A Guide to

Combined Heat and Power

in Ireland

Produced by the Irish CHP Association

IRISH CHP ASSOCIATION

Supported by

sei SUSTAINABLE ENERGY IRELAND

A Guide to CHP in Ireland

Combined Heat and Power, often referred to as cogeneration or CHP, is a highly efficient energy solution which has an important part to play in Ireland's climate change strategy and overall energy policy. This guide is aimed at explaining what CHP is all about, its benefits, how it stands today in Ireland and where to go for further information...

Contents

SUSTAINABLE ENERGY IRELAND

Our Mission

is to promote and assist the development of sustainable energy

Glasnevin
Dublin 9
Ireland

t +353 1 8369080
f +353 1 8372848
e info@sei.ie
w www.sei.ie

NATIONAL DEVELOPMENT PLAN

Sustainable Energy Ireland is funded by the Irish Government under the National Development Plan 2000-2006 with programmes part financed by the European Union

Combined Heat and Power

What is Combined Heat and Power?

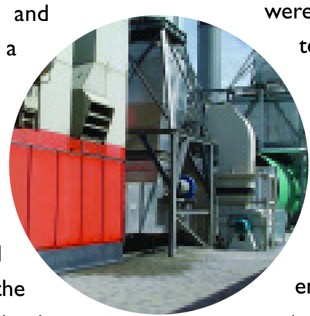
Combined Heat and Power, or CHP as it is more commonly referred to, is the simultaneous generation of usable heat and power (usually electricity) in a single process. In other words, it utilises the heat produced in electricity generation rather than releasing it wastefully into the atmosphere. CHP is sometimes referred to as co-generation or cogen.

In typical conventional power generation, much of the total energy input is wasted. Combined Heat and Power (CHP), or co-generation (sometimes referred to as 'total energy'), where the heat produced in electricity generation is put to good use, can reach efficiencies in excess of 85%. CHP can provide a secure and highly efficient method of generating eletricity and heat at the point of use. Due to utilisation of heat from electricity generation and the avoidance of transmission losses because electricity is generated on site, CHP achieves a significant reduction in primary energy usage compared with power stations and heat only boilers.
Typically a good CHP scheme can deliver an increase of 20% / 25% in efficiency against the separate energy system it replaces.

By recovering the majority of what would otherwise be waste heat, overall energy savings of between 20 per cent and 40 per cent may be achieved. For an energy intensive business this can represent a very substantial saving. Combined with other energy efficiency measures CHP can deliver even greater cost savings for customers.

Applications that are generally suitable for CHP or co-generation include hotels, hospitals, industrial processes and commercial buildings, where a continuous demand for both heat and power exists.

The installation of CHP has been widely recognised as a key measure to help reduce harmful emissions of carbon dioxide, the main greenhouse gas, while delivering the same amount of useful energy. It is estimated that for every 1 MW of CHP installed, CO_2 emissions are reduced by at least 1,000 tonnes per annum.



On balance, co-generation can result in savings of up to 50 per cent of CO_2 emissions compared with conventional sources of heat and power. Reduced emissions of sulphur dioxide and particulates are further benefits.

The energy efficiency of CHP is recognised throughout the energy world. However, many commentators feel that if the full economic and environmental benefits were fully valued in Ireland in terms of market structures and regulation, then the CHP sector would develop more rapidly. There are few solutions that offer, simultaneously, a cleaner lower carbon environment as well as lower costs. Surely an attractive option worth considering by everyone in business.

Combined Heat and Power

The Advantages of CHP

CHP provides a potentially cost effective way of servicing the simultaneous heating and electrical demands of commercial and industrial processes.

The main advantages to customers of using CHP are:

- Reduced energy costs;
- Enhanced security of energy supply;
- Reduced CO_2 emissions, making a valuable contribution to the environment, particularly in light of Ireland's Kyoto Protocol obligations;
- Conservation of valuable fuel resources.

The full advantage of natural gas-fired CHP technology is achieved when the production of power and heat is combined. For this to be technically and economically feasible, it generally requires a simultaneous demand for heat and electricity on the premises, for a minimum of 14 hours per day or around 5,000 hours per annum.

The development of gas turbines has increased the attractiveness of cogeneration for particular industrial applications. By changing from separate systems producing heat and power to a single industrial unit considerable amounts of energy are saved.

Typically, up to 85 per cent of the primary energy is used in industrial CHP or co-generation systems: a very high level of efficiency compared to all other forms of conventional generation.

In particular, combined heat and power offers Irish industry two main benefits:

It represents a highly efficient use of energy, which means lower costs for energy users (which in turn enhances Ireland's industrial competitiveness);
CHP also delivers significant emissions reductions (particularly with natural gas as a fuel). In addition to better local air quality CHP can make a significant contribution to reducing Ireland's emissions of carbon dioxide.

In addition to delivering a significant cost reduction to customer sites CHP is a well tried and trusted highly reliable technology. New CHP installations usually deliver an overall improvement in availability and operational performance as well as technical efficiency.

CHP Greenhouse Gas Impact

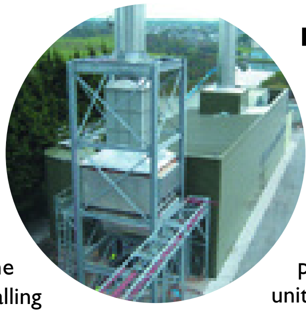
Gas	Estimated net reduction in emissions per kWh of electricity produced (g/kWh)
CO_2	1,000
SO_2	17
NO_x	4.6
CO	(3)
CH_4	3.9

Source: SEI An Examination of the Future Potential of CHP in Ireland

The impact of installing increased CHP capacity on CO_2 emissions forms part of the National Climate Change Strategy. The strategy sets a CO_2 reduction target of 0.25Mt implying around 250 MWe of newly installed CHP. The environmental benefits of installing CHP are significant and the emissions savings are shown in the table above.

CHP Applications

Conventionally CHP applications have been divided into two broad categories, based on design output: large scale (greater than or equal to 1MW) and small scale (less than 1MW). However, recent technological advances have introduced the third 'Micro-CHP' category (less than 50kW). In essence combined heat and power allows a customer to generate their own electricity (reducing their payments to the electricity utility) and then make good use of the substantial quantities of heat created as a by-product of electricity production. In a normal gas-fired CHP scheme the waste heat is recovered and distributed to where it is needed in the form of hot water or steam. (Further explanation of the technology behind CHP applications is set out on pages 4-7).



Large Scale CHP

The prime mover in large scale CHP can be a gas turbine or spark ignition gas engine. This drives a generator, which produces the electricity, the exhaust gases then pass through a recovery unit which provides the heat in the form required by the site (e.g. steam). Additional steam or hot water, can be produced using a technique called after-firing, this involves burning more gas in the oxygen rich gases prior to the waste heat boiler. This increases the heat output with the facility to modulate heat production without affecting electricity generation. As with small scale CHP, electricity may be imported from, or exported to, the national grid as site demand varies (known as top-up and spill).

The choice of prime mover is based on a number of factors and even with similar energy requirements, no two sites are the same. (For more detail on the various types of prime movers for CHP solution see the CHP Technology section below).

