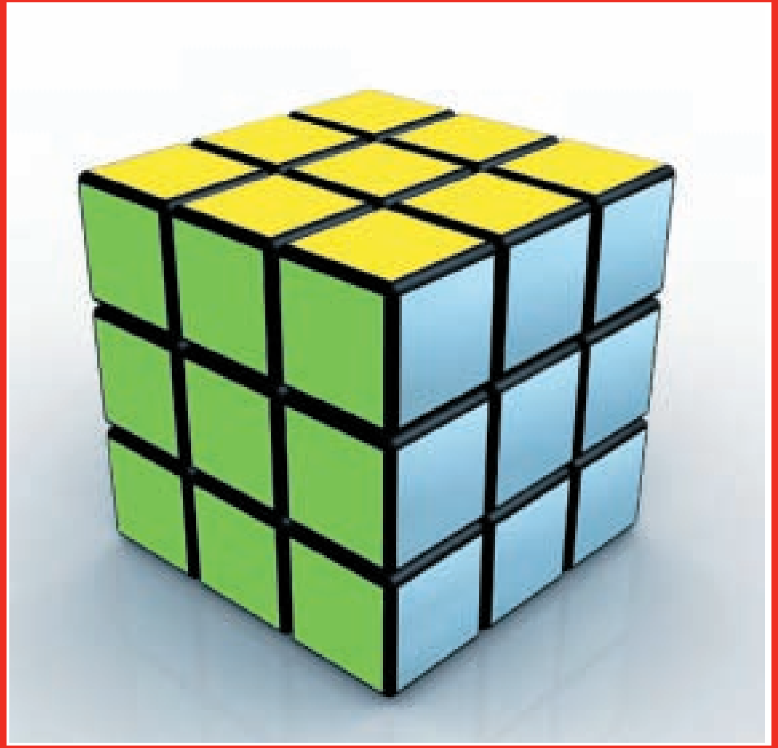

The Essential Guide to Small Scale Combined Heat & Power

ENER·G COMBINED POWER

efficient energy solutions

Providing the answer to all those puzzling Combined Heat & Power permutations – in one easy move...

The Essential Guide to Small Scale Combined Heat & Power

This guide is written in plain English. It's purpose is to explain what Combined Heat and Power is, and how to best use it.

EASY MOVE

Look for the Easy Move symbols throughout – and find your answers to all those puzzling CHP permutations.

This guide is written by ENER·G Combined Power Ltd. With over 20 years experience, more than 1,000 units manufactured, some 5,700 CHP running years logged and an amazing 1,676,000 tonnes of CO_2 saved by our CHP users, ENER·G are the largest provider of small scale CHP in Europe.

Contents

1.0 What is Combined Heat & Power?

Introduction to Combined Heat & Power

Combined Heat & Power (CHP or Cogeneration as it is also known) converts a single fuel into both electricity and heat in a single process at the point of use. CHP is highly energy efficient and as well as supplying heat and power, it can deliver a number of positive financial, operational and environmental benefits.

CHP should always be considered when:

- Designing a new building
- Installing new boiler plant
- Replacing or refurbishing existing plant
- Reviewing electricity supply
- Reviewing standby electricity generation or plant
- Considering energy efficiency in general
- Exploring options towards building regulation compliance
- Reducing CO_2 emissions and environmental impact

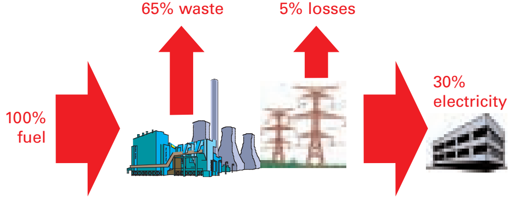

Diagram 1

CHP is a well-proven technology, recognised worldwide as a viable alternative to traditional centralised generation.

In the more conventional centralised electrical generation processes (see diagram 1) much of the energy is wasted as there is no localised uses for the heat produced, which is simply lost into the atmosphere.

With CHP, (see diagram 2) an engine which is normally mains gas fuelled, is linked to an alternator to produce electricity. CHP maximises the fuel and converts it into electricity at around 30% efficiency and heat at around 55%. Heat is recovered from the engine by removal from the exhaust, water jacket and oil cooling circuits.

Typically a good CHP scheme can deliver an efficiency increase of anything up to 25% compared to the separate energy systems it replaces.

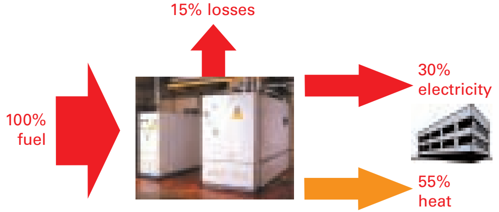

Diagram 2

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Advantages of Combined Heat & Power

- Reduces running costs
  - Reduces sites actual energy costs
  - Avoidance of Climate Change Levy
  - Claimable Enhanced Capital Allowances
  - Off-set capital expenditure for replacement boilers
  - Stabilizes energy costs over a period of time
- Reduces CO_2 emissions
  - Points for BREAM assessment
  - ECOhomes
  - Legislative compliance with part L2 of building regulations.
- Security of supply
  - Acts as back-up generator
  - Back-up heat supply
  - Reduces dependency

- **Financial Benefits**

CHP represents a highly efficient use of fuel, which means lower energy costs for the user.

EASY MOVE

A model has been included within this guide to demonstrate these potential energy cost savings.

In the UK, taxation benefits can be obtained through avoidance of Climate Change Levy (good quality CHP) and the possibility of Enhanced Capital Allowances for eligible organisations. In other countries, a range of fiscal support measures also enhance the financial benefit of CHP. Third party or supplier funding options for CHP means an organisation has the option of outsourcing the CHP system without capital outlay giving an immediate payback.

- **Emission Benefits**

In the UK, the recent amendments to the Building Regulations, Part L2A and Part L2B seek to reduce both energy consumption and $C0_2$ emissions by up to 28% compared to the 2002 regulations. All CHP

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schemes produce reduced emissions compared to the separate supply of mains electricity and traditional means of site heat production.

Well designed and operated CHP plant can contribute significantly towards Part L compliance. Impacts can be readily assessed through SBEM or other energy performance modelling software packages.

EASY MOVE

$C0_2$ savings are calculated using the following formula:

Mains electricity displaced + boiler heat displaced – CHP fuel input = Net $C0_2$ saving

The figures to use in this calculation are found in the Building Regulations 2000, Part L2A (2006 Edition) which are: **0.194kg $C0_2$/kWh** for combusted natural gas

0.568kg $C0_2$/kWh mains electricity displaced.

Additionally, NO_x and SO_2 emissions will also be reduced.

Contact ENER.G Combined Power for further assistance in establishing your potential CO2 savings through CHP.

Combined Heat & Power Applications

Small scale CHP is particularly suitable for applications where there is a constant demand for heat throughout the year. Common applications include hotels and leisure centres. Larger scale applications include universities and industrial facilities such as chemical and pharmaceutical plants.

