Combined Heat and Power (CHP) Potential in Ireland

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Potential in Ireland

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August 2009

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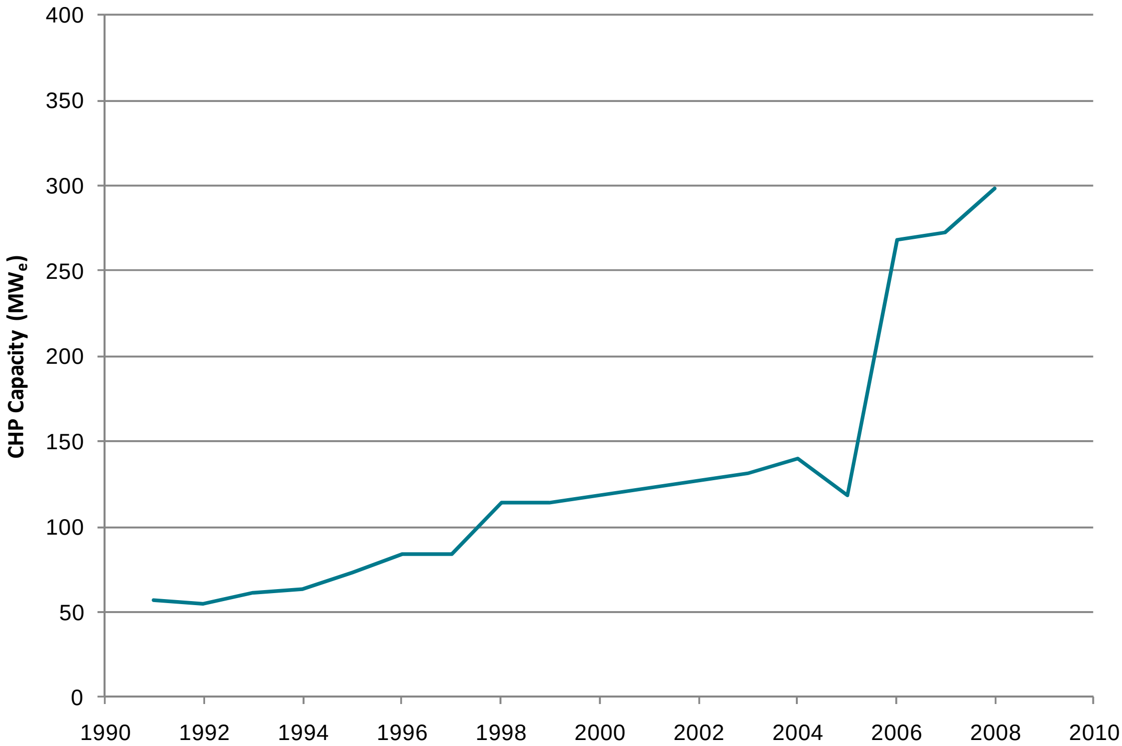
Executive Summary

Ireland's National CHP targets were set out in the Government's Energy White Paper *Delivering a Sustainable Energy Future for Ireland* published in 2007. This paper set a target of 400 MW_e by 2010 and 800 MW_e by 2020 of installed CHP capacity. At the end of 2008 the total installed active CHP capacity was 298.7 MW_e, an increase of 30 MW_e against the installed (active) capacity in 2006. Over half of the total installed capacity (160 MW_e) is accounted for in a single site (Aughinish Alumina).

Figure 1: Installed (Active) CHP Capacity: 1991 - 2008[1]



