MITSUBISHI ELECTRIC
AIR CONDITIONING SYSTEMS

Information Guide

Combined Heat and Power

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Issue Sixteen >

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Combined Heat and Power

Information Guide

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today. The guide accompanies a series of seminars, all of which are CPD accredited. The changing face of construction in the 21st Century demands that designers, specifiers and suppliers work as teams to create better buildings - for occupants and the environment. Mitsubishi Electric aims to be a part of this by encouraging employees and customers to work together to increase their knowledge of the latest technology, legislation and markets.

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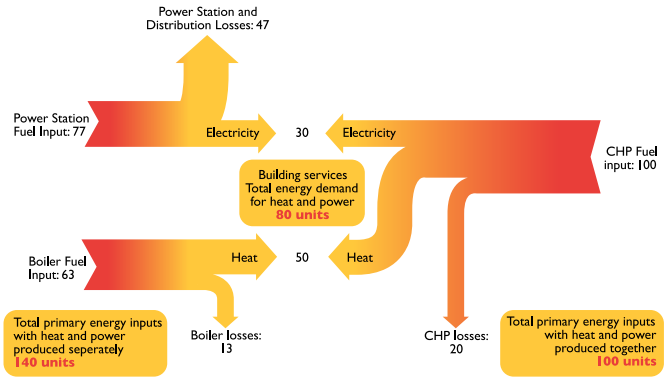
Combined Heat and Power

Combined heat and power is high efficiency technology which is being strongly backed by the UK government.

This is largely due to the fact that CHP has the potential to make a large contribution to the UK's carbon emission reduction campaign, and the government has set a target of 10,000 MW of installed CHP capacity by 2010.



The principles of CHP energy efficiency

Government figures show that every 1MW of CHP operating in the UK helps to reduce carbon emissions by between 600 and 800 tonnes per year. Current installed CHP capacity (in early 2007) is at 5,700MW on over 1500 sites across the UK. This saves over 4 million tonnes of carbon annually, representing one of the largest single carbon reduction measures in the government's Climate Change Programme.

Combined heat and power (CHP) is the simultaneous production of usable heat and electricity in a single process. The heat generated from the production of electricity can be delivered in a number of ways, including warm water (for space heating in homes) or through steam for commercial and industrial uses. CHP systems can be employed over a wide range of sizes, applications, fuels and technologies.

In its simplest form, a CHP system employs a gas turbine, an engine or a steam turbine to drive an alternator, and the resulting electricity can be used either wholly or partially on-site. The heat produced during power generation is recovered, usually in a heat recovery boiler and can be used to raise steam for a number of industrial processes, to provide hot water for space heating, or, as mentioned above with appropriate equipment installed, cooling.

CHP is a very energy efficient way to produce power and heat, which can use either fossil fuels or renewable sources. These systems can convert up to 90% of the energy in the fuel into electrical power and heat. This compares very favourably with conventional power generation which has a delivered energy efficiency of only around 30% to 45%.

Systems can run on fossil fuels such as gas or diesel, but they can also be converted to use renewable energy sources such as biogas from waste. Technologies currently in most widespread use are steam turbines, gas turbines and diesel-driven turbines.

A Summary of the Outputs of CHP Prime Mover			
Type of Prime Mover	Typical Output	Typical Fuels	Grade of Heat Output
Gas Turbine	0.5MWe Upwards	Natural Gas, Gas oil, Landfill Gas, Biogas, Mine gas/process gas	High
Spark ignition engine	Up to 4MVe	Natural Gas, Landfill Gas, Biogas, Mine gas/process gas	Low and High
Compression ignition engine	2MWEe Upwards	Natural Gas + 5% oil, Heavy fuel oil	Low and High
Steam Turbine	0.5MVe Upwards	Any but converted to steam	Medium
Combined cycle	10MVe Upwards	Natural Gas, Gas oil, Landfill Gas, Biogas, Mine gas/process gas	Medium

As the above table shows, CHP can be used over a wide range of sizes, applications and fuels. The main factor in selecting CHP is that the site or building requires both heating and electricity at the same time, to ensure that the investment is worthwhile.

Although they are energy efficient, it is unlikely that a CHP system will supply all the required power and heat, so when designing with this technology in mind, it must be integrated with other energy systems on site. It is recommended that CHP is always used as the lead boiler to maximise energy savings.

The electricity produced by CHP is best used on-site. However, it is possible to export this power back to the grid which is worthwhile if demand is low. If this is the intention an export meter must be installed alongside the normal import meter. But if clients are considering export to the grid, they must take care that the sell-back tariffs are high enough to justify doing this.