Typical CHP users:

- Leisure centres
- Hotels
- Hospitals
- Universities
- Military bases
- Prisons
- Industrial manufacturers
- Commercial premises
- Horticulture
- Airports
- Waste water treatment works
- Municipal buildings
- District heating schemes ie offices, residential

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2.0 Combined Heat & Power Technology

The Equipment

Prime Movers

The most common form of CHP contains spark-ignition gas reciprocating engines. Spark-ignition engines are derivatives of their diesel engine equivalents and have similar cooling water systems of temperatures up to 90ºC. These prime movers are suited to smaller, simpler cogeneration systems of up to typically 2MWe in size, although multiple units can be used to deliver greater capacity. Spark-ignition engines deliver a CHP unit with a heat to power ratio of about 1.5:1

Other prime movers include gas turbines, fuel cells and Sterling engines. These have their advantages and disadvantages. They also have different heat-to-power ratios which, in turn, make them less suitable for small scale applications discussed in this guide. Usually the cooling of the engine is combined with the heat recovery of the exhaust system providing low temperature hot water to site, however the exhaust is sometimes separated to enhance site requirements for steam. These prime movers generally operate on clean gaseous fuels such as natural gas, biogas and propane.

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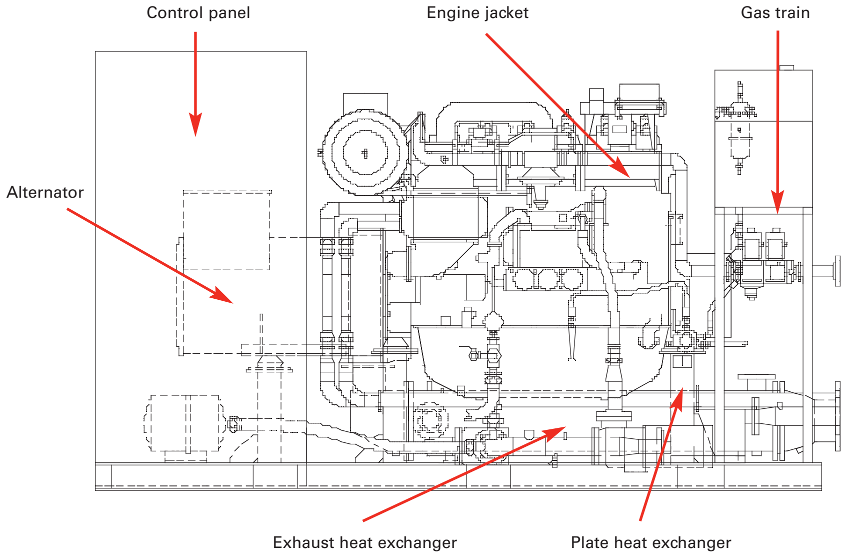
Typical components of a CHP unit

The CHP unit is an integrated package. The main component parts of the package are:

- The gas engine
- The alternator
- The heat recovery system
- The base frame and enclosure
- The control, protection and monitoring system



The Gas Engine and Alternator

The engine and alternator are assembled as a unit with the drive from the engine transmitted to the alternator through a flexible power coupling. This assembly is attached to a steel sub-frame by flexible mounts with flexible connections to other mechanical equipment installed within the enclosure.

Heat Recovery System

The closed primary water circuit recovers heat from the engine jacket, oil cooler and the exhaust gas heat exchanger. A thermostatic valve controls the temperature of the primary cooling system. This valve manages the warm up and cool down of the engine avoiding any thermal shocks.

CHP heat is transferred to the client secondary water systems through a high efficiency plate heat exchanger. This plate heat exchanger hydraulically separates the primary and secondary water circuits. This hydraulic separation prevents either primary or secondary circuit contamination from the other water circuit and permits ease of maintenance and security of heat supply.

Standard secondary water pumps are generally supplied as loose equipment and will accommodate a minimum external pressure drop beyond the CHP unit itself at the design flow rates.

The Base Frame and Enclosure

The CHP enclosure comprises a steel frame with sound insulated closure panels and doors.

Removable/openable enclosure doors allow easy access for repair and maintenance.

Ventilation air is drawn through a sound attenuator in the air inlet and pulled through the enclosure by an enclosure mounted fan.

Combustion air is drawn independently into the engine through a dedicated combustion air attenuator located on the top of the enclosure.

Ventilation air is normally ducted into the enclosure air intake and ducted away from the enclosure fan on the roof of the enclosure by others.

Control and protection

The unit is primarily designed to operate as a 'stand-alone' package with automatic control that requires minimal or no supervision. In exceptional cases, manual intervention or supervision can be advantageous. The unit control and electrical system is installed in a cabinet that forms part of the enclosure. It is specially designed to control and protect the CHP unit. Principal areas of control are:

- Electric output
- Heat
- Import and export interface with grid
- Electrical isolation

A Remote Monitoring System collects data continuously and would be connected to a central control desk. This allows remote operation and adjustment of settings when needed.

The unit is usually controlled and protected by a remote monitoring and control system, often covering more than 70 operating parameters.

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Options

A number of options are generally available for the CHP units in order to meet special requirements:

- External acoustic container packages
- CHP absorption chiller packages
- BEMS interface card
- Gas and fire detection systems
- Island (emergency) operation
- Heat and gas metering
- Export control
- Heat rejection radiators and control equipment
- Medium Pressure Hot Water (MPHW) on certain larger units
- Steam and on larger units only
- Anti-vibration support platforms for special applications
- Heat rejection and interface control systems
- Local display – digital display to show unit status and performance information
- Catalytic converter for reduced emissions
- Enhanced monitoring for boilerhouse performance information
- Exhaust silencers (industrial and residential grade)

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In the UK, CHP units should be designed and constructed to the following standards and regulations:

ETR113	Electricity Association Engineering Technical Report
G59/1	Electricity Councils Chief Engineers Regulations
IGE/UP/1(Ed.2)	Strength testing and purging of industrial and commercial gas installations
IGE/UP/2	Gas installation pipe work, boosters and compressors on industrial and commercial premises
IGE/UP/3	Gas fuelled spark ignition and dual fuel engines
IGE/UP/4(Ed.2)	Commissioning of gas fired plant on industrial and commercial premises
72/23/EEC	The Low Voltage Directive
89/336/EC	Electromagnetic Compatibility
89/392/EEC	Machinery Safety Directive
16th Edition	IEE Regulations
BS EN 60034	General requirements for rotating electrical machines
ISO3046/1	Reciprocating internal combustion engines – Performance

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Plant Optimisation

In order to optimise the CHP system "sizing" is critical to the success of the project. The aim of the process is to maximise the potential financial savings and ensure compliance with current legislation. The most important factor is to establish the energy profiles – the site's electrical and thermal characteristics; these can be ascertained by referring to either the site's utility bills or by following the "rule of thumb" design data for new build projects:

- Determine the on-site gas consumption (kWh) for heating and domestic hot water. (If gas is used for any other non-heating use on-site, this must not be included).
- Determine the site electrical consumption (kWh) preferably half-hourly data (this can usually be obtained from the electricity provider).
- In the case of new buildings, modelling software is best employed to establish load profiles.

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The base-load thermal demand is the target level for sizing the CHP unit. Assessing the base load and comparing this to the thermal output of actual CHP units will optimise the size of the CHP.

