW out w/ equivalent Btu value of 32 MM Btu/hr.
- 100 MM Btu/hr in to TG (steam boiler) yields 80 MM Btu/hr of equivalent steam (66,500 pph of steam @ 400F/150 psi).
- $EFF_{SHP} = \left\{ \dfrac{32 \text{ MM Btu/hr} + 80 \text{ MM Btu/hr}}{100 \text{ MM Btu/hr} + 100 \text{ MM Btu/hr}} \right.$
- $EFF_{SHP} = \left\{ \dfrac{112 \text{ MM Btu/hr}}{200 \text{ MM Btu/hr}} \right. \rightarrow 56\%$

What's New in Combined Heat & Power

Metrics

- The major attribute of CHP is it's high efficiency relative to SHP (separate heat and power).
- The efficiency of CHP can be measured and expressed in a number of different ways because it co-produces disparate energy forms of electricity and thermal energy.
- The simple approach for CHP (EFF_{CHP}) applications computes the overall efficiency of in a manner that parallels the measure for SHP: sum of the separate components thermal and power (while accounting for integrated effects).

CHP Energy Efficiency Measures

System	Component	Efficiency Measure
Separate heat and power (SHP)	Thermal Efficiency	$EFF_Q = \frac{\text{Net Useful Thermal Output}}{\text{Energy Input}}$
	Electric-only generation	$EFF_P = \frac{\text{Power Output}}{\text{Energy Input}}$
	Overall Efficiency of separate heat and power (SHP)	$EFF_{SHP} = \frac{P + Q}{F_{Power} + F_{Thermal}}$
Combined heat and power (CHP)	**Total CHP System Efficiency**	$\mathbf{EFF_{CHP} = \frac{(P + Q)}{F}}$
	FERC Efficiency Standard	$EFF_{FERC} = \frac{P + (Q/2)}{F_{Power} + F_{Thermal}}$
	Effective Electrical Efficiency (or Fuel Utilization Efficiency, FUE):	$FUE = \frac{P}{F - (Q/EFF_{Thermal})}$
	Percent Fuel Savings	$S = 100*(1 - (F_{CHP}/F_{SHP}))$

What's New in Combined Heat & Power

Metrics

- $EFF_{CHP} = \left\{ \frac{P + Q}{(F_{Power}) + (F_{Thermal})} \right.$
- Continue example of 100 MM Btu/hr of fuel heat input each to power-generator component (CT).
- Continue assumption that power-generator (CT) functions at η = 32% (heat rate = 10,700 Btu/kWh).
- 100 MM Btu/hr in to PG yields 9.4 MW out w/ equivalent Btu value of 32 MM Btu/hr.
- 68 MM Btu/hr exits as exhaust gas energy to HRSG.
- Continue assumption that thermal-generator (HRSG) steam production rate is 66,500 pph (400F/150 psi).
- Assume that overall CHP efficiency of 75%.
- The back-end needs 117 MM Btu/hr of energy which is provided by 68 MM Btu/hr of exhaust energy plus 49 MM Btu/hr of fuel energy.
- $EFF_{CHP} = \left\{ \frac{32 \text{ MM Btu/hr} + 80 \text{ MM Btu/hr}}{100 \text{ MM Btu/hr} + 49 \text{ MM Btu/hr}} \right.$
- $EFF_{CHP} = \left\{ \frac{112 \text{ MM Btu/hr}}{149 \text{ MM Btu/hr}} \right. \rightarrow 75\%$

What's New in Combined Heat & Power

Metrics

- The efficiency of CHP can be measured and expressed in a number of different ways because it co-produces disparate energy forms of electricity and thermal energy.
- The simple approach for CHP applications computes the overall efficiency of in a manner that parallels the measure for SHP: sum of the separate components thermal and power (while accounting for integrated effects).
- While EFF_{CHP} reports a measure for capturing total energy content of power and thermal streams, it may not adequately normalize the differing qualities of these streams. The quality (value) of electric power can be considered higher relative to thermal output (e.g., steam) because the former can be transmitted over longer distances and converted to other forms of energy. To normalize these differences in quality, PURPA 1978 discounts half of the thermal energy in its calculation of the efficiency standard EFF_{FERC}.

CHP Energy Efficiency Measures

System	Component	Efficiency Measure
Separate heat and power (SHP)	Thermal Efficiency	$EFF_Q = \frac{\text{Net Useful Thermal Output}}{\text{Energy Input}}$
	Electric-only generation	$EFF_P = \frac{\text{Power Output}}{\text{Energy Input}}$
	Overall Efficiency of separate heat and power (SHP)	$EFF_{SHP} = \frac{P + Q}{F_{Power} + F_{Thermal}}$
Combined heat and power (CHP)	Total CHP System Efficiency	$EFF_{CHP} = \frac{(P + Q)}{F}$
	FERC Efficiency Standard	$EFF_{FERC} = \frac{P + (Q/2)}{F_{Power} + F_{Thermal}}$
	Effective Electrical Efficiency (or Fuel Utilization Efficiency, FUE):	$FUE = \frac{P}{F - (Q/EFF_{Thermal})}$
	Percent Fuel Savings	$S = 100*(1 - (F_{CHP}/F_{SHP}))$

What's New in Combined Heat & Power

Metrics

- The EFF_{FERC} reports the ratio of net electric output plus half the value of the net thermal output relative to total fuel used (all values converted to the common measure of Btu).
- Using our example ($Fuel_{Power}$ = 100 MM Btu/hr, $Fuel_{Thermal}$ = 49 MM Btu/hr, P = 32 MM Btu/hr equivalent, and Q = 80 MM Btu/hr equivalent), the PURPA EFF_{FERC} measure discounts the value of Q to 40 MM Btu/hr and EFF_{CHP} 75% becomes EFF_{FERC} 48%.
- Arguments offered criticize this metric as being both arbitrary and severe relative to the value of the thermal output even though it attempts to normalize the quality value of the different forms of the energy streams.

