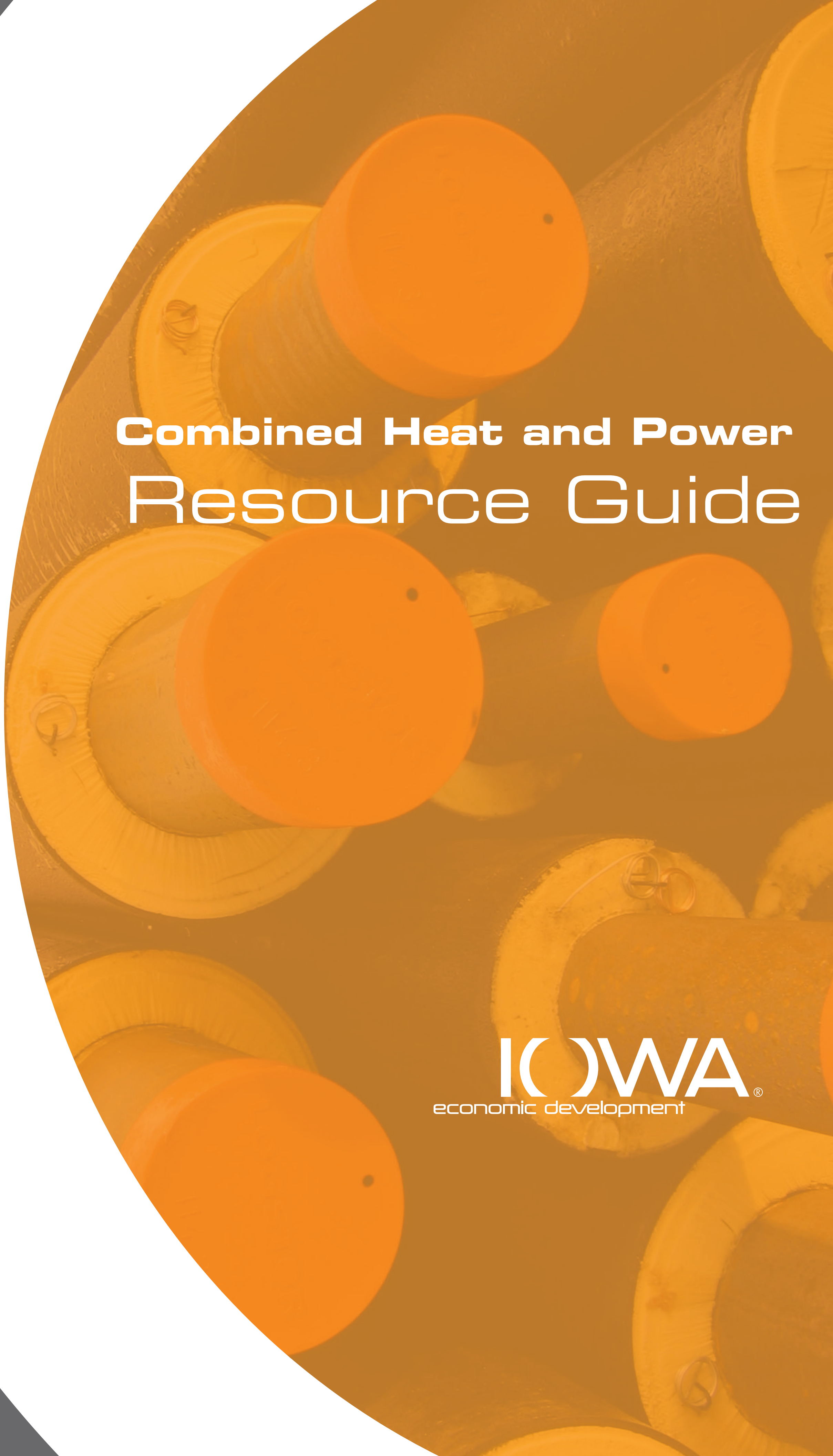
Combined Heat and Power
Resource Guide



economic development

This document was developed with grant funds provided by the U.S. Department of Energy.

Introduction to Combined Heat and Power (CHP)

What is CHP?

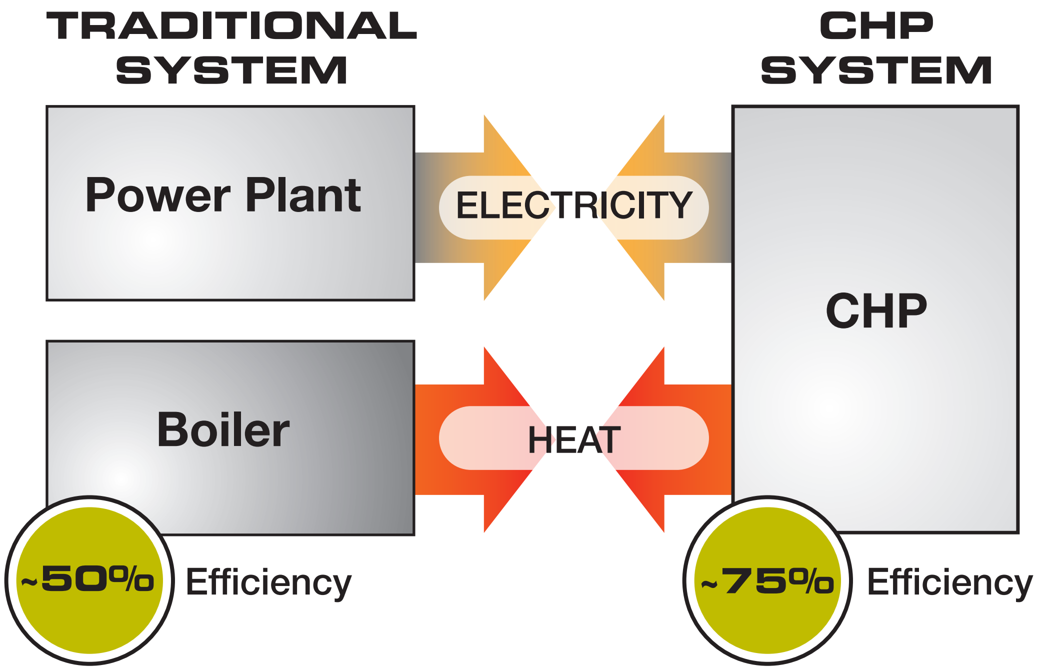
Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of electricity and heat from a single fuel source, such as: natural gas, biomass, biogas, coal, waste heat, or oil. The two most common CHP system configurations are:

- Gas turbine or engine with heat recovery unit
- Steam boiler with steam turbine

See www.energy.gov/eere/amo/combined-heat-and-power-basics for additional information.

Why Should Facilities Consider CHP?

For facilities with favorable conditions for CHP, the efficiency of producing electricity and thermal energy from the same source can be significantly higher than producing them separately. See illustration below:



This greater efficiency can translate into lower operating costs and decreased levels of emissions. In some circumstances, CHP may also offer increased reliability and reductions in congestion and losses on the transmission and distribution systems.

Is My Facility a Good CHP Candidate?

In order for a facility to be a good candidate for CHP, it must have a need for electricity and thermal energy that occurs simultaneously, as both will be produced from the same source.

Thermal energy applications may include steam, hot water, chilled water, hot air, or other similar uses.

CHP may be beneficial for many types of facilities. The following types of Iowa businesses have been identified as having the potential for economical CHP installations:

- ***Industrial manufacturers*** - chemical, refining, ethanol, pulp and paper, food processing, lumber and wood, rubber and plastics, primary and fabricated metals, machinery and computer equipment, and transportation equipment
- ***Institutions*** - colleges and universities, hospitals, and prisons
- ***Commercial buildings*** - hotels and casinos, large office buildings, nursing homes, food stores and restaurants, data centers, and other retail establishments
- ***Municipal/Governmental*** - wastewater treatment facilities and office buildings
- ***Residential*** - multi-family housing

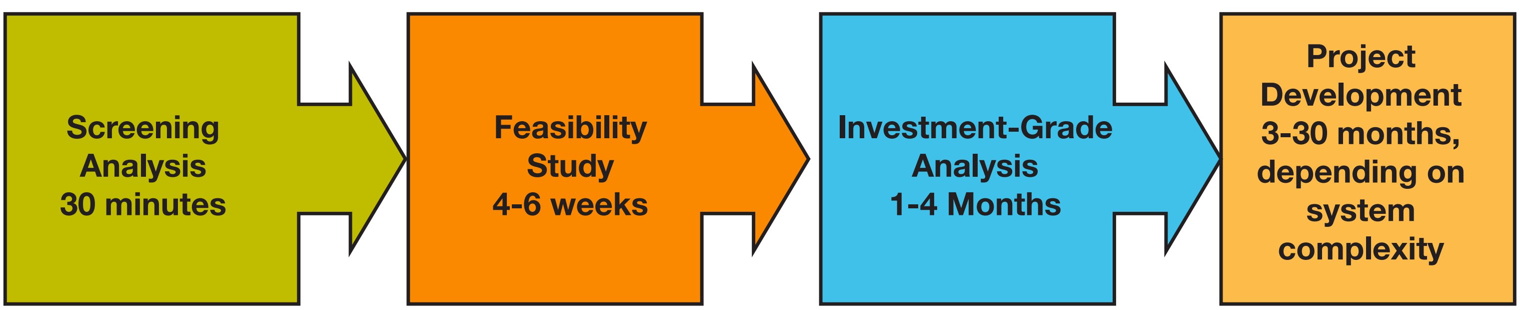
Any business that has an ongoing need for both electricity and thermal energy may be a good candidate, however, even if not specifically part of the identified list.

Other factors that favor consideration of CHP include:

- the number of hours your facility is in operation (more than 5,000/year is beneficial)
- the importance of energy to your business
- relatively high costs of electricity (at least $0.07/kWh) despite implementation of energy efficiency measures
- the importance of high levels of reliability to your business
- plans for significant changes to your central plant or other significant construction project within 3-5 years
- a desire to limit the impact of your facility on the environment
- adequate available square footage at the facility to incorporate a CHP installation
- the amount and quality of steam needed by your business, if applicable

How Long Will CHP Evaluation and Project Development Take?