The most suitable sites for CHP generally have year round demand for heat or cooling, where the unit will be run as "lead boiler" in excess of 4500 hours per year. Viability further improves if standby generation or boiler replacement is considered. For units sized just above base load, thermal modulation is possible, where the unit is run at reduced output for short periods. In some cases, a limited amount of heat may be rejected in order to maintain the CHP unit running at full electrical output.

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The base-load electrical demand of the site is the level that the sites electrical demand never falls below. It is generally the norm to provide a CHP unit that meets this criteria so that all the electricity generated by the CHP will be utilised by the site and any top-up will be provided from the grid. However, there are instances where it maybe beneficial to export electricity onto the grid, provided the full economics behind the scheme are identified and addressed. Electrical modulation is also a possibility to reduce the electrical output.

Other factors

Other local influences that need to be established are site occupancy and the operational hours for the proposed plant, existing boiler efficiencies and future energy requirements that could be provided for.

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3.0 Economics of Combined Heat & Power Systems

Stages of Feasibility

There are generally three stages to completing the economic viability for CHP once the project has been scoped:

- Initial feasibility study – desk-top calculation
- On-site review to determine installation options and costs
- Considerations of options to finance project

Initial Feasibility Study

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Just visit www.energ.co.uk/energyaudit and download an Energy Audit Form.

A simple calculation is usually sufficient at this stage to evaluate whether or not a CHP scheme will offer benefits. This usually takes a short time to complete if all the necessary information is at hand.

The initial feasibility study takes into account the gas consumption, the displaced electricity costs and the displaced thermal boiler energy costs. Provided the site actually utilises 70-75% per annum of the heat

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generated by the Combined Heat & Power system, the scheme will be accredited with the CHPQA Quality Criteria. In the UK, this then means that the taxation known as Climate Change Levy (CCL) will not be payable on the fuel used by the Combined Heat & Power system or on the electricity generated.

EASY MOVE

One quick method to ascertain suitability for CHP is to calculate the "Spark-ratio" – the ratio between the gas and electricity price, for example:

Electricity day rate is 6.5p/kWh

Gas price is 2.2p/kWh

Then the ratio is 6.5:2.2 = 2.95:1

If the ratio is greater than 2.8:1 CHP is certainly worth considering.

In addition to the data required to assess a scheme's viability, careful consideration should also be given to the following:

- The CHP scheme must be properly planned and implemented with the allocation of appropriate resources and time
- Access to load profiles and tariffs (daytime & night time)

Having collected all the necessary data, contact ENER·G Combined Power if you require further assistance in validating your results.

From the data obtained, the CHP is sized to the thermal base-load, ensuring a heat utilisation figure as close to 100% as possible. Under certain conditions it is financially beneficial to adopt a larger unit, this may in effect lower the heat utilisation figure for the proposed plant but could significantly increase the saving. Therefore sensitivity in accurate thermal profile data is important.

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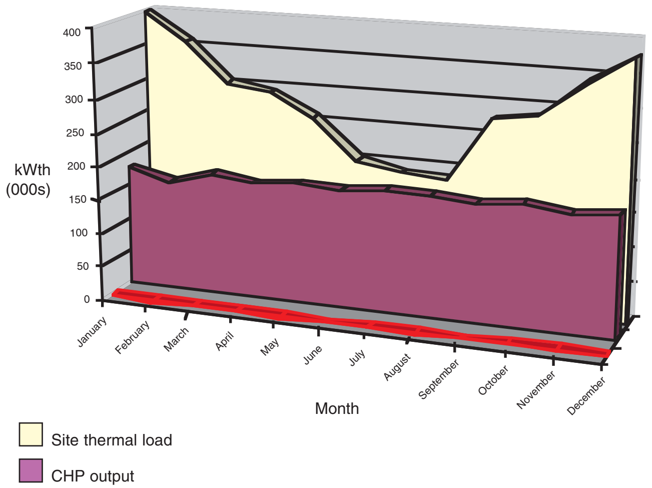
Example Thermal Profile

Site Thermal Load vs CHP Output



This is an example of the thermal energy consumption in a typical large leisure centre, over a period of 1 year. The CHP unit has been sized to operate at 100% heat utilisation ie no heat rejection.

Site Review to Determine Actual Installation Costs

If the desk-top calculation modelling demonstrates a saving, it is imperative to understand the site to ensure suitability regarding interfacing the CHP and, to establish the connective loads are achievable. Installation costs can vary dramatically from site to site depending on several key factors:

- Location of CHP plant
- Space allocation
- Planning implications
- Noise issues
- Local regulations
- Maintenance restrictions
- Electrical connections ie LV, HV, network restrictions

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Once these are established, another more detailed feasibilty review is required to ensure suitability and compliance. ENER·G Combined Power will support in this review, providing applications engineering guidance and budget costings.

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Financing the CHP project

There are a number of financing options that can be specifically tailored to the individual requirements of each project, regardless of project size, cost or complexity.

Capital Purchase

ENER·G Combined Power will provide a fixed cost for the complete turnkey package, including project design, supply, installation and commissioning. In addition to this, a service package can be offered that will operate and maintain the system throughout its life. An advantage to the capital purchase route is the greater savings achievable under this mechanism.

Enhanced Capital Allowance (UK only)

Opting for capital purchase offers the benefit of possibile Enhanced Capital Allowances (ECAs). This enables eligible businesses to claim 100% first year Capital Allowances on investments in energy saving technologies and products such as CHP. Businesses are now able to write off the whole cost of their investment against their taxable profits of the period in which they make the investment.

If Capital Funds are not available, ENER·G Combined Power is able to offer Supplier Financed Packages such as:

Discount Energy Purchase (DEP) scheme

Essentially the CHP provider will fund the entire, or part finance, the costs associated with the implementation of the CHP project, including the design, supply, installation and operation of the scheme over a contract period. ENER·G Combined Power would recover the initial capital costs and the ongoing maintenance charges over a contractual agreement period, usually 10 years, by charging a pence per kWh of electrical generation by the CHP plant. This is usually billed monthly, in arrears.

Each specific project will have a unique p/kWh rate, this is dependant upon a number of factors such as plant selection, project costs, maintenance prices, operational hours and contract period. The rate used later in the working model is purely indicative; site specific rates must be obtained before calculating savings attributable to this option.

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Benefits include:

- No capital outlay/lower risk
- No ongoing maintenance costs
- Faster implementation/immediate savings
- Long term, capped energy costs

Energy Service Performance Contract

ESPC allows Public Sector bodies to out-source the provision of plant; infrastructure, energy and services associated with schemes specifically structured to improve the long term energy utilisation associated with core Public Sector services they provide.

In the UK, this is made possible through Government Public/Private Partnership initiatives and the broader auspices of PFI. These projects can be self-funding and,or cash-releasing using savings provided by the various energy efficient technologies and associated service provision provided under the contract. A proportion of the utility spend avoided is paid as an annual single unitary payment to the ESPC provider.

Part of the payment may then be assigned to an external third party finance provider on a discounted receivable basis. The remainder of the unitary payment is retained by the ESPC provider as payment for the O&M element.