What's New in Combined Heat & Power

Metrics

- The efficiency of CHP can be measured and expressed in a number of different ways because it co-produces disparate energy forms of electricity and thermal energy.
- Another measure of CHP efficiency is effective electrical efficiency or fuel utilization effectiveness (FUE) which expresses CHP_{EFF} as the ratio of net electric output relative to net fuel consumption where net fuel consumption excludes the portion of the fuel that goes to producing useful heat output (net thermal output). The fuel used to produce useful heat is calculated assuming typical boiler efficiency (e.g., 80%).
- This expression, $FUE = P/(F-(Q/EFF_{Thermal}))$, which can be found on the following table, yields a measure of 65% using our example of P = 32 MM Btu/hr equivalent, F_{Total} = 149 MM Btu/hr, Q = 80 MM Btu/hr equivalent, and $EFF_{Thermal}$ = 80%.

CHP Energy Efficiency Measures

System	Component	Efficiency Measure
Separate heat and power (SHP)	Thermal Efficiency	$EFF_Q = \frac{\text{Net Useful Thermal Output}}{\text{Energy Input}}$
	Electric-only generation	$EFF_P = \frac{\text{Power Output}}{\text{Energy Input}}$
	Overall Efficiency of separate heat and power (SHP)	$EFF_{SHP} = \frac{P + Q}{F_{Power} + F_{Thermal}}$
Combined heat and power (CHP)	Total CHP System Efficiency	$EFF_{CHP} = \frac{(P + Q)}{F}$
	FERC Efficiency Standard	$EFF_{FERC} = \frac{P + (Q/2)}{F_{Power} + F_{Thermal}}$
	Effective Electrical Efficiency (or Fuel Utilization Efficiency, FUE):	$FUE = \frac{P}{F_{Total} - (Q/EFF_{Thermal})}$
	Percent Fuel Savings	$S = 100*(1 - (F_{CHP}/F_{SHP}))$

What's New in Combined Heat & Power

Metrics

- The last metric, fuel savings, compares the fuel used by CHP applications relative to the SHP applications.
- As reported in the table, the value of the ratio of total fuel to CHP (F_{CHP}) to total fuel to SHP (F_{SHP}) is subtracted from 1 (which yields a decimal value) and expressed as a percentage.
- Positive values indicate that the F_{CHP} is lower than the F_{SHP} and represent fuel savings. Negative values indicate fuel losses (i.e., the CHP application is using more fuel than the comparable SHP application).
- This expression: **$S = 100*(1 - (F_{CHP}/F_{SHP}))$** yields a savings (S) of 25% using our example of FCHP = 149 MM Btu/hr equivalent and F_{SHP} = 200 MM Btu/hr.

CHP Energy Efficiency Measures

System	Component	Efficiency Measure
Separate heat and power (SHP)	Thermal Efficiency	$EFF_Q = \frac{\text{Net Useful Thermal Output}}{\text{Energy Input}}$
	Electric-only generation	$EFF_P = \frac{\text{Power Output}}{\text{Energy Input}}$
	Overall Efficiency of separate heat and power (SHP)	$EFF_{SHP} = \frac{P + Q}{F_{Power} + F_{Thermal}}$
Combined heat and power (CHP)	Total CHP System Efficiency	$EFF_{CHP} = \frac{(P + Q)}{F}$
	FERC Efficiency Standard	$EFF_{FERC} = \frac{P + (Q/2)}{F_{Power} + F_{Thermal}}$
	Effective Electrical Efficiency (or Fuel Utilization Efficiency, FUE):	$FUE = \frac{P}{F - (Q/EFF_{Thermal})}$
	Percent Fuel Savings (S)	$S = 100*(1 - (F_{CHP}/F_{SHP}))$

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What's New in Combined Heat & Power

ESG
North Chicago Energy Center

What's New in Combined Heat & Power

ESG North Chicago Energy Center

North Chicago Energy Center (NCEC) became operational in 2003 and serves the energy needs of the VA campus in North Chicago. Additional utility services are provided to the adjacent training barracks for the Great Lakes Naval Training Center. Some of the details of this Energy Center include:

- 12 MW of electric generation via 2 CT units
- 2 heat recovery steam generators
- 3 package steam boilers
- 280 kpph steam production
- Dual-fuel capability for added energy security
- HVAC systems: Upgrades and modifications to HVAC control systems
- Chilled water system replacements to maximize energy and cooling effectiveness
- Steam systems: Refurbish & retrofit existing supply system

What's New in Combined Heat & Power

North Chicago Energy Center

Name of utility system owned/leased or under contract:

- North Chicago Veterans Administration Medical Center (NCVAMC)
- Steam generation and distribution
- Electricity generation and distribution
- Chilled water generation and distribution

Duration of ownership/lease/contract for the utility system:

- Construction: 32 months
- O&M start date: October 2003
- Duration of O&M contract: 10 years
- Duration of lease: 35 years

Description of work performed :

- Design, financing, construction, operations, maintenance, repairs, replacements, fuel procurement, and permits (certificates, licenses, permits, plans, & registrations).

