



# The CHP Emissions Calculator

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**U.S. EPA CHP Partnership**

*EPA's Clean DG Policy and CHP Webinar Series*

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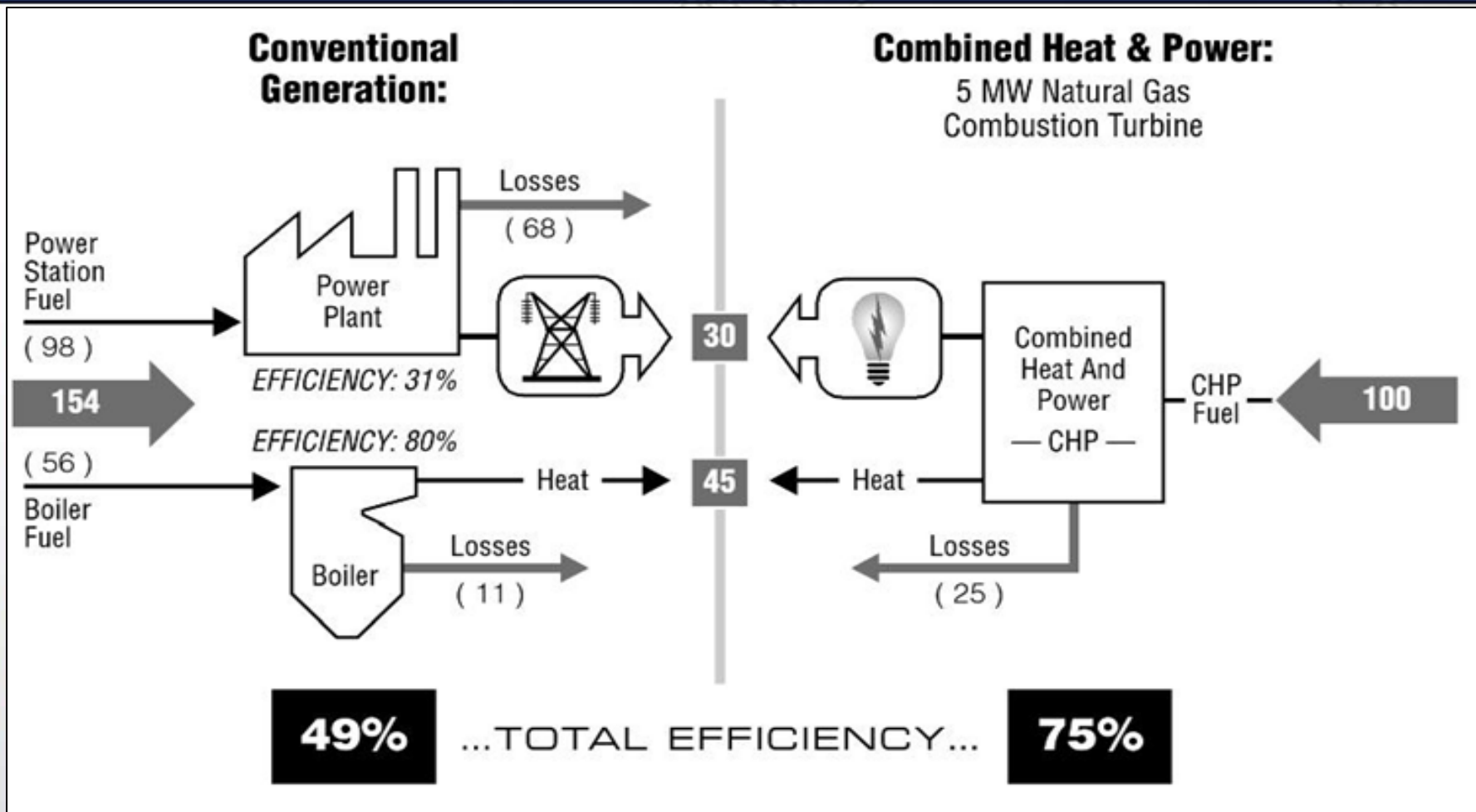
# EPA CHP Partnership

- Voluntary program that seeks to reduce the environmental impact of power generation by promoting the use of highly-efficient CHP
- Works with clean energy stakeholders from the private and public sectors to support the deployment of new CHP projects and to promote their energy, environmental, and economic benefits
- 3 Core Activities
  - Education & Outreach
  - Technical Assistance for CHP Projects
  - Public Recognition
- Through 2007, the CHPP has helped put into operation more than **335 CHP projects** representing **4,450 MW** of capacity, resulting in the emission reductions of over **51 million tons CO<sub>2</sub>**

