BCHP Baseline Analysis for the Missouri Market

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Executive Summary

The purpose of this baseline analysis is to assess the prevailing environment for Building Combined Heat and Power (BCHP) electric generation from a regulatory, private-market and technology perspective in the state. This information will be used to develop educational and market transformation programs, which will foster BCHP applications.

In Missouri there are currently about 26 technical companies actively pursuing BCHP deployment and installations. Companies that are leading the way for BCHP in Missouri are Sega Inc., Vaporphase Engineering Controls Inc., and Laclede Gas Company.

Focusing on BCHP systems in commercial installations, the Midwest CHP Application Center (MAC) identified a total of 9 BCHP systems and target sites, producing over 153,000 kW in Missouri. Schools and Universities seem to be particularly attractive candidates for BCHP in Missouri, followed by district heating systems.

Capital costs as well as operating costs are generally viewed as some of the major hurdles to utilize BCHP technologies. For smaller generating capacity units, this initial cost can have a long payback period unless electric costs are very high and thermal loads well matched. The predominant technologies in BCHP power generation utilize natural gas. They range in size from reciprocating engines and microturbines in the tens of kilowatts to gas turbines in the tens of megawatts range. The least expensive technologies (large natural gas turbines) installed start around $600/kW and increase in cost up to fuel cell technologies that may cost up to $5,000/kW. Natural gas reciprocating engines are the predominate technology, and can range in price from $1,000 to $1,800/kW (installed). Prices of all of these technologies are expected to decrease as the technologies and system designs become more common. Pre-designed packaged CHP systems are beginning to enter the market. Hopefully these packaged design systems, which have been developed for a wide range of applications, will contribute to the reduction in the cost of installing a BCHP system.

For most BCHP systems natural gas constitutes the majority of the variable/operating cost. Volatile natural gas prices, such as those experienced in the winters of 2000/2001 and 2002/2003, could have negative affects on the BCHP market development. Furthermore, natural gas prices in Missouri are already the highest in the Midwest at $7.08 $/MMBtu (average price sold to commercial consumers in 2002). In contrast, Missouri exhibits the lowest electricity prices in the Midwest at 5.44¢/kWh (year-to-date through May 2003).

On the regulatory side in Missouri net metering is available for small biomass-based CHP facilities with a capacity of less than 100 kW. Also, there are currently no exit fees charged to facilities that elect to generate their own electricity.

High backup/standby-fees by local electric utility companies can be particularly discouraging for CHP installations, since many CHP facilities prefer to remain interconnected to use the electric grid as a backup during equipment maintenance and outages. A CHP facility with backup power needs in Ameren Union Electric's territory, Missouri's largest electric utility company, would be subject to Ameren's Supplemental Service Rate, Rider E, which is extremely

discouraging for CHP facilities. This rate structure commits facilities to a so-called "Minimum Bill," which the CHP facility has to pay regardless of the amount of electricity displaced by the CHP system.

The most effective deployment of BCHP technology will come from regional and local activities. This is true because most of the barriers are due to local issues, such as site permitting, interconnection requirements and studies, local utility pricing, and local building codes and standards. These barriers can be overcome with support from regional and local entities. Some of the entities that the MAC has identified that could assist with the development and/or deployment of BCHP in Missouri are:

- Governor's Energy Policy Council
- Missouri Department of Natural Resources Energy Center
- Missouri Public Service Commission
- Midwest CHP Initiative

Missouri's Governor Bob Holden has established an Energy Policy Council to serve as an advisory capacity to the Governor. The Governor's Energy Policy Council in its June, 2003 report recommends establishing a Public Benefits Fund to provide support to programs that "protect low-income Missourians, promote energy efficiency, provide energy education and assist in the development and use of Missouri's renewable energy resources." This report also recommends to "increase the effectiveness of energy efficiency in state facilities by implementing 'performance contracting' and allowing state agencies to retain a portion of energy savings."

Furthermore, informal discussions are currently being conducted between the Missouri Energy Center, the Air Pollution Control Program, and the Missouri Public Service Commission on reducing barriers to CHP adoption. These are potentially very promising developments for CHP in Missouri.

ONSITE Energy Corporation in January 2000 prepared a study for the Energy Information Administration titled "The Market and Technical Potential for Combined Heat and Power in the Commercial/ Institutional Sector." For Missouri, ONSITE estimated a total market potential for electric production to be in the range of 1,320 to 2,410 MW. The market potential for multi-unit residential BCHP installation in Missouri for 2002 is estimated to be about 13,500 units, based on information collected by the UIC/ERC/MAC for this report.

Missouri has also a significant potential for biomass based CHP applications. The state is home to two ethanol facilities that produce approximately 40 million gallons of ethanol annually. The Governor's Council report points out that biodiesel demand has tripled over the last year and that the potential exists for an additional facility with an annual capacity of 15-20 million gallons. Ethanol facilities are good candidates for CHP since a) they have high energy demands, both thermal and electric, and b) the rejected heat in the exhaust from the electric generation equipment can be used in the ethanol production process or the waste gas from the ethanol production process potentially may be "burned" in the primemover to reduce volatile organic compounds (VOCs) formed as part of the ethanol production process.

These market potentials may only be realized if the regulatory and policy issues become more supportive of BCHP installations.

This report concludes with recommendations, which address the need to work with state regulators to educate private market participants on BCHP benefits. Case studies are needed which show the tremendous economic and environmental benefits of BCHP systems. As mentioned above alliances have to be formed with already influential groups in the BCHP field such as the Governor's Energy Council, the Missouri Department of Natural Resources, Laclede Gas Company, and others to develop synergies between these companies and the Midwest CHP Application Center to promote the use of BCHP.

1. Introduction and Purpose

The purpose of this analysis is to assess the current status of the BCHP sector in Missouri and identify current hurdles that prevent the widespread use of BCHP systems. This information will be used to identify target markets for BCHP systems as well as development of education and market transformation programs, which will foster BCHP applications. Finally, an action plan will be developed to further BCHP deployment in Missouri.

Cooling, Heating, and Power for Buildings (BCHP) refers to technologies which generate electricity at or near the point of use, such as a building or building complex, while simultaneously recovering up to 80% of the rejected heat from the generating equipment for heating, cooling and/or dehumidification purposes.

In order to assess the current state of BCHP in Missouri, a comprehensive survey of key players involved with this technology was conducted. Key engineering firms, manufacturers, distributors, architectural firms, energy suppliers and federal, state and local agencies were identified. Furthermore a survey of existing and pending BCHP installations was conducted.

In this report, the initial cost of current BCHP related technologies were evaluated to assess their impact on the marketability of BCHP.

A status assessment of policy related issues pertaining to BCHP was conducted. The assessment was performed for several policy areas: CHP stand-by rate provisions, exit fees, net metering, general status of electric deregulation in the state, emerging legislation, and potential partners/advocates of BCHP.

The market capacity potential for BCHP in Missouri was evaluated to identify the best target sectors for deployment.

This report concludes with recommendations to effectively promote the deployment of BCHP in Missouri.

2. BCHP Contacts in Missouri

2.1 Key Firms in Missouri with BCHP Project Experience or Capabilities

One of the major methods to promoting market acceptability of BCHP technologies is to engage the efforts of commercial firms that can promote the installation of BCHP technologies. Besides those that can benefit directly through profits and savings from BCHP, there are other firms which have the interest and capability to get involved with BCHP applications either because they promote energy efficiency, green building technologies, or have other BCHP supporting missions. The purpose of this section is to identify those key firms that currently exist and that can be allied with the Midwest CHP Application Center to promote the deployment of BCHP in Missouri.

There are about 26 companies in Missouri that are engaged in BCHP system applications or have BCHP system capabilities. Hopefully in the near future interest in BCHP applications will increase even more because of the activities of a multitude of local and regional organizations that are involved with the promotion of BCHP applications.

Architectural and Engineering firms are important to promoting BCHP technologies because the most economical time to install a BCHP system is during the construction of a new building or during an extensive renovation, when the central heating and cooling plant is being initially installed or completely replaced. This is because the payback period associated with the cost to install a BCHP system need only be justified on the cost differential between the BCHP system and a conventional central cooling/heating system which otherwise would have to be installed. Architectural and engineering firms are generally engaged in the design and installation of such facilities in commercial and light industrial applications. Appendix A provides information on architectural firms and engineering firms that are potential allies in the promotion of BCHP installation in Missouri. There are currently about 16 architectural and engineering firms that have developed or have the capabilities to develop BCHP systems in Missouri.

Manufacturers of power generation equipment, absorption chillers, and desiccant dehumidification equipment, and their sales representatives are important to promoting BCHP technologies for obvious reasons, to sell their equipment. In most cases these manufactures have established a market presence and have built relationships with those most likely to install BCHP technologies. Just recently, the manufacturing community, with support form the US DOE, has begun to introduce into the market pre-designed "packaged" CHP systems applicable to a wide variety of applications. These units range in size from 60 kWe to tens of MWe, and are designed so that they can be used in "multiples" to increase their effective size. As packaged type system become more common place, the intial cost of installing a BCHP system is expected to decrease because of the pre-designed aspects of the systems. In the mean time, it is still important to strive to find technically and financially suitable applications where manufactures can work with engineering and architectural firms to install "custom" systems. Appendix B provides information on manufacturers that promote BCHP installations in Missouri. There are currently approximately 10 manufactures/sales offices involved in deployment of BCHP related technologies in Missouri.

Property management firms are important in promoting BCHP technologies because they are the operators of many commercial buildings for which BCHP technologies are

suitable. Building codes for commercial buildings often times require emergency generation backup-power. Since property management firms are already required to install generation equipment, the cost differential to install BCHP over a conventional central heating/cooling system and backup generation capability is again smaller and easier to justify. The two main organizations that represent property management firms in Missouri are BOMA (Building Owners and Managers Association) and IREM (Institute of Real Estate Managers), which accredits recognized real estate management organizations. Information on the Missouri BOMA chapter and IREM accredited Missouri property management companies can be found in Appendix C.