Dollar Value:

- Construction amount @ $29.4 MM & O&M annual revenue @ $2.2 MM

Location and geographic dimension of area served: North Chicago (IL) & 40 Acres

What's New in Combined Heat & Power

ESG North Chicago Energy Center

CHP Elements

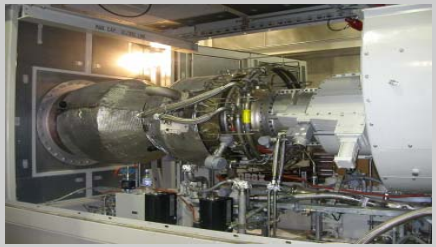
- One (1) CT-HRSG train coupled in a slaved turbine-exhaust gases (TEG) configuration.
  - NG-fired CT (Solar Taurus 60-T7300S) rated (maximum) 72.6 MM Btu/hr (fuel in) & 6.0 MW (net power out).
  - NG-fired HRSG (Superior Boiler w/ Maxon DB) rated (maximum) 43.7 MM Btu/hr (fuel in) & @ 60 kpph steam (thermal out).
- A 2nd CT-HRSG train coupled in TEG configuration.
  - NG-fired CT (Solar Taurus 70-10301S Axial) rated (maximum) 94.5 MM Btu/hr (fuel in) & 8.6 MW (net power out).
  - NG-fired HRSG (Superior Boiler w/ Maxon DB) rated (maximum) 35.0 MM Btu/hr (fuel in) & @ 50 kpph steam (thermal out).
- Three (3) dual fuel (NG primary/DO alternate) steam boilers (Superior Boiler w/ Industrial Combustion LNB) rated (maximum) 63.0 MM Btu/hr (fuel in) and 50 kpph steam (thermal out).
- One (1) DO-fired emergency back-up generator (500 kW).

What's New in Combined Heat & Power

ESG North Chicago Energy Center

CHP Integrated Effects

- The 2nd CT-HRSG train represents a combined rating of 8.6MW & 50 kpph steam using a combined fuel heat input of 130 MM Btu/hr.
- This CT-HRSG's CHP performance can be illustrated by comparing it to operating the CT only in parallel with one steam boiler (SB). The standalone CT plus the standalone SB represents comparable power-out and thermal-out values of 8.6 MW & 50 kpph steam w/ an associated combined fuel heat input of 158 MM Btu/hr.
- The CHP fuel savings due to integrated effects are 18%.
- MM Btu/hr savings = $100 * \left[\frac{(158 - 130)}{158} \right]$
- Comparable air emissions savings are also achieved: CO reduction is 45 tpy vs. 49 tpy (8%), HAP reduction is 30% (0.6 tpy vs.0.9 tpy), GHG reduction tracks fuel consumption (18%).



What's New in Combined Heat & Power

ESG
Chicago West Energy Center

What's New in Combined Heat & Power

ESG Chicago West Energy Center

The Chicago West Energy Center (CWEC) became operational in 2004 and serves the utility needs for the Jesse L. Brown VAMC in Chicago, IL. ESG developed the CWEC in an existing building to keep the footprint small in an already-crowded part of the city:

- 3.4 MW of electric generation
- 1 heat recovery steam generator
- 2 package steam boilers
- 50 kpph steam production
- 2000 tons per hour of chilled water
- Dual-fuel capability for added energy security
- HVAC systems: Upgrades and modifications to HVAC control systems
- Chilled water system improvements to maximize cooling effectiveness
- Steam systems: Refurbish and retrofit existing steam supply system

Name of Utility System owned/leased or under contract:

- Jesse Brown VA Medical Center
- Chilled water generation and distribution
- Steam generation and distribution
- Electricity generation and distribution

What's New in Combined Heat & Power

ESG Chicago West Energy Center (CWEC)

Duration of ownership/lease/contract or the Utility System:

- Construction months: 14 months
- O&M start date: November 2003
- Duration of O&M contract: 10 years
- Duration of lease: 35 years

Description of work performed:

- Design, financing, construction, operations, maintenance, repairs, replacements, fuel procurement, siting, and permitting (certificates, licenses, permits, plans, & registrations)

Dollar value:

- Construction cost: $12.5 MM
- O&M annual revenue: $1.5 MM

Location & geographic dimension of area served: Chicago (IL) & 10 acres

What's New in Combined Heat & Power

ESG Chicago West Energy Center (CWEC)

CHP Elements

- One (1) CT-HRSG train coupled in a slaved turbine-exhaust gases (TEG) configuration.
  - NG-fired CT (Solar Centaur 40T-4700) rated (maximum) 55.5 MM Btu/hr (fuel in) & 4.1 MW (net power out).
  - NG-fired HRSG (Superior Boiler w/ Deltak DB) rated (maximum) 36.0 MM Btu/hr (fuel in) & @ 50 kpph steam (thermal out).
- Two (2) dual fuel (NG primary/DO alternate) steam boilers (Superior Boiler w/ Coen Micro-NOx LN30MP600 LNB) rated (maximum) 34.5 MM Btu/hr (fuel in) and 25 kpph steam (thermal out).
- One (1) emergency DO-fired back-up generator (250 bhp).