Combined Heat and Power

CHP Applications

Small Scale CHP

Small Scale CHP schemes have tended to have a reciprocating engine as prime mover whereas the large schemes tend to be turbine-based. Recent developments in turbine technology have led to the introduction of 'microturbines' for small scale CHP systems.

Small Scale CHP is particularly suitable for applications such as hotels, hospitals and leisure centres, where there is a steady demand for heat and power throughout the year. Large Scale CHP Systems are suitable for use in larger industrial and commercial processes such as chemical/pharmaceutical plants, breweries, airports, universities and food processing plants.

In small scale schemes the CHP unit consists of an engine or microturbine, which is mounted in an acoustic enclosure. Heat exchangers recover heat from the engine exhaust gases and cooling system to produce hot water, which can be integrated into the site services. The unit is normally designed to meet the site's base heat and electrical power requirements. Peak heating demand can be supplied using high efficiency modular gas boilers to provide hot water, with additional electricity being imported from the national grid. A control system will allow the automatic operation of the unit to meet the heat and power demands of the site.

Micro-CHP

Micro-CHP (mCHP) is a mass produced small scale CHP unit that is suitable for domestic and small business applications. mCHP units vary in size up to 50kWe and use a number of different technologies: internal combustion engines; external combustion engines; micro-turbines; and fuel cells (although these are still at the development and demonstration stage).

District Heating

District heating (DH) is heat distributed from a central boiler or CHP plant. The preferred distribution medium is water and district heating has been around for over a century in the US and Europe. District heating has not had the same penetration in Ireland for a number of reasons. Ireland's relatively mild climate does not help the economics of installing DH on a large scale. Low density of housing even in cities makes it impractical to pump warm water over long distances. It has also a poor public perception and is sometimes seen as 'poor man's heat'.

A report by Sustainable Energy Ireland in 2001 quantified the potential for district heating in Ireland. 100MW was 'technically' feasible and 50MW was feasible against 'economic' criteria.

The report identified a potential for between 5-10 'economic' schemes. District heating has had some recent success in the UK with a successful scheme introduced in Southampton and a large city-wide scheme in Leicester.

In 2003 there was around 43MW thermal of district heating in Ireland and the majority of this was the Ballymun scheme which is not being replaced during the current regeneration project.

The economics are such that retrofitting a house for DH can cost in the region of €2,500 per house whereas new houses can be connected to a DH scheme for as little as €150 per unit.

CHP in Hotels

CHP has proved a popular solution for many hotels in Ireland, particularly the larger ones. Now that natural gas is becoming available to more and more parts of the country and the smaller-scale CHP units are becoming increasingly economic the opportunity exists for many more of Ireland's hundreds of hotels to make the switch to cleaner lower cost energy

CHP Technology

Cogeneration plant consists of four basic elements:

- A prime mover (engine);
- An electricity generator;
- A heat recovery system;
- A control system.

Depending on the site requirements, the prime mover may be a steam turbine, reciprocating engine or gas turbine. The prime mover drives the electricity generator and waste heat is recovered. The basic elements are all well established items of equipment, of proven performance and reliability.

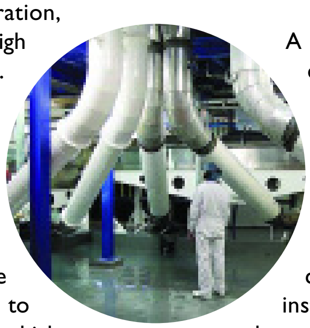
Prime Movers

Cogeneration units are generally classified by the type of prime mover (i.e. drive system), generator and fuel used. The following sections examine the main types.

Steam Turbines

Steam turbines have been used as prime movers for industrial cogeneration systems for many years. High-pressure steam raised in a conventional boiler is expanded within the turbine to produce mechanical energy, which may then be used to drive an electric generator. This system generates less electrical energy per unit of fuel than a gas turbine or reciprocating engine-driven cogeneration system, although its overall efficiency may be higher, achieving up to 84% (based on fuel gross calorific value).

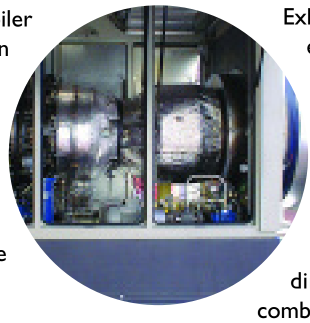
For viable power generation, steam input must be at a high pressure and temperature. The plant is capital intensive because a high-pressure boiler is required to produce the motive steam. At existing sites, where steam systems are supplied by low-pressure boilers, it will be necessary to replace these boilers with high-pressure plant, possibly retaining the original equipment as stand-by.



Steam cycles typically produce a large amount of heat compared with the electrical output, resulting in a high cost installation in terms of Euro/kWe.

Gas Turbines

The gas turbine has become the most widely used prime mover for large-scale cogeneration in recent years, typically generating 1-100 MWe. A gas turbine based system is much easier to install on an existing site than high-pressure boiler plant and a steam turbine. On many sites plot space is at a premium, a factor weighing heavily in favour of gas turbines. This, together with reduced capital cost and the improved reliability of modern machines, often makes gas turbines the optimum choice.



The fuel is burnt in a pressurised combustion chamber using combustion air supplied by a compressor that is integral with the gas turbine. The very hot (900°C-1200°C) pressurised gases are used to turn a series of fan blades, and the shaft on which they are mounted, to produce mechanical energy. Residual energy in the form of a high flow of hot exhaust gases can be used to meet, wholly or partly, the thermal demand of the site.

The available mechanical energy can be applied in the following ways:

- to produce electricity with a generator (most applications);
- to drive pumps, compressors, blowers, etc.

A gas turbine operates under exacting conditions of high speed and high temperature. High-premium fuels are therefore most often used, particularly natural gas. Distillate oils such as gas oil are also suitable, and sets capable of using both are often installed to take advantage of cheaper interruptible gas tariffs.

Waste gases are exhausted from the turbine at 450°C to 550°C, making the gas turbine particularly suitable for high-grade heat supply. The usable heat to power ratio ranges from 1.5:1 to 3:1 depending on the characteristics of the particular gas turbine. Supplementary firing may be used to increase exhaust gas temperatures to 1,000°C or more, raising the overall heat to power ratio to as much as 10:1. Supplementary firing is highly efficient as no additional combustion air is required to burn extra fuel. Efficiencies of 95% or more are typical for the fuel burned in supplementary firing systems.

Exhaust gases can be used in either of the following ways:

- For direct firing and drying processes. The single flow of heat at high temperature is suitable for processes in which direct contact with combustion gases is permissible.
- To raise steam at medium or low pressure for process or space heating in an open-cycle gas turbine cogeneration plant which comprises a gas turbine-alternator unit and a heat recovery boiler.
- To generate hot water, best for high temperature hot water applications where temperatures in excess of 140°C are required.
- To raise steam in a HRSG at high pressure for use in a steam turbine

Gas turbines are available in a wide power output range from 250 kWe to over 200 MWe, although sets smaller than 1 MWe have so far been generally uneconomic due to their comparatively low electrical efficiency and consequent high cost per kWe output. This is starting to change.