Benefits include:

- Guaranteed savings and levels of service delivery
- Zero capital outlay
- Proven method to reduce sites energy consumption
- EUETS (EU Emissions Trading Scheme) and carbon reductions
- Incorporate additional low/zero carbon technology

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Whichever method of financing is preferred, the decision to invest in CHP involves a long term commitment. Check the financial status and history of the CHP provider before committing.

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4.0 Integrating CHP into a Building

Low Temperature Hot Water Systems

The most common and simplest form of heat recovery from a CHP unit involves heat recovery in the form of low temperature hot water (typically 82/71ºC). In this form of heat recovery, it is possible to recover all the oil, jacket and exhaust heat in a common primary water circuit.

Typical LTHW boiler plant

Steam Systems

If the user requires a heat source in the form of steam then the exhaust gases (350 – 450ºC) from the CHP can be diverted directly into a waste heat recovery boiler that can be a single pass or multiple pass arrangement.

Steam generation from CHP is only really viable for units greater than 300kWe as the quantity of recovered energy below this value is small.

These heat recovery boilers are not standard off-the-shelf boilers and need to be designed for each particular project application. The CHP provider would usually work with the boiler manufacturer to design the boiler using the details of the exhaust gas flow rates, temperature and pressure conditions of the required heat output.

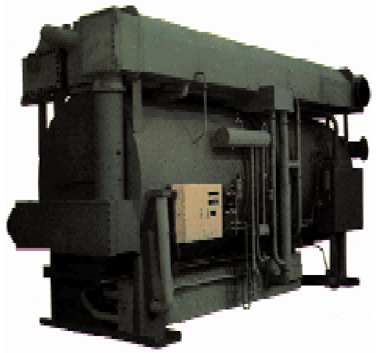
Typical steam boiler

Absorption Cooling Systems (Trigeneration Systems)

Absorption cooling is a technology that allows cooling to be produced from waste heat rather than traditional methods such as a vapour condensing chiller that uses electricity.

Some sites that may consider utilising this method will have a large continuous cooling demand, for example air-conditioning or process cooling, typically these systems require a system temperature of 6 – 12ºC which is particularly suitable for absorption chillers.

Absorption chillers can also be successfully incorporated into schemes that have a large electrical demands but may only have a relativity small thermal demand. The size of the CHP unit could be maximised to meet the sites electrical load profile with the thermal energy being used to drive an absorption chiller. This would in effect lower the sites electrical load by displacing the electrical demand of a conventional chiller.

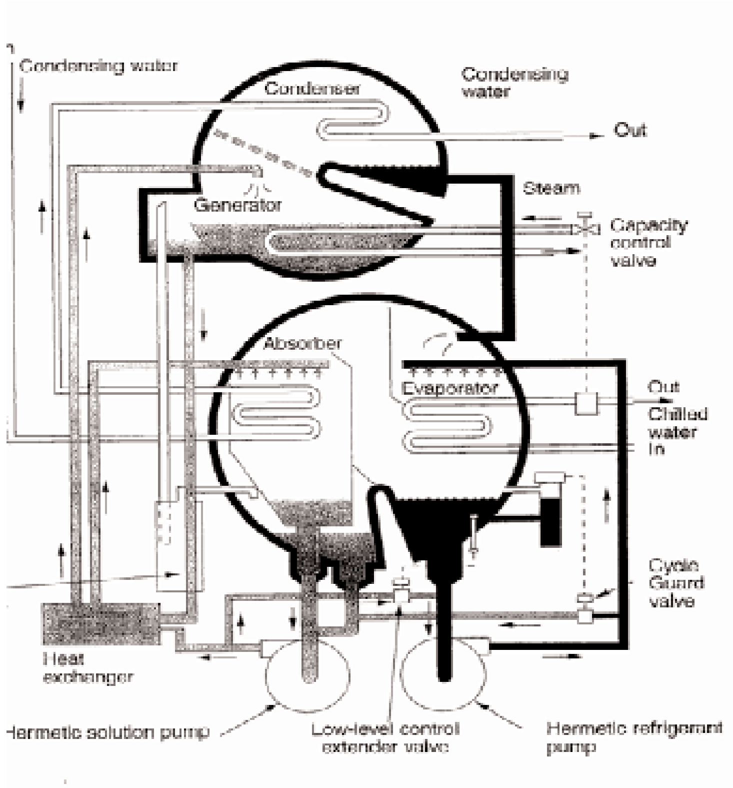


Typical absoption chiller

The additional heat load would allow the plant to operate more efficiently, removing the seasonal variation element and improve the operational hours of the scheme.

Most standard absorption chillers operate on either LTHW, MTHW or steam (90 – 130ºC). Absorption chillers also require some form of heat rejection, generally greater than the amount rejected from a compression chiller of equivalent cooling capacity.

Right: typical absorption chilling process



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5.0 Savings Models – Examples

Example Project

The following section works through a typical CHP application. It assesses the electrical and thermal load characteristics of the building, and sizes the unit required. In addition, two finance options are explored and the savings possible under both methods set out.

The example is typical of a small scale CHP application such as a leisure centre. The data used in the various calculations is set out in detail. The Supplier Finance Option shown is based on ENER·G's own Discount Energy Product (DEP) and is shown for comparison only.

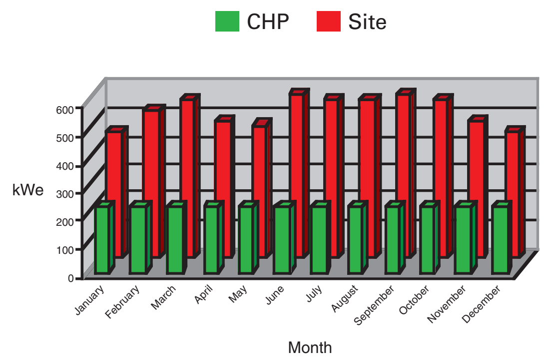
Sizing for a CHP unit

In order to size the CHP unit, the following sites load profiles have been utilised:

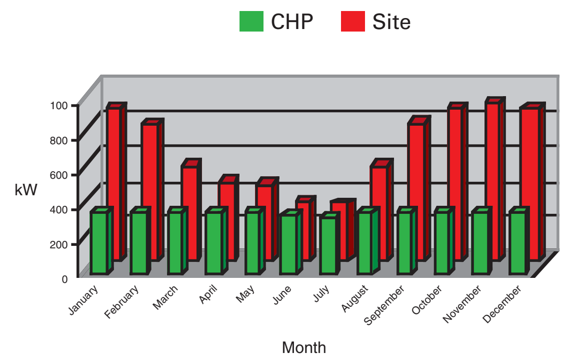
Electrical Load

	Days/ Month	Electrical Usage	kWh Day Electricity	kWh Night Electricity	Adjusted Fuel Usage kWh	Thermal Usage	Fuel usage KWh
January	31	100%	240,000	100,000	760,000	95%	800,000
February	28	100%	250,000	100,000	617,500	95%	650,000
March	31	100%	300,000	100,000	475,000	95%	500,000
April	30	100%	250,000	100,000	380,000	95%	400,000
May	31	100%	250,000	100,000	380,000	95%	400,000
June	30	100%	300,000	100,000	285,000	95%	300,000
July	31	100%	300,000	100,000	285,000	95%	300,000
August	31	100%	300,000	100,000	475,000	95%	500,000
September	30	100%	300,000	100,000	665,000	95%	700,000
October	31	100%	300,000	100,000	760,000	95%	800,000
November	30	100%	250,000	100,000	760,000	95%	800,000
December	31	100%	240,000	100,000	760,000	95%	800,000

Daytime electrical demand (monthly average)



Daytime thermal demand (monthly average)



In this instance the load profiles of the site have been modelled, and it has been established that the size of the unit suitable for this application is a CHP unit providing the following parameters: 228kWe, 358kWth with a fuel input of 718kW (HHV). By selecting this unit, the heat utilisation figure is 99%. Under this option the proposed unit will either reject 1% thermal energy by means of a heat rejection system, or will simply modulate when the thermal demand is reduced in July/August.