What's New in Combined Heat & Power

ESG Chicago West Energy Center (CWEC)

CHP Integrated Effects

- The CT-HRSG train represents a combined rating of 4.1MW & 50 kpph steam using a combined fuel heat input of 92 MM Btu/hr.
- The two (2) identical standalone steam boilers represent a combined steam rating of 50 kpph using a combined fuel heat input of 69 MM Btu/hr.
- This CT-HRSG's CHP performance can be demonstrated by comparing it to operating the CT only in parallel with the two steam boiler (SB) units. The standalone CT plus the standalone SB units represent comparable power-out and thermal-out values of 4.1 MW & 50 kpph steam w/ an associated combined fuel heat input of 125 MM Btu/hr.
- The CHP fuel savings due to integrated effects are 27%.
- MM Btu/hr savings = $100 * \left[\frac{(125 - 92)}{125}\right]$
- Comparable air emissions savings are also achieved: NO_X reduction is 22 tpy (Δ43%) based on 28 tpy (CHP) vs. 50 tpy (SHP), CO reduction is 15 tpy (Δ35%) based on 29 tpy (CHP) vs. 44 tpy (SHP), HAP reduction is 39% (CHP @ 0.5 tpy vs.SHP @ 0.8 tpy), GHG reduction tracks fuel consumption (27%).

Energy Systems Group

What's New in Combined Heat & Power

Mountain Home Energy Center

What's New in Combined Heat & Power

Mountain Home Energy Center

This facility started operation in June 2001 and provides service to the James H. Quillen VA Medical Center in Johnson City, TN. Some of the details of this full service cogeneration facility include:

- 6.7 MW of electric generation
- 4,900 tons of chilled water systems
- 700,000 gallons of chilled water storage
- 30,000 kpph steam production for VA
- Steam systems: refurbish and retrofit existing steam supply system

Name of utility system owned/leased or under contract:

- James H. Quillen Veterans Administration Medical Center
- Chilled water generation and distribution
- Steam generation and distribution
- Hot water generation and distribution
- Electricity generation and distribution

What's New in Combined Heat & Power

Mountain Home Energy Center

Duration of ownership/lease/contract or the Utility System:

- Construction months: 18 months
- O&M Start Date: June 2001
- Duration of O&M: 24 years
- Duration of Lease: 35 years

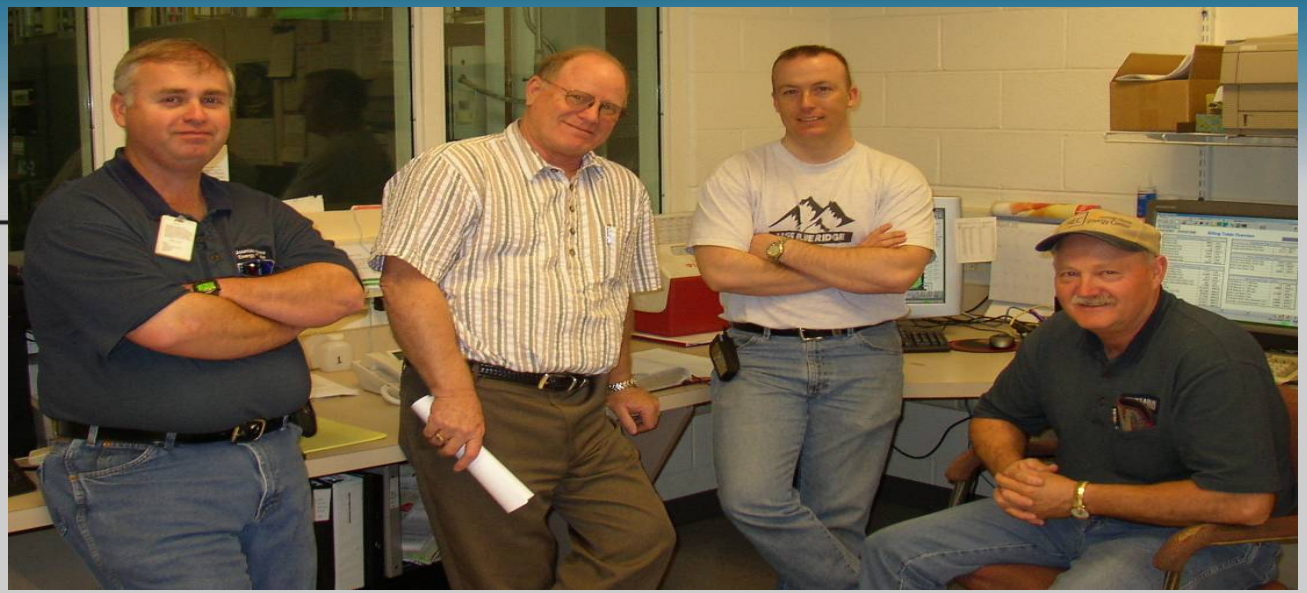
Description of work performed:

- Design, financing, construction, operation, maintenance, repairs, replacements, fuel procurement, and permitting (certificates, licenses, permits, plans, & registrations).

Dollar Value:

- Construction cost: $27.0 MM
- O&M annual revenue: $814.0 k

Location & geographic dimension of area served: Mountain Home, Tennessee. The VA has 38 buildings on 100 acres of land. The VA also leases 31 acres to the James H. Quillen College of Medicine at East Tennessee State University.