The turbine is typically mounted on the same sub-base as its generator, with a step-down gearbox between the two to reduce the high shaft speed of the turbine to a speed suitable for the generator. A gas turbo-generator is extremely noisy and generally housed in an acoustic enclosure for noise attenuation.

Reciprocating Engines

The reciprocating engines used in cogeneration are internal combustion engines operating on the same familiar principles as their petrol and diesel engine automotive counterparts. Although conceptually the system differs very little from that of gas turbines, there are important differences. Reciprocating engines give a higher electrical efficiency, but

The Number one for combined heat and power

With over 15 years experience of installing and operating combined heat and power systems, Temp Technology, working in partnership with the ENER•G Group in the UK are the number one name in Combined Heat and Power (CHP).

Quite simply, with over 80 CHP systems installed, we have more CHP systems throughout Ireland than any other CHP provider. Our solutions include:

- Packaged CHP Applications
- Discount Energy Purchase Solutions
- Total Energy Management
- Full Remote Monitoring

FREE ENERGY AUDITS

Whatever your project energy needs, Temp Technology will carry out a comprehensive assessment of your premises free of charge. Temp Technology will provide you with an initial report outlining the energy savings you would achieve by installing CHP in your premises, along with CHP unit specifications. Let Temp Technology help you save money, save energy and save the environment with Combined Heat and Power.

Simply call us on 061 413299

Profit from our experience

Temp Technology working in partnership with ENER•G

TEMP. TECH. ENER·G

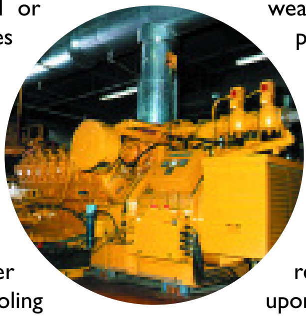
Temp Technology Ltd., Unit 9
Childers Road Industrial Estate, Limerick.
Tel: 061 413299 Fax: 061 414974
e: temptech@iol.ie w: www.temptech.ie

CHP Technology

it is more difficult to use the thermal energy they produce, since it is generally at lower temperatures and is dispersed between exhaust gases and cooling systems.

The usable heat:power ratio range is normally in the range 0.5:1 to 2:1. However, as the exhaust contains large amounts of excess air, supplementary firing is feasible, raising the ratio to a maximum of 5:1.

Compression-ignition ('diesel') engines for large-scale cogeneration are predominantly four-stroke direct-injection machines fitted with turbochargers and intercoolers. Diesel engines will accept gas oil, HFO and natural gas. The latter is in reality a dual-fuel mode, as a small quantity of gas oil (about 5% of the total heat input) has to be injected with the gas to ensure ignition; as the engine can also run on gas oil only it is suited to interruptible gas supplies. Cooling systems are more complex than on spark-ignition engines and temperatures are often lower, typically 85°C maximum, thereby limiting the scope for heat recovery. Exhaust excess air levels are high and supplementary firing is practicable. Compression-ignition engines run at speeds of between 500 and 1500 rev/min. In general, engines up to about 500 kWe (and sometimes up to 2 MWe) are derivatives of the original automotive diesels, operating on gas oil and running at the upper end of their speed range. Engines from 500 kWe to 20 MWe evolved from marine diesels and are dual-fuel or residual fuel oil machines running at medium to low speed.



Spark-ignition engines are derivatives of their diesel engine equivalents and have their same parameter equivalents as 90°C cooling water.

Traditionally, shaft efficiency has been lower than for compression ignition engines. The output of a spark-ignition engine is a little smaller, typically 83% of the diesel engines.

They are suited to smaller, simpler cogeneration installations, often with cooling and exhaust heat recovery cascaded together with a waste heat boiler providing medium or low temperature hot water to site.

Spark-ignition engines operate on clean gaseous fuels, natural gas being the most popular. Biogas and similar recovered gases are also used but, because of their lower calorific value, output is reduced for a given engine size. Spark-ignition engines give up less heat to the exhaust gases than diesel engines. The large lean-burn engines have typically 12% oxygen in exhaust gases, and this can be used with supplementary firing. The following are among the most common applications for the thermal energy produced by reciprocating engines:

- production of up to 15 bar steam utilising the heat of exhaust gases; and separate production of hot water at 85-90°C from the cooling system of the engine;
- production of hot water at 90°C, supplementing the temperature of cooling system water with heat from the gases;
- Exhaust fumes can be used directly in certain processes, such as drying, CO_2 production, etc;
- generation of hot air. All the residual energies from the engine can be used, through the installation of suitable exchange devices, for the generation of hot air.

Reciprocating machines by their nature have more moving parts, some of which wear more rapidly than those in purely rotating machines, and have running as well as shutdown maintenance requirements. Nevertheless, typical availability is about 90-96%.

Gas engines are operated under two distinct air/fuel ration regimes that have a market effect upon environmental performance:

- Stoichiometric engines;
- Lean-burn engines.

NOx emissions can be reduced markedly by operating with large excess of combustion air (lean-burn). However, this has an adverse effect upon the engine's power output.

Stoichiometric engines tend to be smaller (typically <300 kWe) than their lean-burn counterparts and are based upon standard vehicle engine blocks with adapted cylinder heads and spark ignition systems.

Cogeneration diesel plants HFO systems have been built in those places where gas is not available. This includes many islands and developing countries. In places where gas availability will arrive later, the plants can use HFO at the beginning and later switch to gas, or use HFO in winter and gas in summer.

CHP Prime Movers

Type	Output range	Typical fuels	Typical heat to power ratio	Grade of heat output
Gas Turbine	0.5 MW upwards	Natural gas, Gas Oil, Landfill gas, Biogas, Mine gas	1.6:1 up to 5:1 with after firing	High
Compression ignition gas engine	2 MW upwards	Natural gas with gas oil, Heavy fuel oil	1:1 to 1.5:1 up to 2.5:1 with after firing	Low and High
Spark ignition	Up to 4 MW	Natural gas, Landfill gas, Biogas, Mine gas	1:1 to 1.7:1	Low and High
Steam turbine	0.5 MW upwards	Any, but converted to steam	3:1 to 10:1	Medium
CCGT	10 MW upwards	As gas turbine	Down to 0.7:1	Medium

Combined Cycles

Some large systems utilise a combination of gas turbine and steam turbine, with the hot exhaust gases from the gas turbine being used to produce the steam for the steam turbine. This is called a combined cycle.

Gas turbine combined cycle (CCGT) systems have been adopted by public utility companies where supplies of natural gas are plentiful: power stations of up to 1,800 MWe have been constructed. In cogeneration applications of the CCGT, exhaust or pass-out steam from the steam turbine is used for process or other heating duties. The main advantage of CCGT cogeneration is its greater overall efficiency in the production of electricity.

Waste heat recovery units

The heat recovery boiler is an essential component of the cogeneration installation. It recovers the heat from the exhaust gases of gas turbines or reciprocating engines. The simplest one is a heat exchanger through which the exhaust gases pass and the heat is transferred to the boiler feedwater to raise steam. The cooled gases then pass on the exhaust pipe or chimney and are discharged into the atmosphere. In this case, the composition or constituents of the exhaust gases from the prime mover are not changed.