The timeline below shows the steps involved in CHP evaluation and development and gives an estimate of the time required for each. Information regarding the permitting process and associated time requirements is presented in the next section of this guide.



What Do I Need for Further Evaluation?

A next step to take to determine if a more detailed CHP feasibility study may be beneficial is to undertake a CHP qualification screening analysis. A screening analysis provides a first analysis to determine the initial economic viability of a CHP project. This type of analysis is a first cut screening for CHP economic viability at a specific site. It is based on a simple spark spread analysis and utilizes minimal site information. Typically, the operating cost of a CHP system at your site—including fuel, maintenance, and credit for displaced thermal energy—is estimated assuming performance characteristics of a typical CHP system and prevailing fuel price assumptions for the specified site location. Qualitative information is also factored in to determine if the site is a potential candidate for CHP. Complimentary resources are available through the U.S. EPA CHP Partnership and the U.S. DOE CHP Technical Assistance Partnerships to complete these types of analyses.

Information that is typically needed to complete a screening analysis includes:

- Type of business of the facility
- Average monthly electricity usage (kWh) or average electric demand (kW)
- Monthly heating load or fuel use (MMBTu) or average thermal demand (MMBTU/hr)
- Number of hours the facility operates in a year
- Average fuel price ($/MMBTu)
- Average all-in electric price ($/kWh), check with utility to review tariffs as a change in load factor may impact rate structure
- Existing thermal equipment efficiency

Specifics on the two federal tools for screening are as follows:

US EPA CHP Partnership – Spark Spread Estimator

The US EPA CHP Partnership seeks to reduce the environmental impacts of electric power generation by promoting the use of CHP. The Spark Spread Estimator calculates the difference between the delivered electricity price and the total cost to generate power with a prospective CHP system. The Estimator will help individuals evaluate a prospective CHP system for its potential economic feasibility. The Excel model can be downloaded free of charge from the EPA's website below under "Resources" inset on the right-hand side of the page.

www.epa.gov/chp/project-development/stage1.html

While actual values are preferable for all information, the estimator will use default values for information not readily available. Electricity and natural gas usage and cost can be obtained from the local utility(ies). The results of the spark spread estimator will provide an indication of the potential savings from CHP. The estimator will also identify the best technology for use in a CHP application at your facility.

U.S. DOE Midwest CHP Technical Assistance Partnership – CHP Screening & Site Qualification

The U.S. DOE Midwest CHP Technical Assistance Partnership (CHP TAP) assists regional businesses and communities reduce their energy costs, improve efficiency, and strengthen their energy resiliency and reliability through the use of CHP. The Midwest CHP TAP is one of seven regional CHP TAPs formed by the U.S. Department of Energy to promote and assist in transforming the market for CHP throughout the United States. The Midwest CHP TAP provides unbiased, fuel-neutral and technology-neutral resources and expertise to help industrial, commercial, federal, institutional, and other large energy users consider and evaluate CHP for their facilities. The Midwest CHP TAP assists facilities through the project development process, from initial CHP screening to project installation.

The Midwest CHP TAP provides complimentary analyses that are first cut screenings for CHP economic viability at a specific site. The analysis is based on a simple spark spread analysis and utilizes minimal site information. The operating cost of a CHP system at your site—including fuel, maintenance, and credit for displaced thermal energy—is estimated assuming performance characteristics of a typical CHP system and prevailing fuel price assumptions for your site location. Qualitative information is also factored in to determine if your site is a potential candidate for CHP.

To begin this process please visit the Midwest CHP Technical Assistance Partnership at www.midwestchptap.org or call 312.355.3476.

What If My Screening Analysis Looks Good?

If the results of the screening analysis indicate that CHP may be beneficial for a facility, the next step is a feasibility analysis using more detailed site-specific information. Feasibility studies can be completed through the following entities:

1. Completing a high-level feasibility analysis can be contracted out to an engineering firm, developer, and/or consultant (These contacts are listed in the contact directory section of this Guide).
2. The US EPA CHP Partnership maintains a partner's list, which includes supporters of CHP such as federal, state, and local government agencies and private organizations such as energy users, energy service companies, CHP project developers and consultants, and equipment manufacturers. www.epa.gov/chp/aboutus/partners.html
3. The Midwest CHP TAP can provide direct assistance in completing feasibility analyses. www.midwestchptap.org/support/AssistanceScope.pdf

Your local utility may also be a resource for funding a CHP feasibility study.

Information and Data Needed for a Feasibility Study

A list of data items needed for a feasibility study has been compiled by the TAP and can be downloaded at:

www.midwestchptap.org/support/documents/Walkthrough_Checklist.pdf

The feasibility analysis is based on utility bills from the previous year, information on daily and seasonal electric and thermal load profiles, and insights into site-specific issues such as expansion plans or power reliability problems that may factor into CHP system selection or sizing. Different CHP technology or system options may be evaluated with budgetary pricing and economic analysis developed for each option. The results of the analysis provide a sense of the estimated economic, operational, reliability, energy security, and other benefits that CHP might offer your facility.

Additional information you may need to complete this study includes:

- Hourly electric loads
- Electric interconnection requirements (contact your utility for details)
  - MidAmerican Energy interconnection requirements can be referenced at: www.midamericanenergy.com/rates7.aspx
  - Alliant requirements can be referenced at: www.alliantenergy.com/sellmypower
  - Iowa Utilities Board rules regarding utility interconnection standards can be found at: www.legis.iowa.gov/docs/ACO/chapter/199.45.pdf
  - For members served by a municipal utility or rural electric cooperative, contact the utility. Contact information is provided on your most recent electric bill statement.
- Electric tariff for current electric rate, electric standby/supplemental service tariff and rate for utility purchase of excess energy
  - MidAmerican Iowa electric tariffs can be found at: www.midamericanenergy.com/rates1.aspx
  - Alliant Energy tariffs can be found at: www.alliantenergy.com/rates
  - For members served by a municipal utility or rural electric cooperative, contact the utility. Contact information is provided on your most recent electric bill statement.
- Environmental permitting requirements (further detail provided within this guide)
- Available utility rebates/design assistance (further detail provided within this guide)

Where Do I Go for an Investment Grade Analysis?

If the feasibility study indicates CHP would be beneficial, the next step is to commission an investment-grade analysis. This will require assistance from an engineering/design firm. The contact directory section of this guide can provide assistance in finding an engineering/design firm in Iowa and the Midwest with CHP expertise.

The EPA also maintains a partner's list, which includes supporters of CHP such as federal, state, and local government agencies and private organizations such as energy users, energy service companies, CHP project developers and consultants, and equipment manufacturers.

www.epa.gov/chp/aboutus/partners.html

The Midwest CHP TAP can provide unbiased, technical, third-party reviews of vendor proposals and investment-grade analyses.

www.midwestchptap.org/support/AssistanceScope.pdf

The resources directory of this guide provides links to additional documents and websites of interest when evaluating the role of CHP in a facility.

Siting and General Permits

CHP projects may require the following permits and approvals from local agencies before constructing a CHP system.

- City or County Planning Department – check with local agencies for regulations or guidelines on: noise, setbacks, zoning and land use.
- State or Local Building and Fire Departments - check with local agencies regarding project design, fire safety, electrical and structural requirements.

Definitions related to permits are found at the end of this seciton.

Air Quality Permits

Any project that includes construction of a new facility or modification of an existing facility which emits air contaminants requires authorization from the Iowa Department of Natural Resources (DNR) – Construction Permits Section. Permits and approvals are affected by project size and complexity, location, technology, infrastructure modifications and environmental impacts. Allow a minimum of 60 days for standard projects and six months for Prevention of Significant Deterioration permits. For projects located in Linn and Polk counties, construction permits are administered by local air program requirements and fees apply.

Figure 1 depicts the steps for an applicant in the construction permit process, while Figure 2 outlines the review process the DNR follows for permit applications. The forms required for a construction permit application are found at the DNR website. The forms required will depend on the system specifications but will typically include:

- Facilities Information form
- Emissions Unit form, one per unit (such as boiler)
- Stack/Vent Information form
- Emissions Calculations form
- Emissions Inventory form
- Control Equipment form (if applicable)
- Dispersion Modeling information

Contacts

Iowa Department of Natural Resources
www.iowadnr.gov/InsideDNR/RegulatoryAir/ConstructionPermits.aspx
Construction Permitting helpline toll free at 1.877.AIR.IOWA (1.877.247.4692)

Polk County Air Quality Division
www.polkcountyiowa.gov/airquality
515.286.3705

Linn County Public Health Department, Air Quality Division
www.linncleanair.org
319.892.6000

