

Introduction to Combined Heat and Power (CHP)

**And Feasibility Analysis of Potential
Projects**



What is Combined Heat and Power (CHP)? **Also known as Cogeneration**

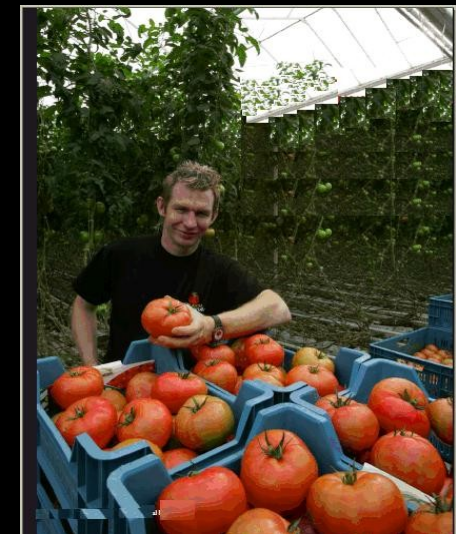
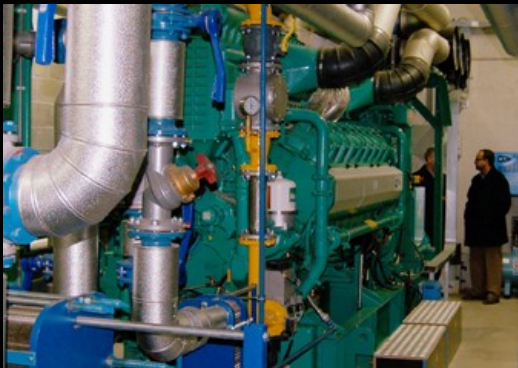
- Simultaneous on-site production of electrical and thermal energy from a single source of fuel

Electrical load is typically consumed at the facility

Typical thermal loads include heating, cooling, steam, ice and chilled water

Some Examples

- Belgian Tomato Grower
- Fonda Fultonville School in NY
- Pharmaceutical Lab in CA
- Anaerobic Digester in Canary Islands
- County Jail in CA
- Hospitals in Canada
- Manufacturing Facility in CA



Why Cogeneration?

- Improved Efficiency

In excess of double the useable energy compared to centralized power

Overall efficiency can approach 90%

- Improved Environmental Footprint

Less fuel burned yields less undesirable emissions

Clean fuel source → lower NO_x and particulate emissions

Reduction in Greenhouse Gasses

Why Cogeneration?

- Improved Electrical Reliability
 - Reduce dependency on overtaxed electrical infrastructure
 - Backup capability
- Financial Savings Due to
 - Improved Efficiency
 - Spark Spread
 - Government Financial Incentives

Costs of Cogeneration

- Capital

 - Dollar value varies with scope and complexity

 - Typical range is \$1500 to \$2000 per kw, installed

- Fuel

 - Generally between \$6 and \$12 per mmBtu

- Operation and Maintenance

 - Primarily maintenance which can range from \$0.01 to \$0.02 per kWh

Is Cogeneration for Me?