Local energy suppliers are also important to promoting BCHP. Many have formed subsidiary companies to promote distributed generation. Especially the gas supply companies such as Laclede Gas Company mentioned above are interested in CHP since natural gas constitutes an important fuel source for CHP systems and hence a potential profit maker for gas supply companies.

In Missouri the majority of electricity is generated by the five large investor owned utility companies (approximately 70%) followed by electric distribution cooperatives (16%), and municipal utilities (approximately 12 percent). The electric distribution cooperatives in Missouri buy wholesale electric power from Associated Electric Cooperative. The wholesale power is transmitted to the electric distribution cooperatives by six transmission cooperatives. The six transmission cooperatives and the local electric distribution cooperatives own Associated Electric Cooperative. A list of all energy supply companies in Missouri is provided in Appendix D.

Energy Services companies (ESCOs) are also interested in BCHP technologies. In the recent past they have not been that interested in CHP because it was easier for them to find other cost saving measures in commercial and light industrial applications like lighting retrofits and energy control systems. Moreover, in many cases regulations and siting requirements served as a disincentive for them (as a third party) to install BCHP. However, end-user interest in providing high-reliability electric service and overall increased energy efficiency in buildings, coupled with end-user restricted capital has recently piqued interest by ESCo's in BCHP. Appendix E lists ESCO's that are active in Missouri.

2.2 Associations and Organizations Involved with BCHP Deployment

Federal, State, and regional entities are becoming more and more interested in BCHP systems because of the energy savings potential and reduction in emissions from this technology. While the Federal government, through the Department of Energy, has provided substantial support, the most effective deployment of BCHP technology will come from regional and local activities. This is true because most of the barriers are due to local issues, such as site permitting, interconnection requirements and studies, local utility pricing, and local building codes and standards. These barriers can be overcome with support from regional and local entities.

The Midwest is home to many non-profit organizations and associations that have come forward to support the deployment of BCHP. In fact the Midwest appears to be leading the way in promoting the deployment of BCHP. In Missouri informal discussions are currently being conducted between the Missouri Energy Center, the Air Pollution Control

Program, and the Missouri Public Service Commission on reducing barriers to CHP adoption. These are potentially very promising developments for CHP in Missouri.

A list of these associations and organizations and their web-addresses, where available, is provided in Appendix F.

3. Survey of BCHP Installations and BCHP Targets in Missouri

3.1 Survey Summary

This survey identifies existing and pending BCHP installations in order to assess the current statutes of BCHP in Missouri; to establish a baseline and to identify those facility types where BCHP was most prevalent.

The survey of BCHP installations and potential BCHP candidates is primarily based on personal interviews as well as the use of published data. Published data consisted of the Energy Information Administration's "Inventory of Nonutility Electric Power Plants in the United States" (http://tonto.eia.doe.gov/FTPROOT/electricity/ 0095992.pdf). The remaining sites represent the best efforts of the Midwest CHP Application Center to identify actual and potential BCHP installations in Missouri at the time of this report. Other existing or potential BCHP sites may exist; they will be added to the database and will be available over the website in the future as they are identified.

A total of 9 BCHP systems and BCHP candidates, producing over 153,000 kW, are known to be in operation in Missouri. Appendix G categorizes and lists the known distributed generation installations based on the facility type in which the system is installed and provides the size of the installed generation capacity. Where it is known, thermal heat recovery has been noted.

3.2 Sector Analysis of the Survey Data

The sites identified during the survey represent the best efforts of the Midwest CHP Application Center to identify actual and potential BCHP installations in Missouri. Other existing or candidate BCHP sites may exist. An analysis of the survey information for the commercial and light industrial sectors is provided in Appendix G.

Table 3—1 BCHP Capacity and Candidates Installed by Sector in Missouri

Business Sector	Installed BCHP Capacity and Target Sites (kW)	Installed BCHP Capacity (kW)
Hospitals	0	0
Municipal Water/Landfills	43,760	760
Hotels/Offices	10,300	10,300
Schools/Universities	59,300	52,000
District Heating	40,000	40,000
Others	0	0
Total:	153,360	103,060

Figure 3-1 BCHP Capacity and Candidates Installed by Sector in Missouri (kW)

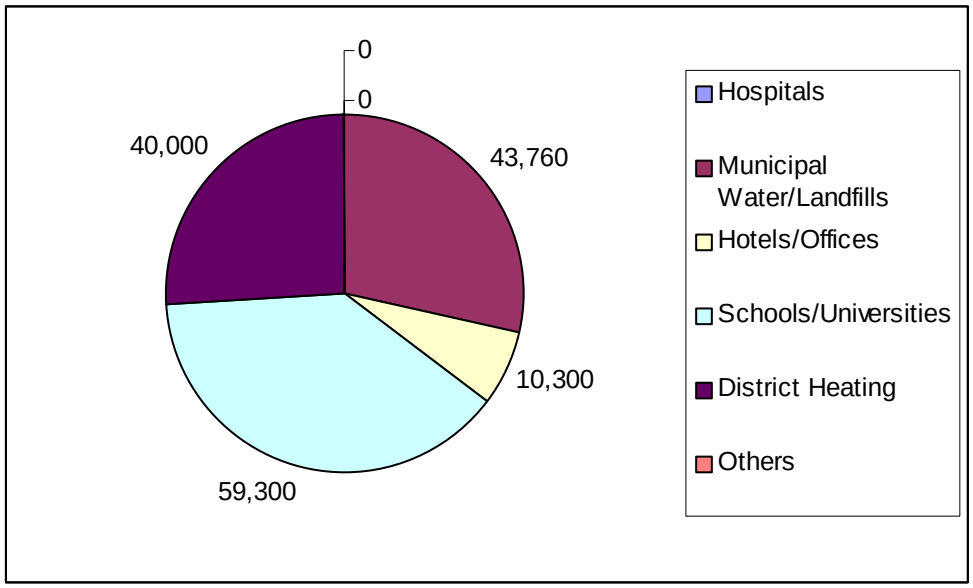
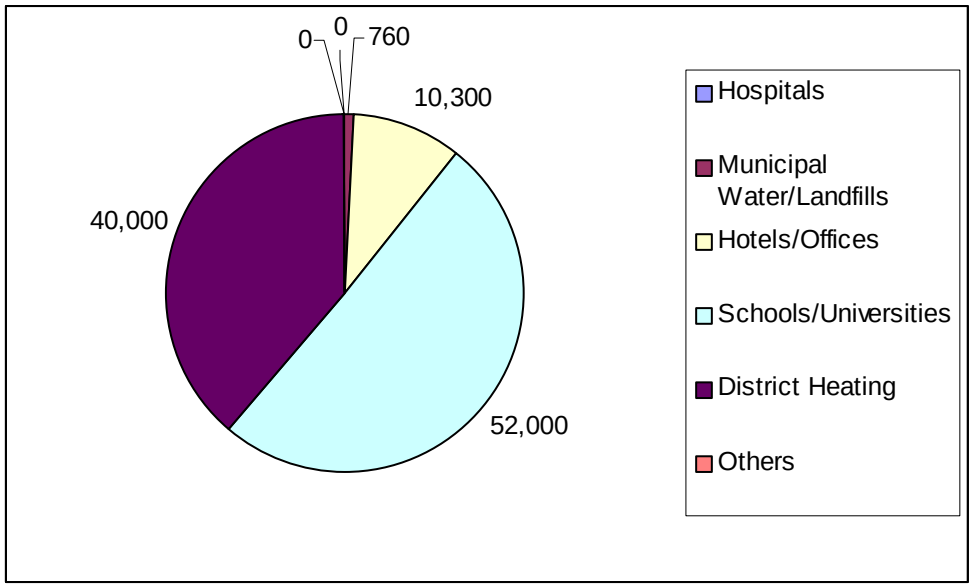


Figure 3-2 BCHP Capacity Installed by Sector in Missouri (kW)



As can be seen Schools/Universities constitute the biggest installed BCHP market segment in Missouri followed by District Heating Systems, and then Hotels/Offices. As indicated in the Table in Appendix G landfills/resource recovery facilities generally do not utilize the waste heat and therefore constitute a good target for BCHP applications because of the relative low cost to add heat recovery to the prime mover that is already installed.

4. Current Pricing Issues

Capital costs as well as operating costs are generally viewed as some of the major hurdles to utilize BCHP technologies. This section will address these issues.

4.1 Equipment and Maintenance Costs

The predominant prime mover technologies in BCHP applications are reciprocating engines, combustion turbines, and microturbines. In the near future fuel cell technology is expected to become a prevalent BCHP technology as well.

Each technology operates at different efficiency and capacity size levels. The following table compiled by the Midwest CHP Application Center indicates the cost and other relevant technical data for the various equipment types.