FIGURE 1

Air Quality Bureau Permitting Requirements for Combined Heat and Power Projects

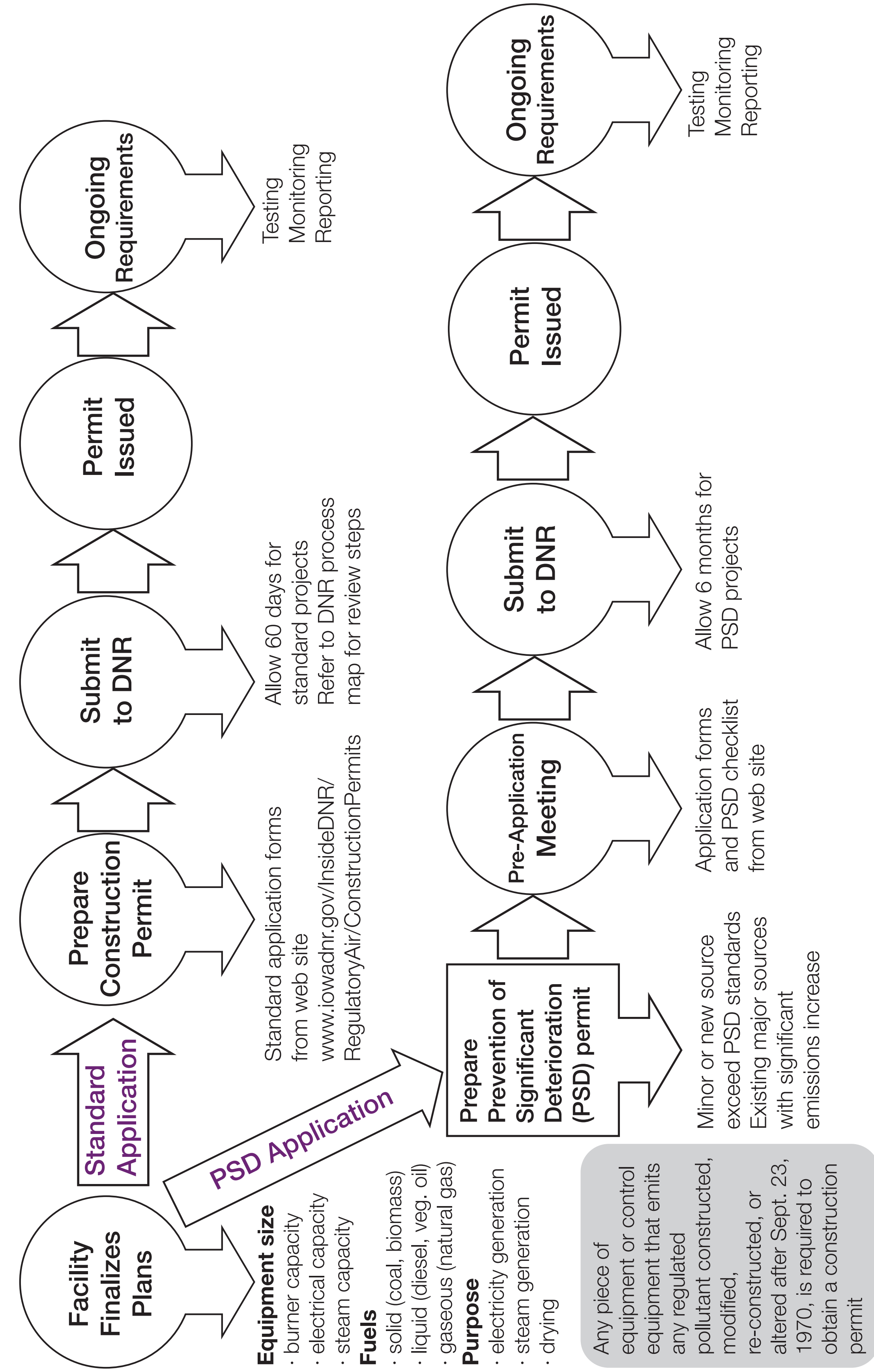
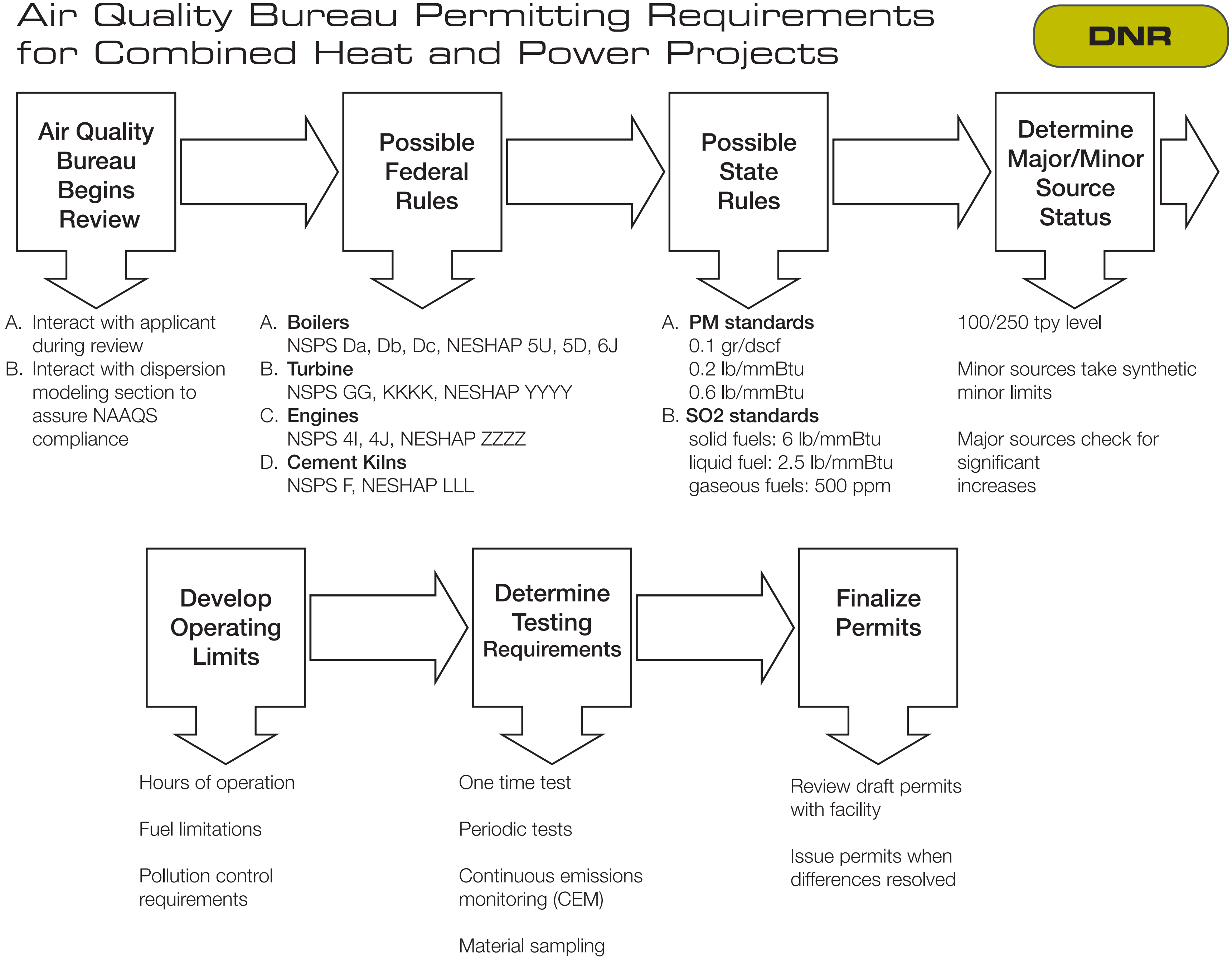


FIGURE 2

Air Quality Bureau Permitting Requirements for Combined Heat and Power Projects



Definitions

Major Title V Source: A facility that emits, or has the potential to emit, one hundred tons or more of a regulated pollutant per year.

Minor Title V Source: A facility that has the potential to emit of less than one hundred tons per year of a regulated pollutant.

PSD Project (Prevention of Significant Deterioration): A project for major sources when emission increases exceed the levels in 40 CFR 52.21(b)(23)(i). A PSD project imposes limitations beyond the typical construction permits.

Major PSD Source: A facility that has the potential to emit of more than two hundred fifty tons per year of a regulated pollutant, or one hundred tons per year if one of the 28 named source categories listed in 40 CFR 52.21(b)(1)(i)(a).

Minor PSD Source: A facility that has the potential to emit of less than two hundred fifty tons per year of a regulated pollutant, or one hundred tons per year if one of the 28 named source categories listed in 40 CFR 52.21(b)(1)(i)(a).

Potential to Emit: The maximum capacity of a stationary source to emit a pollutant under its physical and operational design.

Single Source: The collection of pollutant emitting activities located on contiguous or adjacent properties which belong to the same industrial grouping and under common control.

Second Party Ownership: An emission unit owned or operated by an individual located on the property of a second individual.

Operational Limitations: Limitations in a federally enforceable permit on a unit's throughput, hours of operation, material usage or other factors that limit the potential to emit.

Certified Engine: A Reciprocating Internal Combustion Engine (RICE) certified to meet the applicable NSPS IIII or NSPS JJJJ standards. The engine should have a certificate of conformity from the EPA.

Waste Heat to Power: Waste Heat to Power (WHP) is the process of capturing heat discarded by an existing industrial process and using that heat to generate power. The process is termed a "bottom cycling system", in which fuel is burned to provide thermal input to a furnace or other industrial process, and heat rejected from the process is then used to produce electricity.

Combined Heat and Power (CHP): Combined Heat and Power, also known as cogeneration, refers to the simultaneous production of electricity and thermal energy from a single fuel source. CHP systems can be configured either as a topping or a bottoming cycle. In a typical topping cycle system, fuel is burned in a prime mover to generate electricity. Energy normally lost is the prime mover's hot exhaust and cooling systems is instead recovered to provide heat. A bottoming cycle system is known as Waste Heat Recovery, see definition of Waste Heat Recovery for system detail.

Exemption from Permitting: Exemptions from the requirement to obtain a construction permit are located in 567 IAC 22.1(2). An exemption does not relieve the owner from meeting any applicable emission standards.

General CHP Information and Resources

EPA Combined Heat and Power Partnership: The EPA Combined Heat and Power (CHP) Partnership provides resources about CHP technologies, incentives, emission profiles, and other information on its website.
www.epa.gov/chp

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, CHP Deployment Resources: The Advanced Manufacturing Office's CHP Deployment Program provides stakeholders with the resources necessary to identify CHP market opportunities and support implementation of CHP systems in industrial, federal, commercial, institutional and other applications.
www.energy.gov/eere/amo/chp-deployment

Midwest CHP TAPs: The Department of Energy's CHP Technical Assistance Partnerships (TAPs) promote and assist in transforming the market for CHP, waste heat to power, and district energy with CHP throughout the United States. The Midwest Center is located with the Energy Resources Center at the University of Illinois at Chicago.
www.midwestchptap.org

CHP Project Development

CHP Project Development Handbook: Prepared by the EPA Combined Heat and Power Partnership, this document was developed to assist energy users design, install and operate CHP systems at their facilities.
www.epa.gov/chp/documents/chp_handbook.pdf

CHP Project Profiles

The U.S. DOE CHP Technical Assistance Partnerships have published a series of project profiles of existing CHP projects. A searchable database is located at the U.S. DOE EERE webpage.
www1.eere.energy.gov/manufacturing/distributedenergy/chp_database/

U.S. DOE CHP Installation Database

The DOE CHP Installation Database is a data collection effort sponsored by the U.S. Department of Energy and maintained by ICF International. The database contains a comprehensive listing of combined heat and power installations throughout the country. ICF tracks installations of all sizes, from large industrial systems that are hundreds of megawatts in size to small commercial microturbine and fuel cell systems that are tens of kilowatts. The database is updated on an annual basis and is composed of information from a variety sources including the seven DOE CHP Technical Assistance Partnerships (CHP TAPs), the Energy Information Administration (EIA), the EPA CHP Partnership, utility lists, incentive program data, CHP developers and equipment suppliers, industry periodicals, and news releases.
doe.icfwebservices.com/chpdb

CHP as a Reliability Asset

Guides to enable CHP as an alternative source of power for critical infrastructure during emergencies.

Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings:

www.energy.gov/sites/prod/files/2013/11/f4/chp_for_reliability_guidance.pdf

Combined Heat and Power: Enabling Resilient Energy Infrastructure for Critical Facilities

www.energy.gov/sites/prod/files/2013/11/f4/chp_critical_facilities.pdf

CHP Environmental Considerations

The CHP Emissions Calculator is a Microsoft Excel-based tool that calculates and compares the estimated air pollutant emissions of a CHP system and comparable separate heat and power.

www.epa.gov/chp/basic/calculator.html

Technical Assistance Contacts

Iowa Economic Development Authority (IEDA): IEDA houses the State Energy Office for Iowa. The Energy Team works with stakeholders to facilitate CHP development.
www.iowaeconomicdevelopment.com/Energy/CHP

Shelly Peterson
Program Manager
515.725.0418
shelly.peterson@iowa.gov

Iowa Utilities Board (IUB): The IUB examines utility-related aspects of energy, including CHP.
iub.iowa.gov/on-site-generation

Iowa Utilities Board Main Desk
515.725.7300
iub@iub.iowa.gov

U.S. DOE Midwest Combined Heat and Power Technical Assistance Partnership (CHP TAP): The Department of Energy's CHP TAPs promote and assist in transforming the market for CHP, waste heat to power, and district energy with CHP throughout the United States. The Midwest CHP TAP is managed through the Energy Resources Center at the University of Illinois at Chicago.
www.midwestchptap.org

Cliff Haefke
Director
312.355.3476
Chaefk1@uic.edu

Utility Contacts

Electrical service in Iowa is through a number of different providers. See the following link for a map of electrical service boundaries:
www.iowadot.gov/maps/msp/electrical/electrical.html

Natural gas service may vary and owners should consult their utility bill to determine the provider. Contact information for assistance on utility related matters is below.

MidAmerican Energy Company
Amber Moser
Energy Efficiency Product Manager
563.333.8049
almoser@midamerican.com

Alliant Energy
Christina VanderZee
319.786.4103
christinavanderzee@alliantenergy.com

Black Hills Natural Gas
Amber Buckingham
Energy Efficiency Program Coordinator
515.343.2021
amber.buckingham@blackhillscorp.com

Iowa Association of Electric Cooperatives
Regi Goodale
Director of Regulatory Affairs
515.727.8949
rgoodale@iowarec.org

Iowa Association of Municipal Utilities
Joel Logan
Director of Energy Services
515.289.1999
jlogan@iamu.org

Consultant and Equipment Vendor Contacts

A number of private companies in the state and region provide services related to the development of a CHP project. The list below is not comprehensive and the names of these organizations are provided for information purposes only. The State does not endorse the services of any of these organizations.

Iowa Contacts - Consulting/Engineering

DGR Engineering —Rock Rapids, IA
Michael Carr
712.472.2531
mike.carr@dgr.com
www.dgr.com

Stanley Consultants Inc. — Muscatine, IA
Bill Liegois
563.264.6600
liegoisbill@stanleygroup.com
www.stanleyconsultants.com

Brown Engineering Company — Des Moines, IA
Terry Martin
515.331.1325
tmartin@brownengineeringcompany.com
www.brownengineeringcompany.com

KPE-Consulting Engineers Inc. — Davenport/ Des Moines, IA
Kevin Power
563.323.3197 / 515.254.2925
kpe@kpe-inc.com
www.kpe-inc.com/design

Mark E Vermeer PLC — Ankeny, IA
Mark E. Vermeer
515.333-2360
mevdutch@gmail.com

Iowa Contacts - Equipment Mfg/Sales

Statistics & Control Inc. — West Des Moines, IA
Boris Pusin
515.267.8700
bpusin@statcontrolinc.com
www.stctrl.com

Ziegler CAT — Altoona, IA
Steven Steenhoek
515.957.3838
steve.steenhoek@zieglercat.com
www.zieglercat.com/power-systems/products/new-equipment/electric-power/
www.catgaspower.com/

Midwest/Regional Contacts - Consultant/Engineering

HGA Architects and Engineers — Minneapolis, MN
Leigh Harrison
612.758.4403
lharrison@hga.co

Michaels Energy — LaCrosse, WI
Jeff Ihnen
608.386.0601
jli@MichaelsEnergy.com
www.michaelsenergy.com

CDM Smith Inc. — Kansas City, MO
Pat O'Neill
816.444.8270
oneillpa@cdmsmith.com

O'Shea Environmental Associates Inc. Lemont, IL
William O'Shea
630.243.8364
wjoshea@osheaenv.com
www.osheaenv.com

Midwest/Regional Contacts - Equipment Mfg/Sales

Solar Turbines Inc. — Naperville, IL
Duane Wilson
630.842.8720
dewilson@solarturbines.com

Federal Incentives

The federal government currently provides several financial incentives for CHP projects. A summary of the federal incentives most relevant to CHP projects is listed below:

Federal Business Energy Investment Tax Credit: This existing credit is equal to 10% of expenditures, with no maximum limit stated. Eligible CHP property generally includes systems up to 50 MW in capacity that exceeds 60% energy efficiency.
programs.dsireusa.org/system/program/detail/658

5-year Accelerated Depreciation: The U.S. Tax Code allows business owners to depreciate qualifying CHP equipment using the five-year Modified Accelerated Cost Recovery System (MACRS).
programs.dsireusa.org/system/program/detail/676

Renewable Electricity Production Tax Credit: The federal PTC provides an incentive for electricity generated by qualified energy resources, including biomass and landfill gas resources.
programs.dsireusa.org/system/program/detail/734

Rural Energy for America Guaranteed Loan Program and Rural Energy for America Program Grants: Through its Business Programs, USDA Rural Development provides for business credit needs in under-served rural areas, which includes many areas in the state.
www.rurdev.usda.gov/LP_BusinessPrograms.html

To locate USDA local offices in Iowa, refer to the following:
www.rd.usda.gov/contact-us/state-offices/ia

Energy Loan Guarantee Program: Loan guarantees are issued for projects with high technology risks to encourage early commercial use of new or improved technologies.
programs.dsireusa.org/system/program/detail/3071

State Incentives

The following incentives provided by the State of Iowa may be applicable to a CHP project:

Renewable Energy Production Tax Credit: The renewable energy production tax credit offers a $0.015 per kWh tax credit for energy generated by eligible renewable energy facilities. Additional incentives specific to biogas and hydrogen fuel are also included. A carve out has also been created for natural gas cogeneration at ethanol plants.
programs.dsireusa.org/system/program/detail/1176

Methane Gas Conversion Tax Exemption/Energy Replacement Generation Tax Exemption: Publicly-owned sanitary landfills may qualify for a property tax incentive for converting gas to energy.
programs.dsireusa.org/system/program/detail/185 and
programs.dsireusa.org/system/program/detail/966

Alternate Energy Revolving Loan Program: Created by the Iowa legislature, the program is open to any individual interested in building a renewable energy facility for their home or business.
www.iowaenergycenter.org/alternate-energy-revolving-loan-program-aerlp

IADG Energy Bank Revolving Loan Program: A low interest revolving loan fund is available to businesses and industries for qualifying energy efficiency and renewable energy projects.
www.iadg.com/services/financial-assistance/iadg-energy-bank.aspx

State Revolving Fund (SRF) Program: Wastewater treatment facilities can be a candidate for CHP system installations. The Iowa SRF program can be a source of financing for projects associated with this sector.
www.iowasrf.com

Utility Incentives

Utility programs vary by service provider. A summary of CHP related incentives for the two largest electric investor-owned utilities in the state is provided below. For projects in other service areas, the utility can be contacted directly for information on possible incentives.

MidAmerican Energy CHP Incentive Summary

Program	Qualifications	Customer Report Information
Industrial Partners	Bottoming Cycle Systems only – Waste heat from a facility system is recovered and used to power a turbine for electricity production. This type of CHP system is also known as waste heat recovery.	MidAmerican Energy may offer incentives to eligible facilities for the installation of qualifying bottoming cycle systems. Industrial facilities with high-temperature waste streams may be suitable for implementation of a bottom cycle system.
Commercial Energy Solutions	Bottoming Cycle Systems only – Waste heat from a facility system is recovered and used to power a turbine for electricity production. This type of CHP system is also known as waste heat recovery.	MidAmerican Energy may offer incentives to eligible facilities for the installation of qualifying bottoming cycle systems. Hospitals, hotels and resorts may offer opportunities for implementing CHP because they operate 24 hours per day, year round and require heat at all times for hot water, sterilization, and humidification. CHP systems offer a more reliable alternative to traditional backup generators since they are already operating at the moment of grid service interruption. University campuses may offer opportunities for implementing CHP because they often have a central power plant and/or central boilers with a district heating system. These existing systems may represent opportunities for conversion to CHP operation. Campuses also have a continuous need for heat and electricity, which allows for optimized operation of a CHP system.
Custom Systems	Bottoming Cycle Systems only – Waste heat from a facility system is recovered and used to power a turbine for electricity production. This type of CHP system is also known as waste heat recovery.	MidAmerican Energy may offer incentives to eligible facilities for the installation of qualifying bottoming cycle systems.

Please click on the applicable link below for additional information regarding MidAmerican Energy's Industrial Partners and Commercial Energy Solutions energy efficiency programs.

