

The Applicability of Combined Heat and Power within the Hotel Sector

A BRE Discussion Paper

Paper prepared for The National Assembly for Wales, Economic Development Committee, 12th June 2002

Executive Summary

Building Research Establishment along with the Carbon Trust (Wales) welcomes the opportunity to produce this discussion paper considering the applicability of CHP to the Hotel Sector. This paper outlines the established technology within the hotel sector and comments on current national drivers for CHP to achieve its stated targets. The paper looks at the future utilisation of CHP and makes recommendations for the installation of CHP in the hotel sector in the future.

It is clear that Combined Heat and Power has specific economic and environmental benefits, and could contribute to the provision of secure and reduced carbon energy supplies within the hotel sector, a sector forecast to continue to expand in the future.

1.0 Introduction

CHP has been singled out as having a 'vital role to play' in a number of Government and devolved administration targets.

In the year 2000 the Hotel and Catering section of the UK commercial and public sector was responsible for 17%⁽¹⁾ of the sector's energy consumption and 16%⁽¹⁾ of the sectors carbon emissions. Analysis of the end use of energy for the sector indicates that the top three users of energy within these facilities are for heating, hot water and catering facilities. This illustrates the important role the installation of CHP within hotels has in the context of the reduction of greenhouse gases and the achievement of the targets which have already been set.

The Government's Climate Change Programme issued in 2000 has set a target of at least 10,000MWe (MegaWatts Electrical) installed capacity of 'Good Quality' CHP by 2010. This is in recognition of the important role this technology has to play in assisting the legally binding target under the Kyoto protocol to reduce greenhouse gas emissions to 12.5% below 1990 levels by 2008 - 2012. Along with the internal domestic goal of a 20% reduction of CO₂ based on 1990 levels by 2010. CHP is particularly effective in reducing carbon dioxide (CO₂) emissions. (Indicated within the 1997 Kyoto protocol as being one of the key six greenhouse gases.)

The reasoning behind the effectiveness of CHP to reduce CO₂ emissions is the more efficient generation of electricity with increased fuel efficiency conversion levels.

Conventionally the use of heat and electricity within the hotel building sector consists of fossil fuel fired boilers to generate space heating and domestic hot water whilst also utilising grid transmitted electricity for lighting, small power and air conditioning. There are also many examples of hotels that utilise grid transmitted electricity for heating and hot water for customer use. This process is inherently thermodynamically inefficient.

The energy efficiency of CHP compared with conventional systems is derived from the ability of a CHP scheme to make use of the liberated heat that is wasted during the generation of electricity within conventional power generating plant. Efficiencies of approximately 70% are common for successful schemes, compared to conventional method efficiencies of approximately 45%⁽²⁾ for modern gas fired power stations.

2.0 CHP the technology

Combined Heat and Power (CHP) is the simultaneous generation of heat and power in a single process and is widely recognised as a highly fuel efficient technology.

Packaged Unit

A typical CHP packaged unit (often the equipment specified within hotel plant rooms) usually consists of:

- A prime mover in the form of an engine
- A generator for the production of electricity
- Heat recovery and cooling facility usually in the form of a heat exchanger for hot water provision
- Combustion and ventilation systems for removal of products of combustion and general cooling
- Control system and enclosure around the equipment for acoustic requirements

CHP within the built environment

The application of CHP within buildings has economic and environmental benefits but this can often depend on four fundamental parameters. These often rely on each other.

- Building diurnal heating and electricity demands
- Fuel tariff costs for gas or oil and electricity
- Capacity and heat to power ratio of the equipment
- Possible running hours of the equipment during the year

The applicability of CHP to the hotel sector is ideal. Hotels are good candidates due to long operating hours, the need to maintain customer comfort and the provision of considerable quantities of hot water.

Hotels often include leisure centres with facilities such as swimming pools, saunas and steam rooms. All have a high demand for domestic hot water thus complementing constant heating loads.

Other sectors including hospitals, swimming pools and leisure complexes, nursing homes, prisons and large retail complexes can have similar characteristics and are also inherently viable.