The exhaust gases discharged, contain significant quantities of heat, but not all can be recovered in a boiler.

One typical feature of the exhaust heat boiler (or waste heat recovery unit) is that the typical size is bigger than a conventional fuel-burning unit. This is for two main reasons:

- The lower exhaust gas temperatures require a greater heat transfer area in the boiler;
- There are practical limitations on the flow restriction.

Excessive flow resistance in the exhaust gas stream must be avoided as this can adversely affect operation of the turbine or engine.

Exhaust heat boilers are not, therefore, 'off-the-shelf' items: they need to be designed for the particular exhaust conditions of the specified turbine or engine. The usual procedure is to provide the boiler supplier with details of the exhaust gas flow from which the heat is to be recovered, and with the temperature and pressure conditions of the required heat output. The boiler supplier will then be able to advise on the quantity of heat that can be recovered, and the temperature at which the exhaust gas will be discharged from the boiler.

The choice of prime mover is based on a number of factors and even with similar energy requirements, no two sites are the same.

The critical factor is the Heat to Power ratio of site demand. Where the electrical power requirement is relatively high as a proportion of total energy this tends to favour engines. Conversely where heat demand is typically more than 3 or 4 times electrical demand the turbine begins to have an advantage. Another key factor is the quality of heat required by the customer site. Some industrial processes have little use for low grade heat – the hot water produced in engines-based schemes. Where high temperature steam is the primary heat requirement then the turbine is clearly superior.

Technological Advances

Stirling engines

The Stirling engine is an external combustion device and therefore differs substantially from conventional combustion plant where the fuel burns inside the machine. Heat is supplied to the Stirling engine by an external source, such as burning gas, and this makes a working fluid, e.g. helium, expand and cause one of the two pistons to move inside a cylinder. The Stirling engine has fewer moving parts than conventional engines, and no valves, tappets, fuel injectors or spark ignition systems. It is therefore quieter than normal engines.

Stirling engines also require little maintenance and emissions of particulates, nitrogen oxides, and unburned hydrocarbons are low. The efficiency of these machines is potentially greater than that of internal combustion or gas turbine devices.

There is a more that 60 years experience with this technology, what is newer is its use for micro-cogeneration boilers. For this type of boilers, there is a need for small engines with a capacity between 0.2 and 4 kWe. Gas turbines and even gas engines are unsuited for this kind of size (although the current smallest spark-ignition engine is 3 kWe), while the Stirling engine offers a good alternative.

The advantages of the Stirling engine are: less moving parts with low friction, no need for an extra boiler, no internal burner chamber, high theoretical efficiency and very well suited for mass production. The external burner allows a very clean exhaust and gives the possibility of controlling the electrical output of the engine by reducing the temperature of the hot side. So there is the possibility of varying the electricity production regardless of the need for thermal heat demand.

Microturbines

Microturbines are smaller than conventional reciprocating engines, and capital and maintenance costs are lower. There are environmental advantages, including low NO_x emissions of 10-25 ppm or lower.

Microturbines can be used as a distributed generation resource for power producers and consumers, including industrial, commercial and, in the future, even residential users of electricity. Significant opportunities exist in five key applications:

- Traditional cogeneration,
- Generation using waste and biofuels,
- Backup power,
- Remote Power for those with 'Black Start' capability,
- Peak Shaving,
- Biomass.

Fuel Cells

Fuel cells convert the chemical energy of hydrogen and oxygen directly into electricity without combustion and mechanical work such as in turbines or engines. In fuel cells, the fuel and oxidant (air) are continuously fed to the cell. All fuel cells are based on the oxidation of hydrogen. The hydrogen used as fuel can be derived from a variety of sources, including natural gas, propane, coal and renewables such as biomass, or, through electrolysis, wind and solar energy.

The CHP Project

Initial Evaluation

Initiating a CHP evaluation is a decision that requires careful consideration. Key aspects of this part of the process are as follows:

- There must be a belief that the evaluation can lead to a viable project.
- The evaluation must be properly planned.
- It must be recognised that the evaluation will require investment in terms of both time and resources.

The CHP evaluation process tends to develop over time, the results of one stage defining the needs of the next. Hence, it is difficult to predict accurately the skills required. The initial feasibility study can often be completed with relatively low levels of overall input.

An organisation cannot always meet the CHP evaluation requirements from its available in-house resources. It is then appropriate to consider calling eternal expertise to support or carry out the work.

Initial Feasibility Study

An initial feasibility study is mainly a desktop exercise designed to provide an estimate of the cost savings and financial returns that can be achieved by installing an appropriate CHP plant. The study does not need to be excessively long or complex, but is must be carried out thoroughly by someone who has the right evaluation skills and engineering knowledge.

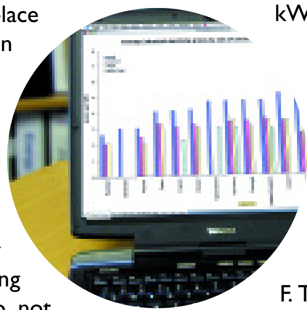
Assessment of Site Energy Demands

It is important to carry out the initial feasibility study using the best possible assessment of the site's future energy consumption. Past consumption data, which can be obtained from site utility bills, usually provide a good indication of future demands, but it is also important to take site-specific factors into account.

Efficiency of energy use. It is important to ensure that energy is used as efficiently as possible.

Future changes in site energy demands. Most sites undergo changes in energy use and equipment over relatively short periods of time, so a CHP plant must be assessed not only against present energy demands, but against those anticipated for the future.

Use of heat to replace electricity. There may be opportunities to replace electrically driven refrigeration plant with heat-driven refrigeration plant that operates on an absorption cycle. This approach may be particularly relevant where older electrically driven plant is due for replacement, or where cooling and heating demands are seasonal and do not usually occur simultaneously.



Timing of demands. Since CHP produces heat and power simultaneously it is essential to consider the extent to which the site has concurrent heat and power demands that can use the outputs of a CHP installation. This requires a time-based assessment of the site's energy demands.

For the purposes of the initial feasibility study, it is sufficient to consider site consumption over a one-year period, sub-dividing this period into a time bands, according to actual site demand conditions. This split would typically be based on distinction between:

- Daytime and night-time.
- Weekday and weekend.
- Summer and winter.

The site supply data required include:

A. The number of hours of the year allocated to each time period. This should total 8,760, thereby representing demand over a full year.

B. The average site electricity demand in kW for each time period.

C. The average site heat demand in kW for each time period.

D. The average cost per unit of electricity consumed in each time period.

E. The quantity of fuel consumed on-site to provide the heat demand identified in C above.

F. The cost per unit of the fuel identified in E above.

The data can be used to make an initial assessment of the annual cost of meeting future site energy demands. These are the costs that a CHP plant would reduce by supplying the energy requirements more efficiently.

Considering a CHP Project? Help is Available online!

Thanks to assistance from Sustainable Energy Ireland the Irish CHP Association has constructed an online tool to help site-owners and developers and all those who are considering the CHP option.