- Industrial Partners - midamericanenergy.com/ee/ia_bus_industrial_partners.aspx
- Commercial Energy Solutions - midamericanenergy.com/ee/ia_bus_optimization.aspx

Alliant Energy CHP Incentive Summary

Program	Qualifications	Customer Report Information
Custom Rebate	Bottoming Cycle Systems only, also known as Waste Heat Recovery CHP or Waste Heat to Power. Waste heat from a facility is recovered and used to power a turbine for electricity production, and the remaining heat is then used in the facility.	Alliant Energy offers rebates to retail gas and combination customers for on-site customer-owned waste heat recovery systems. Facilities with high-temperature waste streams that operate 24 hours per day all year and require heat at all times may be suitable for implementation of a waste heat recovery system. The program includes the following: · 100% of electrical and thermal energy generated must be used on-site. · Customer must first conduct a Feasibility Study using a qualified engineering firm or CHP installation contractor (study may be eligible for reimbursement through Alliant Energy's Feasibility Study program) · Rebates are determined by the first year of energy dollar savings of the primary fuel serving the displaced thermal load.

Financing Resources

A number of resources provide detailed information on financing and incentives for CHP projects. Selected resources are as follows:

EPA Procurement Guide: CHP financing
www.epa.gov/chp/documents/pguide_financing_options.pdf

Power the Future of Healthcare, Financial and Operational Resilience: A Combined Heat and Power Guide for Massachusetts Hospital Decision Makers
www.greenribboncommission.org/downloads/CHP_Guide_091013.pdf

Policies and Incentives Portal – includes both state and federal incentives for CHP
www.epa.gov/chp/policies/database.html

Database of State Incentives for Renewable Energy (DSIRE) – a listing of local, state, and federal incentives for energy efficiency and renewable energy
www.dsireusa.org

Guide to Federal Financing for Energy Efficiency Upgrades and Clean Energy Deployment
energy.gov/sites/prod/files/2014/10/f18/Federal%20Financing%20Guide%2009%2026%2014.pdf

Appendix

IUB Informational Guide for On-Site Generation

Midwest CHP TAP Market Analysis Summary for Iowa

CHP Case Studies

Iowa Utilities Board

Governor Terry E. Branstad
Lt. Governor Kim Reynolds

Elizabeth S. Jacobs, Chair
Nick Wagner, Board Member
Sheila K. Tipton, Board Member

Informational Guide for On-Site Generation (Distributed Generation)

This informational guide is intended to help residential and small business customers who are considering installing electric generation (wind, solar, biomass, etc.) on their property. This document is for informational purposes only and use of the guide is voluntary. Following are the topics covered:

1. Before You Begin
2. Distributed Generation Checklist
3. Choosing a Dealer or Equipment
4. Finance Options
5. Informational Links

1. Before You Begin

Assess Your Goals. Are you exploring on-site generation because you are primarily interested in reducing your energy usage or are you interested in using more or only renewable energy?

- If you are primarily interested in reducing your energy usage, consider an energy efficiency audit and implementing the recommendations. An energy audit may uncover energy efficiency improvements to help you reduce your electric usage and potentially allow you to install a smaller distributed generation system. Contact your utility to get more information about its energy efficiency programs.
  - Alliant Energy - http://www.alliantenergy.com/SaveEnergyAndMoney/
  - MidAmerican - http://www.midamericanenergy.com/ee/ia_res.aspx

  If you are served by an electric cooperative or municipal utility, you should find contact information for your utility on your electric bill. Links to the individual utility Web sites can be found on the associations' Web pages below:
  - Iowa Association of Electric Cooperatives - http://www.iowarec.org/about/links/
  - Iowa Association of Municipal Utilities - http://www.iamu.org/map.cfm

- If you are interested in increasing the amount of renewable energy on the utility grid, you can voluntarily contribute to the development of renewable energy through the utilities' Alternative Energy Purchase Program, also known as green pricing programs. Contact your utility to get more information. Also see Iowa Code § 476.47 (https://www.legis.iowa.gov/docs/code/476.47.pdf) for more information.

- If you are interested in producing your own electricity and having a distributed generation system on your property, the rest of this guide will help you with that process. Please keep in mind that **Iowa law requires that the distributed generation system owner notify the interconnected utility prior to installing a distributed generation system.**

Review Legal Requirements. In order to ensure there are no legal barriers to your proposed distributed generation system, ask the local planning and zoning commission or city officials to identify applicable zoning ordinances and building permit requirements. You should also consult your attorney to determine if your property is covered by restrictive covenants or easements that affect the installation or if there are other legal issues.

Review Insurance Issues. Discuss liability coverage and insurance needs with your insurance agent and review the applicable insurance requirements with your utility.

2. Distributed Generation Checklist

Gather Information.

- ☐ Gather your historical electrical usage for your property and the utility rates charged and paid from your utility bills or contact your utility to request copies.

- ☐ Review information to become familiar with the technology and terminology.
  - Iowa Energy Center - http://www.iowaenergycenter.org/renewable-energy/
  - U.S. Department of Energy - http://www.energy.gov/energysaver/articles/planning-home-renewable-energy-systems
  - Database of State Incentives for Renewables and Efficiency - http://www.dsireusa.org

- ☐ Check out the following links to see the energy potential of your site. Note that the location of your system can have significant impacts on its generation potential.
  - Wind calculator - http://www.iowaenergycenter.org/wind-calculator-tool/
  - Solar calculator - http://www.iowaenergycenter.org/solar-calculator-tool/

Solicit and Compare Quotes from Dealers/Installers. (See the Choosing a Dealer and Equipment section for additional guidance.)

Select Your Dealer/Installer. (See the Choosing a Dealer and Equipment section for additional guidance.)

- ☐ Your qualified dealer/installer should be able to help you with the remaining areas of the checklist. You will have legal obligations with regard to your facility, so you should make sure you are fully aware of your obligations.

Consider Costs.

- ☐ Identify federal, state, and utility incentives. Also, refer to the Database of State Incentives for Renewables and Efficiency. http://www.dsireusa.org

  - Look at finance/ownership options. (See the Finance Options section for more information.)
    - Purchase/Own
    - Lease
    - Third-Party Power Purchase Agreement

  - Check with your accountant, tax advisor, attorney, or finance professional to ensure that the incentives and financing options are right for you.

  - Calculate the estimated simple payback period.

$$\frac{\textit{Total Initial Cost (including interconnection costs)}}{\textit{(Annual Energy Cost Savings – Annual Operating Costs)}} = \textit{Payback (in years)}$$

    Review assumptions used for the following:
    - Cost of the system (include equipment, installation, interconnection, and incentive assumptions).
    - Energy cost savings assumptions (electric rate,[1] utility assumptions (e.g., net metering)).
    - Annual operating costs (insurance, maintenance, etc.).

[1] Understand that electric rates are dynamic and that some fixed aspects of rates may not be offset by a distributed generation system. Future utility rates are difficult to predict and have significant impact when evaluating a quoted price and any projected savings.

2. Distributed Generation Checklist (continued)

Review and Understand Requirements for Utility Interconnection.

- ☐ Contact your utility to discuss distributed generation systems, project plans, utility policies, and interconnection. Review interconnection requirements, safety, and any special permits that may be required. Iowa law requires that the distributed generation system owner notify your electric utility at least 30 days before installing a distributed generation system.

- ☐ Review the Iowa Utilities Board's Interconnection Rules.
  (Please note that not all utilities are subject to these rules)

  https://www.legis.iowa.gov/law/administrativeRules/rules?agency=199&chapter=45&pubDate=07-23-2014

- ☐ Review the Iowa Utilities Board's Cogeneration and Small Power Production Rules.
  (Please note that not all utilities are subject to these rules)

  https://www.legis.iowa.gov/law/administrativeRules/rules?agency=199&chapter=15&pubDate=12-10-2014

- ☐ Plan that the state of Iowa or the applicable local authority will require a construction permit and an inspection upon completion. Your electric utility may also require verification that the system meets applicable standards prior to authorizing your system to operate.

3. Choosing a Dealer and Equipment

There are many "how-to" guides for purchasing solar, wind, or other distributed generation systems. To ensure you get the system that best meets your needs, be diligent in your research and ask questions. Remember that dealers operate independently from your utility.

Get a Written Project Proposal from Multiple Dealers and Compare.

- Make sure the estimates are for the same type and size of system.
- The proposal should include detailed costs and other information (including hardware, installation, connection to the grid, permitting, sales tax, equipment warranty expense, expected life, and ongoing maintenance requirements and costs).
- The proposal should also include an estimate of how much of your electric needs the system will provide and the general time periods during which the electricity will be produced.

Get a Dealer's Qualifications (in writing) Related to a Specific Product/System.

- Can the dealer comply with all the technical requirements included in the utility's Standard Distributed Generation Interconnection Agreement?
- Can the dealer comply with applicable state and local building codes and arrange for any necessary code inspections with respect to this installation?
- Are there any pending complaints or active judgments or liens against the dealer?
  - Contact the Better Business Bureau.
  - Contact the Attorney General Consumer Protection Division at (515) 281-5926 or (888) 777-4590.
- Ask for references and check them. Look at other facilities installed by the dealer.
- Does the dealer have insurance and what does it cover?
- Does the dealer guarantee his work and what are the terms of any guarantee?
- Is the dealer familiar with your utility's policies on interconnection, net metering, or utility buy-back (avoided cost) rates?
- Is the dealer aware of any incentives that may be available for the system?
- Ask about maintenance of the system, training to operate the system, and how you will be able to monitor the system's performance.

For Solar, Ask:

- What type of roof preparation is needed, and what condition does the roof need to be in for a roof mount?
- Who is responsible for repairs if there are structural damages resulting from the installation?
- Who is responsible for removal and reinstallation of the system when your roof needs to be replaced or repaired?

Beware of Scams. Be wary of door-to-door solicitations, requests for verbal agreements, high-pressure sales tactics, demands for cash or large down payments, or scare tactics.

Review and Compare Options. Make notes and keep records of any representations made by the dealer.

Consider the Warranty Associated with the Specific Equipment Manufacturer. Ask:

- Who is responsible for equipment replacement while the hardware is under warranty?
- If there is a hardware warranty issue, who is responsible for the costs of removing the old equipment and installing the replacement equipment?
- Who provides notice, when must it be given, and what other provisions apply if the installer or inspector needs access to your home?

