

Date: 12 June 2002
Time: 14.00 - 17.30
Venue: Committee Room 1, National Assembly for Wales, Cardiff Bay
Title: USER EXPERIENCE OF COMBINED HEAT & POWER IN THE PUBLIC SECTOR – A CASE STUDY

SUMMARY

- This paper describes the application of Combined Heat & Power (CHP) in a specific building in the public sector.
- The benefits are described.
- The replication potential in the public sector is discussed.
- An opinion is given as to the perceived current barriers to the wider application of the technology.

CASE STUDY OF COMBINED HEAT & POWER AT WITBYBUSH HOSPITAL

Key points

- Withybush General Hospital, in Haverfordwest, is the leading public sector building in Wales in the generation of electricity by the use of CHP technology.
- CHP typically generates more than 90% of the hospital's electrical requirements.
- The energy cost performance is the best of all the District Hospitals in Wales.

Background

The hospital

Withybush Hospital opened in 1978 with 338 beds. It is of compact design, built into a hillside, with four floors at the back and three at the front. A number of single storey extensions have been added to the main building. In the grounds there are five accommodation blocks.

With developments over the years the number of beds have increased to 354. Facilities for day and out patients have expanded significantly. Together with residential blocks, the gross internal floor area of the site as at April 2000 was 35,670 square metres and the heated volume 82,263 cubic metres.

Early improvements

In 1982, when the then Pembrokeshire Health Authority undertook a review of costs, it was alarmed to discover that 3.5% of its total revenue budget was being spent on energy. An aggressive energy efficiency programme was instigated. This reduced energy costs over the five years ending 1987/88, to 1.8% of the local health service annual budget. All properties were targeted, but Withybush Hospital, as the largest user, became the focus of attention.

Energy consumption savings of 57% were achieved in the five year period to 1987/88 at the Withybush site. The major savings were made in the use of fossil fuels. An analysis of the 1987/88 energy profiles revealed that electricity had increased to 24% of all energy purchased and 66% of cost. **At this juncture the use of a CHP system was considered.**

CHP implementation

Initial planning

In 1988 information on CHP systems was not readily available. It was necessary to start from first principles. Examination of the thermal and electrical profiles of Withybush Hospital indicated that a two set installation appeared to be the best solution. This would comprise a set of approximately 400KWe for lead in winter and a 280KWe set for lead in summer.

At that time the health authority had the opportunity to acquire a 20 year old standby diesel generator. This was converted, with the addition of heat exchangers, to a CHP unit that had outputs of 440KW (electrical) and 760KW (hot water). It was projected that the unit would be able to run for 8 months of the year. The operational period would be further extended with the installation of a heat store on the primary heating circuit. The boiler house configuration was nearly ideal with the primary electrical intake and heating circuit in very close proximity.

The first set

In December 1988 the 440KWe set was commissioned. In spite of a series of operational problems the energy cost profile of Withybush Hospital started to show an encouraging improvement.

The second set

November 1990 saw the commissioning of a gas fired package unit, sized at 290KW (electrical) and 410KW (hot water), with on-board computer monitoring. This set was designed to work as the lead on summer loads. By 1992/93 the two set installation was generating 55% of the daytime electrical requirement of Withybush Hospital.

Reappraisal

One night in November 1993 disaster struck. The 440KWe diesel set suffered a major and terminal engine failure, which resulted in it being beyond economic repair. This gave an opportunity to re-evaluate the most effective way of providing on-site electrical generation.

After a careful reappraisal of the Wthybush energy consumption profiles, the optimum replacement was determined to be a 300KW (electrical) gas fired set with a split thermal output of 150KW (steam) and 240KW (hot water). This would match the site summer base loads.

Private financing of the scheme was investigated with the option of a supplier owning and operating the proposed installation and selling the hospital the output. The major advantages were perceived as being:

- Capital would not be required;
- The installation would not be added to the Trust's asset base;
- The supplier would take the full financial risk;
- It would be in the supplier's interest to ensure maximum availability of the plant.

The third set

The 300KWe set was commissioned in March 1995 as a replacement for the initial 440KWe unit. The installation had several interesting features:

- It was the first CHP unit in the Welsh health service to have a split thermal output of steam and hot water;
- At the time, it was believed to be the smallest CHP set in Europe to include steam raising;
- It was the first CHP unit in the Welsh health service to use private finance through a discounted electricity purchase scheme.

It had initially been planned to operate the machine 17 hours per day during the period of daytime tariff. The successful contractor proposed 24 hour running, with a two-part tariff, to reduce the maintenance problems normally associated with regular stopping and starting. This proved to be a good decision as the set has maintained a 94% availability factor since commissioning. This unit, together with the set installed in 1990, has enabled the hospital to generate up to almost 94% of its total electrical requirements from 1995/96 and to sell surplus electricity back to the regional electricity company.

Environmental benefit

The introduction of CHP has produced considerable environmental benefit.

- Between 1988/89 and 1996/97 the electricity supplied by CHP sets increased from nothing to nearly 94%.
- Primary energy consumption of the site fell by 26% in the period. This was in spite of the introduction of significant extra loads such as IT equipment and cooling plant.
- Carbon dioxide emissions were reduced at the same time by 27%.