What's New in Combined Heat & Power

Other CHP Design Projects w/ Unique Attributes

What's New in Combined Heat & Power

Other CHP Projects

- Government ammunition manufacturing facility equipped with dedicated aging coal-fired central steam plant and extramural purchase power.
- Approach: replace the existing coal-fired steam plant with state-of-the-art CHP that co-gens both power & steam via NG-firing in the form of CT-HRSG trains, supporting steam boilers, and distributed generators.
- The environmental permitting predicated the approach of replacing the central steam plant w/ efficient generation that would "net out" of major source permitting and create surplus emission reduction credits that could be used as offsets to modernize the plant's munitions manufacturing capability.

What's New in Combined Heat & Power

Other CHP Projects

- Replace derated central steam plant (NPR of 875 kpph/NDC of 460 kpph) w/ 20 MW of extramural peak power demand w/ a CHP that can generate 16 MW of power, 575 kpph steam (460 kpph online), and 9 MW of distributed generation
- Each of two (2) identical CT-HRSG trains would be equipped a supplementally-fired HRSG that could operate in coupled mode ("slaved" to turbine-exhaust gases or TEG) or standalone mode (fresh-air fired or FAF).
- The FAF-mode selection allowed a capital savings by obviating one additional steam boiler (spare).
- The base case SHP represented an energy value of 1264 MM Btu/hr (fuel heat input). The replacement case CHP represented an energy value of 1040 MM Btu/hr (fuel heat input). Overall realizable energy savings was 18% (savings of CHP relative to SHP base case). This simple energy savings was realized despite the uprate in the CHP power side due to the placement of 9 MW DG.

What's New in Combined Heat & Power

Other CHP Projects

- The realizable air emissions "savings" was even more dramatic because the base case SHP was totally coal-based. The GHG (CO_2) reduction was 58% assuming SHP @ 154 tph (243 lb/MM Btu) vs. CHP @ 65 tph (125 lb/MM Btu).
- Another observation concerns the replacement case CHP. There are 3 separate generation configurations within given the CT-$HRSG_{FAF}$ vs. CT-$HRSG_{TEG}$ vs. CT standalone w/ SB. They represent combined equivalent fuel heat input ratings of 253 MM Btu/hr vs. 206 MM Btu/hr vs. 241 MM Btu/hr, respectively. The CT-$HRSG_{TEG}$ is clearly the more energy efficient configuration whereas the CT-$HRSG_{FAF}$ is clearly the least efficient and the CT-SB somewhere in between. The $HRSG_{FAF}$ setup was more fuel intensive than both because of it's double-duty arrangement. The hidden benefit to the $HRSG_{FAF}$ is that it eliminated the need for an extra spare SB (with it's associated cost and consumption demands). Also, the $HRSG_{FAF}$ is more than proportionately higher in its air emission condition for the same reason.

What's New in Combined Heat & Power

Other CHP Projects

- Agricultural-methane projects recover biogas from animal manure and other agricultural substrates through anaerobic digestion for power generation.
- Power produced using internal combustion engines (IC engines) firing in spark-ignited lean-burn setup.
- These applications can offer CHP functionality.
- Thermal energy from IC engine exhaust gas (engine exit @ 950 F) is recuperated through a shell-and-tube heat exchanger (HX exit @ 475 F) and routed back to digester reactor to maintain 100 F operating temperature.

What's New in Combined Heat & Power

Organization of Presentation

- Introduction
- Overview
- Basics
- Benefits
- Metrics
- Case Studies
- ***Permitting***
- Economic Stimulus
- Summary

What's New in Combined Heat & Power

Permitting

- "Permitting" refers to all siting requirements: certificates, licenses, permits, plans, and registrations.
- Venues include siting, air, water, wastewater, solid waste, hazardous waste, bulk material storage, noise, transportation, and land use.
- The following table provides an overview that describes oversight agency, need, review time, and considerations.

Certificates, Licenses, Permits, Plans, and Registrations

Overview of Possible Certificates, Licenses, Permits, Plans, and Registrations				
Venue	**Oversight**	**Need**	**Review Time**	**Considerations**
Siting	State PSC	Petition for Certificate of Necessity	12 months	Required for rate base projects. Discretionary for non-rate base projects.
	Power Siting Board	Certificate of Environmental Compatibility and Public Need	12 months	Required for electric power generation projects of minimum size. A separate submission describing need, technical information, financial information, environmental performance, social impact, ecological impact, and alternatives. A separate series of public review, hearings, and comments.
	State or regional (delegated) or local (delegated) department of natural resources or heritage program.	Endangered species review	2 months	Required to ensure that endangered/concerned species or habitats are not endangered.
	State or regional (delegated) or local (delegated) department of natural resources or historic preservation office.	Historical & archaeological review	2 months	Required to comply with Federal 106 review or to ensure that State historical/archaeological resources are not endangered.
	U.S. EPA, State or regional (delegated) or local (delegated) environmental protection agency.	Coastal Review for construction/conversion activities	TBD	May be required
	U.S. EPA, State or regional (delegated) or local (delegated) environmental protection agency.	Siting analysis (plan)	TBD	Required (for affected facilities) to comply with provisions of Municipal Waste NSPS rule and emission guidelines. Includes mandatory public participation and comment.
	U.S. EPA, State or regional (delegated) or local (delegated) environmental protection agency.	Materials separation plan	TBD	Required (for affected facilities) to comply with provisions of Municipal Waste NSPS rule and emission guidelines. Includes mandatory public participation and comment.