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Quality Index Calculation

The proposed unit must meet the minimum threshold figure of 105 to satisfy the CHPQA guide requirements to enable the user to claim Climate Change Levy rebate.

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Quality Index $= \dfrac{200 \times \text{CHP electric}}{\text{CHP fuel}} + \dfrac{125 \times \text{CHP heat*}}{\text{CHP fuel}}$

**NB: CHP heat utilisation (99% x 358kW)*

For example

$$= \frac{200 \times 228\text{kWe}}{718\text{kW}} + \frac{125 \times 355\text{kW}}{718\text{kW}}$$

$$= 125$$

The proposed Combined Heat & Power unit will be eligible to claim exemption from Climate Change Levy.

Data to be used in the example savings models

Annual gas consumption:	6,950,000kWh
Cost of Gas:	2.2pkWh
Annual day electricity:	3,280,000kWh
Cost of day electricity:	6.5p/kWh
Operational hours:	17 hours per day
CHP Unit availability:	90% (10% downtime for maintenance)
Existing boiler efficiency:	80%
Heat utilisation:	99% (% of actual heat generated by the CHP unit is used by the site)
Climate Change Levy:	0.154 p / kWh gas & 0.441 p / kWh electricity

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Capital Purchase Savings Calculation (Day time operation)

Electric Savings	=	CHP electricity x (site electricity day tariff + CCL)
	=	228kWe x (6.5p/kWh + 0.441p/kWh)
	=	£15.82/hr
Heat Benefit	=	CHP heat utilised x (site gas tariff + CCL / boiler efficiency)
	=	358kW x 99% (2.2p/kWh + 0.154 p / kWh / 80%)
	=	£10.43/hr
Fuel Cost	=	CHP fuel x gas tariff (CCL exempt)
	=	718kW x 2.2p/kWh
	=	£15.80/hr
Annual CHP Benefit	=	(electric savings + heat savings – fuel cost) x hrs x days x availability
	=	(£15.80 + £10.43 - £15.80) x 17 x 365 x 90%
	=	£58,246 pa gross savings including CCL
Maintenance Cost	=	£13,000 pa (approximate)
Net Annual Savings	**=**	**£45,246 pa (including CCL)**

Supplier Financed Package Option (Discount Energy Purchase)

Excluding Climate Change Levy Savings

Electric Savings	=	CHP electricity x (site electricity day tariff – DEP Rate)
	=	228kWe x (6.5p/kWh – 2.05p/kWe)
	=	£10.15/hr
Heat Benefit	=	CHP heat utilised x (site gas tariff / boiler efficiency)
	=	358kW x 99% (2.2 / 80%)
	=	£9.76/hr
Fuel Cost	=	CHP fuel x gas tariff
	=	718kW x 2.2p/kWh
	=	£15.80/hr
Annual CHP Benefit	=	(electric savings + heat savings – fuel cost) x hrs x days x availability
	=	(£10.15 + £9.76 - £15.80) x 17 x 365 x 90%
	=	**£22,952 pa excluding CCL**
Maintenance Cost	=	£Zero – maintenance is included in the DEP Rate

Based on the above Quality Index Calculation the proposed unit will qualify for 100% exemption from CCL

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Including Climate Change Levy Savings

Electric Savings	=	228kW {(6.5p/kWh + 0.441p/kWh) – 2.05p/kWh}	=	£11.15/hr
Heat Savings	=	358kW x 99% {(2.2p/kWh + 0.15p/kWh) / 80%}	=	£10.43/hr
Fuel Costs	=	718kW x 2.2p/kWh (*CHP fuel exempt from CCL*)	=	£15.80/hr
Annual CHP Benefit	=	(electric savings + heat savings – fuel costs) x hrs x days x availability		
	=	(£11.15 + £10.43 - £15.80) x 17 x 365 x 90%		
DEP Savings Option	**=**	**£32,278 pa including CCL**		

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6.0 Typical Case Studies

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Next Generation Clubs

Next Generation is a privately owned group of membership-only leisure clubs located throughout the UK.

Since installing their first CHP system in 2001, the company has amassed a fleet of ten ENER·G units at their various sites ranging in size from 206kWe to 225kWe. At the time of writing the company was **annually saving more than £75,000** without capital outlay, and had accumulated **carbon dioxide savings in excess of 5,200 tonnes**.

Speaking of the technology, Martin Kinnaird, Next Generation's Facilities Manager said, "There were a number of reasons why we chose CHP for our sites, but the main one was financial.

"Avoiding the Climate Change Levy (CCL) was an important factor, even at a time when the cost of electricity was relatively low."

The company took advantage of the fact that good quality CHP is able to claim exemption from the levy, on the basis that they meet the criteria laid down by HMCE, particularly on their scoring on the Quality Index. (See www.chpqa.com for details) The units have provided an instant pay-back for the company, as they opted for a Discount Energy Purchase (DEP) contract. Under this agreement, ENER·G finance, install and operate the CHP system at no capital cost to the client, then sell the energy generated to the client at a discount, offering immediate savings.

"By involving ENER·G at the design stage of building a new club, we have been able to help further reduce costs by carrying out the installation of their systems at the same time as the other mechanical and electrical systems." Martin added, "Although we were not directly paying for the capital cost, ENER·G were able to pass on reduced installation costs in the form of even cheaper energy supply."

"Annually saving more than £75,000 without capital outlay"

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Sheraton Hotel, Heathrow

Located close to what must be one of the world's busiest airports, the 427 room hotel has more than a decade of CHP experience.

The hotel had already reaped the benefits from two ENER·G 206kWe CHP systems that had run the course of their ten-year discount energy supply contract. At the end of the agreement, rather than merely continue, the hotel decided to re-evaluate their heating, hot water and electrical demands for the site.

In 2005 this led them to choose to replace their existing units with two slightly larger 225kWe models, to better meet their increased energy demands – offering them a total available capacity of 450kWe. The new units were able to be installed along side the existing boilers in the basement, avoiding the need to create a new plant room.

They opted for a 12 year Discount Energy Purchase (DEP) contract where the systems are installed at ENER·G's cost, and they agree to purchase electricity at discounted rates.