The facility comprises two main features - a quick calculator mechanism for an initial evaluation of any proposed CHP development and a legislative/regulatory map detailing the rules and arrangements governing permits, construction, operation, connection of CHP plant, as well as procedures for trading. Copies of all application forms and details of how to apply for permissions are provided online.

Visit www.ichpa.com for more information

The CHP Project

Selecting CHP Plant

Once the energy and cost data have been collected and tabulated, the next stage of the initial feasibility study is to select a potentially suitable CHP system.

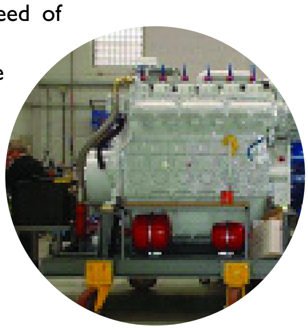
As a minimum, information obtained should include:

- Electrical output, which should include data relating to the power consumption of the CHP plant's own motors etc., so that the net output can be defined.
- Heat output that can be recovered for use on-site, including data on the temperature and flow rate of the fluid in which the heat is contained.
- Fuel consumption of the equipment, taking care to ensure that this can be expressed in gross calorific value terms.
- The cost of supplying and installing the equipment.
- The dimensions and weight of the equipment.
- The approximate cost per kilowatt hour (kWh) generated that should be allowed for servicing and maintaining the equipment.
- Any essential auxiliary items that are not contained within the scope of the equipment.

Selection of prime movers for cogeneration

Steam turbines may be the appropriate choice for sites where:

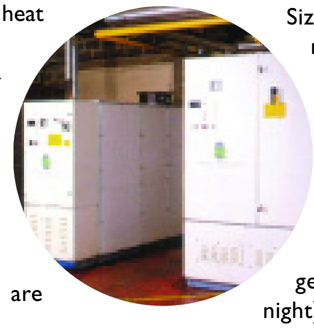
- electrical base load is over 250 kWe
- there is a high process steam requirement; and the heat to power demand ratio is greater than 3:1
- cheap, low-premium fuel is available
- adequate plot space is available
- high grade process waste heat is available (e.g. from furnaces or incinerators)
- existing boiler plant is in need of replacement
- heat to power ratio is to be minimised, using a gas turbine combined cycle



Gas turbines may be suitable if:

- power demand is continuous, and is over 1 MWe (smaller gas turbines are just starting to penetrate the market)
- natural gas is available (although this is not a limiting factor)
- there is high demand for medium/high pressure steam or hot water, particularly at temperature higher than 140°C
- demand exists for hot gases at 450°C or above – the exhaust gas can be diluted with ambient air to cool it, or put through an air heat exchanger

(Also consider using in a combined cycle with a steam turbine)



Reciprocating engines may be suitable for sites where:

- power, or processes are cyclical or not continuous
- low pressure steam or medium or low temperature hot water are required
- there is a low heat to power demand ratio
- when natural gas is available, gas powered reciprocating engines are preferred
- when natural gas is not available, fuel oil or LPG powered diesel engines may be suitable
- electrical load is less than 1 MWe - spark ignition (units available from 3 kWe to 10 MWe)
- electrical load greater than 1 MWe - compression ignition (units from 100 kWe to 20 MWe)

Identifying CHP plant of an appropriate output

Initial selection of CHP plant is often dictated by two factors:

The site heat demand, in terms of quantity, temperature etc., that can be met using heat from the CHP plant.

The base-load electrical demand of the site, i.e. the level below which the site electrical demand seldom falls.

Sizing on heat demand will maximise energy and environmental savings. Depending on the heat to power ratio of site energy demands, sizing to match the heat requirement will result in a scheme that may offer a surplus of electricity generation (eg during the night) or may require top-up electricity supplies (eg at times of peak electricity demand). The economics of exporting the electricity then becomes a key issue in determining economic CHP plant size.

Efficiency First!

Before sizing a CHP scheme around the thermal load or power requirement it makes sense for prospective sites to consider carefully all possible energy efficiency investments/measures that could reduce the overall heat and electricity requirements. Only when energy efficiency has been maximised should the CHP scheme be finally sized.

Fingleton White & Co. Ltd
ENGINEERS & PROJECT MANAGERS

LEADING PROVIDER OF INDUSTRIAL CHP IN IRELAND.
PROVIDER OF INDEPENDENT POWER IN IRELAND SINCE 1981
AND C.H.P. ELECTRICITY SINCE 1993

FIRST COMPANY TO EXPORT TO NATIONAL GRID IN IRELAND

FIRST COMPANY TO RETAIL C.H.P. ELECTRICITY IN IRELAND

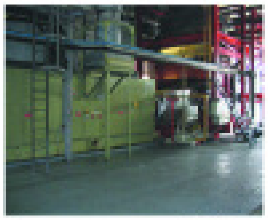
EIGHT GAS TURBINES IN OPERATION IN IRELAND


ASKEATON


MITCHELSTOWN


GUINNESS DUBLIN


CHARLEVILLE


MALLOW

COMBINED HEAT & POWER GENERATORS

NAME	LOCATION	DESCRIPTION	COMMISSIONED
C.H.P. Ltd.	Dairygold Co-Op, Mallow, Co. Cork	4.0MW Gas Turbine 20 tonne/hr Boiler	Mar 1993
CoGen Ltd.- Unit 1	Dairygold Co-Op, Mitchelstown, Co. Cork	4.8MW Gas Turbine 23 tonne/hr Boiler	Feb 1997
CoGen Ltd.- Unit 2	Dairygold Co-Op, Mitchelstown, Co. Cork	5.0MW Gas Turbine 27 tonne/hr Boiler	Nov 1999
Gatepower Ltd. - Unit 1	Guinness Ireland Group, Dublin.	4.8MW Gas Turbine 27 tonne/hr Boiler	Oct 1997
Gatepower Ltd. - Unit 2	Guinness Ireland Group, Dublin.	4.8MW Gas Turbine 27 tonne/hr Boiler	Dec 1997
Gatepower Ltd. - Unit 3	Guinness Ireland Group, Dublin.	4.8MW Gas Turbine 27 tonne/hr Boiler	Jan 1998
GV Power Ltd.	Kerry Group plc, Charleville, Co. Cork	5.0MW Gas Turbine 27 tonne/hr Boiler	Nov 1999
Askeaton Power Ltd.	Askeaton, Co. Limerick	5.0MW Gas Turbine 30 tonne/hr Boiler	Oct 2004

Greenhouse Gases Reduction
The annual reduction in CO_2 emissions due to the CHP projects operated by Fingleton White & Co. Ltd. is over 80,000 tonne / annum.

FOR FURTHER INFORMATION CONTACT

Fingleton White & Co. Ltd
ENGINEERS & PROJECT MANAGERS

BRIDGE STREET CENTRE,
PORTLAOISE,
Co. LAOIS,
IRELAND.

