Good Practice Case Study

CHP Installation at Hydebank Young Offenders Centre

Combined Heat and Power (CHP) achieves efficiencies of 60-80% or more and can make significant energy and cost savings compared to conventional forms of electricity generation and heat only boilers. At sites with relatively constant heat demands the installation of a CHP system can lead to significant energy and carbon savings. At the Hydebank Young Offenders Centre, the benefits resulting from the CHP installation include:

- **Annual Cost Savings of over £44,000**
- **Carbon dioxide savings of over 316 tonnes/annum**
- **A payback period of about 4.7 years**

Hydebank Young Offenders Centre

Hydebank Wood (HMP & YOC) is a young offenders' centre and prison located in South Belfast opposite the entrance to the former Belvoir Park Hospital. The Centre accommodates all young male offenders aged between 17 and 21 years on conviction, serving a period of 4 years or less in custody and all female prisoners including young offenders.

The Project

A Nedalo 210kW$_e$ (210kW electrical output) gas-fired CHP unit was installed complete with natural gas engine, alternator, heat recovery system, stainless steel exhaust silencers and acoustic housing. The installation of the unit was part of a boilerhouse upgrade that was paid for separately. A new exhaust gas flue, ventilation ductwork, boiler connections and electrical connections, including G59 Protection equipment were included in the CHP costs. The CHP was connected to the existing LPHW and MTHW systems, allowing heat to be provided to the whole site with a rejection radiator for excess heat.

The CHP unit at HMP & YOC Hydebank Wood, Belfast, provides power, heating, and hot water for all the buildings in the main complex of the establishment including residential units, the administrative section, healthcare section, chapel, gymnasium, kitchen, education unit and workshops. Some more recent building additions, and more distant outbuildings were not included. Additional electricity is supplied from the grid as required, and additional heating and hot water is supplied from two dual-fuel boilers, which can run on gas or oil as required.

This project received 100% funding from the Northern Ireland public sector Central Energy Efficiency Fund in April 1999 and was installed and commissioned in November 1999.

Background to CHP Technology

Conventional power stations have an electrical efficiency of between 35% and 40%, the remaining 60% being waste heat lost as low grade heat to the atmosphere or to water. Thermodynamic constraints limit steam power plant efficiencies to under 50%, with typical efficiencies of under 40%. The most advanced natural gas combined cycle plants achieve maximum efficiencies of about 55%. Taking into account grid transmission losses from power plant to end user, overall electricity generation efficiencies could be as low as 35%.

Combined Heat and Power is a technology that has been used for over 100 years to generate electricity and heat for use in community heating schemes and industrial processes. CHP plants generate electricity at slightly lower efficiencies than conventional power plants, but the overall efficiency of a typical CHP plant can be as high as 70-75% because waste heat from the generator is recovered and used.

The benefits of CHP depend on the application. A key determinant is the heat-to-power ratio of the site. For a typical building, a CHP plant could increase the overall energy efficiency for the site by up to 25-35% with a corresponding decrease of energy costs and greenhouse gas (GHG) emissions. Traditionally CHP units have been used for large-scale industrial applications using coal, fuel oil or natural gas to run steam turbines or gas turbines. More recently smaller scale reciprocating engines have been used in building applications, such as leisure centres, hospitals and care homes, hotels, housing developments and other government buildings.

Energy and Cost Savings

Before the CHP installation, the annual electricity and heat energy consumption for the Hydebank Young Offenders Centre was metered at 1,295MWh and 6,386MWh respectively, with a total annual energy cost of £162,600. Table 1 summarises the project benefits.

Table 1 - Project Benefits

	Predicted	Post Project Evaluation
Grid Electricity Reduction	801 MWh	514 MWh
Increased Gas Consumption	1,763 MWh	2793 MWh
CO_2 Savings	285 tonnes/yr	316 tonnes/yr
Capital Cost	£155,000	£158,000
Additional Maintenance Cost	£10,000	£10,000
Savings	£50,000	£44,000
Payback Period	3.9 yrs	4.7 yrs

Considerations for Other Sites

- Wheeling electricity was too complex for this site and it was found not worthwhile due to the administration cost. The site plans to install a load control system to stop the CHP exporting.

- Accurate sizing and continuous monitoring of a CHP unit is crucial to realising the benefits from its installation. The site is going to install an electrical, heat and gas monitoring and reporting system to help staff to understand better how the unit is performing, especially now with the increased cost of natural gas.

- The unit rejects heat in the summer months as the space heating is switched off throughout the complex. This should be considered when designing a CHP scheme, especially now with the rising price of gas.

- CHP maintenance costs are a significant ongoing financial burden and over the lifetime of the system could cost as much as the initial capital outlay. The site pays an annual maintenance charge of £10,000, but there is no incentive within the contract to share the risk between the customer and the maintenance provider if the operating hours are reduced. Maintenance costs should be negotiated at the tender stage as costs could increase from year to year. The site should tender for maintenance on a p/kWh basis, which would allow more flexibility in planning operating regimes

Project Conclusions

The site staff were very impressed with the installation although they still do not have a good understanding of the system and how the unit is performing. The CHP will help to reduce the cost of Climate Change Levy on natural gas to buildings when the current exemption ends. The site intends to register the CHP unit under the CHPQA programme for CCL exemption. The CHP has also helped to keep energy costs down at the site over the past few years even though the prison now has higher occupancy than ever before.

Supporting Information

For further information on the Central Energy Efficiency Fund see website:
www.psecni.gov.uk

Publications from the Carbon Trust

GPG388 - Combined Heat and Power for Buildings

FL87 - Saving Money With Combined Heat and Power

GPCS458 - CHP at an Engineering Company

GIR082 - The Managers Guide to Custom Built Combined Heat and Power Systems

For details of the Carbon Trust's services and free publications, call the helpline on 0800 85 20 05 or visit the website:
www.thecarbontrust.co.uk

The Combined Heat and Power Association

Website: www.chpa.co.uk

The Combined Heat and Power Quality Assurance Scheme

Website: www.chpqa.com

To register under the CHPQA scheme for climate change levy exemption a quality index (QI) of greater than 100 is required. The formulae for calculating QI is as follows:

$$QI = X * P + Y * H$$

Where:

X is a factor for power related to alternative electricity supply options.
Y is a factor for heat related to alternative heat supply options.
P is the electrical generation efficiency
H is the heat generation efficiency

For the 210 kWe natural gas fired reciprocating engine unit at Hydebank

$$X = 200 \text{ and } Y = 125$$

The calculated electrical generation efficiency was 30.6%. Therefore P = 0.306
The calculated heat generation efficiency was 32.8%. Therefore H = 0.328

Thus QI = 200 x 0.306 + 125 x 0.328 = 61.14 + 41.0 = 102.14.

Hence the unit at Hydebank qualifies for climate change levy exemption.

Other Publications

Energy Efficiency Office -
Good Practice Guide 312 - Invest to Save

Further Project Information

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