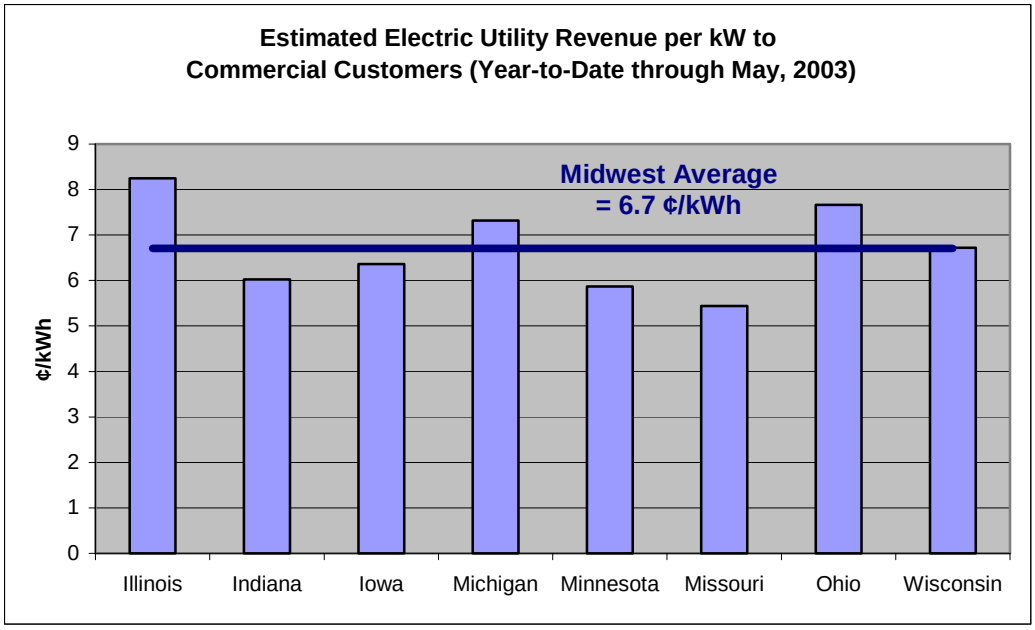
Table 4-1 CHP Technologies

Prime Mover Type	**Reciprocating Engines**		**Gas Turbines – Simple Cycle**		**Microturbines**	**Fuel Cell**
Capacity Rage *(kW)*	100 – 500	500 – 2,000	1,000 – 10,000	10,000 – 50,000	100 – 500	30 – 3,000
Electric Generation Efficiency LHV of Fuel *(%)* Heat Rate *(BTU/kWh)*	 24 – 28 14,000 – 12,000	 28 – 38+ 12,000 – 9,000	 24 – 28 14,000 – 12,000	 31 – 36 11,000 – 9,500	 25 – 30 13,700 – 11,400	 40 – 57
Installed Cost *(/kW)** *(with Heat Recovery)*	 $1,800 – 1,400	 $1,400 – $1,000	 $1,500 – $1,000	 $1,000 – $800	 $2,000 – $1,000	 $2,000 - $5,000
O & M Costs *(/kWh)*	$0.015 – $0.012	$0.012 – $0.010	$0.015 – 0.012	$0.012 – $0.010	$0.015 – $0.012	$0.002 - $0.005
Recoverable Useful Heat Hot Water *(BTU/h per kW)* Steam *(lbs/h per kW)*	 4,000 – 5,000 4 – 5 *(15 – 30 psi)*	 4,000 – 5,000 4-5 *(15 – 30 psi)*	 5,000 – 6,000 5 – 6 *(300 –600 psi)*	 5,000 – 6,000 5 – 6 *(300 –600 psi)*		
Absorption Chiller						
Single ($/RT)	$500 - $1,000	$250 - $500	$200 - $250	$200 - $250		
Double ($/RT)	N/A	N/A	$400 - $500	$350 - $400		
Cooling Capacity (RT/kWe)	0.22 - 0.28	0.22 - 0.28	0.28 – 0.33	0.28 – 0.33		
Electric Chiller ($/RT)	$200 - $300	$200 - $300	$180 -$250	$180 -$250		

4.2 Energy Pricing

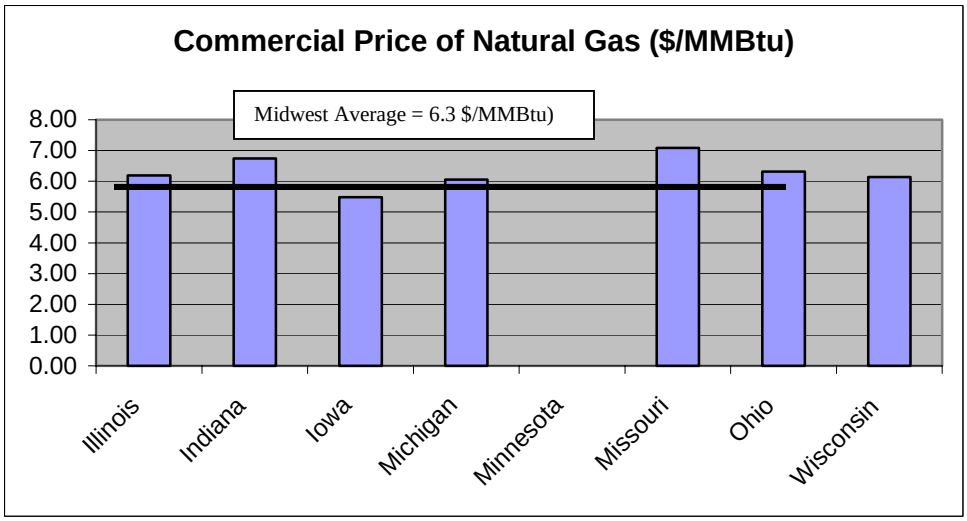
The potential for BCHP in a state depends largely on the prevailing electricity prices as well as on the prevailing natural gas prices, since natural gas is the fuel of choice for many BCHP systems. Relatively high electricity prices and low natural gas prices, for example, result in favorable economics for BCHP.

The following graph shows the electric utility revenue from commercial customers (EIA estimate) for the eight states in the Midwestern Region. As can be seen Missouri exhibits the lowest electricity prices in the Midwest at 5.44¢/kWh (year-to-date through May, 2003).



Source: Energy Information Administration http://www.eia.doe.gov/cneaf/electricity/epm/epmt53p1.html

In contrast, natural gas prices in Missouri are relatively high at $7.08 $/MMBtu (average price sold to commercial consumers in 2002).



Source: http://www.eia.doe.gov/neic/historic/hngas2.htm#Price

Relatively low electricity rates and high natural gas prices in Missouri compared to neighboring Midwestern states may result in a less attractive environment for CHP.

In response to concerns expressed by end-users on the recent fluctuations in natural gas pricing, the Midwest CHP Application Center has developed a methodology to evaluate the break even point for various BCHP applications based on effective electric price per kWh and natural gas prices in MMBTUs. This methodology is presented in Appendix H.

4.3 Financial Incentives for BCHP Systems

Missouri does currently not provide any financial incentives specifically for CHP facilities or CHP relevant applications. However, low interest loans for energy efficiency projects are available to schools, city and county owned hospitals, and local government facilities. CHP projects may qualify for these loans.

5. Summary and Status of BCHP Policy Issues

Policy issues at the State level play an important role in the deployment of BCHP within a state. The purpose of this section is to provide a summary and status of policy related issues pertaining to the advancement of BCHP in the State of Missouri. The following policy areas are summarized below: Backup-power and stand-by tariffs, exit fees, net-metering provisions, general status on progress of deregulation, emerging legislation and regulations, and political partners.

5.1 Backup-power and Stand-by Rates

Similar to other states in the Midwest there are no standardized backup-power and stand-by power rates in Missouri; the backup-power/stand-by rates are set by the individual utility companies. An analysis of the backup-power rates by Ameren shows that these rates can be very detrimental to a CHP system in Missouri.

The effect of Ameren's Supplemental Service Rates (i.e. backup-power service) was analyzed using a hypothetical CHP installation at a 350,000 square-foot hospital located in the Saint Louis area. The hospital's electric demand was assumed to be 2,157 kW in the summer and 1,276 kW in the winter. Using a commercially available energy analysis software ("Building Energy Analyzer" developed by the Gas Technology Institute) the program estimated optimal economics for a small CHP system of 700 kW, which is much smaller than would be expected for a hospital of this size. The reason for the smaller size CHP system providing the optimal economic payback is due to Rider E of the Ameren tariff.

When a facility generates their own electric power on-site, the facility has to oblige to the General Provision stated in Section D of Rider E from the Ameren UE Electric Tariffs:

The Contract Demand is defined as the higher of either:

a. The number of kilowatts mutually agreed upon by Company with customer as representing customer's maximum service requirement under all conditions of use, and such demand shall be specified in customer's Electric Service Agreement; or

b. The maximum demand established by customer in use of Company's service.

Therefore, the maximum demand that the facility may ever require in kilowatts is multiplied by the summer or winter demand charges (summer: $14.48, winter: $6.57) located on Sheet No. 67.4 "Miscellaneous Charges" and added to the monthly customer charge. This total is referred to as the "Minimum Bill." The facility's electric usage charges must be equal to our greater than the amount established by the "Contract Demand"; otherwise the facility is required to pay the established "Minimum Bill" for the month.

Example:

Summer Minimum Bill assuming the maximum monthly electric demand is 2100 kW

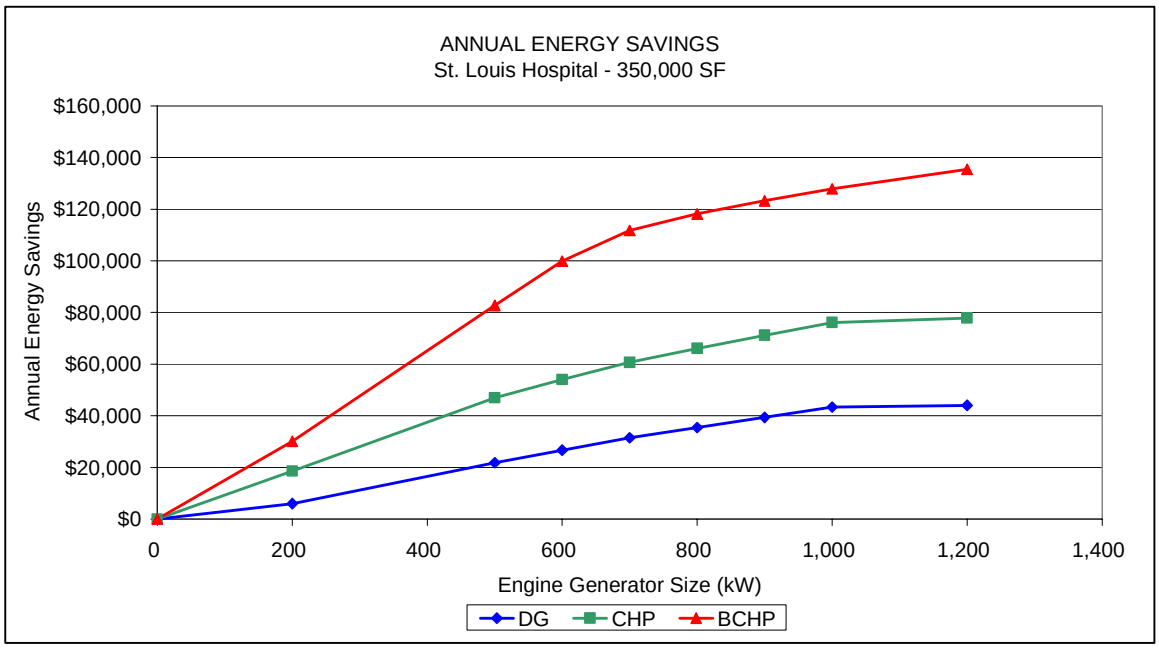
(Max Demand * $14.48) + $210.00 = Minimum Bill

(2,100 kW * $14.48) + $210.00 = $30,618

In the example, the facility would be required to pay a total monthly electric bill of at least $30,618. If the facility's electric usage does not merit charges of $30,618 or more,

the facility is required to pay the "Minimum Bill" of $30,618 for that month. This electric rate structure prevents a facility from installing a larger sized BCHP system and experiencing optimal paybacks because the facility still needs to pay a minimum amount whether or not it actually uses that amount of electricity from the utility.