T: 00 353 (0)502 65400
F: 00 353 (0)502 65444
E: info@fingleton.ie
W: www.fingleton.ie

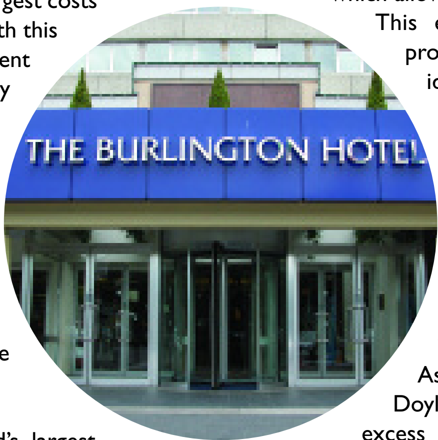
CHP Case Study 1: The Burlington Hotel, Dublin

The Burlington Hotel Dublin - A Profile

Electrical Output	185kWe (30%)
Heat Output	310kW (50%)
Fuel Input	580kW
Heating Water Temp	80°C
Operational Hours	15hrs per day
Availability	96%
Contract Type	Capital Purchase
Payback Period	2.3 yrs
Savings	73,269 Euro pa
Installation Date	May 1991

Profile

At the Jurys Doyle Hotel Group one of the main objectives is to offer a high standard of service whilst offering customers value for money. The group achieves this by running the hotels efficiently, and keeping costs to a minimum. One of the largest costs for any company is energy expenditure and with this in mind the hotel group decided to implement Combined Heat and Power (CHP) Technology in conjunction with an Energy Management System (EMS) into the Jurys Doyle Burlington Hotel situated in Ballsbridge, near central Dublin.



The use of Combined Heat and Power would allow the hotel group to produce electricity onsite at a lower cost and benefit from the heat produced as a by product of the generation process.

The Jurys Doyle Burlington Hotel is Ireland's largest hotel with over 500 bedrooms, excellent conference facilities and an exceptionally high degree of comfort, decor and service. A hotel of this size is perfect for the application of Combined Heat and Power technology as it has a high electrical and heat requirement.

The hotel group selected Limerick based Temp Technology Ltd to provide, install and maintain the CHP system. Temp Technology has been operating in the CHP market for many years and with over 80 installations to date they are one of Ireland's leading CHP suppliers with a high level of operational experience.

Maximum Demand Reduction

The CHP installed by Temp Technology at the Burlington Hotel avails of ESB's maximum demand tariff. By reducing its peak demand at specific periods i.e. spreading its electricity usage more evenly, it can achieve substantial savings on its electricity bill. CHP helps considerably in this regard as it provides 185kW of electricity, which would otherwise be supplied by ESB.

Additionally, because of the high availability of the CHP unit, the reduced demand due to the tighter control by the Energy Management System and the judicious switching out of non-essential loads by the EMS, maximum demand reductions of 260kW (min)-495kW(max) have been achieved.

Savings

The Jurys Doyle Hotel Group are now receiving very substantial savings, at the Jurys Doyle Burlington Hotel as a result of their CHP installation.

Environmental Savings

During one year's generation a 185kWe CHP unit will displace 1,154 tons of carbon dioxide from escaping into the atmosphere each year compared to conventional heat and power generation

Maintenance

Temp Technology carries out all maintenance of the Burlington's CHP scheme. The unit is equipped with an on board computer which allows continuous monitoring of the unit via modem. This expert systems allows Temp Technology to produce monthly performance reports and to identify any problems with the unit before a breakdown occurs.

Temp Technology also carries out routine maintenance every 800 hours - a service that includes the replacements of oil and filters, oil quality, sparkplugs, and an engine performance analysis.

Savings

As a result of their CHP installation the Jurys Doyle Hotel Group are now receiving savings in excess of €73,000 per annum at the Jurys Doyle Burlington Hotel whilst making a positive contribution to the environment and the CHP system reduces the amount of energy consumed and the harmful Carbon Dioxide gas produced.

The Burlington Hotel Dublin was one of the first Irish Hotels to install CHP. Many others have since followed and there is almost certain to be a case study available relevant to any hotel considering CHP - irrespective of size.

Contact Sustainable Energy Ireland in the first instance or see the list of CHP developers at the back of this guide.

CHP suits hotels of all sizes!

Although coming within the definition of small-scale CHP, the Burlington Hotel in Dublin, is one of Ireland's largest hotels. However CHP can be attractive in hotels of any size - as they tend to follow a similar energy demand profile. CHP is an even more attractive solution for hotels with swimming pools/ leisure centres.

CHP Case Study2: Carbery - CM Power Cork

Carbery - CM Power

CM Power CHP Technical Data	
Prime Mover:	Alstom Typhoon Gas Turbine
Gross Electrical Output:	5,029 kWe
Net Electrical Output:	4,841 kWe
Steam Production Unfired:	12,800 tonne/hr @ 30 bar
Steam Production Fired:	30,000 tonne/hr @ 30 bar
Site Boundary Noise Level:	45 dBA
Engine speed:	17384 rev/min
Relative humidity:	60%
Gearbox efficiency:	99.0%
Alternator efficiency:	96.5%
Natural Gas fuel only	
Exhaust Gas Mass Flow:	20.1kg/sec
Exhaust Gas Temp:	540C
Gas Temp Leaving Boiler:	140C
Mean Specific Heat:	0.26kcal/kg/C
Pollutant Emissions	
NO_x	GT 50mg/m^3, HRSG 35mg/m^3
CO_2	GT 50mg/m^3, HRSG 100mg/m^3

Carbery - CM Power

Carbery Milk Products

Carbery Milk Products was formed in 1965 as a joint venture between Express Dairies, a UK based dairy processing company, and the four West Cork Co-operatives: Bandon, Barryroe, Drinagh and Lisavaird. In 1992 these four co-operatives acquired the full shareholding of Carbery Milk Products.

Carbery is now one of Ireland's most technologically advanced food companies, which through pioneering research has developed a leading range of quality food products. Using leading edge cheese production technology, Carbery's output of cheddar, low fat, speciality, vegetarian and mozzarella cheeses are produced to exacting standards.

The company is particularly well known for its whey processing technology, which enables the company to manufacture a large range of protein and based food ingredients. Carbery's whey processing technology is also used in the fermentation of lactose into ethanol, making the company a major supplier of neutral spirit to the Drinks, Flavour Extraction and Industrial Sectors.

CM Power - a BG CoGen and Carbery Joint Venture

In 2000, BG CoGen and Carbery Milk Products formed a joint venture, CM Power, to develop a cogeneration installation at Carbery's Ballineen production facility. Based on the electricity and heat load of the site, it was deemed that a CHP Gas Turbine would best fit the plant requirements. Following a competitive tendering process, an Alstom 5.2MWe Typhoon Gas Turbine and generator was commissioned for site use.

Aside from the installation of the actual Gas Turbine, a number of modifications were required to the Ballineen plant's infrastructure to facilitate the optimal operation of the cogeneration unit. This necessitated the installation of an Aalborg Water Tube Boiler and a complete ABB SCADA control system, to integrate all of Carbery's boilers with the CHP module. The CHP unit was constructed within a block building with a storage area and a self contained control room for the equipment.

The Ballineen CHP plant became operational in May 2001, and will generate significant energy input cost saving throughout its operational life. The nature of the joint venture agreement between developer BG CoGen and Carbery Milk Products will ensure that both partners will directly appreciate the benefits of CHP usage.

The dairy industry has been to the forefront of CHP uptake in Ireland. Carbery Milk Products is one of the more recent large-scale CHP installations in the dairy sector. The cost savings generated by the investment will no doubt help keep Carbery in a leading position in the competitive markets it serves.