Integration of CHP with building services design can often depend on the requirements of the facilities and its occupants. Heat can be utilised for the provision of heating demand during winter months, hot water demand all year, and within some applications that require air conditioning. Heat can be applied to absorption chilling equipment that can generate chilled water to supply fan convectors and/or ductwork for the supply of cool, fresh air during summer months.

Often hotel facilities require constant electrical supplies for occupant comfort and safety and subsequently the installation of additional Uninterrupted Power Supplies (UPS) equipment can be expensive. Often CHP can utilise the advantage of being its own independent electricity generator by being designed to run 'in parallel' with the mains electricity supplies and therefore provide standby facilities should there be a power failure.

3.0 Benefits and Barriers with regard to CHP in hotels

Benefits from installing CHP

The benefits of installed CHP in particular for hotels are listed within table 1 below.

Overall reduction of electrical energy costs for an individual site or building
Reduced impact of building on the environment
Facility of uninterruptable power supply providing security of supply
Facility for useful interlinking with required air conditioning systems
Exemption from Climate Change Levy avoiding increased energy budget
Eligibility for claiming Enhanced Capital Allowances
Potential to export generated heat, cooling or electricity to other buildings
Clear financial benefits – the ‘Whole Life Costing’ methodology

Table 1. Benefits of installed CHP for the hotel and catering sector

One of the important financial benefits of introducing CHP to an hotel building is the opportunity for claiming Enhanced Capital Allowances.

Enhanced Capital Allowances are 100% first year capital allowances on investments within the area of energy saving equipment. Businesses are able to write off the whole cost of their investment against their taxable profits during the financial year the investment is made.

Challenges for CHP to overcome

Barriers for CHP have increased over the past three years. The New Electricity Trading Arrangements (NETA) in England and Wales has been recognised as being responsible for the decrease in electricity energy costs and the disruption in the consistency of electricity export revenues. This accompanied by a clear increase in gas energy prices has restricted the potential for CHP installation during this time although it must be recognised this has affected the industrial sector greater than sectors within the built environment.

Current knowledge and technical expertise can often be perceived as a barrier for the technology. From Consulting engineers to technical staff installing CHP there is a lack of experience of design, implementation and operation. This is not a ‘fit and forget’ technology and therefore requires a constant level of operational maintenance after installation for many years.

Initial capital costs of CHP can often deter financial decision makers who are only considering quick payback periods ie 3 to 5 years. When considering savings and possible increased revenues, Combined Heat and Power installations often have a longer ‘Whole Life Costing’ payback of between 5 to 15 years.

Often the management and finance options available are not considered in full detail by feasibility studies. The specification of CHP can depend on what the client views more important, cost, efficiency or environmental impact. The client can often choose a Capital Purchase scheme, where the hotel purchases and installs the equipment with maintenance completed by a sub contractor. Or an energy supply contract with an Energy Services Company (or ESCO) designs, installs, finances and operates the equipment over a number of years. The financial advantage of this is minimal capital outlay for a fixed energy tariff for heat and electricity. For many hotels, hospitality rather than energy supply is their core business and this may therefore be the better option. Although at present this is rarely considered.

4.0 Feasibility and financing requirements for CHP

By highlighting the benefits and barriers for CHP the importance of completing a full feasibility study by experts, is recognised.

An outline procedure for the completion of the feasibility study process is as follows.

- Initial Outline and viability study
- Option appraisal
- Full feasibility study

Initial outline and viability study

The initial outline and viability study may include the collection and collation of heating and electricity demand data for the proposed building or site. This can often determine the market for heating, cooling and power. This information can often be obtained from historical data. Should the building be new build energy modelling techniques may be required to determine the data, the information may then be utilised to complete load profile analysis to determine base heat and electrical loads influencing the selection of CHP equipment. This can be completed by an energy or building services manager.

In 1999 Government issued software to conduct a preliminary evaluation of CHP for new hospitals and hotels called CHP sizer. Copies can be obtained from the Energy Efficiency Best Practice programme (EEBPP) website referenced within section 7.0.

Option appraisal

The option study may include a survey of installed building services, particularly if the site consists of existing building(s). Often this may be commissioned to Consulting Engineers. Following the survey which can determine the condition and configuration of the building services currently operational, recommendations can be made regarding the applicability of CHP and how the equipment may utilise the useful heat and electricity produced.