It is estimated that this will lead to the hotel making **an annual saving of £20,000, and to date has prevented the release of 400 tonnes of Carbon Dioxide.**

"An annual saving of £20,000 and to date has prevented the release of 400 tonnes of CO_2"

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Radisson SAS Hotel, Liverpool

Located in the heart of Liverpool's business district, the hotel has 194 guest rooms, a swimming pool, dance studio, gymnasium and other amenities. Also connected to the hotel are a number of private residential apartments.

Having looked at two other potential suppliers, Consulting Engineers Buro Happold specified ENER·G Combined Power's CHP system, and involved the company in the design of the system, to ensure that it was optimally sized to meet the needs of the hotel, the leisure facilities and the private apartments.

The chosen system was supplied under a Discount Energy Purchase (DEP) agreement, where it is installed at no capital cost to the client. They now simply pay a discounted rate for the energy supplied, making immediate savings.

The CHP system is powered by natural gas and provides 206kWe of electrical power, and recovers 324kWt of heat for use in space heating, hot water and the swimming pool. The unit is sited on the hotel roof, and to ensure quiet operation, it was housed in a special acoustic enclosure, standing on anti-vibration mountings.

Richard Wiltshire, Energy Officer with Radisson SAS commented, "With running hours of 7am until midnight, the CHP system is providing the energy we need". He continued, "It's very competitive, and **we estimate that it will annually save us well over £10,000."**

The new CHP system to date has also **saved more than 400 tonnes of Carbon Dioxide** from being released into the atmosphere.

"The CHP system is providing the energy we need... it's very competitive, we estimate that it will annually save us well over £10,000"

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South West Water – Exeter Sewage Treatment Works

South West Water provide clean water and sewerage services to over 1.5 million people, 365 days a year. Dedicated to environment and conservation issues South West Water (SWW) are committed to using Energy Efficient Combined Heat and Power generation systems. Using biogas, South West Water generate high value electricity from waste, and then utilise the heat, generated as a by product, around the site.

South West Water's existing CHP equipment had been installed for the past 16 years and with two out of the four units non operational, the plant had reached the end of it's life. For these reasons SWW tendered for the replacement of the four 165kW CHP units for their Sewage Treatment Works in Exeter.

Manchester based ENER·G Combined Power Ltd are the UK's largest manufacturer of small-scale CHP systems. With over 700 installations to date, Combined Power offer the full spectrum of CHP services as well as bespoke CHP packages.

South West Water were favourably impressed with the quality and the reliability of Combined Power's CHP installations at comparable sites throughout the UK. Also the comprehensive design and maintenance service offered by Combined Power far exceeded that which SWW and their Consultants - Pell Frischmann had previously encountered.

Therefore SWW moved away from their original supplier and opted to purchase their new units from ENER·G Combined Power using a capital purchase.

Using biogas, South West Water generate high value electricity from waste, and then utilise the heat, generated as a by product, around the site.

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Scotstoun Leisure Centre

Owned and managed by Glasgow City Council, Scotstoun Leisure Centre is situated in the heart of the City's West End. They have a range of facilities that include a swimming pool – something that is great for taking heat from a CHP system. As a public sector body, the Council needed to demonstrate that the project would offer best value for the public purse, so went out to tender for a turnkey contract for the supply, installation and commissioning of a system rated at 150kWe.

Having selected four companies to tender for the project, ENER·G Combined Power were chosen, and work soon got underway. The system was installed as external containerised plant, avoiding the need to alter the existing building fabric, reducing installation costs. Jim Smith, Senior Engineer commented, "This system looks set to offer us a substantial saving compared to the alternative traditional utility supply, some **£13,500 every year.** With the rate at which energy prices are increasing, we installed the system just in time – our payback period just keeps on improving."

The system still in its first year of operation is expected to save **670 tonnes of Carbon Dioxide** from being released into the atmosphere, helping the fight against global warming.

"...our payback period just keeps on improving"

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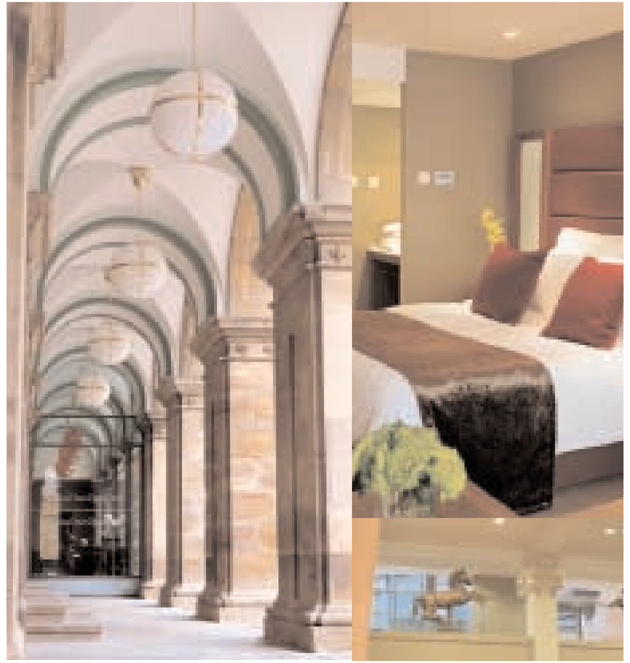
Radisson Manchester, Free Trade Hall Hotel

Owned and operated by the Radisson Edwardian Group, the 263 bedroom five-star hotel was built on the famous Free Trade Hall site and carefully preserved the listed Italianate frontage.

ENER·G assisted the project's Consulting Engineers at the design stage, to ensure that the CHP system specified would be of optimal size to meet the demands of the site. This was critical as the system was also required to provide power for emergency ventilation, lighting and other services.

Following this design work, ENER·G successfully tendered for the contract, which included the supply (capital purchase) and commissioning of one 206kWe CHP unit. The unit was situated inside the roof-top plant room, surrounded by an acoustic enclosure with anti-vibration mountings to prevent noise.



It is estimated that the system will annually **save the client more than £33,000 and 346 tonnes of Carbon Dioxide** (CO_2). Now in full operation, ENER·G are providing Radisson with their all-encompassing "Premier Plus" maintenance contract, which provides the site owner with round the clock support.

"It is estimated that the system will annually save the client more than £33,000"

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D C Leisure Centres

DC Leisure Management

DC Leisure Management Limited specialises in the development and management of leisure facilities in partnership with local authorities throughout the UK. With a portfolio of over 110 sites, energy efficiency is high up the company's agenda, as is providing competitive services for their public sector clients.

Having already recognised the contribution that CHP can offer their business, they now run a fleet of seven units across their sites. At the Wyre Forest Glades Leisure Centre, in Kidderminster, they already had a first generation CHP system that had reached the end of its useful life. Knowing the savings that their ageing unit was still making, they took the decision to replace it with a brand new system from ENER·G Combined Power. Opting for a Discount Energy Purchase (DEP) contract, they were able to realise an instant payback. Under this agreement, ENER·G finance,

install and operate the CHP system at no capital cost to the client, then sell the energy generated to the client at a discount, offering immediate savings. "Having a 24/7 need for electricity, and a 17hr a day demand for hot water, we are running at a level that can best exploit the benefits of CHP", explained Mike Morgan, Project Manager with DC Leisure.