The graph below indicates that the annual energy savings from a CHP system in Missouri level off for larger generator sizes (DG in the graph refers to a generating system without heat recovery, CHP to a generating system with heat recovery for heating and hot water needs, BCHP to a system with heat recovery for heating, hot water, and cooling needs). Absent of Ameren's supplemental rate structure the economics for larger generator sizes should be substantially better.



5.2 Exit Fees

There appear to be no exit fees imposed by any of the Missouri utility companies on distributed generation projects.

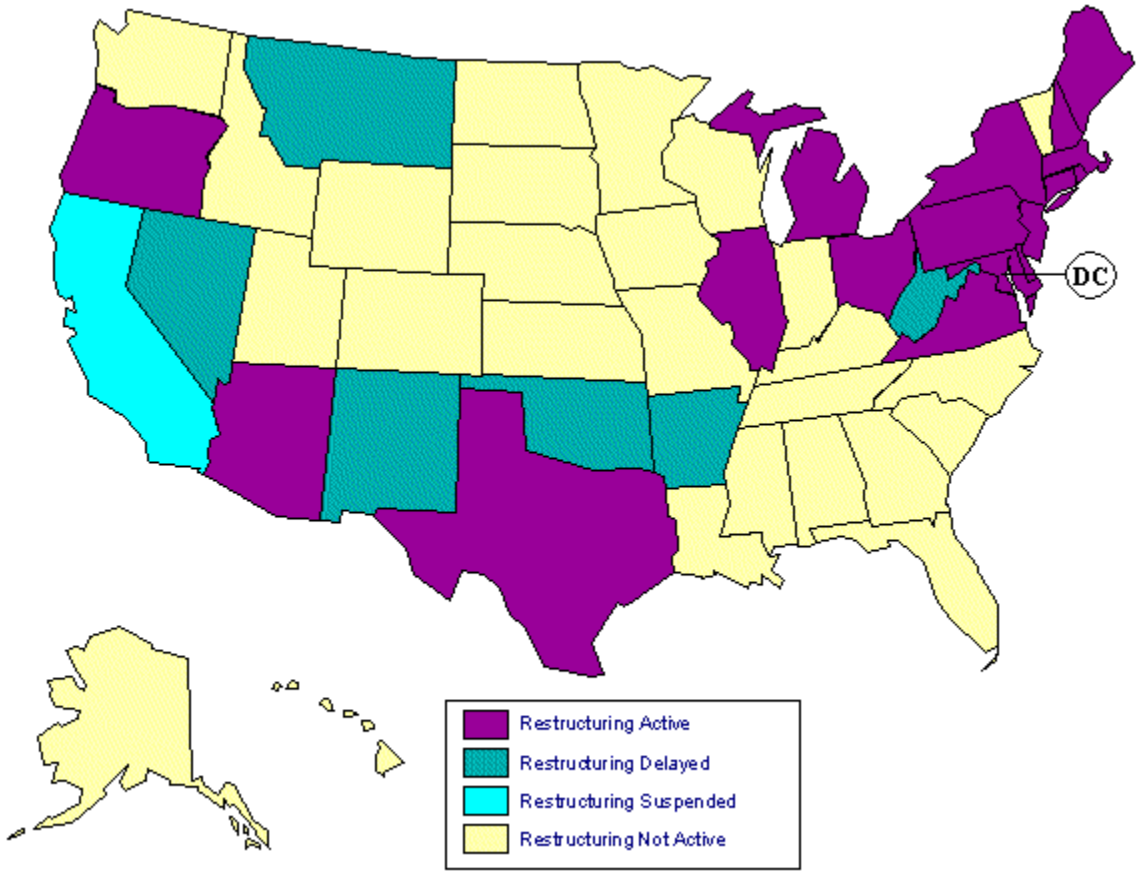
5.3 Net Metering

Net metering is provided to small energy systems with an installed capacity of less than 100 kW utilizing hydrogen fuel cell, wind, sun, or biomass technology. This means that small biomass-based CHP systems may qualify for net-metering in Missouri.

5.4 General Status of Progress on Deregulation

The following graph shows the state restructuring activities on a state-by-state basis. As can be seen, Missouri is classified "restructuring not active" as of October 2002 (Source: EIA; http://www.eia.doe.gov/cneaf/electricity/chg_str/regmap.html):

Status of State Electric Industry Restructuring Activity
-- as of October 2002 --



In March 1997 the Missouri Public Service Commission created several working groups to study retail wheeling (The Retail Competition Task Force). The Task Force's final report was issued in May 1998. The report provides recommendations on stranded cost issues, reliability, and public interest issues in a deregulated environment. However, retail electric competition in Missouri has not been enacted to date and is not expected in the foreseeable future.

5.5 Emerging Legislation and Regulations

The Governor's Energy Policy Council in its June, 2003 report recommends establishing a Public Benefits Fund to provide support to programs that "protect low-income Missourians, promote energy efficiency, provide energy education and assist in the development and use of Missouri's renewable energy resources." This report also recommends to "increase the effectiveness of energy efficiency in state facilities by implementing 'performance contracting' and allowing state agencies to retain a portion of energy savings." At this point these are only recommendations. However, these recommendations may influence future regulatory approaches.

Also, informal discussions are currently being conducted between the Missouri Energy Center, the Air Pollution Control Program, and the Missouri Public Service Commission on reducing barriers to CHP adoption.

5.6 U.S. EPA CHP Partnership

The EPA CHP Partnership is a voluntary program designed to foster cost-effective CHP projects. Through the program EPA engages the CHP industry, state and local governments, and other stakeholders in cooperative relationships to expand the use of CHP.

As part of the partnership program, state and local governments agree to host a CHP workshop and review EPA documents detailing state and local regulations that may affect CHP development. Industrial partners agree to work with EPA to evaluate the use of additional CHP at their facilities. The University of Missouri – Columbia is an EPA CHP Partner.

5.7 Potential Political Partners or Advocates of BCHP

Below is a list of groups, other than the Midwest Application Center, that could assist with the development and/or deployment of a BCHP in Missouri.

- Governor's Energy Policy Council
- Missouri Department of Natural Resources Energy Center
- Missouri Public Service Commission
- Midwest CHP Initiative

Obviously, the Missouri Governor, the Mayors of Saint Louis and Kansas City, or the leadership in the Missouri House or Senate could also help, however, they are likely to be more difficult to reach and/or influence. Members of their staffs may be better targets with any BCHP initiative. The groups listed above are not to be viewed as all-inclusive, as there are other groups and or organizations to be targeted. Those listed above, however, should make for a good starting point.

6. The Market Capacity Potential of BCHP in Missouri

The previous sections identified the key parties currently involved with BCHP technology and detailed some of the areas preventing market transformation. However, market transformation in favor of BCHP technologies is only viable if the market potential exists. Therefore this report discusses the market potential for each BCHP category: industrial, commercial, and multi-unit residential.

Estimates for the Industrial/Commercial Sector were derived from a previous study conducted by ONSITE-SYCOM Energy Corporation (ONSITE). Estimates for the Multi-family Residential Sector are based on Midwest CHP Application Center research.

6.1 Industrial and Commercial Market

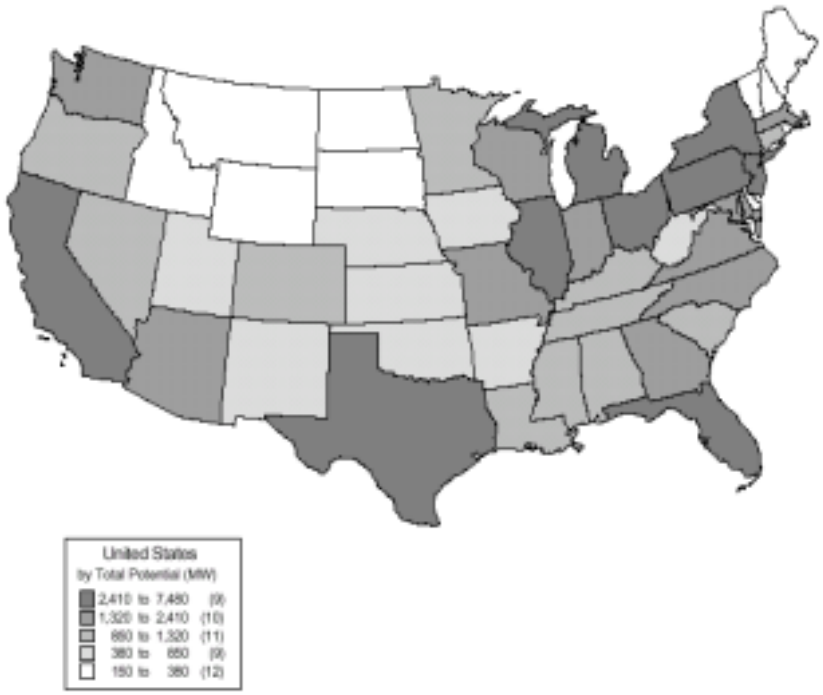
ONSITE Energy Corporation in January 2000 prepared a study for the Energy Information Administration titled "The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector." This study identified potential BCHP application sites using the iMarket, Inc. MarketPlace Database to select commercial/industrial building types based on SIC codes.