Full feasibility study

It would be expected that the full feasibility study would consist of a detailed technical and financial appraisal including the outline, viability and option appraisal. A financial appraisal would consider the marginal capital cost of the CHP equipment over and above any avoided costs of a boiler or standby generation plant. The financial appraisal should be using whole life costing methodology, which considers revenue and operating costs in comparison with other alternatives for the generation of heating hot water and electricity. Often this methodology will yield a result favourable for the specification of CHP. The feasibility study should consider possible financing options for the purchase of the CHP equipment. Two options for purchasing CHP are:

- Capital Purchase
- Energy Supply Contract

Capital Purchase

As mentioned within section 3.0, a client who has completed a full feasibility study will often be provided with the option of purchasing the installed and operating equipment outright. However, the client will have the responsibility of operating and maintaining the equipment.

Energy Supply Contract provided by an Energy Services Company

The company designs, installs, finances and operates the equipment over a number of years, with minimal capital outlay for a fixed energy tariff for heat and electricity.

5.0 Application of CHP and Case Studies within the hotel sector

Often examples of the application of Combined Heat and Power within the hotel sector fall within the following two categories although the majority are currently installed within the dedicated installation category:

CHP installed within the hotel plantroom as part of a dedicated installation

An hotel has its own dedicated CHP installed on-site supplying the hotels own building(s) and facilities with heating, electricity and sometimes cooling. Of the two categories dedicated CHP to one site or building is the most applicable within this sector as the facility of energy linking to and from other buildings is not possible primarily due to location.

This type of installation can be operated and maintained by the hotel or sub contracted out to an appropriate company.

The energy efficiency best practice programme is currently planning to issue a CHP building sector supplement on CHP within the hotel sector which will have a number of case studies outlining the relevance of dedicated installations of CHP.

CHP as part of a District Energy or Community Energy Scheme.

The hotel is one of a number of customers that are supplied with heating/cooling and/or electricity from an energy centre some distance from the hotel. This type of large-scale scheme is often operated and maintained by, an established energy services company (ESCO).

The following case study illustrates an hotel utilising CHP as part of a District Energy application:

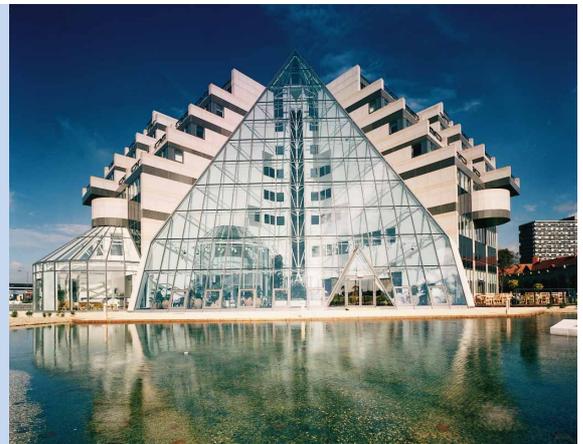
CASE STUDY

The De Vere Grand Harbour Hotel, Southampton

The hotel was built and connected in 1994 and took advantage of the Southampton Geothermal Heating Company site wide expansion of its district heating and chilling scheme using CHP. (SGHC is a partnership company between Utilicom Ltd and Southampton City Council)

It was already agreed that district heating and cooling would be supplied to the hotel before it was built. The hotel negotiated a special arrangement where it did not pay for the cost of the connection to the scheme. De Vere did however sign a Heat and Cooling Contract at an agreed fixed energy tariff for a fixed number of years.

The hotel has no main plant room as there is no boiler or air conditioning equipment required with all energy being supplied to the hotel via buried district heat and cooling mains. Pipework routed around the city has a number of features including electronic detection for potential leaks, monitoring facilities to check water temperature as it flows to consumers, and metering facilities to check energy consumption and automatically calculate the energy bill .



Case study details:

Date of installation	1994
No. of hotel rooms	172
Financial Arrangement:	ESCO Contract

6.0 The future for CHP and recommendations

The hotel and catering sector had a measured energy consumption of 149PJ (Petajoules) in 2000⁽²⁾. This is estimated to increase to 174PJ by 2020⁽²⁾. The total delivered energy consumption for Hotels, Inns and Restaurants in Wales in 2000 was 6.03PJ⁽³⁾ approximately 4% of the total. Even if the sectors energy consumption increases over the next 18 years, the installation of Combined Heat and Power can increase energy efficiency and reduce carbon dioxide emissions.