Certificates, Licenses, Permits, Plans, & Registrations

Overview of Possible Certificates, Licenses, Permits, Plans, and Registrations				
Venue	**Oversight**	**Need**	**Review Time**	**Considerations**
Air	State or regional (delegated) or local (delegated) environmental protection agency.	Air construction permit	12 months	Required for major, minor, new, reconstructed, or modified sources.
	State or regional (delegated) or local (delegated) environmental protection agency.	Air operating permit	12 months	Required for the commercial operation of new or existing major, minor, new, reconstructed or modified sources.
Water	State or regional (delegated) or local (delegated) environmental protection agency.	Surface water withdrawal registration	3 months	Required for withdrawal for projects of specified capacity.
	State or regional (delegated) or local (delegated) environmental protection agency.	Public water supply system	1 month	Required for projects that qualify as a public water system.
	State or regional (delegated) or local (delegated) environmental protection agency.	Construction in a floodplain	4 months	Required for projects in a floodway (river, stream, or adjacent wetlands).
	State or regional (delegated) or local (delegated) environmental protection agency.	Well permit	1 month	Required for new water wells in restricted areas.

Certificates, Licenses, Permits, Plans, and Registrations

Overview of Possible Certificates, Licenses, Permits, Plans, and Registrations				
Venue	**Oversight**	**Need**	**Review Time**	**Considerations**
Wastewater	State or regional (delegated) or local (delegated) environmental protection agency.	Water quality certification	4 months	Required by CWA for discharges and wetlands.
	State or regional (delegated) or local (delegated) environmental protection agency.	NPDES Industrial wastewater	6 months	Point source discharge effluent standards.
	State or regional (delegated) or local (delegated) environmental protection agency.	Wastewater treatment facility	2 months	Required for the construction of a new wastewater treatment facility.
	State or regional (delegated) or local (delegated) environmental protection agency.	Stormwater	6 months	General and individual permits. Requires associated SWMP (stormwater management plan).
Solid Waste	State or regional (delegated) or local (delegated) environmental protection agency.	Waste disposal system	8 months	Required for the collection, treatment, & disposal of sewage or industrial wastes.
Hazardous Waste	State or regional (delegated) or local (delegated) environmental protection agency.	Hazardous waste contingency plan	TBD	Required for the collection, treatment, & disposal of hazardous wastes.
	State or regional (delegated) or local (delegated) environmental protection agency.	Pollution prevention plan for hazardous materials	TBD	Required for the collection, treatment, & disposal of hazardous wastes.

Certificates, Licenses, Permits, Plans, and Registrations

Overview of Possible Certificates, Licenses, Permits, Plans, and Registrations				
Venue	**Oversight**	**Need**	**Review Time**	**Considerations**
Bulk Material Storage	State or regional (delegated) or local (delegated) environmental protection agency or fire marshal.	Underground storage tank registration	1 month	Required for regulated substances of specified capacity. Requires associated SPCC (Spill Prevention, Control, and Countermeasures) Plan in accordance with the requirements of 40 CFR 112.
	State or regional (delegated) or local (delegated) environmental protection agency or fire marshal.	Above-ground storage tank registration	1 month	Required for regulated substances of specified capacity. Requires associated SPCC (Spill Prevention, Control, and Countermeasures) Plan in accordance with the requirements of 40 CFR 112.
Noise	State or regional (delegated) or local (delegated) environmental protection agency.	Noise abatement	TBD	Required sound-proofing structures for specified activities and equipment.
Transportation	State or regional (delegated) or local (delegated) environmental protection agency.	Registrations w/ DOT for the transportation of raw materials and products	TBD	TBD
	State or regional (delegated) or local (delegated) environmental protection agency.	DOT security plan	TBD	TBD
	State or regional (delegated) or local (delegated) environmental protection agency.	Portage/barge access and reconstruction and storage	TBD	TBD

What's New in Combined Heat & Power

Air Permitting *Overview*

- Federal Rule Programs and Stationary Source Standards
  - NSPS
  - NESHAP
  - Air Permitting
    - Air Construction (New Source Review)
    - Air Operating (Title V)
- State and Local Rule Programs and Stationary Source Standards
  - Delegated Title V
  - FESOP
  - State-Origin
- CHP Stationary Source Applicability
  - NSPS and NESHAP Rules
    - Steam Generators
    - Combustion Turbines
    - IC Engines

What's New in Combined Heat & Power

Air Permitting

- Federal Rule Programs and Stationary Source Standards
  - Standards of Performance for Stationary Sources also known as New Source Performance Standards or NSPS:
    - Performance standards represent air emission limits and/or operating practices
    - Air emission limits represent best demonstrated technology
    - Apply to new, modified, or reconstructed sources
    - Apply to criteria pollutants (PM, SO_2, & NO_X)
    - Rule begins upon issuance of draft (proposed) rule
  - National Emission Standards for Hazardous Air Pollutants or NESHAP:

(Continued)

What's New in Combined Heat & Power

Air Permitting

- Federal Rule Programs and Stationary Source Standards
  - National Emission Standards for Hazardous Air Pollutants or NESHAP:
    - Performance standards represent air emission limits or operating practices.
    - Air emission limits represent Maximum Achievable Control Technology (MACT)
    - Apply to both new (new/modified/reconstructed) and existing sources
    - Apply to hazardous air pollutants (HAP) or their surrogates
    - Apply (typically) to major source facilities (single HAP @ 10 tpy/multiple HAP @ 25 tpy). [N.B. – Minor HAP sources are known as area sources and certain rules include area source provisions.]
    - Rule begins for new sources upon issuance of draft (proposed) rule and existing sources within 3 years of promulgation.