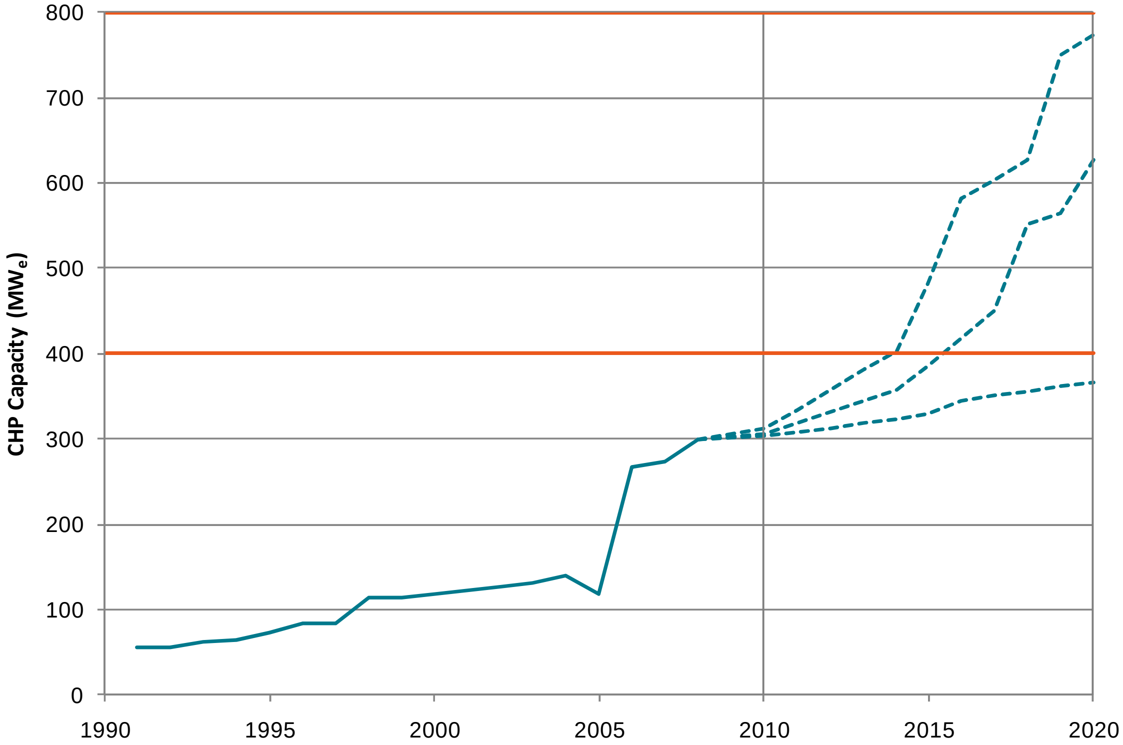
The underlying rate of growth in installed CHP capacity has remained relatively low since the early 1990s, with a small increase in the late 1990s to early 2000s. In the absence of the commissioning of the Aughinish Alumina plant, the historical growth rate would only have resulted in an installed capacity of approximately 145 MW_e in 2008, approaching 155 MW_e in 2010 and reaching just above 200 MW_e in 2020, falling significantly short of the targets set out in the Energy White Paper.

Previous studies undertaken by and on behalf of Sustainable Energy Ireland (SEI) have identified a range of barriers to the uptake of CHP, ranging from poor economic conditions (compared to corporate investment criteria), lack of supports in terms of advice and long term financial assistance, although there has been and currently is a capital grant assistance programme in place, and an infrastructure unsuited to the large scale uptake of CHP. While some of these barriers can be removed through additional support schemes and regulatory review, the largest barrier is likely to remain, namely Ireland's infrastructure, through the lack of large industrial heat loads and a dispersed, low density population with no history of district heating.

[1] Based upon Figure 1 in *Combined Heat and Power in Ireland – 2007 Update, SEI (EPSSU)*

In assessing the potential for growth in CHP, three growth scenarios were considered: Low, Medium and High. Under each of these scenarios, the potential installed CHP capacity in 2010 and 2020 was estimated based upon historic uptake patterns and an assessment of the impact of removing the identified barriers.

Figure 2: Potential Installed CHP Capacity under Three Uptake Scenarios



Under each of these scenarios Ireland is not expected to meet the target of 400 MW_e in 2010, achieving at most a capacity of 312 MW_e, although there is little variation between the three scenarios (303 MW_e to 312 MW_e). Furthermore, it is projected that Ireland will fall short of the 2020 target of 800 MW_e, although there is a considerably greater spread between the three scenarios, ranging from a shortfall of 434 MW_e under the low scenario to just under 27 MW_e in the high scenario.

The achievement of the 2020 target (or the high uptake scenario projection) will be dependent upon the level of support provided by a wide variety of stakeholders, from the Department of Communications, Energy and Natural Resources, the Commission for Energy Regulation and SEI, to industry and business groups and individual end users. The greatest prospect for achieving the National target is through the installation of large scale plants. However, in recent years the commercial sector has seen the strongest growth and it is likely that the residential sector will see similar growth once domestic scale micro CHP technology becomes more widely available to the market. It is important, therefore, to consider all scales of CHP in achieving the target.

NOTE:

At the time of drafting this report the Commission for Energy Regulation sought comments from the public on its consultation document *Treatment of Small, Renewable and Low Carbon Generators outside the Group Processing Approach (CER/09/044)*. Immediately prior to publication of the current report, the Commission issued its Decision Paper on the consultation. The outcome from the Decision Paper has certain implications for the treatment of CHP projects connecting to the national grid. However, in the context of the barriers identified in the current report, the impact of the Decision Paper is considered to be secondary to the economic barriers to CHP that remain, while the estimates of future potential remain valid.