# CHP as Pollution Prevention

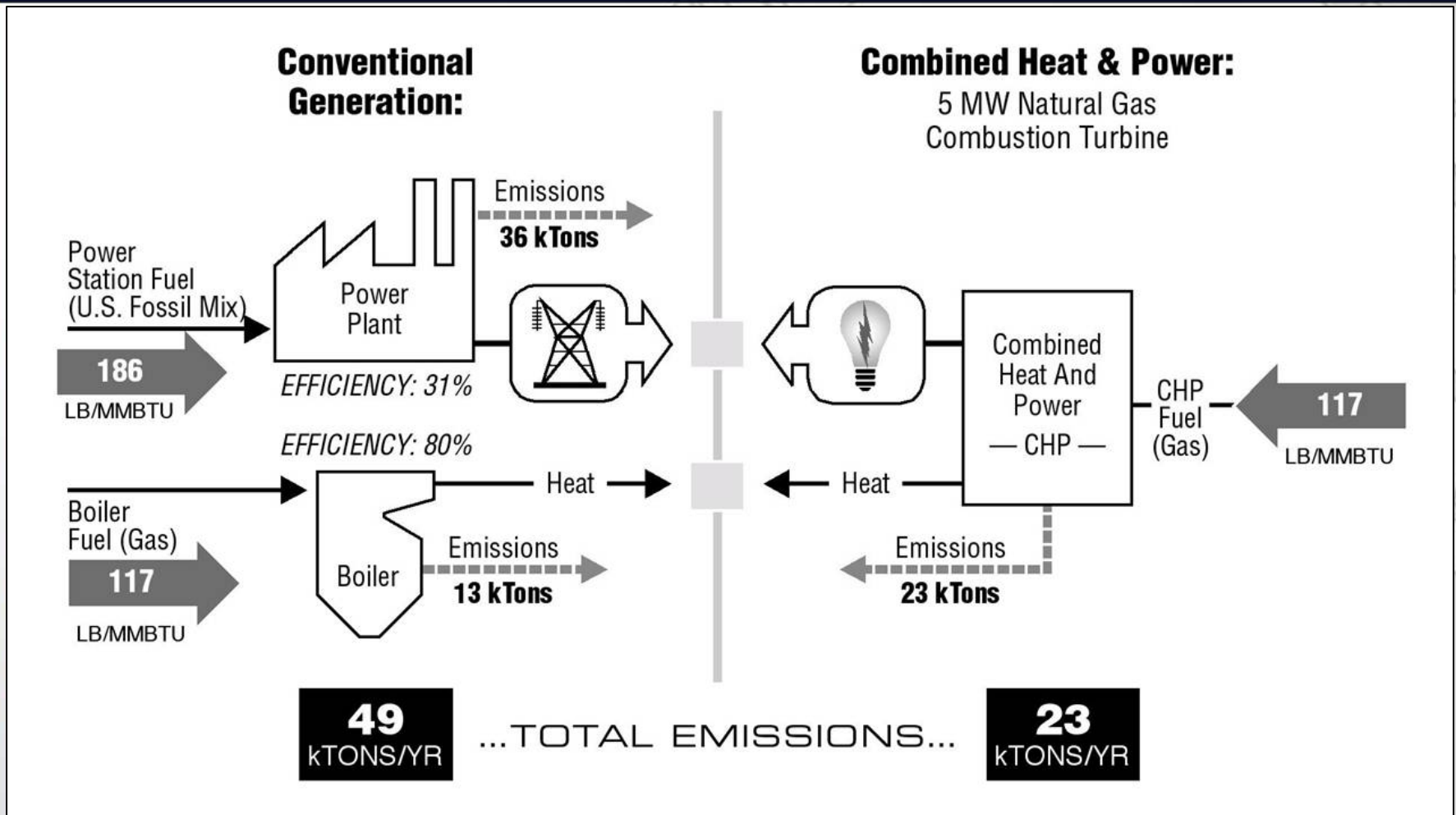
- CHP provides energy services more efficiently than separate heat and power
- Efficiency gains translate into emission reductions
  - Direct and Indirect
  - Greenhouse Gas Emissions
  - Criteria pollutants

# The Efficiency Benefits of CHP



Source: ICF

# Environmental Benefits of CHP – CO<sub>2</sub> Example



Source: ICF

# The CHP Emissions Calculator

- Calculates **CO<sub>2</sub>**, **SO<sub>2</sub>**, and **NO<sub>x</sub>** emissions from a user-defined CHP system
- Compares a specific CHP system to equivalent separate heat and power (SHP)
- Requires as few as 3 CHP system-specific inputs; can customize up to 31 fields
- Outputs
  - Energy Savings
  - CHP and SHP emissions
  - CHP emissions reductions and relational benefits (e.g. acres of forest, emissions from cars)