The potential buildings were: hotels/motels, nursing homes, hospitals, schools, colleges, commercial laundries, car washes, health clubs, golf clubs, museums, correctional facilities, water treatment plants, extended service restaurants, supermarkets and refrigerated warehouses. The buildings were divided into different groups based on their electric demand. The electric demand was estimated using data from Wharton Economic Forecasting. As a result ONSITE selected 1,431,805 buildings in the United States as suitable for BCHP applications requiring a capacity of 77,281 MW.

There study focused on applications where thermal energy load was in the form of steam or hot water usage. It did not take into consideration the use of thermal activated technologies such as absorption chillers or desiccant dehumidifiers as potential candidates for thermal load. Taking into consideration these technologies will likely increase the market potential from their estimates.

On a state-by-state basis, ONSITE estimated the potential in each of the 48 contagious states in America. The figure on the following page shows the result of their study.

For Missouri, ONSITE estimated a total market potential for BCHP based electric production to be in the range of 1,320 to 2,410 MW. This represents 3 to 5% of the projected DOE long-term goal of 47 gigawatts of installed BCHP capacity that was developed as part of the BCHP Roadmap Workshop. This potential may only be realized if the regulatory and policy issues become more supportive of BCHP installations. Also if incentives are provided, additional market potential capacity could be realized.



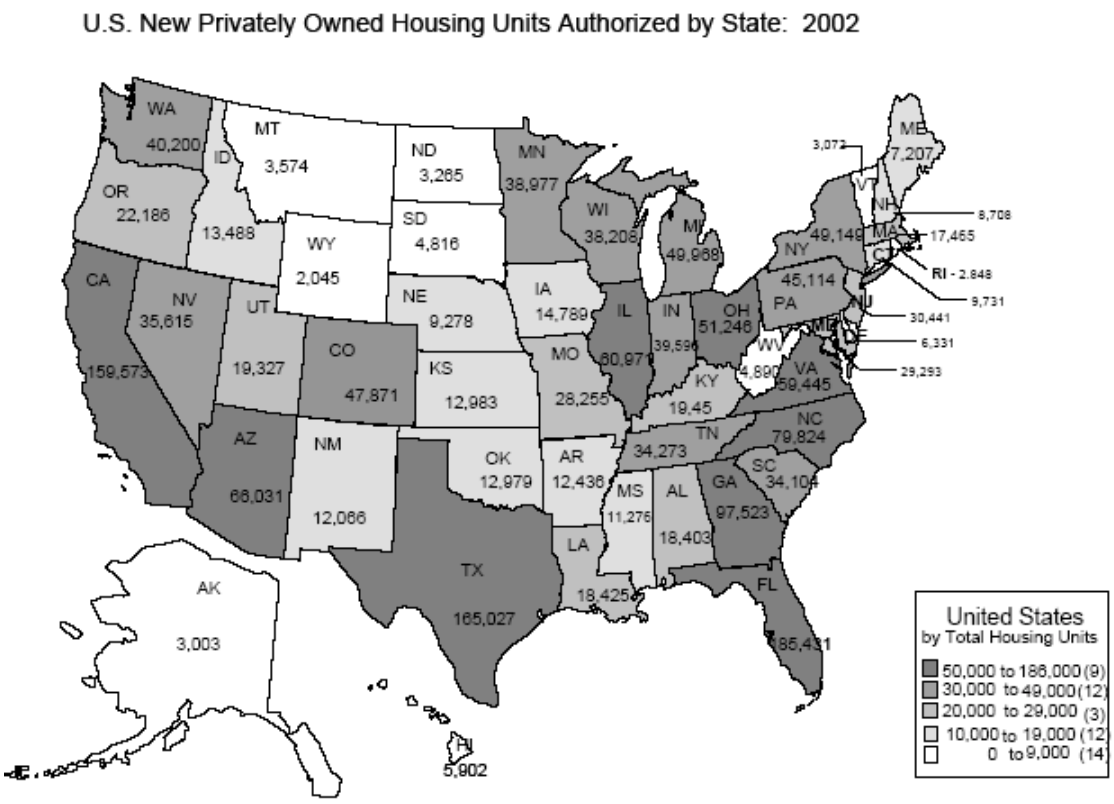
6.2 Multi-Family Residential Market

Besides commercial and industrial applications BCHP systems also have potential market viability for multi-unit residences (those with 2 or more units). Compared to conventional HVAC systems BCHP installations are particularly competitive when it comes to new construction or complete replacement of old HVAC systems. Since all new and replacement HVAC systems need to be permitted in Missouri, permitting data provides a good estimate of buildings where BCHP systems may be a potential alternative. As the map on the following page indicates, overall privately owned construction activities in the State of Missouri are around the average for all states (Source: U.S. Census Bureau).

Applying the following assumptions the potential market for BCHP applications for multi-unit residences can be estimated:

- New construction remains at or near the same level as in the year 2002 (7,823 units, excludes single-family units),
- HVAC systems need to be replaced every 20 years, therefore units installed in 1982 would need to be replaced in the year 2002, and
- The number of HVAC units replaced in 2002 is consistent with the number of units installed in 1982 (5,733 units).

Applying these assumptions the new building permit data for multi-unit residences was obtained for 1982 and 2002. Therefore the market potential for multi-unit residential BCHP installation in Missouri for 2002 is estimated to be about 13,500 units (replacement plus new construction units).



6.3 Biomass Based CHP Applications

A report by the Governor's Energy Council issued June 1, 2003 states that Missouri depends heavily on fossil fuel imports for its current energy supply. The report cites that Missouri imports 95% of its energy sources in the form of coal, petroleum, and natural gas. The report recommends reducing this dependency on out of state fossil fuel and meeting future energy needs through increased energy efficiency and renewable energy development. Missouri seems to lag behind other states in this area. The Governor's Energy Council report states that Missouri in a study by the Union of Concerned Scientists received a Grade of "F" and is listed as one of six states in the "Hall of Shame" for a lack of commitment to renewable energy.

However, several successful renewable energy based projects exist in Missouri that are relevant to CHP. Northwest Missouri State University operates a CHP project that has been significantly expanded over the years. The project started out in 1979 using wood waste and it was expanded in 1990 to burn paper pellets. In 1994 the project's third expansion phase started the use of animal waste.

Missouri is also home to two ethanol production facilities that produce 40 million gallons of ethanol annually. The Governor's Council report points out that biodiesel demand has tripled over the last year and that the potential exists for an additional facility with an annual capacity of a 15-20 million gallons. Ethanol facilities are good candidates for CHP since a) they have high energy demands, both thermal and electric, and b) the

rejected heat in the exhaust from the electric generation equipment can be used in the ethanol production process the waste gas from the ethanol production process potentially may be “burned” in the primemover to reduce volatile organic compounds (VOCs) formed as part of the ethanol production process.

7. Conclusions and Recommendations

7.1 Conclusions

7.1.1 Interest Level

In Missouri approximately 26 technical companies are actively involved in BCHP deployment in the State. There are several large well-known engineering firms, as well as equipment manufactures and distributors who are aggressively pursuing the BCHP market in Missouri.

The Midwest is home to many non-profit organizations and associations that have come forward to support the deployment of BCHP, in fact the Midwest appears to be leading the way in promoting the deployment of BCHP with such organizations as the Midwest CHP Application Center and the Midwest CHP Initiative.

7.1.2 Installation Status

There is a significant amount of BCHP systems installed at universities (52,000 kW) as well as district heating systems (40,000 kW). There is also a large potential market for an additional 43,000 kW at municipal water/landfill facilities where thermal heat recovery technologies could be added.

7.1.3 Barriers

Capital costs and payback time frames are of concern. The least expensive electric generating technologies (large natural gas turbines) installed start around $600/kW and increase up in cost to fuel cell technologies that run up to $5,000/kW. Additional costs, associated with thermal recovery equipment and engineering costs further add to the cost of the project. For smaller generating capacity units, this initial cost can have a long payback period unless electric costs are very high and thermal loads well matched. Prices are expected to decrease as the technologies and "packaged" system designs become more common.

Operating costs due to volatile gas prices as seen in the winter of 2000/2001 and 2002/2003 may be perceived as a concern.

Natural gas prices in Missouri are relatively high ($7.08/MMBtu for commercial customers in 2002) compared to other Midwestern states while electricity prices are relatively low (5.44 ¢/kWh year-to-date through May 2003).

Stand-by power rates in Missouri are of concern. A CHP facility with backup power needs in Ameren Union Electric's territory, Missouri's largest electric utility company, would be subject to Ameren's Supplemental Service Rate, Rider E, which is extremely discouraging for CHP facilities. This rate structure commits facilities to a so-called "Minimum Bill," which the CHP facility has to pay regardless of the amount of electricity generated by the CHP system.

7.1.4 Favorable Characteristics

Exit fees are not imposed on distributed generating projects in Missouri.

Low interest loans for energy efficiency projects are available to schools, city and county owned hospitals, and local government facilities. CHP projects may qualify for these loans.

Favorable alliances exist in Missouri. Informal discussions are currently being conducted between the Missouri Energy Center, the Air Pollution Control Program, and the Missouri Public Service Commission on reducing barriers to CHP adoption.

Market potential appears to be good for BCHP. ONSITE Energy Corporation estimates for Missouri a total market potential of between 1,320 and 2,410 MW. Besides commercial and industrial estimates by ONSITE the MAC estimated that the potential Missouri market for BCHP installations in the multi-unit residential sector to be about 13,500 units. Furthermore Missouri has a good potential for CHP at ethanol facilities. The Governor's Energy Policy Council projects an additional demand for ethanol producing facilities, which are well suited for CHP systems, with an additional capacity of 15-20 million gallons in the state.