1. Introduction

1.1 Terms of Reference

In November 2008, Byrne Ó Cléirigh (BÓC) was appointed by Sustainable Energy Ireland to undertake a study into the potential for Combined Heat and Power (CHP) in Ireland. The Terms of Reference of the study set out the background to the project:

> *The 2007 Government White Paper – Delivering a Sustainable Energy Future for Ireland*[2] *- lays out a framework for Ireland's energy policy up to 2020. Two broad actions are proposed on combined heat and power (CHP) within that framework:*
>
> - *achieve at least 400 MW from CHP by 2010 through continued support under the CHP Deployment Programme and R&D supports with particular emphasis on biomass fuelled CHP and will aim to achieve at least 800 MW by 2020;*
>
> - *within two years a further target for CHP will be considered for 2020 in light of further feasibility studies into CHP applications, a review by CER of potential administrative and regulatory barriers and decisions on appropriate price support mechanisms for electricity generated from new high-efficiency, large-scale CHP. Our approach will be in line with the EU Directive on CHP*[3] *and further EU developments.*
>
> *The Government had previously established the CHP Policy Group to advise on appropriate future policy options, targets and support measures for CHP as input to the White Paper. The CHP Group's report – CHP in Ireland*[4] *provided estimates of the potential for CHP based on historic studies*[5] [6]*, and recommended that:*
>
> - *estimates of the market potential for CHP in the industrial and residential markets should be produced.*
>
> *The structure of the Irish industrial and commercial markets and the impact of fuel prices have changed since 2000, due to market issues such as those arising from the liberalisation of the energy markets and barriers such as gas market volatility. These and other critical factors, as identified by the CHP Policy Group report, affect the degree of risk a CHP project is likely to experience in the market.*
>
> *SEI is now seeking to update estimates of the potential for CHP in Ireland in light of evolving market conditions to contribute to taking forward the actions on CHP in the White Paper. In addition to managing the CHP Deployment Programme, aimed at stimulating the uptake of small-scale CHP in the industrial, commercial, service and public sectors, SEI is conducting trials of micro CHP in the industrial, commercial and residential markets in order to contribute to subsequent estimates of the market potential of micro CHP.*

1.2 Objectives

The objectives of this study are threefold:

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[2] Delivering a Sustainable Energy future for Ireland – The Energy Policy Framework 2007-2020, Department of Communications Marine and Natural Resources, 2007.
[3] On the Promotion of Cogeneration Based on a Useful Heat Demand in the Internal Market, Directive of the European Parliament and of the Council 2004/8/EC, February 2004.
[4] CHP in Ireland – Options for a National Policy to 2010, Department of Communications, Marine and Natural Resources, February 2006.
[5] An Examination of the Future Potential of CHP in Ireland, Irish Energy Centre, 2001.
[6] Assessment of the Barriers and Opportunities Facing the Deployment of District Heating in Ireland, Sustainable Energy Ireland, 2002.

1. Estimate the market potential for micro, small and large-scale CHP in the industrial, commercial, public sector and services markets and the residential sector for each of the years 2010, 2016 and 2020.

2. Identify and examine the current market conditions, issues and barriers to realisation of the CHP potential identified and develop proposals for possible actions to curb the current barriers.

3. Update the barriers and opportunities, in current market conditions, for District Heating in Ireland[7].

[7] Assessment of the Barriers & Opportunities Facing the Deployment of DH in Ireland, Sept 2002.

2. Background

2.1 CHP Targets

In 2007, the Government published the Energy White Paper *Delivering a Sustainable Energy Future for Ireland*. This paper identified the areas of growth to be targeted in the period to 2020, including growth in the uptake of CHP. The White Paper states:

> *Growth in Combined Heat and Power deployment is an important objective to 2020. The national economic benefit from CHP grows with scale of deployment. It is also the case that CHP investment yields a relatively low return at high risk. So barriers need to be addressed and supports maintained in order to realise the deployment potential, not just in community and buildings, but also in large scale plants.*

Thus, while the White Paper acknowledges the potential benefits of CHP, it also recognises that there are substantial barriers, although specific targets for installed CHP capacity were set as follows:

- 400 MW by 2010
- 800 MW by 2020

The White Paper also set out three specific actions in relation to CHP:

1. *Continued support under the CHP Deployment Programme and R&D supports with particular emphasis on biomass fuelled CHP*

2. *Within two years (from 2007) a further target for CHP will be considered for 2020 in light of further feasibility studies into CHP applications.*

3. *A review by CER of potential administrative and regulatory barriers and decisions on appropriate price support mechanisms for electricity generated from new high-efficiency, large-scale CHP.*

The budget for this most recent CHP Deployment Programme was €11 million, allocated between fossil fuel fired CHP and biomass/anaerobic digestion (AD) fired CHP. The indicative budget for the biomass/anaerobic digestion element of the programme was between €5 and €8 million (out of the €11 million). The Deployment Programme is discussed in more detail in Section 7.1.

As of the end of 2008, approximately 50% of the funding available had been allocated to CHP projects. During our discussions with SEI and the IBEC CHP Ireland Group, both parties indicated that they were confident that the remaining fund would be fully utilised. As of December 2008[8], the total installed and approved CHP capacity under this Deployment Programme was approximately 13 MW_e at a cost of support of approximately €400 per kW_e.

The size range of the fossil fuel fired projects supported ranged from 55 kW_e to 999 kW_e. There were no biomass projects in the uptake to December 2008. However, during the first half of 2009, a large scale biomass fired CHP project was granted funding under this Deployment Programme and was under construction, while a number of anaerobic digestion plants were also under consideration.

[8] As of June 2009, the installed and approved CHP capacity under this grant scheme was approximately 18 MW_e, which included a 3 MW_e biomass fired unit using wood biomass.