BRE's report to the Carbon Trust (Wales) and the National Assembly for Wales (issued March 2002) indicated considerable potential for cost-effective carbon savings in the hotel sector.

It is acknowledged that CHP is currently installed in hotels within Wales. A number of large hotel companies are embracing environmental management with detailed energy strategies that are predominantly concentrating on low energy design alongside the commitment of installing CHP within their hotels. Some hotels are also following the installation of CHP measuring their carbon dioxide reduction and offsetting remaining amounts by planting trees to contribute towards a 'carbon neutral' development or building.

It is anticipated that soon there will be recognition that hotels installing CHP are assisting the hospitality sector to meet the voluntary energy efficiency agreement signed between the Government and the Hotel and Catering International Management Association (HCIMA). HCIMA are the professional body for the international hospitality industry that have signed an agreement to reduce carbon emissions by 15% below 1999 levels by 2010. The agreement aims to recruit 7500 establishments as members to meet this target, there are no definitive targets for Wales or other regions. It is stated that this agreement could save industry £31Million in annual energy costs.

CHP is being supported in many other sectors including hotels. Therefore the future application of the technology is expected to increase considerably over the next decade. The potential for hotels to become energy centres generating their own heating, hot water and electricity and even exporting this energy to other nearby adjacent buildings creating additional revenue is also recognised.

Recommendations

To promote CHP by considering the formation of a 'CHP for Hotels in Wales' panel responsible for the encouragement of the installation of CHP equipment within the sector and be responsible for the dissemination of information to assist the sector and those parties interested.

To consider the promotion of 'Champions of Hotels with CHP' as examples of what can be achieved within this sector in Wales.

To promote CHP by requiring the developers of new build or owners for the refurbishment of existing hotels to submit documentation stating they have considered CHP. Utilising the 'Whole Life Costing' methodology and indicating the installation of CHP has been assessed against other alternatives for the generation of heating and electricity.

Recommend an integrated approach for new build hotels considering architectural and building services design to maximise the potential for the specification of CHP within the sector, preferably utilising wet-based heating systems (for use with CHP generated heat) as opposed to electric heating without CHP.

Encourage more hotels to become their own energy centres. This can be particularly energy efficient and financially effective in areas of high density such as city centres and also energy link to large residential complexes.

7.0 Further Information

Website information

www.energy-efficiency.gov.uk	website of the Energy Efficiency Best Practice programme (EEBPp)
www.bre.co.uk	website of the Building Research Establishment
www.thecarbontrust.co.uk	The Carbon Trust
www.chpa.co.uk	Combined Heat and Power Association
www.eca.gov.uk	Enhanced Capital Allowances

The following documents have been produced as part of the Government's Energy Efficiency Best Practice programme and can be ordered/obtained from the energy efficiency website referenced above.

Good Practice Guides

GPG1	Guidance notes for the implementation of small scale packaged Combined Heat and Power
GPG3	An introduction to small scale Combined Heat and Power
GPG115	An environmental guide to small scale Combined Heat and Power
GPG176	Small scale Combined Heat and Power for buildings
GPG226	The operation and maintenance of small scale Combined Heat and Power
GPG227	How to appraise CHP

Good Practice Case Studies

GPCS210	A corporate policy on Combined Heat and Power
GPCS244	Energy efficiency refurbishment of a medium sized hotel
GPCS293	Long term operation of Combined Heat and Power in an hotel

8.0 References

1. Carbon dioxide emissions from non domestic buildings: 2000 and beyond. (Pout, Mackenzie and Bettle) BRE 2002
2. Small scale combined heat and power for buildings Applications Manual AM12:1999 (CIBSE 1999)
3. BRE Report 208-145 – Establishing a Quantative Picture of Energy use and savings potential in Wales: Non-domestic buildings. March 2002. (Client: Carbon Trust Wales and National Assembly for Wales).



Lee Paul Hargreaves
BRE
Garston, Watford WD25 9XX
Tel 01923 664000