4. Finance Options

Compare the costs to own a distributed generation system versus the costs of a lease or a third-party power purchase agreement.[2]

Purchase/Own

- A distributed generation system is a long-term investment. When you own the system, you assume the responsibility of operating and maintaining the system.
- Consider whether to purchase the distributed generation system by:
  - Paying for the system up front or
  - Financing the system through a bank or other financial institution.

Lease

- Leases typically require less capital investment up front. The customer simply rents the system from a company for a fixed monthly payment for a period of time no matter how much electricity the system generates each month. The monthly lease payment may escalate with time. You may or may not be responsible for operation and maintenance costs. There may also be lease-to-own options. You should review the terms of any lease agreement carefully to make sure you understand your rights and obligations, as well as the services provided by the Lessor.

Third-Party Power Purchase Agreement

- In a third-party power purchase agreement a third-party developer owns and operates the system on a customer's property. That customer purchases the system's electric output for a period of time and at a price (typically per kWh) specified in the agreement.

Considerations for a Lease or a Third-Party Power Purchase Agreement

- Who owns any renewable energy credits or certificates[3] associated with the system? (Renewable energy credits may decrease your costs if you own them and can use them or sell them.)
- Who receives any tax credits or other incentives?
- Will the installation affect my property taxes?
- Who pays the taxes on it, including any increase in property taxes?
- What happens to the lease and the installation if the property is sold?
- Can a system be bought before the end of the agreement/lease?
- Who owns a leased system at the end of the agreement/lease?
- Is the product and performance of the product specified in the agreement/lease?
- Does the agreement specify who is responsible for system maintenance?
- Does the monthly fee or price per kWh increase over time?
- If I do not own my distributed generation system, will I be compensated for any excess power generated?

- For solar, ask: Who pays to remove the system and repair the roof (if repairs are necessary) at the end of the agreement/lease?

[2] The third-party power purchase agreement refers to a situation where the facility is owned by a third party who sells the output to the customer under a power purchase agreement. This is a different scenario from one in which the customer owns the facility and sells the output to the interconnected utility under a power purchase agreement.

[3] Renewable Energy Credits/Certificates (RECs) represent the environmental, social, and other non-power attributes of renewable electricity generation. The RECs are tradable or can be sold separately from the electricity associated with the renewable generation.

5. Informational Links

General Information

Iowa Energy Center	http://www.iowaenergycenter.org/
U.S. Department of Energy	Guide to Purchasing Green Power: http://www.epa.gov/greenpower/documents/purchasing_guide_for_web.pdf
North American Board of Certified Energy Practitioners	To see if your installer is certified: http://www.nabcep.org/
Attorney General	To file a consumer complaint: https://www.iowaattorneygeneral.gov/for-consumers/file-a-consumer-complaint/
State Fire Marshal Division	Licenses Electrical Contractors: http://www.dps.state.ia.us/fm/electrician/index.shtml
Iowa Economic Development Authority	Energy Programs: http://www.iowaeconomicdevelopment.com/Programs/Energy Combined Heat and Power: http://www.iowaeconomicdevelopment.com/Energy/CHP
Iowa Utilities Board	Interconnection Rules: https://www.legis.iowa.gov/law/administrativeRules/199 chapter45 Cogeneration and Small Power Production Rules: https://www.legis.iowa.gov/law/administrativeRules/199 chapter15

Utility Information

Utility information can be obtained from the utility's tariff or by contacting the utility directly. Aside from the links below, you can also search the utility's Web site by using key words such as: net metering, payment for excess generation, energy efficiency, and interconnection or distributed (or customer-owned) generation.

Alliant Energy (Interstate Power and Light Company) (800) 255-4268	Home page: http://www.alliantenergy.com/ Energy Efficiency: http://www.alliantenergy.com/SaveEnergyAndMoney/ Customer-Owned Generation: http://www.alliantenergy.com/sellmypower or (800) 972-5325 Second Nature Program: http://www.alliantenergy.com/SecondNature/index.htm
MidAmerican Energy Company (888) 427-5632	Home page: http://www.midamericanenergy.com/ Energy Efficiency: http://www.midamericanenergy.com/ee/ Distributed Generation: http://www.midamericanenergy.com/environment7.aspx Renewable Advantage Program: http://www.midamericanenergy.com/wind_advantage.aspx
Iowa Association of Electric Cooperatives	http://www.iowarec.org/about/links/ (The association site should have links to the individual rural electric cooperative Web sites)
Iowa Association of Municipal Utilities	http://www.iamu.org/map.cfm (The association site should have contact information for the individual municipal utilities)

Incentive Information

The list below is not meant to be a comprehensive list of all incentives available in Iowa. Please check with your dealer, utility, or legal or tax professional to see if other incentives are available.

Database of State Incentives for Renewable Energy	http://www.dsireusa.org/incentives/index.cfm?state=IA&re=0&ee=0&spv=0&st=0&srp=1
Iowa Solar Energy System Tax Credits	https://tax.iowa.gov/solar-energy-system-tax-credits
Iowa Renewable Energy Tax Credit	http://www.state.ia.us/government/com/util/energy/renewable_tax_credits.html

Commercial Sector Combined Heat and Power Potential in Iowa

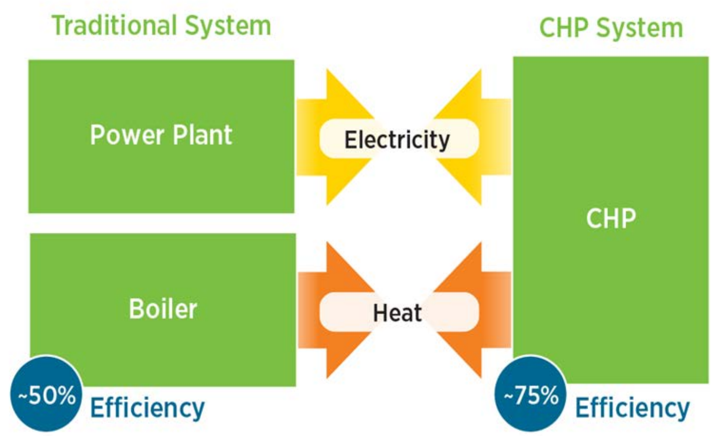
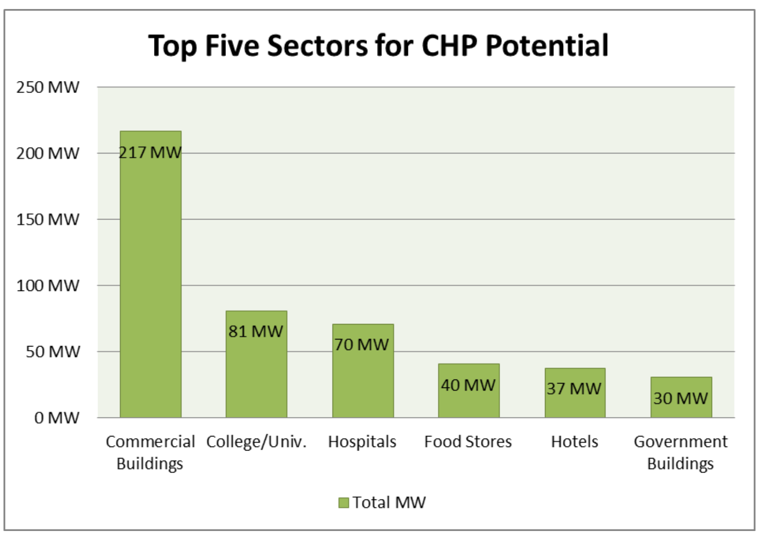


Figure 1: Diagram of CHP Operations

Combined heat and power (CHP) can be an efficient and clean method of generating electric power and useful thermal energy from a single fuel source at the point of use. Instead of purchasing electricity from the local utility and burning fuel in an on-site furnace or boiler to produce needed thermal energy, an industrial or commercial user can use CHP to provide both energy services in one energy-efficient step. Consequently, CHP can provide significant energy efficiency and environmental advantages over separate heat and power. As with all power generation, CHP deployment has unique cost, operational, and other characteristics, but it is a proven and effective available clean energy option that can help the United States enhance energy efficiency, reduce greenhouse gas (GHG) emissions, promote economic growth, and maintain a robust energy infrastructure.

CHP is all the more important when one compares the efficiency levels to large central station power plants. On average, two-thirds of the fuel used to generate electricity in the U.S. is wasted by venting unused thermal energy into the atmosphere or discharging it into water streams. While there have been impressive efficiency gains in other sectors of the economy since the oil price shocks of the 1970's, the average efficiency of power generation within the U.S. has remained around 33% since 1960. Even when the higher efficiencies of an on-site boiler (70-80%) are combined with centrally generated electricity (33%) these combined efficiencies only reach 51%. By productively using the otherwise wasted thermal energy, CHP systems can significantly increase energy utilization to efficiencies 80% and higher. Simply put, combined heat and power is the most efficient way of generating power available today.



Commercial CHP Potential

Iowa has 726 MW of CHP capacity currently installed; however, the vast majority of this installed capacity is in the industrial sector. Today, there is less than 100 MW of installed CHP capacity in the commercial sector but over 640 MW of CHP potential to be installed. This represents an enormous opportunity for CHP in Iowa.

The five sectors with the largest amount of CHP potential are Commercial Buildings, Colleges/Universities, Hospitals, Food Stores, Hotels and Government Buildings. However, much of this potential is from sites with an individual capacity of 5 MW or less. This means that there are far more sites with CHP potential in the commercial sector, requiring more decisions by more people in order to realize this potential capacity.

The commercial building sector epitomizes this focus on smaller systems. Though the sector as a whole accounts for 217 MW of CHP potential it is largely focused in applications with an individual capacity between 500 kW and 1,000 kW. Commercial buildings with CHP potential would be those in downtown Des Moines, Cedar Rapids or Iowa City that usually house multiple tenants.

Though smaller in absolute potential capacity, the hospital and college/university sectors contain a greater amount of larger sized potential CHP applications. The majority of hospital sector CHP potential is found in the 1-5 MW size category (40 MW)while the majority of CHP potential in the college/university sector is equally split between the 1-5 MW category (34 MW) and the 5-20 MW category (33 MW).