Based on the licensing rules of CER and our understanding of the time lag to achieve an export grid connection for schemes exporting greater than 500 kW_e[9], we have assumed that any of the projects supported in the recent CHP grant programme and sized at greater than 500 kW_e were designed exclusively for own-use (internal use) of the electricity generated and not for export to the grid[10].

This current study by Byrne Ó Cléirigh, completed in the second quarter of 2009, is intended to inform the setting of new targets, in particular for 2020.

2.2 CHP Surveys & Assessments

Since the early 1990s SEI, its forerunner the Irish Energy Centre, and the ESB have carried out surveys of CHP in Ireland. In addition, since the late 1990s more detailed assessments[11] of the market for CHP have been carried out in order to identify the main barriers to the uptake of CHP and the options for improving its prospects.

In 2006, a series of studies was carried out for SEI on a variety of aspects of CHP and the barriers to it, including:

1. CHP in Ireland – Options for a National Policy to 2010
2. Evaluation of Legislation and Regulation Affecting New CHP Installations in Ireland
3. New Technologies for CHP
4. Benchmarking Report: Status of CHP in EU Member States
5. Irish Supply Chain Capability for CHP Applications

These reports, and in particular *CHP in Ireland – Options for a National Policy to 2010* and *Evaluation of Legislation and Regulation Affecting New CHP Installations in Ireland* (reports (1) and (2) above), identified particular barriers to CHP and set out broad recommendations to overcome them.

Table 1 lists the barriers identified in these reports. These barriers, together with additional barriers identified in the course of this study, were discussed with stakeholders to establish the extent to which they remain genuine barriers to the uptake of CHP.

---

[9] CER direction CER/5/49 allows for generators with an MEC less than 500 kW_e to be considered for treatment and processing outside the Gate Processing Approach.
[10] In March 2009, CER published a consultation paper on the *Treatment of Small, Renewable and Low Carbon Generators outside the Group Processing Approach*. This consultation is due to close on 30th July 2009. The term 'low carbon' is used to signify electricity that is generated using sources such as high efficiency CHP.
[11] An Examination of the Future Potential of CHP in Ireland – A Report for Public Consultation (December 2001).
Combined Heat and Power in Ireland – Trends and Issues 1991-2002 (February 2004).
Combined Heat and Power in Ireland – 2007 Update.

Table 1: Summary of Barriers Previously Identified

Category	Barrier
Regulatory	Licensing Procedure
	Imposition of PSO Levies
	CHP Definition
	Use of System Charges
	Ownership
Economic	Spark Gap
	Gas Market Price Volatility & Gas Prices
	Electricity System Tariffs & Charges
	EU Emissions Trading*
	Carbon Tax*
	Availability of Finance
	Top-Up and Spill Prices
Technical	Heat Load Availability
	Extent of Gas Grid
	Run Hours
	Low Population Density
	Lack of Heavy Industry
Market & Awareness	Utility Deregulation
	Uncertainty in the Market
	Absence of ESCos
	Lack of Awareness
	Non-Core Business
	Encouragement of CCGT & Dispatch Tolerances
	Resistance to Domestic Centralised Heat Supply

* Not applicable to biomass/AD fired CHP

3. Overview of CHP

Combined heat and power is the simultaneous generation in one process of thermal energy and electrical and/or mechanical energy. The same principle applies in the industrial, commercial and residential sectors.

3.1 Definitions

EU Directive 2004/8/EC *on the promotion of cogeneration based on a useful heat demand in the internal energy market* has defined the following terms in relation to Combined Heat & Power:

Cogeneration:	the simultaneous generation in one process of thermal energy and electrical and/or mechanical energy.
Useful Heat:	heat produced in a cogeneration process to satisfy an economically justifiable demand for heating or cooling.
Economically Justifiable Demand:	the demand that does not exceed the needs for heat or cooling and which would otherwise be satisfied at market conditions by energy generation process other than cogeneration.
Micro-cogeneration Unit:	a cogeneration unit with a maximum capacity below 50 kW_e.
Small Scale Cogeneration:	cogeneration units with an installed capacity below 1 MW_e.

