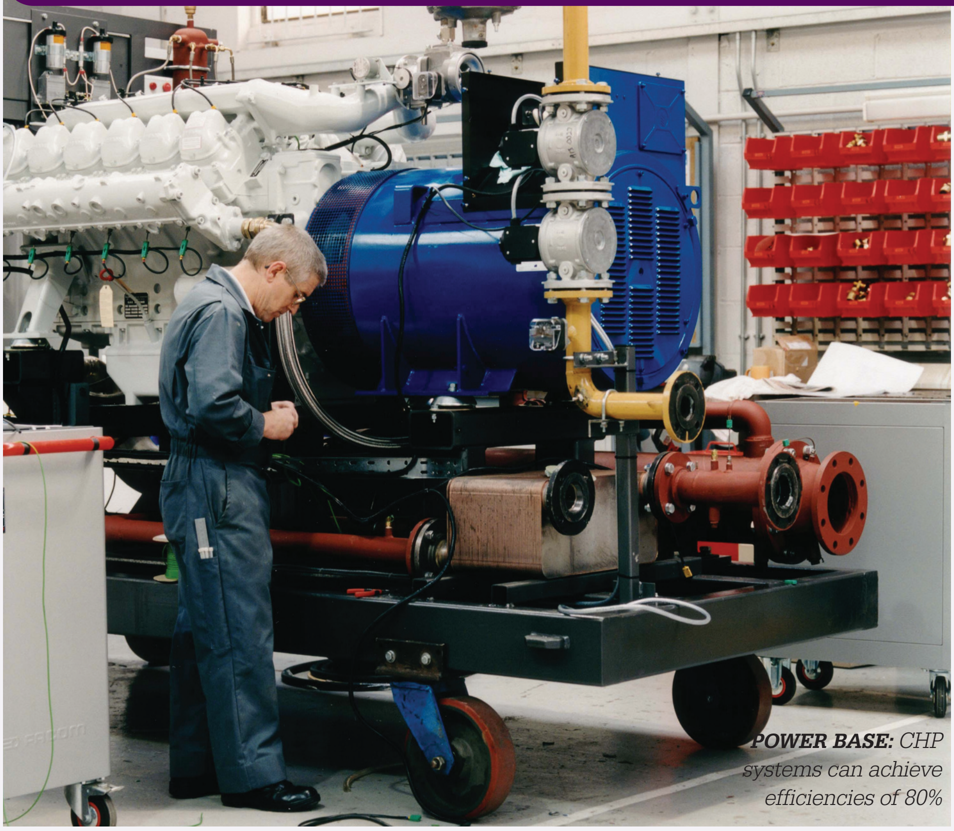
CPD

Combined heat and power

WHAT YOU'LL LEARN

- HOW A CHP ENERGY SYSTEM WORKS
- WHAT YOU NEED TO MAKE A SYSTEM VIABLE
- HOW TO INSTALL A CHP UNIT



POWER BASE: *CHP systems can achieve efficiencies of 80%*

POWERING THE FUTURE

Combined heat and power systems are becoming increasingly common as organisations tune in to their economic and environmental benefits. **Tom Fern** of the Combined Heat and Power Association reports

Energy use and efficiency is an issue that is increasing in importance. Regulatory, cost and corporate social responsibility pressures are raising its relevance and bringing it to the attention of a growing range of organisations. The appeal of reducing CO_2 emissions as well as costs is clear – and combined heat and power (CHP) systems offer a means to achieve this.

As long as there is significant and simultaneous demand for both heat and electricity, CHP offers considerable financial and environmental benefits. Existing users, for instance, can typically save around 20% on energy costs.

It's no surprise that more and more businesses, local authorities and public sector bodies are opting for CHP. Currently it provides just over 7% of UK electricity and saved an equivalent 10.8 million tonnes of CO_2 in 2008 by replacing less efficient alternative forms of energy generation. But there is an opportunity for CHP to make a much greater contribution.