CHP Development in Ireland

CHP Development in Ireland

CHP is not new technology in Ireland. Most CHP in the period before 1993 was steam cycle based and used coal, peat or oil as fuel. By 1993 there were 13 CHP sites in the country with installed capacity of 55 MWe. It tended to be associated with sites where the steam demand was high and where requirements for electricity were large in relation to local grid capacity. Examples include brewing, sugar extraction, milk drying and briquette manufacture.

Sustainable Energy Ireland, was instrumental in ensuring the success of a joint application by Bord Gáis and ESB for funding under the EU's THERMIE programme for a scheme to install 10 CHP units in a variety of applications. This programme part funded CHP applications ranging from 50kW to 750kW on 10 sites in hotels, hospitals and small industrial and commercial enterprises around the country. These applications have demonstrated the reliability of the latest CHP technology and contract servicing. A further fourteen small scale CHP reference sites were supported by Sustainable Energy Ireland through the Energy Efficiency Investment Support Scheme.

The installed capacity of operational CHP units increased from 56.8MWe in 1981 to 125.3MWe in 2002 – an overall increase of 121% and an average annual growth rate of 7.5%.

CHP Applications in Ireland

The bulk of the installed capacity – over 80% – is in the industrial sector. However, most of the actual installations are in the services sector - hotels, hospitals, colleges etc. A similar proportion of the installed capacity is fuelled by natural gas. The remainder are mainly diesel or gas oil, with some installations fired by solid fuel.

As a relatively small CHP market by international and European standards, Ireland has a long way to go to reach the CHP development levels in other European Countries. The Irish market of 131.5MW of capacity consists of about 105 units and around 100 actual CHP sites. (Source: SEI)

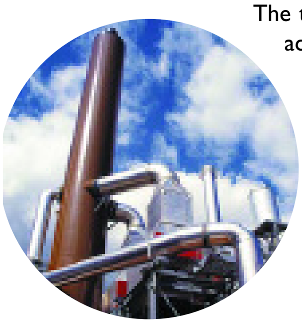
Although there is a major large-scale CHP project (150MW) under development at the Aughinish Alumina, alumina manufacturing site in Co Limerick there are currently no very large-scale CHP schemes operational in Ireland. The largest scheme is the 15MW project at Guinness Brewery in Dublin. There are only 3 units with capacity above 10MWe and a further 27 units above 1MWe capacity. It is immediately clear at the outset that Ireland is not only a small market, but also a market characterised by relatively small CHP units.

Irish CHP Installations by Capacity

Electricity Capacity Size Range	Number of Units Total (%)	Share of Total (%)	Total Electrical Capacity kWe	Share of Total (%)
Less than 100 kWe	21	20	1574	1
100 kWe – 999kWe	54	51	11781	9
1000 kWe – 9999 kWe	27	26	80166	61
Greater than 10000kWe	3	3	38000	29
Total	105	100	131521	100

Source: SEI

In addition to being small the Irish CHP Market is relatively underdeveloped with CHP accounting for only 2.4% of total electricity generated as against an EU average of 10% and proportions as high as 50% in the Netherlands and Denmark.



The table above sets out the capacity ranges of Ireland's installed capacity. It can be seen that while only 29% of actual units have a capacity greater than 1MWe they account for some 90% of the actual electricity produced. There is currently more rapid growth in the smaller end of the market in terms of new units installed. Viable technology has now reached the domestic sector and a number of pilot programmes are underway.

CHP Development in Ireland

CHP in Ireland: Some Facts

Installed Capacity

- The total installed capacity of CHP in Ireland at the end of 2002 was 131.5 MWe an increase of 2.2 % over 2001.
- The installed capacity of operational CHP units increased from 56.8 MWe in 1991 to 125.3 MWe in 2002. This represents an overall increase of 121% and an average annual growth rate of 7.5%.
- In 2002 the bulk of installed capacity (82% or 108 MWe) was in the industrial sector.
- Over the period 1994 to 2002 (the period where a sub-sectoral breakdown is available) there was growth across most sectors and industrial sub-sectors.
- The largest absolute increase (24.7 MWe) over the same period occurred in the food, beverages and tobacco industrial sub-sector.

Number of Units

- There was a total of 105 CHP units in 2002, an increase of 7 units on 2001. The number of operational units in 1991 was only 10.
- In 2002, the services sector, comprising private services (hotels, leisure centres, etc.) and public services (hospitals, universities etc.), accounted for 77 (73%) of the 105 units.
- In 2002 food, beverages and tobacco was the most populated industrial sub-sector with a total of 13 units.
- Over the period 1994-2002 most of the growth in the number of CHP units can be attributed to the services sector. In 2002, the services sector accounted for 73% (69 units) of the total number compared with 18% in 1994.

Future Growth

- Future growth in installed CHP capacity is expected to be dominated by a small number of large units in the industrial sector. There are also a number of smaller capacity units planned for the services sector.

Source: SEI

Megawatt electrical or MWe is the unit which represents the installed electricity generating capacity or size of a CHP plant. The sectors and industrial sub-sectors used in this report are per Eurostat methodology.

Future Outlook for CHP Development

The European Commission has stated that CHP 'offers an adaptable instrument for achieving a range of EU objectives – reducing environmental impact, encouraging innovation and improving competitiveness'.

Currently, around 10 per cent of electricity demand in the EU is accounted for by CHP. The EU Commission has indicated that it should be feasible to double the share of co-generation in the European Union to 18 per cent by 2010. In some countries, such as the Netherlands, Finland and Denmark, CHP supplies more than 40 per cent of electricity requirements already. Ireland, however, has one of the lowest levels of electricity generated from CHP.

An estimate of the potential for CHP in Ireland, based on known thermal loads, carried out in the early 1990s, suggested a figure of the order of 250 MW. The expansion of the Irish economy and subsequent growth in the industrial and commercial sectors, suggests that this figure could be at least doubled to 500 MW. Projected EU average penetration of 13 per cent capacity applied to Ireland would imply about 575 MW, a huge increase on existing installed capacity. A more recent analysis conducted by Sustainable Energy Ireland assessed CHP potential, concluded that over 700 MW could be economic given a favourable environment. However at the time of the study less than 90MW of market potential was identified – most of it in large and medium scale industry.

Sustainable Energy Ireland also identified barriers to the expansion of CHP including:

- interface issues including connection costs top-up and spill.
- a limited gas grid;
- financing/payback criteria;
- unfavourable regulation of the electricity and gas markets;
- lack of awareness of CHP;
- lack of information on the potential market for CHP in Ireland;

Supporters of CHP cite the incentives/concessions enjoyed by promoters of renewable sources of energy and have lobbied for similar treatment for CHP. So far Government and CER have resisted extending full legislative/regulatory privileges to CHP (i.e. those accorded to renewables) despite recognising its highly efficient use of energy and potential contribution to the environment.

However further support measures are expected to be introduced following the recommendations of a sector-wide CHP policy group established by government.