- Key Economic Factors

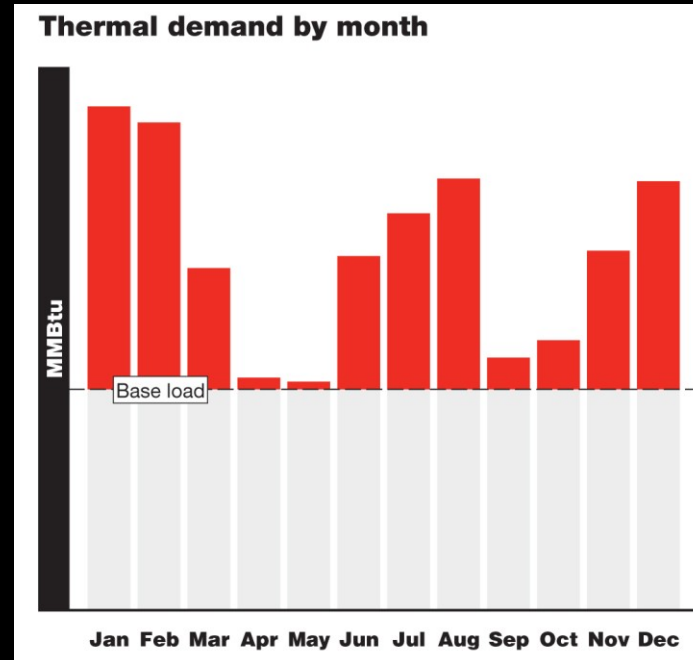
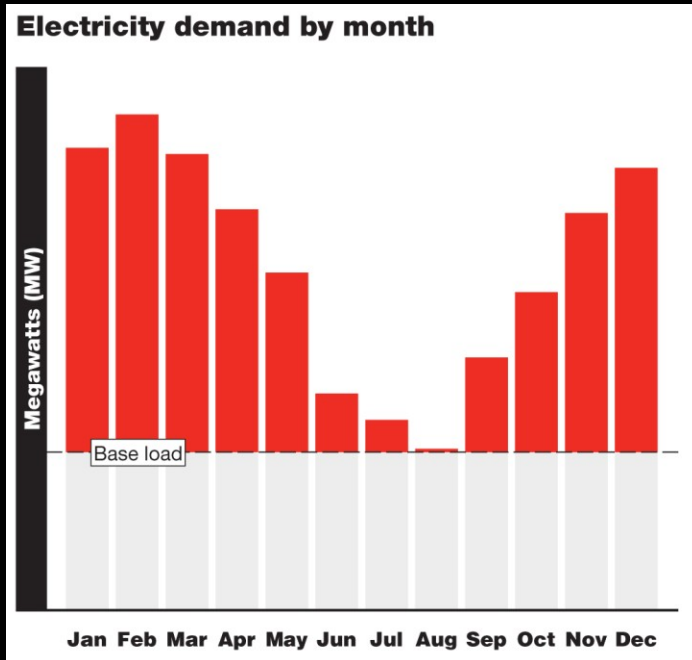
Simultaneous electrical and thermal load

Cost ratio of producing power with natural gas to purchase price from electric utility or “Spark Spread”

Government Incentives and Rebates

Is Cogeneration for Me?

- Evaluate Load Profile



Is Cogeneration for Me?

- Simple Payback Analysis

Inputs

Average cost for electrical energy (\$/kWh)

Average cost for gas (\$/mmBtu)

Output

Compare the inputs with the following payback chart

CHP Payback Calculator

Electricity (\$/kWh)

\$/MMBtu	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
↓ 13.00	-14.67	-28.57	-539.27	31.96	15.52	10.25	7.65	6.10	5.08	4.34	3.80	3.37
12.80	-15.54	-32.04	517.80	28.51	14.66	9.86	7.43	5.96	4.98	4.27	3.74	3.33
12.60	-16.51	-36.46	174.92	25.73	13.89	9.51	7.23	5.83	4.89	4.21	3.69	3.29
12.40	-17.61	-42.29	105.24	23.45	13.19	9.18	7.04	5.71	4.80	4.14	3.64	3.25
12.20	-18.87	-50.36	75.26	21.54	12.57	8.87	6.86	5.59	4.71	4.06	3.59	3.21
12.00	-20.32	-62.22	58.57	19.91	12.00	8.58	6.68	5.47	4.63	4.04	3.54	3.17
11.80	-22.01	-81.39	47.94	18.52	11.47	8.31	6.52	5.36	4.56	3.95	3.50	3.13
11.60	-24.01	-117.63	40.58	17.30	11.00	8.06	6.36	5.25	4.47	3.90	3.45	3.10
11.40	-26.41	-212.06	35.17	16.24	10.56	7.82	6.21	5.15	4.40	3.84	3.41	3.06
11.20	-29.35	-1075.23	31.04	15.30	10.15	7.60	6.07	5.05	4.33	3.78	3.36	3.03
11.00	-33.01	350.19	27.78	14.46	9.78	7.38	5.93	4.96	4.26	3.73	3.32	2.99
10.80	-37.73	15.58	25.13	13.71	9.43	7.18	5.80	4.87	4.19	3.68	3.28	2.96
10.60	-44.02	95.91	22.95	13.03	9.10	6.99	5.68	4.78	4.12	3.63	3.24	2.92
10.40	-52.82	70.36	21.12	12.42	8.80	6.81	5.56	4.69	4.06	3.58	3.20	2.89
10.20	-66.01	55.56	19.55	11.86	8.52	6.64	5.44	4.61	4.00	3.53	3.16	2.86
10.00	88.01	45.91	18.21	11.35	8.25	6.48	5.33	4.53	3.94	3.48	3.12	2.83
9.80	-131.98	39.11	17.03	10.89	8.00	6.32	5.23	4.46	3.88	3.44	3.09	2.80
9.60	-263.76	34.07	16.00	10.46	7.76	6.18	5.13	4.38	3.83	3.40	3.05	2.77
9.40	-275.00	30.17	15.09	10.06	7.54	6.03	5.03	4.31	3.77	3.35	3.02	2.74
9.20	264.56	27.06	14.27	9.69	7.33	5.90	4.93	4.24	3.72	3.31	2.98	2.71
9.00	132.18	24.56	13.54	9.35	7.14	5.77	4.84	4.17	3.67	3.27	2.95	2.69
8.80	88.10	22.47	12.88	9.03	6.95	5.65	4.76	4.11	3.62	3.23	2.92	2.66
8.60	66.06	20.71	12.28	8.73	6.77	5.53	4.67	4.05	3.57	3.19	2.89	2.63
8.40	52.85	19.21	11.74	8.45	6.60	5.42	4.59	3.98	3.52	3.15	2.85	2.61
8.20	44.04	17.90	11.24	8.19	6.44	5.31	4.51	3.93	3.47	3.12	2.82	2.58
8.00	37.75	16.77	10.78	7.94	6.29	5.20	4.44	3.87	3.43	3.08	2.79	2.56
7.80	33.03	15.77	10.36	7.71	6.14	5.10	4.36	3.81	3.38	3.04	2.76	2.53
7.60	29.36	14.88	9.96	7.49	6.00	5.01	4.29	3.76	3.34	3.01	2.74	2.51
7.40	26.42	14.09	9.60	7.28	5.87	4.91	4.22	3.71	3.30	2.97	2.71	2.48
7.20	26.42	14.09	9.24	7.07	5.74	4.83	4.15	3.66	3.26	2.94	2.68	2.45
7.00	26.42	14.09	8.88	6.86	5.61	4.75	4.08	3.61	3.22	2.91	2.65	2.42