What's New in Combined Heat & Power

Air Permitting

- Federal Rule Programs and Stationary Source Standards
  - Air permitting
    - **Air construction**
      - Major sources
      - New Source Review (NSR)
      - Covers non-attainment NSR & attainment NSR (Prevention of Significant Deterioration or PSD)
      - Applies to new major sources or modification/reconstruction of existing major sources
      - Major new source threshold either 250 or 100 tpy
      - Major existing source modification thresholds can be 100/40/25/15 tpy depending on pollutant
      - Applicable primarily to criteria pollutants (PM forms/SO_2/NO_X/CO/VOC)
      - Requires Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) determination and air dispersion modeling

What's New in Combined Heat & Power

Air Permitting

- Federal rule programs and stationary source standards
  - Air Permitting
    - Air Construction
    - **Air Operating:**
      - o Operating permit analog of NSR major source air construction permit
      - o Major source definition under operating permit program different than air construction permit program
      - o Enabled by Title V of 1990 CAAA and known as Title V or Part 70 air operating permit (Part 70 rules program)
      - o Title V purportedly does not apply an additional set of requirements

What's New in Combined Heat & Power

Air Permitting

- Federal rule programs and stationary source standards
  - Air Permitting
    - Air Construction
    - **Air Operating:**
      - Applicable to major sources: criteria pollutant levels are ≥ 100 tpy (or NAA threshold level) and/or hazardous air pollutant (HAP) levels are > 10 tpy/25 tpy (1/multiple HAP), and/or subject to Federal NSPS or NESHAP rule
      - Renewable permit (5-yr)
      - Annual operating fees assessed against actual emissions on a dollars-per-ton basis.
      - Minor source variation, synthetic minor permit, is known as a Federally-Enforceable State Operating Permit or FESOP

What's New in Combined Heat & Power

Air Permitting

- Federal rule programs and stationary source standards
  - Air Permitting
    - Air Construction
    - **Air Operating:**
      - The FESOP is a variant of the Title V Part 70 air operating permit that has federal enforceability but is administered at the state agency level.
      - Operating restrictions are imposed to create a minor operating source that limit its emission condition.
    - State Agencies:
      - Air permitting programs coordinate with federal permitting programs
      - Delegated Part 70 authority and administer FESOP and lesser air permits applicable to restricted minor or true minor sources (state-origin air permits)

What's New in Combined Heat & Power

Air Permitting

Some comments about CHP rule applicability:

- Generally the CHP facility will follow the prime mover
- *If prime mover is a steam boiler, then the NSPS rule set for steam generators will dictate the allowable emissions*
- NSPS steam generator rules is the Subpart D set of 40 CFR 60:
  - Subpart D and Da for electric utility boilers
  - Subpart Db and Dc for large and small industrial-commercial-institutional boilers, respectively
  - Greater than 100 MM Btu/hr & less than 100 MM/hr down to equal to 10 MM Btu/hr, respectively
  - PM, SO_2, and NO_X depending on fuel category and annual utilization

What's New in Combined Heat & Power

Air Permitting

- NESHAP steam generator rules (CAMR for utility and Industrial Boiler MACT for ICI) were vacated and remanded for repromulgation.
- The Industrial Boiler MACT (40 CFR 63, Subpart DDDD) is due out this Fall. It should have requirements for particulate-phase trace element HAP (surrogate PM), volatile inorganic HAP (HCl & Hg), and organic HAP (surrogate CO). It *will be* more stringent than vacated rule, have an "area" (minor) source component, and apply to both new and existing sources.
- *If the prime mover is a combustion turbine (CT), then it is covered by both NSPS and NESHAP:*
- There are two CT NSPS rules:
  - Subpart GG (40 CFR 60, Subpart GG) effective Oct. 1977
  - Subpart KKKK (40 CFR 60, Subpart KKKK) effective July 2006

What's New in Combined Heat & Power

Air Permitting

- The CT NSPS rule Subpart KKKK (40 CFR 60, Subpart KKKK) effective July 2006 (construction/ modification/reconstruction after Feb. 15, 2005)
- The CT NSPS Subpart KKKK divides (subcategorizes) affected CT sources by size (fuel heat input of < 50 MM Btu/hr, 50 to ≤ 850 MM Btu/hr, & > 850 MM Btu/hr), fuel (NG or other), application (new vs. modified/reconstructed v new/modified/reconstructed), duty (electrical vs. mechanical), location (continental vs. non-continental), pollutant (NO_X varies and SO_2 does not change), standard (fuel quality vs. exhaust concentration vs. useful output), and application (heat recovery units such as HRSG)
- Affected HRSG and supplemental burners are exempt from NSPS Subparts Da, Db, or Dc.

What's New in Combined Heat & Power

Air Permitting

- There is one CT NESHAP rule:
  - NESHAP Subpart YYYY (40 CFR 63, Subpart YYYY)
  - Promulgated Mar. 2004
  - Affected units must be major sources of HAP (10 tpy/25 tpy)
  - Applies to new (new/modified/reconstructed) and existing units
  - PQNG fuel equipped with dry low-NO_X combustion (DLN or lean premix-fired technology) are deleted subcategories
  - Critical pollutant is HCOH (formaldehyde)
  - The HCOH control technology of choice is CO oxidation catalyst since it destroys the VOC component of UHC in the form of unsaturated or branches aliphatic and aromatic hydrocarbons
  - Unlike NSPS Subpart KKKK, duct burners in supplementally-fired HRSG units are *not* covered by this rule (treated as steam generating units)