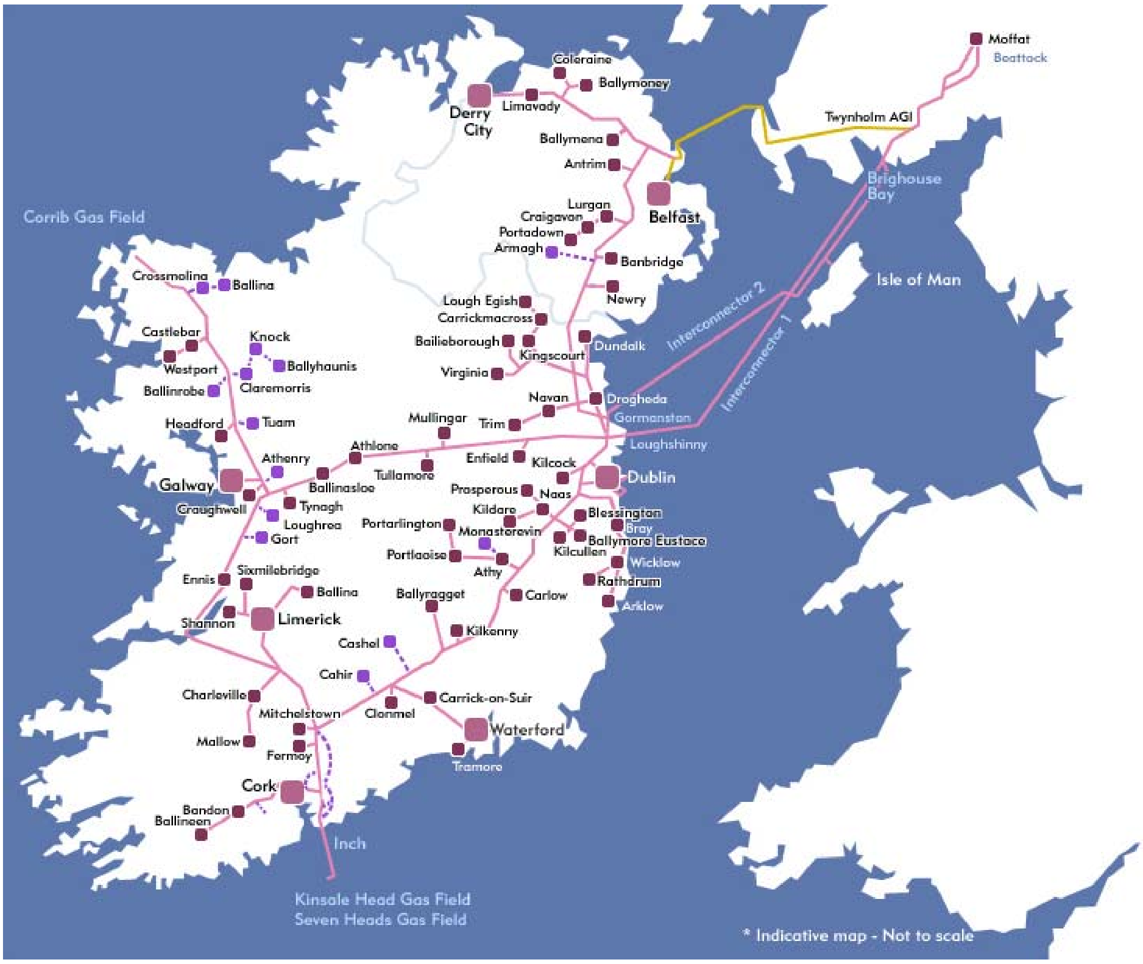
3.2 Fuel Options

3.2.1 Natural Gas

Natural gas has been the dominant fuel for the majority of CHP schemes installed to date (approximately 95% of the installed CHP capacity and 94% of CHP units are fired on natural gas). Furthermore, natural gas is the fuel of choice for many sites where CHP is under consideration. Of the fifty-two projects completed or being progressed within the CHP Deployment Programme at the end of 2008, 94% were fired on natural gas (97% of the installed capacity). Figure 3 shows the extent of the natural gas gird while a list of the towns on the network is included in Annex D. Bord Gáis, in accordance with its *Connection Policy* approved by the Commission for Energy Regulation (CER), is in the process of carrying out a three stage study to evaluate the extension of the natural gas network to new towns around the country.

At the end of 2008, Bord Gáis supplied natural gas to almost 630,000 consumers in 146 population centres within nineteen counties. An additional 21,000 new residential customers were added during the year, although this was considerably less than the number of new connections in 2007, a result of the downturn in the housing market.

Figure 3: Natural Gas Pipeline (source: Bord Gáis)



3.2.2 Kerosene & Gas Oil

At present, approximately 46% of all households with central heating systems[12] in Ireland are fuelled on oil (kerosene or gas oil). However, while it is technically feasible to operate small CHP units, including micro-CHP units, on kerosene (or gas oil), it is not particularly attractive to end users or ESCOs as we understand that the maintenance required on the units is more extensive than for gas fired units. Consequently, the potential for the conversion from an oil based boiler heating system to an oil based CHP system in the residential sector is likely to be limited.

However, the recent sharp drop in the price of kerosene for home heating may mean that the potential for kerosene-fired CHP has improved in 2008 and 2009.

A similar technical potential exists within the industrial/commercial sectors, where there is a market for small and micro scale CHP units in areas not connected to the natural gas grid and/or that currently operate oil fired heating systems or generators. While the application of these units may be considered less favourable than similar gas fired units, oil fired CHP may offer savings over more traditional electricity and heat generation.

However, it is significant that under the CHP Deployment Programme no project based on gas oil or kerosene had been approved up to December 2008.

[12] It is estimated that approximately 90% of all houses have a central heating system.