What is CHP?

CHP is the simultaneous generation of usable heat and power in a single process. In its simplest form, it generally uses a reciprocating engine, gas turbine or a steam turbine to drive an alternator, and the resulting electricity is used 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, to provide hot water for space heating and other uses and, where viable, for cooling.

Because CHP systems make extensive use of the heat produced during electricity generation, they can achieve overall efficiencies in excess of 80% at the point of use. In contrast, the efficiency of a conventional coal-fired power station is typically about 38% and is lower still at the point of use as 9% of electricity produced is lost in transmission across the grid.

The scale and application of CHP varies widely from application to application. At one end of the spectrum are large-scale industrial CHP sites (providing upwards of 1MW of electricity). At the opposite end domestic or micro-CHP is being developed, which will replace household boilers, providing around 1.5kW of electricity to meet domestic needs. These products are in the final stages of development before reaching market.

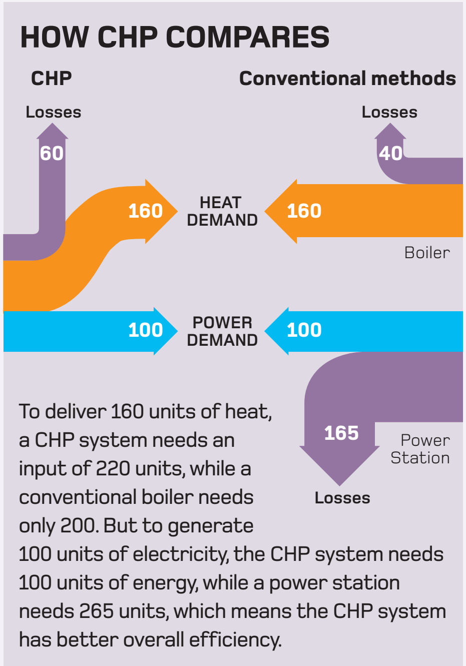
In the middle, and forming the focus of this article, are packaged units that provide capacity in the region of 50kW to 1MW to meet the energy requirements of medium-sized buildings or plant, such as leisure centres or property developments.

Selecting the best unit for the job

To get optimum efficiency from a CHP unit, it is essential that all the options are carefully considered. A feasibility study is essential before installation. The best way to maximise benefits is to ensure that the system installed is a 'best fit' and is fully optimised to the existing and future energy requirements of the building it will serve.

There are, however, certain base criteria that determine whether CHP is viable. There should normally be heat and power requirements for at least 18 hours a day (although CHP can sometimes be cost-effective over a shorter period). The organisation in question should also be looking to install the unit as a long-term investment and future requirements for heat and power should be anticipated, preferably over the lifetime of the CHP plant.

The relative proportion of heat to power required for end use is an important factor that will influence the most appropriate type of unit. Reciprocating engines are by far the most popular type of unit where packaged CHP is being considered. These are available in a range of power outputs, from 50kW to around 5MW. They are reliable with minimal maintenance requirements and generally produce two to



three units of heat for every one of electricity. They use natural gas as fuel, but increasingly they are making use of forms of bio-energy.

A site with a large and continuous cooling demand, with significant availability but declining demand for heat, could also consider replacing a conventional electricity-based cooling system with absorption cooling – a system that uses heat instead of electricity for the cooling process.

There are three principal approaches to funding a CHP development. The first involves purchase and outright ownership of the CHP unit. This approach requires upfront capital outlay and is comparatively more complex than alternatives, but ensures maximum return on the investment.

A second approach, which still requires at least some degree of capital outlay, is to lease the CHP plant from a third party energy services company (ESCO). Or an organisation could enter into a contract with an ESCO to provide a CHP facility owned by this third party but kept on site as part of a long-term agreement to supply the host organisation with heat and power at agreed rates. Both of these two options are known as 'turnkey packages', which denotes the involvement of a third party to some significant extent. The detail varies, but this will usually cover design and installation of the plant and a stake of some kind in longer-term ownership of the plant.