Is Cogeneration for Me?

■ Industrial

- Chemical processing
- Food and feed processing
- Commercial bakeries
- Data centers
- Refrigerated warehousing
- Wastewater treatment
- Garbage digesters and landfills

■ Commercial

- Schools and universities
- Greenhouses
- Large office complexes
- Health care facilities
- Hotels and resorts
- Health clubs and spas
- Swimming pools

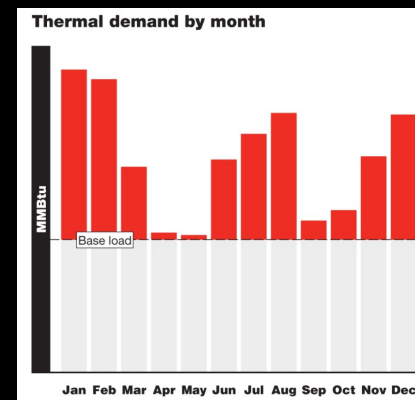
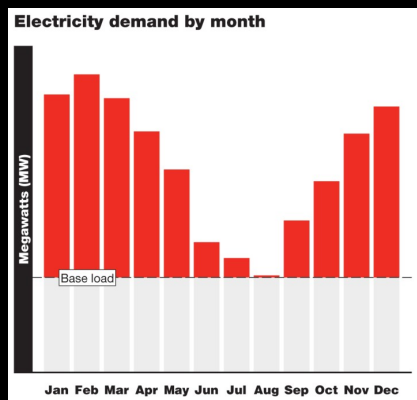
Getting Started

■ Preliminary Sizing

Identify Baseload

- Thermal
- Electrical

Match Cogeneration Plant to Minimum Baseload



Getting Started

- **Seek Expert Advice**
 - Conduct detailed load profile study
 - Evaluate the specific uses of thermal energy
 - Refine the financial analysis to verify viability
 - Proceed with design and selection process
- **Cummins Power Generation can Assist**
 - Analysis
 - Design and Engineering
 - Project Management
 - Installation and Operation

Example Potential Project Evaluation

■ Commercial Facility in California

Loads

- Electric – 12,400,000 kWh per year, peak 2,656 kW
- Thermal – 500 tons of cooling, peak 1000 tons

Energy Costs

- Electric – average of \$0.15 per kWh
- Natural Gas - \$11 per mmBtu

CHP Payback Calculator

Electricity (\$/kWh)

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Page

Example Potential Project Evaluation

■ Commercial Facility in California

The Solution

- Cummins 1250 kW Lean Burn Natural Gas Genset
- SCR
- Exhaust Heat Drives 250 ton Absorption Chiller
- Overall Efficiency – 86%
- Cost of Electricity - \$0.12 per kWh
- 4.2 mmBtu per hour of thermal energy

Industrial Campus Using Cogeneration



Industrial Campus Using Cogeneration



Cogeneration

- Open Discussion...