Hospital Sector

Currently there are at least two hospitals in Iowa currently operating CHP applications; however, there exists an additional 70 MW of CHP potential in the Hospital/Healthcare sector. Hospitals are appealing candidates for combined heat and power because they are one of the most energy-intensive businesses in the commercial sector, consuming more than twice the energy per square foot as average commercial buildings. Furthermore, hospitals are considered critical infrastructure that operate 24/7 and must have a reliable source of both electric and thermal energy at all times. This consistent and critical demand for high quality, highly reliable power makes hospitals ideal for CHP. Hospitals and medical campuses that have installed CHP systems enjoy reduced operating costs and higher reliability of continued service during both instantaneous and lengthy electricity outages.

Hospitals are already required to have backup power generation systems in case of a blackout; however, these are typically diesel generators that can only operate for a few hours before requiring refueling and do not produce needed thermal energy. CHP systems can provide critical infrastructure like hospitals, nursing homes or emergency services with a reliable source of both electricity and thermal energy. CHP systems designed to serve critical infrastructure are able to operate when the grid is offline, allowing facilities continuous operation.

College / University Sector

Currently there are four CHP applications operating in Iowa Universities with a combined nameplate capacity of over 81 MW; however, though the installed capacity is large there still exists an additional 81 MW in potential capacity. Universities, particularly those with large campuses, are ideal candidates for the installation of CHP/district energy systems due to their large thermal loads, desire for reliable power, year-round usage, and the need for a steady supply of electricity and thermal energy. For universities with sensitive testing equipment CHP can provide a stable and reliable source of power to ensure the continuation of experimental data.

University of Iowa CHP Plant

Universities can also be used as places of refuge during emergency situations. For instance, during power outages, people may be displaced from their homes. A university can provide heating/cooling and other essential services to a large number of displaced people if a CHP system is installed, even with a failure of the regional power grid.

Other Sectors

In addition to that CHP potential discussed above there still remain good CHP opportunities throughout the commercial sector in Iowa. Sites with a critical need for power are often a good source of CHP potential. This includes government buildings (30 MW of CHP potential), Nursing Homes (23 MW), Prisons (20 MW), Data Centers (11 MW), Military Bases (10 MW), and Airports (4 MW).

For more reading on the benefits of CHP Applications please visit http://www.midwestchptap.org/

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US DOE Midwest CHP Technical Assistance Partnership

MIDWEST

U.S. DOE

CHP TECHNICAL ASSISTANCE PARTNERSHIPS

PROJECT PROFILE

Des Moines Wastewater Reclamation Authority

4.6 MW CHP System

Quick Facts

LOCATION: Des Moines, Iowa
MARKET SECTOR: Wastewater Treatment
FACILITY SIZE: 134 MGD
CHP GENERATING CAPACITY: 4.6 MW
CHP HEAT RECOVERY RATE:
>25,000 MMBtu per year
CHP PRIME MOVERS:
3 Superior Reciprocating Engines @ 600 kW (installed 1992)
2 Jenbacher Reciprocating Engines @ 1,400 kW (installed 2015)
CHP SYSTEM EFFICIENCY: 65-70% in the winter [when heating is used for buildings] and 40% in the summer.
CHP FUEL: Biogas

Following Data is available for the initial 1.8 MW CHP System (installed 1992):
TOTAL PROJECT COST: $1,873,432
ENERGY SAVINGS: $358,000 in 2014
SIMPLE PAYBACK: 4.8 years

Project Overview

The Des Moines Wastewater Reclamation Authority (WRA) is composed of 17 communities, counties, and townships and is the largest wastewater treatment facility in Iowa. The WRA processes sewer waste from the Des Moines metro region in addition to high strength waste from waste haulers.

The WRA has successfully been running combined heat and power (CHP) since 1992. The CHP concept began in 1987 when the WRA received a Clean Water grant from the U.S. Environmental Protection Agency (EPA) to install three 600 kW Superior reciprocating engines with heat recovery. Although these engines have duel fuel capability for operating on either digester biogas or natural gas, these units primarily run on digester biogas.

In 2014, over 25,000 MMBtu of heat was recovered from the engine jackets and exhaust gases. This waste heat is used to heat the digesters and to provide heating for three buildings. The three engines run upwards of 7,500 hours per year providing a base load electric supply for the site.

The Reclamation Process / Anaerobic Digestion

The wastewater reclamation plant can process up to 134 million gallons per day (MGD) and up to 200 MGD during wet weather flows and uses anaerobic digesters to treat the sludge.

All wastewater treatment/reclamation plants produce organic sludge that requires further treatment to render it harmless prior to its disposal. The anaerobic digestion process breaks down the organic waste contained in the sludge in a controlled oxygen free environment. This process produces several outputs, a sludge that is ready for land application by local farmers, a liquid high in nutrient content (mainly nitrogen) that must be further treated, and a biogas that contains 64% methane that can be utilized for energy related projects.

Superior 600 kW Engine. Source Iowa Environmental Council

The WRA operates a total of six digesters. The five primary digesters have a capacity of over 3 million gallons of waste while the secondary digester can hold a maximum of 2.6 million gallons. The digesters today produce 1.6 million cu ft/day of biogas.

The gas is stored in either the storage sphere or dome. The biogas sphere can hold over 141,000 cu ft at 45 psi while the dome provides storage up to 450,000 cu ft. The WRA maintains an inventory of 500,000 cubic feet of biogas at all times to ensure fuel supply in case of on outage. The three superior engines consume 10,000 cu ft/day of biogas. In addition to the gas consumed onsite by the engines, the WRA sends biogas across the street to the Cargill facility that is used for process needs. In 2010 the WRA sold 117 million cubic feet to Cargill.

In the 1990s the WRA became engaged in a high strength waste receiving program that now comprises 40% of the plant organic loading. The site has a 140,000 gallon tank used to hold the 40-50 hauled loads per day. This waste comes from all across Iowa and as far away as Illinois, Ohio, Wisconsin and even Mississippi. The WRA currently receives between $0.015-$0.029 / gal of received waste as a tipping fee. This potent waste, in the form of fats, oils, and greases (FOGs) allows the WRA to create up to 27 cubic feet of biogas per pound of volatile solids destroyed. The additional biogas enabled the WRA to explore additional uses of the increased volume of biogas and the future expansion of their CHP system.

CHP Heat Recovery Integration and CHP Maintenance

The treatment system consists of 5 primary and 1 secondary digesters each of 115 ft diameter and 15 ft depth. Plate type heat exchangers are utilized to transfer the thermal energy recovered from the engine's exhaust and jacket water to the system that provides heating for the buildings and digesters. The digesters require a temperature of 90-100 degrees Fahrenheit to maintain proper operation. Hydraulic detention time is approximately 20-25 days after which biosolid waste is brought to local farmers to be used as fertilizer. Maintenance for the CHP engines is minimal with oil changes occurring every 2,800 hours of operation and large overhauls/rebuilds occurring approximately every 30,000 hours of operation.

Recent Facility and CHP Expansion

In 2010 construction began on a Combined Sewer Solids Separation Facility to handle sewage overflow during larger rain events. The WRA used this expansion as an opportunity to purchase additional CHP engine units.

Due to the success of the existing CHP system and the increased output of biogas from the hauled waste program, the WRA added four new 1.4 MW Jenbacher engines in January 2015. These engines are turbo charged, lean burn, and significantly more efficient than the older Superior engines. Two of the new engines are intended to run primarily on digester gas and will operate 24/7 and incorporate heat recovery. The other two engines will run solely on natural gas and are intended for backup and peaking without heat recovery. Once final testing is completed by Fall 2015, the upgraded CHP system will have an overall output of 4.6 MW.

New 1.4 MW Jenbacher Engine.
Source: Iowa Environmental Council

The new engines were paid for from Iowa's Clean Water State Revolving Fund (SRF), a loan program that funds wastewater treatment, sewer rehabilitation, and storm water quality improvements, as well as non-point source projects. The SRF provided construction and planning and design loans for the CSSSF at an interest rate of 1.75%.

For More Information

U.S. DOE MIDWEST CHP TECHNICAL ASSISTANCE PARTNERSHIP (CHP TAP)

1309 South Halsted Street (MC156), Chicago, Illinois 60607-7054

Phone: (312) 996-4490, Fax: (312) 996-5620

www.MidwestCHPTAP.org

The Midwest CHP TAP is a U.S. DOE sponsored program managed by the Energy Resources Center located at the University of Illinois of Chicago.

PROJECT PROFILE

MIDWEST

U.S. DOE

CLEAN ENERGY APPLICATION CENTER

National Animal Disease Center

4.7 MW CHP System

Project Overview

Located in Ames, Iowa, the National Animal Disease Center (NADC) is the largest federal animal disease center in the U.S. The NADC conducts research to solve animal health and food safety problems faced by livestock producers and the public. Opened in 1961, the NADC today includes over one million square feet of laboratory, animal housing, administrative and other support facilities.

NADC's first experience with combined heat and power (CHP) began in 2002 when they installed a 1.2 MW CHP plant. That system utilized a Solar Saturn 20™ natural gas fueled combustion turbine with heat recovery from the turbine exhaust gases. The exhaust gases are recycled through a heat recovery steam generator (HRSG) to produce 8,300 lbs/hr of process steam for use in the facility laboratories. The HRSG is also equipped with additional natural gas fired duct burners that can boost the thermal output to 29,000 lbs/hr of steam to satisfy both the process and space heating requirements of the Center. When installed, the thermal capability of the CHP system allowed the NADC to completely avoid operating an existing 40-year-old 70% energy efficient boiler (now used strictly as a backup boiler for added reliability).