7.2 Recommendations

1) Increase Interest and Market Penetration

   Develop a higher level of interest in BCHP by providing information and education to Architects, Engineers, Property Management Firms on the
   - Technical and financial benefits of BCHP,
   - Siting and permitting process,
   - Successful BCHP installations (Case Studies), and
   - Technical and financial assessments tools and resources available.

2) Influence the Removal of Regulatory Barriers

   - Work with the Missouri Energy Center, the Air Pollution Control Program, and the Missouri Public Service Commission to support and formalize their existing informal discussions on reducing barriers to CHP adoption.
   - Work with the Legislative to establish further incentives for BCHP such as tax breaks and environmental credits.

3) Build Alliances

   Build alliances with additional potential partners such as:
   - Large Architect/Engineering Firms with BCHP capabilities.
   - Laclede Gas Company, Missouri Department of Natural Resources Energy Center, the Missouri Public Service Commission, and the Governor's Energy Policy Council.

Appendix A Architect and Engineering Firms Promoting BCHP Technologies in Missouri

1) American Institute of Architects (AIA) – Mid Missouri Chapter
204 E. High Street
Jefferson City, MO 65101

2) AIA St. Louis
911 Washington Street, #225
St. Louis, MO 63101-1203
Phone: 314-621-3484

3) AIA Missouri
204 A East High Street
Jefferson City, MO 65101
Phone: 573-635-8555

4) AIA Kansas City
104 West Ninth Street
Kansas City , MO 64105
Phone: 816-221-3485

5) Energy Engineering Associates, Inc.
409 Vandiver Drive, Building 4, Suite 200
Columbia, Missouri 65202
Phone: 573-449-5273
Capabilities: Energy Engineering

6) Ballard Engineering
3555 Electric Avenue
Rockford, IL 61125
Phone: (815) 229-1800
Capabilities: BCHP Turnkey Systems

7) CAI Commonwealth Associates, Inc.
P.O. Box 1124
Jackson, MI 49204
Phone: (517) 788-3474
Capabilities: Consulting Engineers and Construction Management

8) Cogentrix
9405 Arrowpoint Boulevard
Charlotte, NC 28273-8110

9) GKC-EME
205 W. Wacker Drive
Chicago, IL 60606
Capabilities: BCHP Turnkey Installations

10) Innovative Controls Engineer
719 George St

Marshfield, MO 65706
Phone: (417) 859-2405

11) La Salle Associates
3700 North Southport
Chicago, IL 60613
Capabilities: BCHP Turnkey Installations

12) Monsanto Enviro Chem Systems Inc
14522 S Outer 40
Chesterfield, MO 63017-5737
Phone: (314) 275-5700
Capabilities: Ethanol Plant Engineering

13) Primera Engineering
25 E. Washington St.
Suite 510
Chicago, IL 60602
Contact: Ken Panunci
Phone: (312) 606-0629
Capabilities: HVAC Engineering, BCHP Potential

14) Sega Inc.
16041 Foster
P.O. Box 1000
Stilwell, KS 66085-1000
Phone: (913) 681-2881
Capabilities: BCHP Engineering

15) Stanley Consultants, Inc.
225 Iowa Avenue
Muscatine, IA 52761
Phone: (563) 264-6457
Capabilities: BCHP Engineering, Environmental and Construction Services

16) Trigen-St Louis Energy Corp
1 Ashley St
Saint Louis, MO 63102-2233
Phone: (314) 621-3550
Capabilities: BCHP Engineering

NOTE: *This list represents only those firms that the MW BCHP Application Center was able to identify at the time of this report. Other firms may exist that promote BCHP; they will be added to the database and will be available over the website in the future as they are identified.*

Appendix B Equipment Distributors/Manufactures That Promote BCHP Technologies in Missouri

1) ADA Systems
955 North Lively Boulevard
Wood Dale, IL 60191
Capabilities: Evaporative Cooling Systems, Energy Recovery

2) Caterpillar
Fabick Power Systems
101 Fabick Dr
Fenton, MO
63026-2900 US
Phone: 636-349-5500
Capabilities: Caterpillar Distributor

3) Eisenmann
150 E. Dartmoor Dr.
Crystal Lake, IL 60014
Phone: 815-455-4100
Capabilities: Air Purification Equipment

4) Generac Power Systems
Ultimate Service Dealer
4800 Deramus
Kansas City, MO, 64120-1186
Phone: 816-245-5400
Capabilities: Electric Generation Equipment Manufacturer

5) Hess Microgen
12 Industrial Parkway, Unit B-1
Carson City, NV 89706
Phone: (775) 884-1000
Capabilities: Generators Equipment with Heat Recovery

6) Huntington Environmental Systems, Inc.
707C West Algonquin Road
Arlington Heights, IL 60005
Capabilities: Emissions Control Equipment

7) Nixon Power Services Company11910 Carrier Court
Louisville, KY 40299
Phone: 502-267-0474
Capabilities: Distributor for Kohler and Waukesha engines

8) Solar Turbines Incorporated
40 Shuman Blvd. Suite 350
Naperville, IL 60563
Phone: (630) 527-1700
Capabilities: Electric Generation Equipment Manufacturer

9) Trane
2275 Cassens Court
Suite 105
Fenton, MO 63122
Phone: 636-305-3600
Capabilities: HVAC Systems, Air Handling Products

10) Vaporphase Engineering Controls Inc.
600 South Holmes Avenue
Saint Louis, MO 63122
Phone: 314-821-7900
Capabilities: Waste Heat Recovery Equipment Manufacturer

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Appendix C Property Management Organizations and Firms in Missouri

1) BOMA Kansas City
   P.O. Box 1534
   Liberty, MO 64069
   Phone: (816) 729-1096

2) BOMA St. Louis
   7745 Carondelet Ave.
   Suite 308
   St. Louis, MO 63105
   Phone: (314) 721-5050

3) BOMA Southwest Missouri
   333 S. Jefferson
   Suite 200
   Springfield, MO658006
   Phone: (417) 865-0200

IREP Accredited Real Estate Management Firms:

1) American Spectrum Realty, Inc.
   One Memorial Dr., Ste. 675,
   St. Louis, MO 63102
   Phone: 314/206-6600

2) Block & Co., Inc., Realtors
   605 W. 47th St., Ste. 100
   Kansas City, MO 64112
   Phone: 816/531-1400

3) Camden Property Trust
   12400 Olive Blvd., Ste. 400
   St. Louis, MO 63141
   Phone: 314/878-1660

4) CB Richard Ellis, Inc.
   4717 Grand Ave., Ste. 500
   Kansas City, MO 64112-2206
   Phone: 816/968-5842

5) Cecil Management Group, Inc.
   6976 Chippewa
   St. Louis, MO 63109
   Phone: 314/352-3773

6) Charles F. Curry Real Estate Co.
   2700 Kendallwood Pkwy., Ste. 208
   Kansas City, MO 64119
   Phone: 816/414-5200

7) Cohen-Esrey Real Estate Services, Inc.
   1100 Main St., Ste. 2700
   Kansas City, MO 64105
   Phone: 816/531-8100

8) Colliers Turley Martin Tucker
   1101 S. Walnut, Ste. 1710
   Kansas City, MO 64106
   Phone: 816/221-2200

9) Colliers Turley Martin Tucker
   7701 Forsyth Blvd., Ste. 500
   St. Louis, MO 63105
   Phone: 314/862-7100

10) Crown Management, Inc.
    800 W. 47th St., No. 225
    Kansas City, MO 64112
    Phone: 816/756-1084

11) Dominium Management Services, Inc.
    109 Virginia Ave., Ste. 274
    Hannibal, MO 63401
    Phone: 573/406-0802

12) Draper and Kramer, Inc.
    1951 Oberlin Dr.
    St. Louis, MO 63146-2899
    Phone: 314/469-4410

13) Follman Properties ONCOR International
    165 N. Meramec, Ste. 500
    St. Louis, MO 63105
    Phone: 314/721-3444

14) Freeman Webb Co., Realtors
    11043 Mollerus Drive
    St Louis, MO 63138
    Phone: 314/867-3397

15) Grubb & Ellis Management Services, Inc.
    7701 Forsyth Blvd. Ste. 700
    St. Louis, MO 63105
    Phone: 314/863-4888

16) Insignia/ESG, Inc.
    701 Market St., Ste. 1220
    St. Louis, MO 63101
    Phone: 314/436-2020

17) Kohner Properties, Inc.
7730 Forsyth Blvd, Ste. 300
St. Louis, MO 63105-1819
Phone: 314/862-5955

18) The Lipton Group, Inc.
9100 Overland Plaza
St. Louis, MO 63114
Phone: 314/423-2222

19) MC Lioness Realty Group, LLC
114 W. 11th St., Ste. 200
Kansas City, MO 64105
Phone: 816/221-1313

20) MC Lioness Realty Group, LLC
c/o H & R Block World HQ
Kansas City, MO 64111
Phone: 816/932-7500

21) MC Lioness Realty Group, LLC
333 W. 11th St.
Kansas City, MO 64105
Phone: 816/860-7501

22) The Medve Group
8251 Maryland Ave., Ste. 10
St. Louis, MO 63105
Phone: 314/726-2000

23) The Michelson Organization
7701 Forsyth Blvd., Ste. 900
St. Louis, MO 63105
Phone: 314/862-7080

24) Nutter & Associates, Inc.
4044 Central
Kansas City, MO 64111
Phone: 816/531-6811

25) Professional Equities, Inc.
18433 Edison Ave.
Chesterfield, MO 63005
Phone: 636/519-7255

26) Regency Centers Corp.
16640 Chesterfield Grove Ct., Ste. 170
Chesterfield, MO 63005-1410

27) Regency Centers Corp.
16640 Chesterfield Grove Rd., Ste. 170

Chesterfield, MO 63005
Phone: 636/728-2700

28) Trammell Crow Company
8000 Maryland Ave., Ste. 850
St. Louis, MO 63119
Phone: 314/721-4477

29) Zimmer Real Estate Services, Inc.
1220 Washington
Kansas City, MO 64105
Phone: 816/474-2000

NOTE: *This list represents only those firms that the MW BCHP Application Center was able to identify at the time of this report.*