Financial support for CHP:

The UK government and the EU offer financial incentives for businesses to use CHP. These include:

- Exemption from the Climate Change Levy for all good quality CHP fuel inputs and electricity outputs
- Eligibility for Enhanced Capital Allowances
- Business Rates exception for CHP power generation plant and machinery
- Reduction in VAT on certain domestic CHP installations
- Bio-energy Capital Grants Scheme

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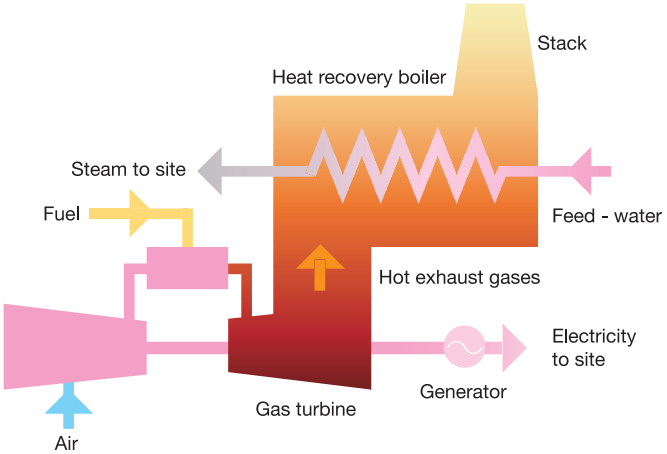
CHP technology

Combined heat and power is not a new idea, having been in use for well over fifty years. There are a number of more recent developments in the technologies used to produce simultaneous heat and electricity which are being explored.



How CHP works

These options, which include using biomass or fuel cells, are alternatives to natural gas which is currently the main option for driving CHP systems. The aim is to reduce reliance on fossil fuels, and also to ensure that CHP is financially viable as gas prices look set to rise steadily in the foreseeable future.

As an alternative to fossil fuels, biomass is becoming increasingly attractive. The Carbon Trust estimated that renewable sources such as woodchip could deliver carbon savings of up to 5.6 million tonnes of carbon per year in the UK.

Biomass fuels which can be used to run the internal combustion engine in a CHP system include biodiesel made from vegetable oil; or bioethanol produced from starch or sugar. Some CHP systems have been designed for what are termed 'high moisture content material' such as sewage sludge or food waste. Of these, woodchips are an increasingly popular choice.

Use of woodchip to fuel CHP plant is seen as a way not only to reduce CO_2 emissions, but also to cut down on waste which would otherwise go to landfill. The London Borough of Croydon and the BioRegional Development Group were funded by the Carbon Trust to research the possibility of using waste wood material to fuel CHP.

A survey of tree surgeons revealed that there is an estimated 120,000 tonnes of tree waste produced each year in the capital alone. A number of projects around the capital are now teaming up tree surgeons with combined heat and power operators.

Selection of the fuel is important at the outset when considering CHP as this will not only affect the type of technology used, but also the availability and quality of supply needs to be carefully considered.

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As an alternative to combustion driven CHP, fuels cells are another established technology (first demonstrated in 1839) which is seeing new popularity. They can be used in conjunction with CHP to create a self-sufficient system producing its own electricity and heat. The most well-known UK example of fuel cell/CHP in action is by Woking Borough Council. Here, a fuel cell CHP system provides the local leisure complex with heat for the swimming pool, space heating, electricity and pure water via a recovery system.

By using fuel cells, this system is not only self-sufficient in electricity, it also exports the power all year round. Surplus energy is exported to other council sites, via a private wire network. This is separate from the National Grid, and allows electricity to be sold directly to those buildings or facilities connected to it.

A fuel cell converts hydrogen into electricity, without combustion. It produces this electricity with a conversion efficiency of up to 50%. In conjunction with CHP, by using the waste heat from this process, the efficiency can rise up to 80%. There are a number of different types of fuel cell technology, with different characteristics including power output and operating temperature.

The science behind a fuel cell works in a similar way to a battery, but with the fuel, an oxidant is stored externally. An anode and cathode are insulated by an electrolyte. Hydrogen is supplied to the anode, and oxygen to the cathode. As the two gases attempt to mix, the electrolyte causes the hydrogen atom to split into a proton and an electron. The proton passes through the electrolyte, while the electron creates an electrical current before recombining with the hydrogen and oxygen to create pure water as a by-product.

Although CHP is an established technology, linking it with other renewable energy sources makes it an increasingly attractive energy and heat source. As the market develops and demand, driven by Government grants grows, these alternatives to fossil fuels will become more viable and widely available.

Choosing a CHP system
Points to consider:

What is your annual heat and power requirement?
CHP is a good choice for buildings which need heat and power simultaneously for more than 4,000 hours per year.

What is your heat demand in kW and °C?
This will affect your choice of supplier, as there are a wide variety of CHP options now available.