# The CHP Emissions Calculator

- **CHP System Definitions and Assumptions**
  - Adaptable for generation equipment: Gas turbine, recip. engine, fuel cell, microturbine, boiler/steam turbine, other
  - Fuel flexible: Natural gas, coal, oil, biomass, other
  - May utilize user-defined or default values for various system characteristics (e.g. efficiency, thermal output, fuel specs, emission rates)
- **Separate Heat and Power Assumptions**
  - May utilize user-defined or default values for displaced thermal efficiency and emission rates
  - Displaced central station assumptions based on eGRID  
Customizable by NERC region, State, fuel type

# Applications of the CHP Emissions Tool

- Quantify, understand and recognize environmental benefit of projects
- Public recognition
  - EPA CHP and ENERGY STAR® Awards
  - EPA CHP Partnership Letters of Recognition or Support available to Partners
- Public education up-front

# Example: Estimate of Benefits – Newmarket, NH



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

OFFICE OF AIR AND RADIATION

Climate Protection Partnership Division

U.S. EPA 6202J  
Washington, DC 20460

March 22, 2006

Mr. Bob Coffey  
President  
Green Power Management, Inc.  
11 Huckins Dr.  
Newmarket, NH 03857

Dear Mr. Coffey,

On behalf of the US Environmental Protection Agency we have determined that the Town of Newmarket project in New Hampshire is expected to achieve

On March 1, 2006, Green Power Management, Inc. Heat and Power Partnership of the Town of Newmarket developed a three-phased distributed generation project in Newmarket, NH. The project consists of a natural gas-fired combustion turbine-based combined cycle power plant, a solar array, and a displaced natural gas-fired boiler. The entire project is expected to have a capacity of 11 MW<sub>e</sub> from turbine generators and include 430,000 solar panels.

Based on our analysis, the project will have a considerable emissions reduction impact. We estimate that the project will reduce annual CO<sub>2</sub> emissions by 208,000 tons - equivalent to removing the emissions of approximately 35,500 cars each year.

We calculate that your prospective project will reduce emissions by the following amount, by displacing emissions from less efficient electric and heat production systems:

- Carbon dioxide (CO<sub>2</sub>) emissions by 54%,
- Nitrogen oxides (NO<sub>x</sub>) emissions by 65%, and
- Sulfur dioxide (SO<sub>2</sub>) emissions by 100%

Our analysis was based on performance specifications for typical gas-fired combustion turbines and solar arrays, conservative solar insolation data for New Hampshire, EPA's E-GRID 2000 emissions data for fossil fuel-fired sources in the state of New Hampshire, and estimated emissions from a displaced natural gas-fired boiler.

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# Example: Tool Used for Cornell Univ. Factsheet



Cornell University

## CORNELL COMBINED HEAT AND POWER PROJECT

### Project description

The Cornell Combined Heat and Power Project will add two gas turbine generators, totaling a nominal 30,000 kilowatts of electrical output with heat recovery steam generators, at the current central heating plant. A gas turbine generator, which is a type of internal combustion engine, is a device that converts energy stored in the fuel to useful mechanical energy in the form of rotational power. The gas turbines will combust natural gas to provide the power necessary to turn a large electric generator. Waste heat leaving the gas turbines will then provide the heat energy to produce steam for campus needs. The project will complement the current cogeneration and hydroelectric facilities on campus. An approximately 15,000 square-foot addition south of the existing central heating plant on Route 366 will house the new equipment.

### What is combined heat and power?

Combined heat and power (CHP) is the simultaneous production of electricity and utilization of waste heat for local heating requirements. Exhaust heat leaving the gas turbine electric generator is used by a heat-recovery boiler to produce steam. Steam generated in the waste-heat boiler then produces more electrical power in a steam turbine generator as it goes to campus for heating and thermal needs. CHP systems are typically 35 percent more efficient than conventional methods to supply heat and electricity.

### Anticipated emission savings

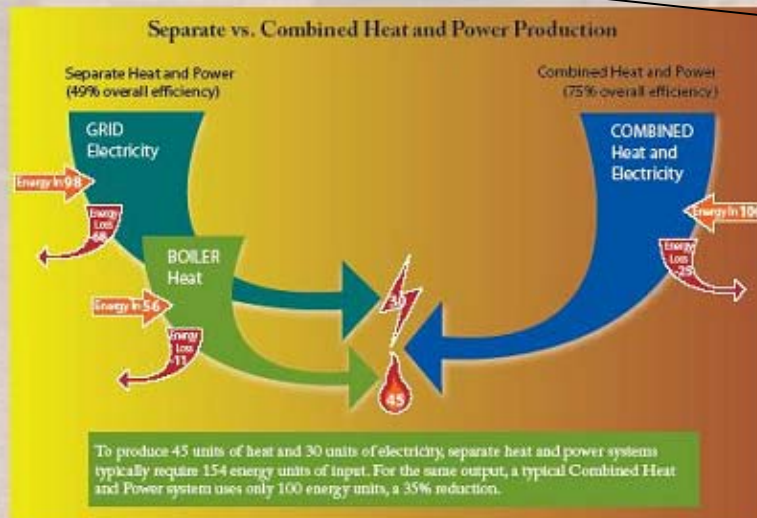
This project will significantly reduce the emission of greenhouse gases and acid rain precursors associated with Cornell's operations. It is anticipated that this project will accomplish the following annual reductions due to the offset of on-site coal combustion and grid power:

CO<sub>2</sub> - 50,000 tons/yr  
NO<sub>x</sub> - 250 tons/yr  
SO<sub>2</sub> - 800 tons/yr

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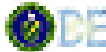

# Sample Calculation – “College”

- Based on ENERGY STAR CHP award
- Gas-fired, base-loaded CHP system
  - Natural gas fueled
  - Single gas turbine
  - Heat recovery steam generator
  - Steam at 150 psig to central heating
- 15.0 MW power output
- 90 MMBtu/hr steam (unfired); 157 MMBtu/hr (fired)
- Net electric efficiency of turbine = 30.7% (HHV)
- 7,500 full load hours/year
  - 112,500 MWh generated,

# For More Information & To Download

[www.epa.gov/chp/basic/calculator.html](http://www.epa.gov/chp/basic/calculator.html)

**CHP Results**

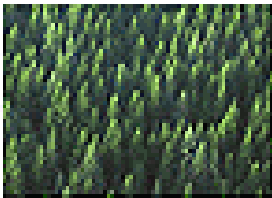
**Annual Emissions Analysis**

	CHP System	Deployed (Electricity Production)	Deployed (Thermal Production)	Emissions Reduction	Percent Reduction
1	NG (combined)	23.00	204.00	4,000	98.00%
2	NG (combined)	0.00	142.75	4,171	600%
3	CO2 (combined)	20,701	10,200	30,700	70%
4	Carbon dioxide (total)	20,701	10,200	30,700	70%
5	Fuel Consumption (MWh/yr)	20,701	10,200	14,500	100%
6	CO2 (total)	20,701	10,200	30,700	100%
7	CO2 (total)	20,701	10,200	30,700	100%
8	CO2 (total)	20,701	10,200	30,700	100%
9	CO2 (total)	20,701	10,200	30,700	100%
10	CO2 (total)	20,701	10,200	30,700	100%
11	CO2 (total)	20,701	10,200	30,700	100%
12	CO2 (total)	20,701	10,200	30,700	100%
13	CO2 (total)	20,701	10,200	30,700	100%
14	CO2 (total)	20,701	10,200	30,700	100%
15	CO2 (total)	20,701	10,200	30,700	100%
16	CO2 (total)	20,701	10,200	30,700	100%
17	CO2 (total)	20,701	10,200	30,700	100%
18	CO2 (total)	20,701	10,200	30,700	100%
19	CO2 (total)	20,701	10,200	30,700	100%
20	CO2 (total)	20,701	10,200	30,700	100%
21	CO2 (total)	20,701	10,200	30,700	100%
22	CO2 (total)	20,701	10,200	30,700	100%
23	CO2 (total)	20,701	10,200	30,700	100%
24	CO2 (total)	20,701	10,200	30,700	100%
25	CO2 (total)	20,701	10,200	30,700	100%
26	CO2 (total)	20,701	10,200	30,700	100%
27	CO2 (total)	20,701	10,200	30,700	100%
28	CO2 (total)	20,701	10,200	30,700	100%
29	CO2 (total)	20,701	10,200	30,700	100%
30	CO2 (total)	20,701	10,200	30,700	100%
31	CO2 (total)	20,701	10,200	30,700	100%
32	CO2 (total)	20,701	10,200	30,700	100%
33	CO2 (total)	20,701	10,200	30,700	100%
34	CO2 (total)	20,701	10,200	30,700	100%
35	CO2 (total)	20,701	10,200	30,700	100%
36	CO2 (total)	20,701	10,200	30,700	100%
37	CO2 (total)	20,701	10,200	30,700	100%
38	CO2 (total)	20,701	10,200	30,700	100%
39	CO2 (total)	20,701	10,200	30,700	100%
40	CO2 (total)	20,701	10,200	30,700	100%


This CHP project will reduce emissions of Carbon Dioxide (CO2) by 75,773 tons per year  
This is equal to 29,045 metric tons of carbon equivalent (MTC) per year

This reduction is equal to the carbon absorbed by 28,845 acres of forest

This reduction is equal to the carbon absorbed by 12,276 cars off the road



OR



# Contact

For specific questions or comments related to the CHP Emissions Calculator, please contact the CHP Partnership Helpline.

## CHP Partnership Helpline

(703) 373-8108

[chp@epa.gov](mailto:chp@epa.gov)