What's New in Combined Heat & Power

Air Permitting

- *If the prime mover is an IC engine (ICE), then it is covered by both NSPS and NESHAP:*
  - NSPS Subpart IIII (40 CFR 60, Subpart IIII) applies to compression-ignition ICE:
    - Engine manufacturer tiered standards (Tiers 1, 2, 3, & 4)
    - Subcategorized by model year (tier), application (emergency vs. non-emergency), size (hp and cylinder displacement), and pollutants (PM, NO_X, HC, or NO_X+ HC)
  - NSPS Subpart JJJJ (40 CFR 60, Subpart JJJJ) applies to spark-ignition ICE:
    - Engine manufacturer standards
    - Subcategorized by size (bhp or kW), manufacturer date, fuel (PQNG, LPG, LFG, & BG), firing (LB vs. RB), pollutant (NO_X, CO, VOC, NO_X+VOC, or NO_X+UHC), and duty (emergency vs. non-emergency)

What's New in Combined Heat & Power

Air Permitting

- NESHAP Subpart ZZZZ (40 CFR 63, Subpart ZZZZ) applies to ICE units (all reciprocating internal combustion engines):
  - Applies to new (new/modified/reconstructed) and existing units
  - Applies to major (10 tpy/25 tpy) and area sources and small units (< 500 bhp)
  - Subcategorized by engine type (SI-ICE vs. CI-ICE), engine firing (4-stroke/2-stroke, rich burn/lean burn), and date
  - Critical pollutant is HCOH (formaldehyde) and CO (surrogate controlled via CO oxidation catalyst)

What's New in Combined Heat & Power

Organization of Presentation

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- Summary

What's New in Combined Heat & Power

Economic Stimulus

- American Recovery and Reinvestment Act (ARRA) of 2009 (PL 111-5) signed into law Feb. 17, 2009, appropriated nearly $800B through grant programs, tax credits, and R&D towards (among others) energy independence and renewable energy technologies. See: Division A, Title IV (Energy and Water Development, which provides $3.2B towards the Energy Efficiency and Conservation Block Grant (EECBG) Program.
- The EECBG Program, funded under ARRA, has allocated $2.7B in formula grants to US states, territories, local governments, and Indian tribes by authorizing Title V (Energy Savings in Government and Public Institutions) Subtitle E (Energy Efficiency and Conservation Block Grants) of the Energy Independence and Security Act (EISA) 2007.
- The EECBG Formula Grants was announced through a U.S. DOE Funding Opportunity Announcement (FOA) issued May 11, 2009 (0000013).

What's New in Combined Heat & Power

Economic Stimulus

- This FOA (0000013) offers grants for eligible government entities to reduce fossil fuel emissions, reduce energy usage, and improve energy efficiency in the building sector.
- EISA 2007 (PL 110-140) was enacted Dec. 19, 2007, with provisions to increase the supply of renewable alternative fuel sources, increase energy efficiency standards, reduce fossil fuel usage and emissions.
- EISA 2007 Title IV (Energy Savings in Building and Industry) Subtitle D (Industrial Energy Efficiency) was authorized through ARRA via DOE FOA 0000044. EISA Title IV Subtitle D Sections 451 to 453 addresses industrial energy efficiency, energy-intensive industries, and energy efficiency for data center buildings. FOA 0000044 offers grants ($256 MM in combined value of which $156 MM is marked for CHP, DE, and efficient industrial equipment) for deployment of CHP systems, district energy (DE) systems, waste energy recovery systems, and efficient industrial equipment.

What's New in Combined Heat & Power

Economic Stimulus

- Energy Improvement and Extension Act 2008 was enacted on Oct. 03, 2008, as part of the Emergency Economic Stabilization Act (PL 110-343) and offered several provisions to CHP deployment:
  - Investment tax credit (ITC) for CHP and waste energy projects through CY2016.
  - Extension of 5-yr accelerated depreciation schedule for CHP applications.
  - Extension of existing ITC for fuel cells (30%) and microturbines (10%) through CY2016.
  - Extension of renewable energy tax credits through 2010.
- Energy Policy Act (EPAct) 2005 was enacted on Aug. 08, 2005, authorized the development of competitive grant programs, demonstration and testing initiatives, and tax incentives that promote the production of use of alternative fuels and advanced vehicles. EPAct 2005's Section 721 was re-authorized by ARRA 2009 per Title IV of Division A (awardees will be state and local governments & metropolitan transportation authorities).

What's New in Combined Heat & Power

Organization of Presentation

- Introduction
- Overview
- Basics
- Benefits
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- Overview of Technologies
- Permitting
- Economic Stimulus
- ***Summary***

What's New in Combined Heat & Power

Summary

What's new in combined heat & power is renewed interest in its benefits relative to the demands of Renewable Portfolio Standards (RPS), Energy Efficiency Resource Standards (EERS), and greenhouse gas (GHG) emissions. CHP is the concurrent generation of multiple forms of useful energy through an integrated system from a single fuel source. CHP, which is characterized by the type of prime mover that drives the overall system, typically includes internal combustion engines, combustion turbines, microturbines, steam turbines, and fuel cells. CHP offers energy, environmental, and cost benefits relative to separate heat and power (SHP) applications. CHP applications can be located at the point of use and avoid the T&D losses associated with SHP applications. CHP deployment is versatile and can be coupled with existing and planned technologies for many different applications in the industrial-commercial-institutional sectors.

What's New in Combined Heat & Power

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