Appendix D Energy Supply and Service Companies in Missouri

Natural Gas Providers:

1) AmerenUE formerly Union Electric Company
   1901 Chouteau Avenue
   P.O. Box 14963166-0149
   St. Louis, MO 63103
   Phone: 314-621-3222

2) Fidelity Natural Gas, Inc.
   64 North Clark
   P.O. Box 669
   Sullivan, MO 63080-0669
   Phone: 573-468-8081

3) Greeley Gas Company (*a division of Atmos Energy Corporation)*
   Penn Center, Suite 800
   1301 Pennsylvania Street
   Denver, CO80203-5015
   Phone: 303-861-8080

4) Laclede Gas Company
   720 Olive Street
   St. Louis, MO 63101
   Phone: 314-342-0500

5) Missouri Gas Energy
   a division of Southern Union Company
   3420 Broadway
   Kansas City, MO 64111
   Phone: 816-756-5261

6) Missouri Public Service
   a division of Aquila, Inc
   10700 East 350 Highway
   P.O. Box 11739
   Kansas City, MO 64138
   Phone: 816-737-7502

7) St. Joseph Light & Power Company
   a division of Aquila Inc.
   520 Francis Street
   P.O. Box 998
   St. Joseph, MO 64502-0998
   Phone: 816-233-8888

8) Southern Missouri Gas Company
   301 East 17th Street
   Mountain Grove, MO 65711
   Phone: 417-926-7533

9) United Cities Gas Company
   a division of Atmos Energy Corporation
   5300 Maryland Way
   Brentwood, TN 37027
   Phone: 615-373-0104

Electricity Providers:

Investor Owned Electric Utilities

1) AmerenUE formerly Union Electric Company
   1901 Chouteau Avenue
   P.O. Box 149 63166-0149
   St. Louis, MO 63103
   Phone: 314-621-3222

2) Citizens Electric Corporation
   150 Merchant Street
   P.O. Box 311
   Ste. Genevieve, MO 63670-0311
   Phone: 573-883-3511

3) Empire District Electric Company, The
   602 Joplin Street
   P.O. Box 127
   Joplin, MO 64801-0127
   Phone: 417-623-4700

4) Kansas City Power & Light Company
   1201 Walnut 64106
   P.O. Box 418679
   Kansas City, MO 64141-9679
   Phone: 816-556-2200

5) Aquila (formerly Missouri Public Service)
   10700 East 350 Highway
   P.O. Box 11739
   Kansas City, MO 64138-1739
   Phone: 816-737-7815

6) Aquila *(formerly St. Joseph Light & Power Company)*
Glenn Keefe, Vice President-Operations
10700 East 350 Highway
P.O. Box 11739
Kansas City, MO 64138-1739
Phone: 816-737-7815

Missouri Electric Cooperatives

The wholesale supplier of electricity to Missouri's electric co-ops:

Associated Electric Cooperative
Main P.O. Box 754
2814 S. Golden
Springfield, MO 65801
Phone: 417-881-1204

Missouri's Transmission Cooperatives and the Distribution Cooperatives Served Respectively:

1) Central Electric Power Cooperative
P.O. Box 269
2106 Jefferson St.
Jefferson City, MO 65102
Phone: 573-634-2454
Transmits power to: Boone, Callaway, Central Missouri, Co-Mo, Consolidated, Cuivre River, Howard and Three Rivers electric cooperatives.

2) KAMO Power
P.O. Box 577
500 S. KAMO Drive
Vinita, OK 74301
Phone: (918) 256-5551
Transmits power to: Barry, Barton County, New-Mac, Osage Valley, Ozark, Sac Osage, Southwest and White River Valley electric cooperative in Missouri as well as several cooperatives in Oklahoma and Arkansas.

3) M & A Electric Power Cooperative
P.O. Box 670
Highway PP
Poplar Bluff, MO 63902
Phone: (573) 785-9651
Transmits power to: Black River, Ozark Border, Pemiscot-Dunklin and SEMO electric cooperatives.

4) Northeast Missouri Electric Power Cooperative
   P.O. Box 191
   Business Route 61 North
   Palmyra, MO 63461
   Phone: (573) 769-2107
   Transmits power to: Lewis County, Macon, Missouri Rural, Ralls County and Tri-County electric cooperatives in Missouri as well as three Iowa co-ops.

5) N.W. Electric Power Cooperative, Inc.
   P.O. Box 565
   1001 West Grand Ave.
   Cameron, MO 64429
   Phone: (816) 632-2121
   Transmits power to: Atchison-Holt, Farmers', Grundy, North Central Missouri, Platte-Clay, United and West Central electric cooperatives.

6) Sho-Me Power Electric Cooperative
   P.O. Drawer D
   301 West Jackson
   Marshfield, MO 65706
   Phone: (417) 468-2615
   Transmits power to: Crawford , Gascosade, Howell-Oregon, Intercounty, Laclede, Se-Ma-No, Southwest, Webster and White River Valley electric cooperatives.

Appendix E Energy Service Companies listed by National Association of Energy Service Companies

1) Burns & McDonnell
   9400 Ward Parkway
   Kansas City, MO 64114

2) Cambridge Engineering, Inc.
   17825 Chesterfield Airport Rd.
   Chesterfield, MO 63006

3) ORIX Public Finance LLC
   2690 Grand Elsa
   Suite 380
   Kansas City. MO 84109
   Phone: 770-970-2100

NOTE: *This list represents only those firms that the MW BCHP Application Center was able to identify at the time of this report. Other firms may exist that promote BCHP; they will be added to the database and will be available over the website in the future as they are identified.*

Appendix F Associations/Organizations Associated with BCHP Deployment in Missouri

Missouri/Regional Organizations

	Organization	Website
1.	American Institute of Architects	http://www.aia.org
2.	BOMA Building Owners and Managers Association	http://www.boma.org
3.	Center for Neighborhood Technology	http://www.cnt.org
4.	Delta Institute	http://www.delta-institute.org
5.	Energy Resources Center – University of Illinois at Chicago	http://www.erc.uic.edu
6.	Environmental Law and Policy Center	http://www.elpc.org
7.	Gas Technology Institute	http://www.gastechnology.org
8.	Great Lakes Renewable Energy Association	http://glrea.org
9.	Interstate Renewable Energy Council (IREC)	http://www.eren.doe.gov/cro
10.	Midwest CHP for Buildings Application Center	http://www.chpcentermw.org
11.	Midwest Cogeneration Association	http://www.cogeneration.org
12.	Midwest Energy Efficiency Alliance (MEEA)	http://www.elpc.org/energy/index.htm
13.	Missouri Department of Natural Resources Energy Center	http://www.dnr.state.mo.us
14.	Missouri Public Service Commission	http://www.psc.state.mo.us
15.	University of Missouri, Food and Agricultural Policy Research Institute	www.fapri.missouri.edu

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Federal Government Agencies

	Agency	Website/Contact Information
1.	DOE Combined Heat and Power (BCHP) Initiative	http://www.eren.doe.gov/der/BCHP/
2.	DOE Distributed Energy Resources (DER) Taskforce	http://www.eren.doe.gov/der/
3.	DOE Distributed Power (DP) Program	http://www.eren.doe.gov/distributedpower/
4.	DOE Energy Efficiency and Renewable Energy Network (EREN)	http://www.eren.doe.gov/
5.	DOE Energy Information Administration	http://www.eia.doe.gov/
6.	DOE Industries of the Future (IOF)	http://www.oit.doe.gov/industries.shtml
7.	DOE Inventions & Innovation Program (I&I)	http://www.oit.doe.gov/inventions/
8.	DOE Office of Energy Efficiency and Renewable Energy (EERE)	http://www.eren.doe.gov/ee.html
9.	DOE Office of Industrial Technologies	http://www.oit.doe.gov/
10.	DOE Office of Power Technologies (OPT)	http://www.eren.doe.gov/power/
11.	EPA Climate Protection Division (CPD)	http://www.epa.gov/cpd.html
12.	EPA Office of Air & Radiation	http://www.epa.gov/oar/
13.	EPA Office of Air Quality Planning and Standards	http://www.epa.gov/oar/oaqps/
14.	EPA-DOE Energy Star Program	http://www.energystar.gov
15.	Federal Energy Management Program (FEMP)	http://www.eren.doe.gov/femp/
16.	Federal Laboratory Consortium for Technology Transfer	http://www.fedlabs.org
17.	Manufacturing Extension Partnership (MEP)	http://www.mep.nist.gov/
18.	US Department of Energy (DOE)	http://www.energy.gov
19.	US Department of Housing & Urban Development (HUD)	http://www.hud.gov/
20.	US Environmental Protection Agency (EPA)	http://www.epa.gov

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Others Associations and Organizations

	Organization/Association	Website/Contact Information
1.	Alliance to Save Energy	http://www.ase.org
2.	American Council for an Energy-Efficient Economy (ACEEE)	http://aceee.org
3.	American Planning Organization (APA)	http://www.apa.org
4.	Brookhaven National Laboratory	http://www.bnl.gov
5.	Consortium for Energy Efficiency (CEE)	http://www.ceeformt.org/
6.	Distributed Power Coalition of America (DPCA)	http://www.dpc.org
7.	Electric Power Research Institute (EPRI)	http://www.epri.com
8.	Electric Power Supply Association (EPSA)	http://www.epsa.org
9.	International District Energy Association (IDEA)	http://www.districtenergy.org/
10.	National Association of Regulatory Utility Commissioners (NARUC)	http://www.naruc.org
11.	National Association of State Energy Officials (NASEO)	http://www.naseo.org
12.	National Energy Technology Laboratory	http://www.netl.doe.gov
13.	National Renewable Energy Laboratory	http://www.nrel.gov
14.	Natural Resources Defense Council (NRDC)	http://www.nrdc.org
15.	Northeast Midwest Institute	http://www.nemw.org
16.	Oak Ridge National Laboratory	http://www.ornl.gov
17.	Regulatory Assistance Project	http://www.rapmaine.org
18.	U.S. Combined Heat and Power Association (USBCHPA)	http://www.nemw.org/usBCHPa/