Related Links

www.cumminspower.com

www.northeastchp.org

www.nemw.org

www.energy.ca.gov/distgen/index.html

www.distributedenergy.com/de.html

www.dsireusa.org

www.cospp.com

uschpa.admgt.com

www.aeecenter.org

www.localpower.org

<http://www.epa.gov/CHP>

Related Programs

- CA DG Emissions Certification
- Renewable Energy Credits
- Utility Interconnect Standards – Rule 21
- State Funded Loans
- Cogen Gas Rates

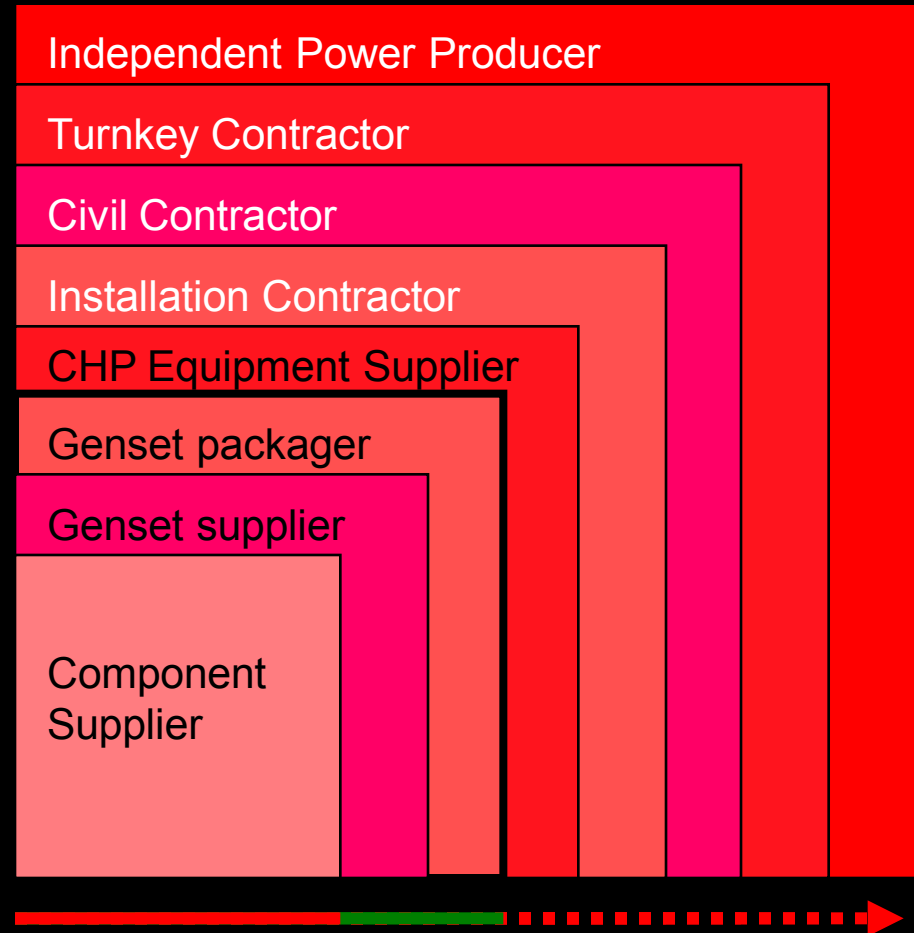
Energy Solutions Business Who We Are

A single point of contact for:

- Project design*
- Equipment specification*
- Installation & commissioning*
- Financing*
- Power guarantees*
- Guaranteed maintenance contracts*

Integration is the “Power of One”

- Integrated Power Command*
- Lean burn gas generator sets*
- Diesel generator sets*
- Digital Master Controls*
- Paralleling switchgear*
- Transfer switches... and more*



Cummins Contact Information

- Presenter

Kelly Samons

Cummins Power Generation

Energy Solutions Business

kelly.s.samons@cummins.com

812-405-2418

- General Manager

Donald Fisher

donald.k.fisher@cummins.com

973-316-6040