How much do you currently pay for heating?
You must know your current energy expenditure in order to carry out a sensible cost-benefit analysis of using CHP.

When sizing, think small!
A CHP that is too large for the application won't save money. It is better to have one which is slightly too small.

Think life cycle costs!
It may be tempting to select the cheapest option at the outset, but CHP is a long-term investment. Consider the payback over a period of time.

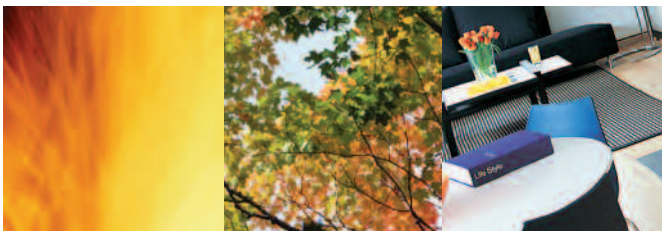
Don't just purchase the equipment!
Buy maintenance and guaranteed performance. Find a supplier with a good track record, and buy an O & M contract as well as installation.

Know which renewable grants and funds you can apply for!
The Government is encouraging greater use of CHP, and has set high targets. Our 'More Information' List tells you where to look online for more details.

CHP - a growing trend

At a recent conference (CIBSE National Conference 2007), London's Deputy Mayor Nicky Gavron made clear the capital's strong commitment to CHP, saying that the GLA aims to use CHP to reduce the capital's carbon emissions.

The objective is that by 2025 CHP systems will be capable of meeting 25% of London's energy needs.



A number of large developments in London are already set to use CHP, including Elephant & Castle, Kings Cross Central and the London 2012 site.

The idea of a decentralised energy system is already proving attractive to local authorities around the UK. Woking Borough Council was one of the first in the UK to use CHP on a large scale. However, to obtain the greatest benefit from CHP it is necessary to make investments in a community heating system.

Heat is distributed from the CHP in the form of hot water through well-insulated pipes in the ground. The circuit forms a closed loop with flow and return pipes. Heat is transferred from this system into a building from the pipes through a heat exchanger.

In other parts of Europe, CHP is used to a greater extent. In Scandinavia power stations are built using CHP technology and the heat is used to supply large-scale district heating networks. The cities of Copenhagen and Helsinki are heated in this way.

In the UK our power stations are generally built further away from urban centres, making this strategy less practical. However, the development of a range of sizes of CHP plant mean that it has become a viable option for city centres, and there are a growing number of examples of urban CHP used at district and individual building levels.

For example, Sheffield City Council is already using this technology, with its District Energy Network. This provides over 140 buildings of all sizes and types with a low carbon energy source generated locally. More than 44km of underground pipes deliver energy generated by recovering energy from waste to some of the city's most prestigious and landmark buildings.

And in London's Greenwich Millennium Village, CHP is used to supply heat and electricity to around 1400 homes - the first time it had been used in a private development.

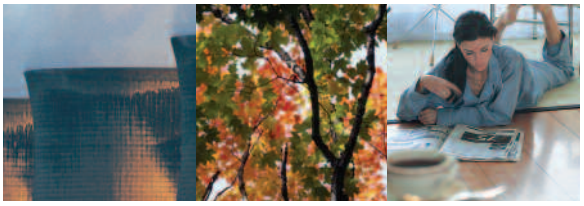
Cost is clearly a crucial factor in selecting CHP. Generally, the capital costs for CHP will be higher than for conventional plant, but it does offer long-term savings. Fuel is the major running cost. Natural gas is the most common fuel for small-scale CHP (from 1kW to around 5mW).

Clearly, future prices of gas need to be considered when examining the viability of CHP. It may also be possible to use some other fuel source such as biomass. The important point to bear in mind is that the more the heat element of CHP can be used, the better the economics.

Maintenance of CHP systems is very important as it will help ensure efficient operation and reduce down-time. Specialist knowledge is required and often the suppliers of CHP will also contract to carry out regular maintenance, often on the basis of contracted performance levels.

CHP is receiving strong backing from Government at national and local level, with various incentives and regulations driving more use of this technology. It is acknowledged as a potentially large contributor to reducing CO_2 emissions, but CHP cannot achieve all the cuts required.

In order for CHP to be viable, it must be used in domestic and commercial buildings which are energy efficient, and which utilise other energy efficient technologies such as heat pump boilers to provide top-up heat during times of peak demand, for example.



Further information

www.carbontrust.co.uk

www.dti.gov.uk

www.defra.gov.uk

www.chpa.co.uk

www.london.gov.uk

If you missed the CPD seminar on **Combined Heat and Power**, you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

Please call one of the numbers below:

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www.greengatewayinitiative.co.uk