NOTE: *This list represents only those organizations that the MW BCHP Application Center was able to identify at the time of this report. Other organizations may exist that promote BCHP; they will be added to the database and will be available over the website in the future as they are identified.*

Appendix G Distributed Generation – Commercial/Light CHP Facilities in Missouri

Project Name	Capacity (kW)	Generator Type	Primary Energy Source	Generating Unit Status	Heat Recovery
Hospitals					
No installations	0				
Municipal Water/Landfills					
North Kansas City	4,000	gas turbine	natural gas		
Waterloo Municipality	5,000	gas turbine	natural gas	operating	no
Poplar Bluff Municipal Electric	34,000	gas turbine	natural gas	operating	no
Metropolitan Sewer District	760		digester gas	operating	yes
Hotels/Offices					
Laclede Gas Office Building	4,300	internal combustion engine	natural gas	operating	yes
Southwestern Bell Telephone Company	6,000	internal combustion engine	fuel oil	operating	yes
Schools/Universities					
University of Missouri - Columbia	52,000	backpressure turbine, coal boiler, gas turbine	coal, natural gas	operating	yes
Southeast Missouri State University	7,300	internal combustion engine/steam turbine	fuel oil		no
District Heating					
Trigen Saint Louis	40,000	combined cycle	natural gas	operating	yes
Others					
None	0				

Indicates Heat Recovery

NOTE: *This list represents only those commercial and light industrial facilities that the MW BCHP Application Center was able to identify at the time of this report. Other commercial and light industrial facilities may exist that have distributed generation; they will be added to the database and will be available over the website in the future as they are identified.*

Appendix H Cogeneration Systems and Gas Price Volatility

Given variations in natural gas prices, owners of cogeneration systems may occasionally contemplate turning their systems off during periods of gas high prices and reverting to their pre-existing boiler systems. At what gas price is such a move warranted? This question can be quickly answered with the help of the following calculation and chart.

This should be done with the most recent electric bill. The results will vary with the season and should be repeated during each season.

Line	From a Recent Electric Bill - Input			
1	Electric Consumption (On-Peak)	*From Electric Bill*		kwh/Mo
2	Electric Energy Charge (On-Peak)	*From Electric Bill*		$
3	Average Energy Charge	*Divide Line 2 by Line 1*		$/kWh
4	Monthly Demand	*From Electric Bill*		kW
5	Demand Charges	*From Electric Bill*		$
6	Allocated Demand Charge	*Divide Line 5 by Line 1*		$/kWh
	Total Cost of Utility Electricity	*Add Lines 3 and 6*		$/kWh

Table H.1: Calculate True Cost of Electricity

Follow these steps:

- Calculate your true cost of electric power as shown in Table H.1.
- Plot the true cost of electricity and your current gas cost on
- If your point is above the appropriate breakeven line – the cogeneration system should continue to operate

If your cogeneration system operates during off-peak power periods, repeat the calculation using the off-peak numbers. If this point is below your breakeven line, consider running your cogeneration system during on-peak hours only.

Your breakeven line is selected in the following manner:

- For generation systems with no heat recovery, use the 0 Btu/kW line

- For an engine cogeneration systems with high pressure steam (125 psig) heat recovery from the exhaust heat only, use the 1,500 Btu/kW line. This assumes that you have a load that equals or exceeds the engines steam producing capacity at all times. If less than full steam capacity is used, correct the value down. For example, if only 50% of the engines steam capacity is used, plot the value at 750 Btu/kW.

- For a gas turbine cogeneration systems with high pressure steam (125 psig) heat recovery from the exhaust heat only, use the 4,500 Btu/kW line. This assumes that you have a load that equals or exceeds the engines steam producing capacity at all times. Otherwise correct as above.

- For cogeneration systems with low temperature hydronic heat recovery (180-250^{o}F) on the jacket and engine exhaust system, use 3,000 in the spring and fall and 4,500 in the winter. In the summer use 4,500 if you have an absorption chiller and 3,000 if not.

- For cogeneration systems feeding low temperature processes or hot water loads (140^{o}F and below), use 6,000 Btu/kW.

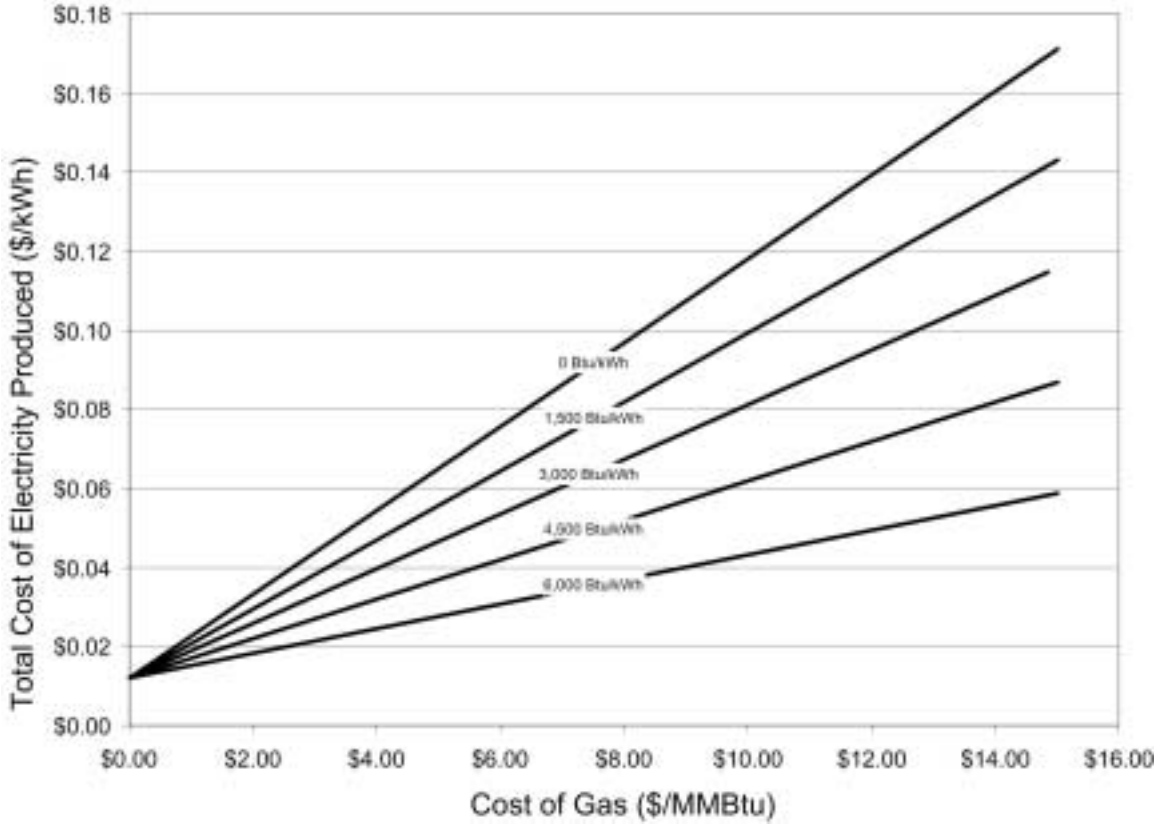


Figure H.1: Breakeven Chart

Example

Question

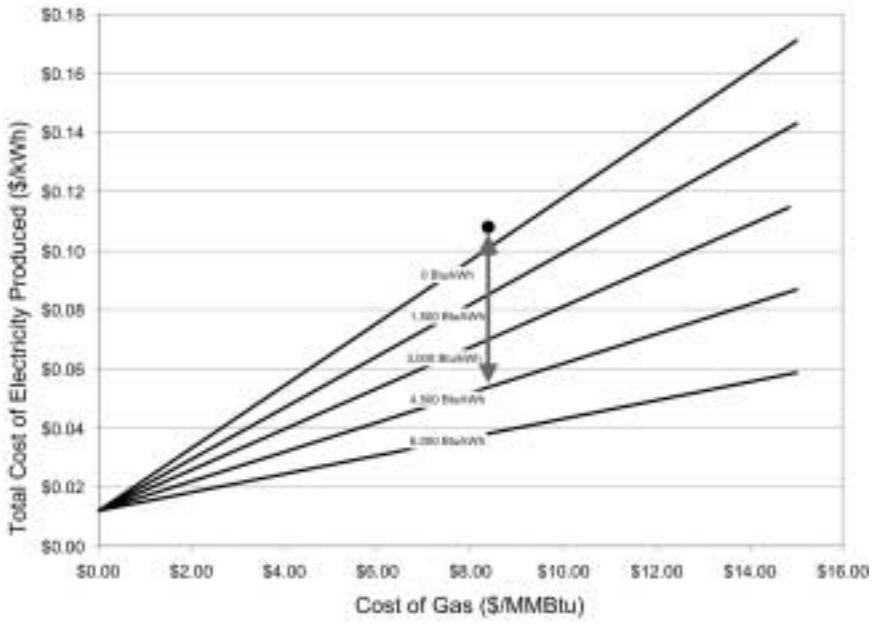
A cogeneration system provides power and heating to a commercial building. The owner's gas price spikes to $0.80/therm in January. Should the cogeneration system be run during this gas price spike?

Answer

The owner's electric bill gives the following information:

Line	From a Recent Electric Bill - Input			
1	Electric Consumption (On-Peak)	*From Electric Bill*	340,000	kwh/Mo
2	Electric Energy Charge (On-Peak)	*From Electric Bill*	20,400	$
3	Average Energy Charge	*Divide Line 2 by Line 1*	0.0600	$/kWh
4	Monthly Demand	*From Electric Bill*	1,123	kW
5	Demand Charges	*From Electric Bill*	16,387	$
6	Allocated Demand Charge	*Divide Line 5 by Line 1*	0.0482	$/kWh
	Total Cost of Utility Electricity	*Add Lines 3 and 6*	0.1082	$/kWh

Plotting this on Figure H.1 gives:



The point is well above the 4,500 Btu/kW line and the system should be left on.