Quick Facts

LOCATION: Ames, Iowa

FACILITY SIZE: Over One Million Square Feet

CHP GENERATING CAPACITY: 4.7 Megawatts

PRIME MOVERS: 1.2 MW Solar Saturn 20™ Combustion Turbine (CT-1), 3.5 MW Solar Centaur 40™ Combustion Turbine (CT-2)

HEAT RECOVERY RATE:
- **CT-1:** 8,300 lb/hr Steam Unfired; 29,000 lb/hr Steam with Duct Firing
- **CT-2:** 23,500 lbs/hr

USE OF THERMAL ENERGY: Steam for Laboratories, Space Heating, Absorption Chillers

FUEL: Natural Gas

BEGAN OPERATION:
- 2002 – 1.2 MW CHP System (CT-1)
- 2007 – 3.5 MW CHP System (CT-2)

Due to the success of the first system (CT-1), NADC installed a second 3.5 MW CHP gas turbine in 2007 (CT-2). The exhaust gases from the second turbine are also recycled and sent through a HRSG producing 23,500 lbs/hr of process steam. Unlike with CT-1, the HRSG on CT-2 does not have duct firing and only operates when the turbine is in operation. Currently, this unit provides base load power to the facility while CT-1 operates only during peak periods.

Reasons for CHP

An opportune time for an organization to consider investing in a CHP system is during new facility construction or during a major facility/boiler room upgrade. In 2001 the NADC was in such a situation. Its existing boiler plant was 40 years old and the maintenance and fuel costs on the 70% efficient boiler were becoming an issue. An analysis of the total facility's energy requirements revealed several conditions favorable for consideration of a CHP system:

NADC CHP Facility

- Simultaneous and balanced electric and thermal loads
- Concerns over electric reliability and rising energy costs
- Aging equipment (boilers and chillers)

Solar Centaur 3.5 MW System

With limited capital improvement project funds available to make a multi-million dollar investment, the NADC turned to Johnson Controls (an energy services company) and a funding mechanism called energy service performance contracting (ESPC) to finance a CHP system.

In 2007 the situation was very different. Congress had just authorized over $50 million in spending to modernize the existing NADC and National Veterinary Services Laboratory / Center for Veterinary Biologics (NVSL/CVB) Research Facilities in Ames, Iowa, creating the new National Center for Animal Health. The total project consisted of the construction of over one million ft^2 of new laboratory, animal housing, and administrative and other support facilities. Funds for this expansion included funds for new chillers and a new boiler plant that included the new 3.5 MW turbine. This new turbine helped offset the increased electric load from the newly revamped and modernized site, and also provided increased energy security and reliability.

CHP is crucial for the NADC because the facility houses BSL2 and BSL3 level laboratories, the third and second highest Biosafety Level risk categories, respectively. Containment is critical because of the infectious nature of these diseases. The labs used for BSL2 and BSL3 testing cannot lose power no matter the circumstance. The two combustion turbine CHP systems offer a secure and reliable power supply that will continue to run in case of an emergency; the NADC also has five 2.5 MW diesel backup generators on site that provide further redundancy.

Improving Indoor Air Quality

Many of the animal research areas need to meet animal care standards and require High Efficiency Particle Air (HEPA) and other air filtration methods that requires many air changes per hour to meet standards. In addition to maintaining high levels of indoor air quality (IAQ) for the animals, the NADC wanted to improve the air quality for its 270 employees. Increasing the IAQ throughout the center increases employee productivity, increases employee safety and health, and lowers employee absenteeism and turnover rates.

The penalty associated with such a high number of air changes per hour throughout the center is the increased energy requirements to thermally treat the outside air (heating, cooling, dehumidifying). This is where the benefits of a CHP system are further highlighted. The high and relatively constant thermal requirements allow for maximum use of the heat from the CHP system. When utilizing the recycled heat from the turbine exhaust gases and the supplemental duct burners, the CHP efficiency reaches up to 92%.

> *"Our tremendous energy savings is accompanied by improvements in operation and maintenance designed to keep the NADC running smoothly and meeting its goals for years to come."*
>
> *- Dennis Jones, NADC Facility Engineer*

For More Information

U.S. DOE MIDWEST CHP TECHNICAL ASSISTANCE PARTNERSHIP

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Version 0915

MIDWEST

U.S. DOE

Clean Energy Application Center

PROJECT PROFILE

University of Iowa

25.5 MW CHP Application

Background

Combined Heat & Power (CHP) is not a new concept at the University of Iowa, located in Iowa City. As early as 1947, the University introduced CHP into its central plant utilizing coal to produce high pressure steam. The steam was utilized to generate electricity and provide for thermal loads at the University through the use of extraction steam turbines. The campus spans 1,900 acres and has 119 buildings with a total footprint of 14.5 million ft^2. Today the CHP plant supplies 100% of the campus heat and 30% of the campus electrical demand. Approximately 85% of the required steam is produced from coal and the co-firing of coal and biomass, with the remaining 15% of the steam met with natural gas, utilized typically during peaking and backup steam production needs.

Quick Facts

LOCATION: Iowa City, Iowa
SIZE: 1,900 acres, 119 building, 14.5 million ft^2
GENERATING CAPACITY: 24.9 MW
PRIME MOVER: (3) Steam Turbines
- 18 MW Worthington Steam Turbine
- 4.0 MW Worthington Steam Turbine
- 3.5 MW Elliott Steam Turbine

BOILERS:
- 1 – Pyroflow© Circulating Fluidized Bed (CFB) – 170,000 lbs/hr capacity
- 1 – Riley Stoker – 170,000 lbs/hr capacity
- 2 – Riley (back-up and peak) – 145,000 lbs/hr capacity each

FUEL UTILIZED: Coal, Oat Hulls, Wood Chips, Giant Miscanthus.
CONVERSION COST IN 2001 TO ACCEPT AND CO-FIRE OAT HULLS:
$500,000 (<1 year simple payback)

Beginning to Co-Fire with Biomass

In 2001, the University and the Quaker Oats Cereal Mill, located 20 miles away in Cedar Rapids, Iowa, identified a potential opportunity to co-fire raw oat hulls in the coal fired CFB boiler. Quaker tested the direct use of raw oat hulls as the co-fired fuel and found the results very encouraging. The raw oat hulls, the plant casings that house oats, are the byproduct of the commercial cereal products that are the main product at the Quaker Oats mill. A volume of twelve rail cars of oat hulls were produced daily at the mill. The initial cost of converting the boiler and CHP plant to accept and efficiently burn the oat hulls was approximately $500,000, this included the design, procurement, and installation of a new storage, handling, and pneumatic injection system. The payback on the investment was less than 1 year. The co-fired CHP plant has resulted in much lower air pollutants, including an annual reduction of 60 tons of SO_2, and an annual reduction of 55,000 tons of CO_2.

Today, the 170,000 lb/hr circulating fluidized bed boiler has been modified to burn 50% coal and 50% raw oat hulls. This results in 23,000 tons of coal annually being replaced with approximately 35,000 tons of less expensive and more environmentally friendly oat hulls.

Biomass Fuel Characteristics

Oat hulls are produced as a residual from the oat milling process. The raw oat grain is milled and the protein containing center removed. The remaining hull has little protein, but does have a heat content of about 7,000 Btu/lb. This compares to coal that is used in the power plant with a heat content of about 11,000 Btu/lb. The lower heat rate content of the oat hulls is due to a 34% reduction in carbon content of the oat hulls as compared to coal. The density of oat hulls is 7 lbs/ft^3, much less than that of coal at 55 lbs/ft^3. Also the sulfur content of oat hulls is nearly zero compared to coal and the nitrogen level in oat hulls is approx 50% lower than in coal. However, the oxygen level in oat hulls is approx 500% higher than in coal, resulting in the need for modifications in the boiler combustion controls to properly adjust the amount of combustion air supplied as the co-firing rate is increased. The cost of the biomass fuel is approximately half the cost of coal and therefore provides economic savings to the University of Iowa for their on-site steam and electric production.

Moving Towards Cleaner Generation

Truck Delivering Coal and Woodchip Mixture

Since the adoption of oat hulls in 2001 the University of Iowa has been looking to increase the amount of biomass used to provide energy to the campus. Their experience with co-firing oat hulls has demonstrated that biomass is a cleaner, more environment friendly fuel source and one that can be obtained at a price comparable with coal.

In 2013 the University of Iowa began exploring how woodchips could further supplement the coal used in their boilers. This idea started as a collaboration between the University and the Johnson County Conservation Department when the Conservation Department needed to root out invasive conifer trees in parks throughout the county. This opportunity fuel was tested by the University in the CFB boilers and proved to work quite well. Today the University now purchases woodchips from the Odessa Wood and Pallet Company in Wapello through a fuel aggregator which mixes the chips with the coal to be delivered to the university. Woodchips comprise 40% of the delivered fuel volume the university receives for its CFB boilers. Because of the success co-firing oat hulls and woodchips, the CFB boiler currently generates 70-80% of its heating load through biomass.

Not content to stop there, the University of Iowa wanted to explore how to further reduce their coal needs. In 2014, the University began planting Giant Miscanthus as an energy fuel to replace coal in the Riley Stoker boilers. Currently used in Europe as an energy crop, Giant Miscanthus is a woody grass native to Eastern Asia and is texturally similar to bamboo. The grass has an estimated energy content of 6,500-7,000 Btu/lb which is similar to the oat hulls already co-fired on site. In 2015, the University had 200 acres of Miscanthus planted with a goal of planting a total of 2,000 acres over the coming years. The grass is currently being tested co-firing with coal in the Riley Stoker boilers so that the University can gauge the most beneficial ratio.

Future Expansion

In 2015 the Iowa Board of Regents approved a new $75 million power plant to serve the west campus of the University of Iowa. The new plant is to be built as a CHP. The West Campus Energy Plant will provide critical steam for heating, cooling, and sterilization to buildings on the west side of campus and provide energy security for all UI campus facilities in the event of flood, grid failure, or other adverse event. The new plant will likely take two years to construct and will be operational in four years. According to Glen Mowery, director of Utilities and Energy Management, "The University of Iowa Hospital and Clinics' research and residential services require continuous, uninterrupted supplies of steam. The new plant will not only ensure continuity of services to our most critical health and research facilities, but also provide back-up service to both sides of campus while providing the most flexibility in fuel sources."

For More Information

U.S. DOE MIDWEST CHP TECHNICAL ASSISTANCE PARTNERSHIP

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The Midwest CHP TAP is a U.S. DOE sponsored program managed by the Energy Resources Center located at the University of Illinois of Chicago.

Version 0915

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