Irish CHP Association

Irish CHP Association

A CHP sectoral association has now been established to promote greater uptake of CHP, spread information and lobby for appropriate change to the CHP economic and operating environment. The association is broad-based including CHP developers, equipment suppliers, consultants and all other interested organisations and individuals.

Irish CHP Association: Mission Statement

To achieve through research, information and positive engagement a step change in the amount of electricity produced from CHP sources in Ireland. To work to bring about a favourable regulatory and business framework that reflects the real benefits this highly efficient form of energy can deliver.

Irish CHP Association
c/o bmf Business Services
128 Lower Baggot, Dublin 2
Tel: 01 661 3755 / Fax: 01 661 3786

TSL House
38 Bachelors Walk, Lisburn, BT28 1XN, Northern Ireland
Tel: 028 9262 8787 / Fax: 028 9262 8789
Email: info@ichpa.ie
Web: www.ichpa.ie

Principal Activities of the ICHPA

The main activities of the Irish CHPA are set out below *(this is by no means an exhaustive list and is not set out in order of priority):*

- Lobbying/public affairs (the economic and environmental benefits of CHP are not fully appreciated by everyone in a position to create a more favourable legislative and regulatory environment);
- Promotion of CHP - raising awareness in key audiences;
- Research/membership surveys – aimed at establishing how overall the CHP sector views a range of specific issues (to inform future action);
- Contact point/exchange for ideas, help etc (mainly via website);
- Signposting service - website and hotline;
- Dissemination of information via newsletters, seminars, workshops etc;
- 'Networking' development - bringing people together in business and social events.

Work to date...

Already the Association has made a significant impact in the CHP community. It has made influential submissions on a range of energy policy consultations including electricity market trading rules and the regime for emissions trading. It lobbies regulators and government departments in pursuit of its objectives and has participated actively in the work of COGEN Europe - one of the key influencers of European Union policy on CHP.

The work of the Association has been recognised by the various authorities and the Association has been invited to be represented on the government's National CHP Strategy Group. A similar group is currently being formed in Northern Ireland and the Association has been invited to join also.


CALOR
www.calorgas.ie

CHP Developers in Ireland

CHP Developers in Ireland

Aughinish CHP
Aughinish Island, Askeaton, Co. Limerick
Tel: 061 604 000 / Fax: 061 604 099
Web: www.aughinish.com
Contact: John Ryan

Aircogen CHP
Werrington Parkway, Peterborough, PE4 5HG
Tel: 01733 292450
Web: www.peterbrotherhood.co.uk

ALSTOM Power
61 Lower Baggot Street, Dublin 2
Tel: 01 661 5489
Web: www.power.alstom.com

Atkins Power
3200 Century Power, Thorpe Park
Leeds, LS15 8ZB
Tel: 0113 603 6000
Web: www.wsatkins.co.uk

BG CoGen
Po Box 51, Gas Works Road, Cork
Tel: 01 453 4000 / Fax: 01 453 4001
Web: www.bgcogen.com
Email: bgcogen@bge.ie

Combined Power (ENER-G)
ENER-G House, Daniel Adamson Road
Manchester, M5 2DT
Tel: 0161 745 7450
Web: www.combined-power.com

Edina Limited
Unit 142A, Slaney Close
Dublin Industrial Estate
Glasnevin, Dublin 11
Tel: 01 830 7788 / Fax: 01 830 7422
Web: www.endinapower.com
Email: sales@edina.ie
Contact: Patrick Cushen

Edina Manufacturing Ltd
Lissue Industrial Estate West
Lisburn, Co Antrim, BT28 2RE
Tel: 028 9262 2122 / Fax: 028 9262 1940
Web: www.edinapower.com
Contact: Colin McKibbin

ESB Power Generation
27 Lower Fitzwilliam Street, Dublin 2
Tel: 01 702 6244 / Fax: 01 638 4664
Email: brian.ryan@mail.esb.ie
Contact: Brian Ryan

ESB has developed CHP units at UCD and a major 10MW scheme at the large Glanbia dairy in Ballyragget, Co Kilkenny.

Evolution Energy
2 Windsor Hill, Hillsborough
Co Down, BT26 6RL
Tel: 028 9268 3338
Contact: Jim Cleland

EXUS Energy
Unit 27, Templemore Business Park
Northland Road
Londonderry , BT48 0LD
Tel: 028 7127 1520 / Fax: 028 7130 8090
Web: www.exusenergy.co.uk
Contact: Joanne Galloway

F4energy Ltd
Unit 14, Penrose Wharf, Cork
Tel: 021 486 1420 / Fax: 021 455 2628
Web: www.f4energy.com
Email: aidan.mcdonnell@f4energy.com
Business Manager: Aidan McDonnell

Fingleton White & Co
Bridge Street Centre
Portlaoise, Co Laois
Tel: 050 221 010 / Fax: 050 222 382
Email: info@fingleton.ie
Web: www.fingleton.ie
Managing Director: John Fingleton

HDS Energy Group Ltd
Celbridge Industrial Estate
Celbridge, Naas, Co Kildare
Tel: 01 627 1011 / Fax: 01 627 1015
Web: www.hds-energy.com
Email: info@hds-energy.com
Contact: Alan Fox, Technical Director

Integrated Energy Systems International Ltd
11A Lune Street
Preston, Lancashire, PR1 2NL
Tel: 01772 250707
Contact: John O'Shea

Npower Cogen
Cogen Court
Cranmore Boulevard
Shirley, Solihull
West Midlands, B90 4LN
Tel: 0121 506 8000
Web: www.rwenpower.com

Phoenix Natural Gas
197 Airport Road West
Belfast, BT3 9ED
Tel: 08454 55 55 55 / Fax: 028 9055 5500
Web: www.phoenix-natural-gas.co.uk
Email: info@phoenix-natural-gas.com
Contact: John Ellis

Rolls-Royce Power Engineering plc
Reciprocating Engines Division
Queens Engineering Works
Ford End Road, Bedford, MK 40 4JB
Tel: 01234 272000 / Fax: 01234 353934

Temp Technology
Unit 9, Childers Road Industrial Estate
Limerick
Tel: 061 413299 / Fax: 061 414974
Email: temptech@iol.ie
Contact: William Ryan

Thames Energy
Energy Centre, 31 Church Hill
Walthamstow, London, E17 3RU
Tel: 020 8520 9880
Web: www.lessenergy.co.uk

Cogenco
Parsonage Farm Business Park
Parsonage Way, Horsham
West Sussex, RH12 4AC
Tel: 01403 272270
Web: www.cogenco.co.uk

Vital Energi Utilities Ltd
Burden Works, Burden Road
Bolton, BL3 2RB
Tel: 01204 554500
Web: www.vitalenergi.co.uk

Acknowledgement

The Irish CHP Association would like to acknowledge the support of Sustainable Energy Ireland in the production of this guide and the many other organisations and individuals who helped the publication through the provision of advice, textual material or photographic images. Their co-operation is very much appreciated.

Written and Produced by bmf Business Services
Dublin: 128 Lower Baggot Street, Dublin 2
Tel: 01 661 3755 / Fax: 01 661 3786

Northern Ireland: TSL House
38 Bachelors Walk, Lisburn BT28 1XN
Tel: 028 9262 8787 / Fax: 028 9262 8789