3.2.3 Biomass

The provisional National Energy Balance for 2008 indicates that approximately 171 ktoe (1,989 GWh) of biomass was produced in Ireland, with a further 13 ktoe (151 GWh) imported. The majority of this biomass was consumed by industry (82%), with the remainder consumed in the residential sector (12.5%), the commercial sector (2.7%) and energy production (3.8%)[13]. Within the energy production sector, only 3 ktoe (34.9 GWh) was consumed in CHP units, accounting for only 0.04% of total electricity production, with a further 4 ktoe (46.5 GWh) used as fuel in Public Thermal Power Plants.

However, while biomass does not currently contribute a significant input to energy consumption or CHP, a number of studies have identified its potential for growth, including a report carried out for the Western Development Council in September 2008 (*Biomass CHP Market Potential in the Western Region: An Assessment)*. One of the key findings from this report was that biomass fired CHP is possible, with current commercially available technologies, for users with a continuous heat load of 600 kW_{th}, equivalent to the heat load that may be present at a large hotel, a swimming pool or a hospital.

In order for any significant potential uptake of biomass CHP, there must be a suitable supply of biomass available. While this is discussed in more detail in Section 6.6.3, a paper[14] delivered at the Irish Bioenergy Conference in February 2009 estimated that if half the CHP target of 800 MW_e in 2020 were to be met by biomass (400 MW_e) then two million tonnes of biomass would be required, equivalent to 5,000 tonnes of biomass per MW_e, although no reference to the moisture content of the biomass is provided.

A further study carried out on behalf of the Department of Trade and Industry in the UK[15] provides an indication of the energy input required from a variety of biofuels for the generation of electricity and heat. This study included both large and small scale biomass fired CHP and found that, as an example, an 8.2 MW_e rated plant would require in the order of 32,000 tonnes of oven dried wood chip per annum (at 25% moisture content), equivalent to 3,900 tonnes per MW_e.

Analysis of the biomass input and energy outputs from a number of biomass fired CHP units in Finland and Ireland indicates that a significantly higher quantity of biomass than 2 million tonnes (as bark and sawdust) would be required to achieve 400 MW_e of biomass based CHP.

3.2.4 Anaerobic Digestion

In 2005, the Strategic Policy Unit in the EPA prepared a discussion paper on *Anaerobic Digestion: Benefits for Waste Management, Agriculture, Energy and the Environment*. This paper recognises anaerobic digestion as a proven technology, extracting biogas from organic wastes, including residues from livestock farming, food processing industries, and waste water treatment sludges which can then be used to generate electricity or used to fire a CHP unit. In Germany, anaerobic digestion has been used extensively on kitchen wastes (brown bin collections) as well as on farms, abattoirs and food processing plants, with many examples of gas engines of electrical output in the range 100 to 1,000 kW_e.

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[13] There are statistical differences associated with the National Energy Balance which account for the apparent over allocation of biomass across the end users.

[14] *The Outlook for Biofuels*, B. Rice and J. Finnan, Teagasc.

[15] Carbon and Energy Balances for a Range of Biofuels Options, M.A. Elsayed, R. Matthews and N.D. Mortimer, 2003.

The 2005 Discussion Paper estimated that the energy potential of cattle, pig and poultry wastes could generate electricity equivalent to 11% of the 2001 national electricity demand (2,759 GWh)[16]. However, notwithstanding this potential and in spite of SEI's CHP Deployment Programme and the increase in the feed-in tariff for electricity produced from biomass, there has been very little uptake of this technology[17] due to a number of barriers (discussed in more detail in Section 6), including grid connection, planning, available heat demand and, reportedly, animal health issues (land spreading of AD digestate).

Clearly, there is significant theoretical potential for anaerobic digestion based CHP based on the inherent energy content of many waste streams in Ireland. While there has been no uptake under the current CHP Deployment Programme, a number of municipal waste water treatment plants have installed this technology and are generating power from biogas. There are currently a number of projects under consideration within the Deployment Programme.

However, the most likely locations for anaerobic digestion CHP plants are distant from large population centres with many in rural areas and therefore there is less likely to be a suitable heat demand at such sites. Anaerobic digestion processes requiring a heat input (e.g. waste water treatment plants (WWTP)) may be considered as supplying a justifiable heat demand. However, in the absence of a sufficiently large heat demand, such a unit may not qualify as CHP under the definition within the Directive and therefore the potential for anaerobic digestion to contribute to the CHP target is less certain, despite the large potential for electricity generation. This is a similar constraint to CHP units fired on landfill gas, where there is less likely to be a sufficiently large heat demand to utilise the heat produced.

Despite this uncertainty as to the contribution that anaerobic digestion can make towards the CHP target, it should be noted that the process (and the use of landfill gas), can provide significant benefits in terms of electricity production alone, both in terms of displacing traditional electrical generation capacity by distributed generation and making beneficial use of otherwise waste gases generated through natural digestion and decomposition. The conversion of methane to CO_2 through combustion of biogas in gas engines also has benefits in reducing Ireland's greenhouse gas emissions due to the high global warming potential of methane compared to CO_2.