"For Wyre Forest Glades alone we have gained **annual savings in the region of £3,000** – which is good. It would be higher, but as we are already purchasing green electricity for the site, so there is only Climate Change Levy on our gas supply that can be saved. I have used CHP for some time, and with us securing one of the latest generation of CHP systems we have experienced a marked improvement on availability over that of the old system. It's great because the unit has only had to be stopped for planned maintenance. Environmental benefits are also apparent with **over 650 tonnes reduction in CO_2 emissions per year**" Mike concluded.

"...a marked improvement on availability over that of the old system"

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Ofgem's Millbank HQ

The Office For Gas and Electricity Markets (OFGEM) has demonstrated its commitment to CHP by installing a CHP unit from the market leading supplier, Manchester-based ENER·G Combined Power Ltd.

Installed as part of OFGEM's quest to use energy more efficiently and maintain its ISO14001 ,accreditation, ENER·G Combined Power have used a unit carefully matched to the base heat ,load of the building. This was particularly important as OFGEM and their onsite facilities management company, Cavendish Group were keen to maximise the environmental benefit of installing the system. Avoiding the need for a heat rejection system helped ensure an efficiency rate exceeding 85%.

One unusual aspect of the application was the need to link the CHP to a Bosari system. This thermal storage system stores

From left to right: David Green – CHPA , Brian Bender – DEFRA and Callum McCarthy – OFGEM

surplus heat produced by the unit for use when the building needs it most. This energy efficient design helps maintain the stone fabric of the building at an optimal 15°C or above.

ENER·G Combined Power specialise in small-scale CHP systems using gas reciprocating engines. "Looking back, I'm convinced it was our proven ability to operate efficient and reliable units that helped secure this prestigious contract...we are constantly looking at ways to extend our systems into more and more applications... the fact OFGEM now use CHP can only help" comments Alan Barlow, Managing Director, ENER·G Combined Power Ltd .

OFGEM has demonstrated its commitment to CHP by installing a CHP unit from market leading supplier– Manchester-based ENER·G Combined Power Ltd.

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7.0 Glossary of Terms

Absorption Chiller

Absorption chillers use heat instead of mechanical energy to provide cooling. Therefore they can be combined with a Cogeneration (CHP) unit to provide Trigeneration.

Action Energy

Now known as the Carbon Trust.

BEMS

Building Energy Management Systems

Biogas

Biogas is generated when bacteria degrades biological material in the absence of oxygen, in a process known as anaerobic digestion. Since biogas is a mixture of methane (also known as marsh gas or natural gas) and carbon dioxide it is classed as a renewable fuel.

BMS

Building Management Systems

Building Management Systems

Controls associated with space heating, air conditioning, hot water service and lighting in buildings.

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Calorific Value

Amount of heat generated by a given mass of fuel when it is completely burned. It is measured in joules per kilogram.

Carbon Credits

Carbon credits are created when a project reduces or avoids the emission of greenhouse gases, such as carbon dioxide (CO_2) and methane (CH_4). The carbon credits are measured against a baseline.

Carbon Trading

The UK Emissions Trading Scheme, launched in April 2002, is the world's first economy-wide national-level greenhouse gas trading scheme. Emissions trading is designed to allow businesses to reduce their emissions of greenhouse gases in the most economic way.

Carbon Trust

The Carbon Trust works with UK business and public sector to cut emissions of carbon dioxide, and reduce climate change. An independent, not-for-profit company set up and funded by the government to help the UK meet its international climate change obligations; the Carbon Trust creates practical solutions to help businesses cut their emissions, bringing both business and environmental benefits.

Catalytic Converter

A catalyst provides a means to further reduce exhaust emissions for NOx and CO.

CCAs

Climate Change Agreements are voluntary agreements for energy efficiency improvements within energy intensive industries.

CCL

See Climate Change Levy

CHP

See Cogeneration

CHPA

The Combined Heat and Power Association works within the UK, to promote the wider use of Combined Heat and Power and District Heating schemes. Clean and efficient Combined Heat and Power (CHP) is already in use on close to 1,400 locations around the UK.

CHPQA

The CHPQA programme is unique to the UK and is carried out on behalf of the Department for Environment, Food & Rural Affairs. CHPQA provides the means to assess and monitor Good Quality CHP Capacity, for CCL exemption.

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Climate Change Levy

The Climate Change Levy is a UK only tax on energy use in industry, commerce, agriculture and the public sector. Tax is levied on a p/kWh basis. Rates are set to increase in April 2007 by approximately 2.5%.

CO

Carbon Monoxide

CO_2

Carbon Dioxide – odourless gas which is harmful to the environment

CO_2 Fertilising

Pumping of CO_2 gases into a greenhouse to support plant growth. An attractive way is to use cleaned exhaust gases using a selective catalytic reductor from a CHP unit.

Cogeneration

Also referred to as Combined Heat and Power and CHP – on-site generation of electricity, heat and/or cooling for the public and private sector

Combined Heat and Power

Also referred to as Cogeneration – on-site generation of electricity, heat and/or cooling for the public and private sector

COP

Coefficient of Performance (COP = chiller load/ heat input)

DEP

See Discount Energy Purchase

Discount Energy Purchase

Cogeneration technology supplied, installed and maintained by the ENER·G Group with no capital cost incurred to the client. The energy produced from the unit is then sold at a discounted rate to the client.

DNO

District Network Operator

Dual Fuel

When a Cogeneration unit is enable to operate on two fuels

ECA

See Enhanced Capital Allowances

EEBA

Energy & Environmental Building Association – promotes the awareness, education and development of energy efficient, environmentally responsible buildings and communities within the UK.

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Electrical Efficiency

Electrical output in relation to fuel input

Energy from Waste

Energy recovery of post recycling waste residue – an alternative to landfill.

Energy Services Performance Contracting

Reductions in utility consumption associated with the provision and operation of various energy efficient technologies provided with no capital cost to the customer.

Energy Technology List

Only investment in products approved for the Energy Technology List can qualify for an ECA claim. Those organisations who are not eligible to make ECA claims can still benefit from ongoing energy savings by using the Energy Technology List as a procurement tool.

Enhanced Capital Allowances

Capital allowances on plant and machinery are generally given at 25% a year on a reducing balance basis. However, with ECAs, businesses can write off 100% of the cost of energy saving equipment against their taxable profits within the first year of investment. Businesses claim the allowance on their income tax or corporation tax returns. This applies to the UK only.

EPBD (Energy Performance of Building Directive)

Energy Performance of Building Directive – The EPB Directive 2002/91/EC was originally introduced in 2000 and following various revisions the current draft was formally adopted by the Council of Ministers on 16 December 2002 and published in the Official Journal on 4th January 2003. It is expected to result in savings of 45 million tonnes of CO_2 by 2010.

ESPC

See Energy Services Performance Contracting

EU ETS

The European Union Emission Trading Scheme is the largest multi-national greenhouse gas emissions trading scheme in the world and is the main pillar of EU climate policy.

Feasibility Studies

Carried out free of charge by the ENER·G Group to determine the viability of our technologies in a particular application.