Energy consumption profiles were dramatically changed. Comparison of the 1999/2000 consumptions with best practice benchmarks for acute hospitals [supplied in the Guide for "Energy Efficiency in

Buildings" from the Chartered Institute of Building Service Engineers] shows the very significantly lower use of imported electricity. This is seen in the right hand column below.

Fossil fuel (kWh/sq.m) Electricity (kWh/sq.m)

Withybush 1999/2000 consumption 438 7

BEST PRACTICE BENCHMARKS 422 78

Financial benefit

The main driver for the introduction of CHP was to achieve financial savings. In this objective Withybush Hospital has been very successful, even allowing for the problems associated with the first installation.

The first set, commissioned in 1988, did not achieve a payback. The scheme included changes to the mechanical services infrastructure and the installation of a heat store. These elements were incorporated into the subsequent CHP schemes.

The second set, installed in 1990, achieved savings in the period from November 1990 to March 2001 of £430,000 and a pay back of 2.75 years.

The third set, installed in 1995, achieved savings in the period from March 1995 to March 2001 of £182,000 with no capital outlay.

The annual net saving for the two sets in 1999/2000 was £62,000.

These savings have had a considerable impact on the overall site energy cost performance [as shown following] and compared very well with the benchmark for the year, produced by Building Research Establishment. The hospital's performance was the best of all the district general hospitals in Wales.

Withybush Hospital 1999/2000 energy costs per square metre of building

- Electricity £0.90/sq.m
- Gas/oil £2.67/sq.m
- Total energy **£3.57/sq.m**

BEST PRACTICE COMPARATOR **£6.60/sq.m**

CHP running cost (capital, maintenance, operation) £1.91/sq.m

Climate Change Levy

Withybush Hospital was well placed to minimise the impact of the Climate Change Levy (CCL) when it was introduced in April 2001. The majority (98%) of imported energy is gas. Of this 70% is consumed by the CHP sets. These sets meet the quality criteria for exemption from the levy.

The sets are projected to make a total annual saving of £84,500 in 2001/02 when the savings from the CCL are added. This includes some £22,500 CCL that would have been charged had the CHP units not been supplying electricity and heat.

Key features for successful installation

The features of the Withybush Hospital CHP installation that have made it a success are:

- Making basic energy savings before considering CHP;
- Ensuring correct sizing and design;
- Care in contract preparation;
- Planning for the future;
- Good maintenance;
- Effective overall site operational management of all plant and services.

Withybush General Hospital is a relatively small hospital. What has been achieved in environmental, energy and cost improvements clearly demonstrates the potential of correctly applied CHP technology.

REPLICATION POTENTIAL

- CHP is only one of a range of available technologies that can be used in energy efficiency strategies.
- CHP is usually only viable in buildings with a maximum hourly electrical demand in excess of 100KW. There should be a use for all the heat and electrical output of a CHP unit for at least 5000 hours per year. Typical public sector applications could include residential and nursing homes, swimming pools, universities, certain museums, prisons, MOD establishments and hospitals.
- In the health sector 11 of the major hospitals in Wales have CHP installed. Only 2 of the installations generate more than 50% of the site electrical requirements and 5 generate less than 35%. Of the other major hospitals 6 do not have any CHP installation. If Withybush Hospital were used as the benchmark, there would appear to be a significant potential for new and expanded installations in the NHS.
- Other parts of the public sector in Wales have lagged behind the NHS in the adoption of CHP. There is scope for expansion.
- There have been interesting recent developments in the production of micro CHP sets from 1 to 30 KW (electrical). The viability of these has yet to be proved. The UK government has allocated funding for pilot applications in the domestic sector. If maintenance, reliability and financial issues can be resolved a significant expansion into housing and public sector buildings could be possible.

BARRIERS TO THE EXPANSION OF CHP TECHNOLOGY

Low energy costs.

Energy costs have dropped in real terms very markedly in the last 20 years. Energy is now perceived as a very low priority when compared with the many other pressures that public sector managers are under, in respect of the services they are providing.

Reduced cost differential between electricity and fossil fuels.

The financial viability of CHP is dependent on off setting the purchase of high cost electricity by on site electrical generation from low cost fossil fuels (ie gas, oil) and achieving net savings after the cost of the energy conversion (capital, maintenance, operation) has been included. The rising cost of fossil fuels and the reducing cost of purchased electricity in the last two years have made some CHP installations no longer viable.

Complex technology.

CHP installations are more complex than standard building services. Boards, whose core business is not energy, are reluctant to sanction projects that are perceived as having a high risk.

Lack of technical expertise.

There is often a shortage of in-house technical staff with operational experience of CHP installations and a consequential reluctance to consider such schemes. This lack of expertise extends to the private sector. This has led to a number of poorly conceived, designed and performing installations being cited as the reason for not considering CHP.

CONCLUSION

There is considerable potential for expanding the use of CHP in public sector buildings in Wales as part of a wider energy strategy. This would provide environmental and financial benefits. A coordinated and concerted approach by the Assembly will be required if this is to be achieved.

C P Le Breton
May 2002