Funding a CHP unit from existing resources will maximise savings. Once a packaged system is in place capital costs can generally be recovered in two to four years, although the exact timeframe varies on a case-by-case basis. While third party options offer lower relative returns, they minimise risk and remove upfront cost and complexity from the equation. For these reasons, they are an increasingly attractive route for many organisations looking to harness the benefits of CHP.

Location, location, location

The location of the CHP plant needs to be carefully considered at an early stage. The plant must be sited where it can remain for a long period without disrupting or obstructing normal site use, either initially or in the future. There must also be sufficient space to allow access for maintenance purposes and to house auxiliary equipment such as compressors, electrical switchgear and control panels.

It should also be placed on foundations that are suitable for the static and dynamic loads imposed by the plant, which may require the construction of a concrete base and, in some cases, the installation of piles.

Plant should also be located in a position from which the recovered heat can be passed into the existing and future heating systems. This will usually involve installing new steam or hot water pipework, so it is preferable to keep the length of this piping to a minimum to restrict heat loss.

The CHP unit must also be connected to the site's electrical distribution and fuel supply systems. These connections also influence plant location, although the routing and installation of fuel pipework and electrical cabling are usually less complex and expensive than the pipework for the steam/hot water connections.

The CHP plant may also require the installation of a new stack to comply with regulations covering air quality. And although most CHP gas turbines and engines are supplied with acoustic enclosures, noise is produced by the plant and its auxiliary equipment. Since the plant may operate almost continuously, its location should minimise noise impact.

STACKED UP: *The University of Liverpool has a gas-powered CHP Energy Centre*

SQUARE DEAL: *Barratt's Dalston Square development in east London uses gas-fired CHP to produce 5MW of power*

CHP MAY RESULT IN YOUR CARBON FOOTPRINT RISING, BUT THE OVERALL OUTCOME WILL BE A REDUCTION IN EMISSIONS

Installation and utility connections

External plant rooms containing CHP installations will require planning consent so issues such as access, visual impact, noise and construction activity will need to be addressed.

Installation of the CHP plant is generally carried out by the manufacturer. The division of responsibilities between the company and other relevant contractors depends on the specifics of each project, but generally the majority of work will be undertaken by the third-party contractor.

Where a CHP plant is to be installed on an operational site, the ideal arrangement is to have a designated area, possibly within its own 'boundary fence', that is independent of the rest of the site. If the integration and connection of the CHP plant cannot be achieved without prolonged disruption to site energy supplies, it may be necessary to provide temporary boiler plant and other facilities.

While a small number of CHP systems do operate completely independently of the local electricity supply system, the majority operate on sites that maintain a connection to the local system. There are two advantages in doing so:

the site can draw on the local supply if it needs more electricity than the CHP plant can provide or as back up if it needs maintenance; and power that is surplus to site requirements can then also be exported to the grid.

A natural-gas-fired CHP plant will almost always increase the site's annual gas consumption. More significantly, it will also increase the maximum rate of consumption. So it is critical to establish whether the local gas supply system and the existing site gas connection can meet the new peak requirement. If not, a new or updated connection will be needed and it may be advantageous to leave the existing site connection in place and to consider a new gas supply at a higher pressure to meet the requirements of the CHP plant.

This increase in consumption will, of course, serve as a substitute for other forms of energy consumption – mainly electricity through the grid. As a result of opting for CHP an organisation's carbon footprint may actually rise, but the overall net outcome will be a reduction in emissions, due to the increased efficiency of production on site previously explained.

Most CHP schemes are also connected to a heat distribution system, which transfers heat from the CHP plant to its point of use. The sizing and design of these systems is affected by the maximum heat throughput required and often the systems are connected to other heat- or steam-raising plant that can operate as top-up and stand-by for the CHP plant. cm

Tom Fern is communications manager at the Combined Heat and Power Association