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Fossil Fuels

Coal, oil and gas are called "fossil fuels" because they have been formed from the fossilised remains of prehistoric plants and animals. They provide around 66% of the world's electrical power, and 95% of the world's total energy demands (including heating, transport, electricity generation and other uses).

G59

Recommendations for the connection of embedded generating plant to the DNO's distribution systems and the provision of standby generators

Global Warming

A rise in global temperatures threatening wildlife and its habitat, often attributed to the burning of fossil fuels

GPRS

The General Packet Radio Service (GPRS) is a new non-voice value added service that allows information to be sent and received across a mobile telephone network. GPRS has several unique features which can be summarised as: speed; immediacy; better applications; service access.

GSM

Global System for Mobile communications, the second generation digital technology originally developed for Europe but which now has in excess of 71 per cent of the world market. Initially developed for operation in the 900MHz band and subsequently modified for the 850, 1800 and 1900MHz bands. GSM originally stood for Groupe Speciale Mobile, the CEPT committee which began the GSM standardisation process.

GWh

Giga Watt Hour

Heat Rate

Energy input per unit of time, usually expressed in kWh/h or BTU/h

HHV

Higher Heat Value

HTHW

High Temperature Hot Water

HVAC

Heating, Ventilation and Air-conditioning

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Island Mode / Standby Cogeneration

Ability of the Cogeneration unit to operate independently from the grid

ISO14001

ISO 14000 is a series of international standards on environmental management. It provides a framework for the development of an environmental management system and the supporting audit programme. The main thrust for its development came as a result of the Rio Summit on the Environment held in 1992.

kWh

Kilo Watt Hour

Kyoto Accord

Agreed in Japan 1997 targets ‘carbon-rich’ gases and commits 38 industrialised countries to emissions cut of 5.2% by 2010.

Lean-burn

Lean-burn is the ability to ignite air and fuel mixtures that contain higher amounts of air than normally used.

Levy Exemption Certificates (UK)

Organisations that pay the CCL can enter into agreements with suppliers to purchase renewable electricity. The Levy Exemption Certificates (LECs) are evidence of CCL exempt electricity supply generated from qualifying renewable sources. LECs will be redeemed by suppliers to HM Customs and Excise to demonstrate the amount of non-climate change electricity able to be levied that had been supplied to non-domestic customers in the given period.

LPHW

Low Pressure Hot Water

LTHW

Low Temperature Hot Water

Motor Management System

Monitoring and control system for gas engine, enabling safe and efficient operation

MTHW

Medium Temperature Hot Water

MWh

Mega Watt Hour

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Netcaretaker

Part of ENER·G's Building Energy Management System (BEMS), NETcaretaker automatically looks after your site. It constantly monitors system performance and records any changes made to the BEMS. Using the power of the Internet, NETcaretaker sends e-mailed reports twice daily and immediately on parameter change to our dedicated support centre where these are decoded and handled by NETmail and our team of energy consultants.

Netmail

NETmail automatically decodes e-mail messages from our NETcaretaker equipped sites. Messages contain archive data which is automatically stored and exception reporting that requires immediate action. NETmail automatically flags key issues to both operators and customers and in some instances takes automated corrective action. In addition NETmail will also calculate the energy impact of parameter changes such as temperature setpoints and plant operating hours.

NOx

Nitrogen oxides (NOx) act as indirect greenhouse gases by producing the tropospheric greenhouse gas 'ozone' during their breakdown in the atmosphere.

OPTIMA

Discount Energy Purchase Scheme operated by ENER·G outside of the UK.

Parallel Grid Mode

This is where the Cogeneration unit runs in parallel with the grid

Part L

Part L of the UK Building Regulations deals with the conservation of fuel and power in buildings throughout the UK. It is part of a broad wave of European legislation which seeks to encourage industry-wide adoption of energy efficient practices and waste minimisation techniques as the embodiment of the EU Performance of Buildings Directive, the legislation is only in its infancy. However it is already having a significant impact on the UK building industry

PFI

Private Finance Initiative

PPP

Public Private Partnership

REC's

Regional Electricity Companies

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Renewable Obligation Certificates (UK)

Renewable Obligation Certificates or ROCs for short is the name given to the digital certificates which holds details of exactly how a unit of electricity was made, by whom and finally who bought and used it. These ROCs are traded separately to the actual electricity itself and work as a bonus premium on top of the price paid for the unit.

Renewables Obligation (UK)

The new Renewables Obligation and associated Renewables (Scotland) Obligation came into force in April 2002 as part of the Utilities Act (2000). It requires power suppliers to derive from renewables a specified proportion of the electricity they supply to their customers. This starts at 3% in 2003, rising gradually to 10% by 2010. The cost to consumers will be limited by a price cap and the obligation is guaranteed in law until 2027.

RMS3

Third Generation Remote Monitoring System to control and monitor Cogeneration / CHP application

ROCs (UK)

See Renewable Obligation Certificates

SBEM

The standard building energy model is a software package used to determine the energy performance of properties greater than 450m^2.

Sound Pressure Level (dB(A))

A weighted sound pressure level at a certain distance from the source

Spark Spread

The difference between electricity price and gas price – can affect the viability of the cogeneration system.

Standard Reference Conditions

Standard conditions for ambient air, ambient air pressure, relative humidity, cooling water temperature referred to when defining engine output, fuel consumption etc.

Thermal Efficiency

Quantity of heat produced in relation to fuel input

Total Efficiency

Sum of the electrical and thermal efficiency in relation to the fuel consumed

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Trigeneration

The absorption chilling unit uses waste heat available from the CHP system in the summer months to provide chilled water.

UK Emissions Trading Scheme

Based on the international Kyoto Summit on Climate Change agreement, this describes the UKs National Emissions Trading scheme designed to reduce a range of greenhouse gases, 80% of which is carbon dioxide.

Unbalance Market

Difference between electricity production and demand.

VC Chiller

A chiller that uses mechanical vapour compression.

VuSite

VuSite is a graphical management tool used as part of ENER·G's Building Energy Management Systems (BEMS). The tool typically displays a site plan upon which real time operating temperatures are shown and allows the user to make adjustment of time setting and temperature set points. In addition temperature records can be viewed, normally in the form of a simple graph.

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8.0 CIBSE Accredited CPD Courses

ENER·G Combined Power provides free CIBSE approved CPD seminars for consultants.

Find out what you can achieve with CHP

Contact Ruth Hope on 0161 745 7450

ruth.hope@energ.co.uk www.energ.co.uk/cpd

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9.0 Useful Contacts & Further Information

Contacts

CIBSE CHP Group	www.cibse.org/chp
CHP Association	www.chpa.co.uk
Energy Saving Trust	www.est.co.uk
The Carbon Trust	www.carbontrust.co.uk
DEFRA	www.defra.gov.uk

Information

CHP Quality Assurance	www.chpqa.com
Climate Change Levy	www.hmce.gov.uk/business/other taxes
Enhanced Capital Allowances	www.eca.gov.uk

Further ENER.G Group Services www.energ.co.uk

Energy Purchase Schemes

Energy Management

Renewable Energy

Energy from Waste

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