3.2.5 Landfill Gas

In 2008, 26 ktoe (302 GWh) of landfill gas was produced and was consumed in the generation of electricity. In our survey of CHP sites in Ireland, we identified 19 generation units fired on landfill gas, all of which have an installed capacity greater than 1 MWe, yielding a total installed capacity of 21.5 $MW_{e.}$ However, the use of landfill gas in these generation units is not considered to meet the criteria for CHP unless there is an *economically justifiable heat demand* at this scale[18]. Therefore, in its current form, the generation of electricity from landfill gas in such large quantities could not be justified for inclusion as part of Ireland's CHP capacity, unless a large heat demand proximate to the site were available. Thus, the summary tables of installed CHP capacity in Section 4.2 and the projections of CHP installed capacity in Section 8 do not include installations for power generation from landfill gas.

However, smaller CHP units fired on landfill gas providing electricity for and meeting the (small) heat demand of the waste management site would qualify, and therefore could be counted towards Ireland's CHP targets.

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[16] Ireland's Provisional Energy Balance for 2008 indicates that the total final consumption of electricity was 2,289 ktoe, equivalent to 26,620 GWh.
[17] The Outlook for Biofuels, B. Rice and J. Finnan, Teagasc, 2009.
[18] Landfill sites may have a demand for a small portion of the heat generated from such a unit, but the definitions in the Directive do not allow for the apportionment of only some of the heat generated to be considered *economically justifiable*.

3.2.6 Geothermal Energy

At the time of writing this report, no CHP plants in Ireland source their energy inputs from geothermal energy. A 2009 report by Byrne Ó Cléirigh derived preliminary estimates of geothermal potential in Ireland to 2020 and considered, *inter alia*, the use of this energy source as an input to CHP plants. In general, the heat required in industry is at much higher temperatures than that available from geothermal energy, particularly as the source temperatures available in Ireland are typically less than 100°C, even from depths of 2 to 3 km.

On this basis, the report concluded that there was little prospect for the uptake of geothermal CHP in industry in the short term. However, it was noted that small scale CHP plants may become feasible in the medium term, using Organic Rankine Cycle systems with outputs in the region of 200 to 300 kW_e.

There are several deep geothermal projects under active review on the Blackrock–Rathcoole fault in the Dublin area where temperature gradients of 30ºC per km depth have been indicated. In addition, a 700 kW_{th} direct-use project for the UCD campus has been studied, with the potential for the geothermal energy to feed into the existing district heating scheme at UCD Belfield. UCD announced a further phase of the geothermal feasibility study in January 2009.

Another, much larger project is being developed by Geothermal Energy Ltd. in the Newcastle and Tallaght areas of Dublin. This deep geothermal project is likely to be in the range of 10 to 20 MW_{th}, with the heat used for district heating. However, in contrast to the potential UCD scheme, the Newcastle-Tallaght scheme would require the installation of a district heating mains system to link the project to the end users.

The potential for geothermal CHP in the commercial and residential sectors is closely linked to the prospects of community or district heating (refer to Section 3.3).

3.3 District Heating

In 2002, WS Atkins prepared a report on the barriers to and opportunities for district heating in Ireland[19]. In its assessment of the potential for a district heating system to be fed from a CHP plant, the report stated that:

> *Using heat only boilers to serve a DH system, particularly in a new build situation, is not generally cost effective because the revenue from heat sales is not sufficient to justify the capital investment. It is necessary to boost revenue by selling electricity.*
>
> *Therefore, it is likely that any future DH schemes in Ireland will only be commercially viable if the heat is supplied from a small CHP plant or is "free heat" from an appropriately sized power station co-located with the potential heat load.*
>
> *It is unlikely that viable DH schemes could be developed by feeding heat to neighbouring towns from existing large scale power plants. If, in the future, generators are obliged to meet more stringent environmental performance targets, then the opportunity for an associated DH scheme should be considered at the planning stage.*

In order for a district heating system to be considered a viable outlet for the heat from a CHP plant, a number of requirements must be met[20]:

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[19] *Assessment of the Barriers and Opportunities Facing the Deployment of District Heating in Ireland*, WS Atkins, September 2002.
[20] *Preliminary Estimates of Ireland's Theoretical Resources and Market Potential for Geothermal Energy*, Byrne Ó Cléirigh, 2009.

- A collection of heating loads must be available, whose owners/operators are willing to sign up to the district heating concept;

- Matching of the heat demands to the CHP source (essential);

- The offer of CHP-based thermal energy must be competitive with the costs of alternative thermal energy available to the owner of a district heating network or an ESCo operating such schemes.

There has been increasing interest in the concept of centralised boiler houses and district/ community heating in Ireland of late. This has been assisted by the rapid increase in apartment living where service charges are the norm. However, the challenges for a CHP breakthrough in the large heat market in centralised urban areas are:

(a) gaining access to a large enough demand in either commercial or residential new build developments, or

(b) retrofitting a district heating network and heat exchangers into existing premises currently served by individual boilers.

The retrofitting of district heating to homes which were not initially designed for district heating has never proven feasible in Ireland, although changing energy costs and the pricing in of carbon costs may improve the economics of district heating in the longer term. Some recently constructed developments, or proposed developments, with communal or district heating schemes in Ireland are described below.

Heuston Square	This development will ultimately comprise 343 apartments, 40,000 m^2 of office blocks, retail facilities, a crèche, leisure centre and a 240 bedroom hotel. The heating plan envisages starting the scheme using centralised gas-fired boilers. Ultimately, it is planned to install a biomass boiler to supply a large portion of the base-load thermal energy demand using a carbon neutral renewable energy source such as wood chip or pellets. These new apartments are fitted with distribution mains from a central boiler house and with individual heat exchanger units used in conjunction with traditional radiators for heat distribution within the apartments. This indicates that for major new build mixed use development the cost of the district heating and the net cost of heat supplied to the apartments were considered competitive compared to providing individual natural gas boilers in each apartment or providing all electric dwellings at the time the scheme was designed.
Spencer Dock	This development will serve approximately 600 apartments and several office blocks. A major convention centre is also under construction and retail space and a hotel are planned. The plan is to fuel the scheme initially with natural gas boilers. Ultimately, this scheme may be linked into a proposed district heating scheme which will be supplied, *inter alia*, with energy from the waste heat from the Dublin City Council Incinerator Project in Dublin Port. In the future, the district heating scheme proposed by Dublin City Council may also take in heat from other CHP units elsewhere in the city. We understand that the Spencer Dock development has agreed in principle to connect to the Dublin Port Incinerator Project and some heat distribution pipework has already been laid.

Dundalk Renewable Energy Zone	A new district heating scheme is under consideration which will be based at Dundalk Institute of Technology. In concept, it will be similar to Heuston Square i.e. fuelled by a biomass-fired boiler (base-load) with natural gas used for peak demands. A small biomass-fired CHP unit was initially also under consideration as a pilot scheme but this is more likely to be a longer term option. Two major public buildings - DKIT and the Regional Hospital have been identified as the potential 'anchor tenants' for the scheme. This scheme will require the laying of new DH mains linking the main heat users.
Charlotte Quay	The CHP units in the Charlotte Quay apartments were funded by SEI's House of Tomorrow Programme and are being monitored as part of the micro-CHP Field trial. The 78 apartments in the development are heated by a centralised plant room comprising two natural gas boilers and two micro-CHP units. The micro-CHP units are designed to provide some 30% of the overall heating and hot water demand.

3.4 Heat Recovery from Incineration

One of the key issues that we have identified for the future of CHP and district heating is the emergence of energy recovery and the exploitation of waste heat from municipal waste incineration for use in district heating (for example, the plants proposed for Dublin and Ringaskiddy). Many cities in Continental Europe use municipal waste incineration as a source of electricity generation and of thermal energy for supplying district heating networks and using large public buildings, such as hospitals, as the anchor tenants around which schemes may develop. Stakeholders in the Irish market point to Continental Europe as the model which we should follow. However, Ireland has not embraced Waste-to-Energy[21](WTE) projects to date and in our view this has hampered the potential for the development of district heating schemes.

At the beginning of 2009 there were three projects in train for the incineration of waste in Ireland. The Indaver plant at Carranstown Co. Meath is currently under construction, although this plant is remote from any potential district heating opportunities.

Dublin City Council's Waste-to-Energy Project in Dublin Port and Indaver's Ringaskiddy Project are at various stages in the development process. The combined electrical output of these two projects would be approximately 76 MW_e and the thermal input in the waste would be of the order of 350 MW_{th}. The output from these plants is thus potentially very significant in the context of the national CHP targets.

The Dublin City Council Project is the largest of these WTE projects in terms of annual throughput (600,000 tonnes) and is the one nearest[22] to a reasonable residential and commercial heat load[23]. The Indaver project at Ringaskiddy, which is currently progressing through the planning and permitting process, would also be sufficiently close to major industries to consider a district heating network.

[21] The combustion of biomass in boilers and CHP units may be considered as Waste-to-Energy, as the biomass can be a waste/by-product from the production process. However, in the context of Waste-to-Energy in Continental Europe we are primarily referring to the combustion of municipal waste.
[22] Including new development at the former Irish Glass Bottle Plant at Ringsend.
[23] It should be noted that the economics of the Dublin City Council District Heating Scheme predated the collapse of oil prices in 2008 and the collapse of the rate of house building and commercial property development. This may impact on the speed at which the project is completed.

3.5 Tri-Generation

Tri-generation is the simultaneous production of electrical and/or mechanical energy combined with thermal energy for both heating and cooling. As in the case of CHP (cogeneration), the waste heat from the production of the electrical/mechanical energy is recovered to provide heat energy via traditional heat exchanger systems, and cooling energy via absorption chilling systems.

4. Status of CHP in Ireland

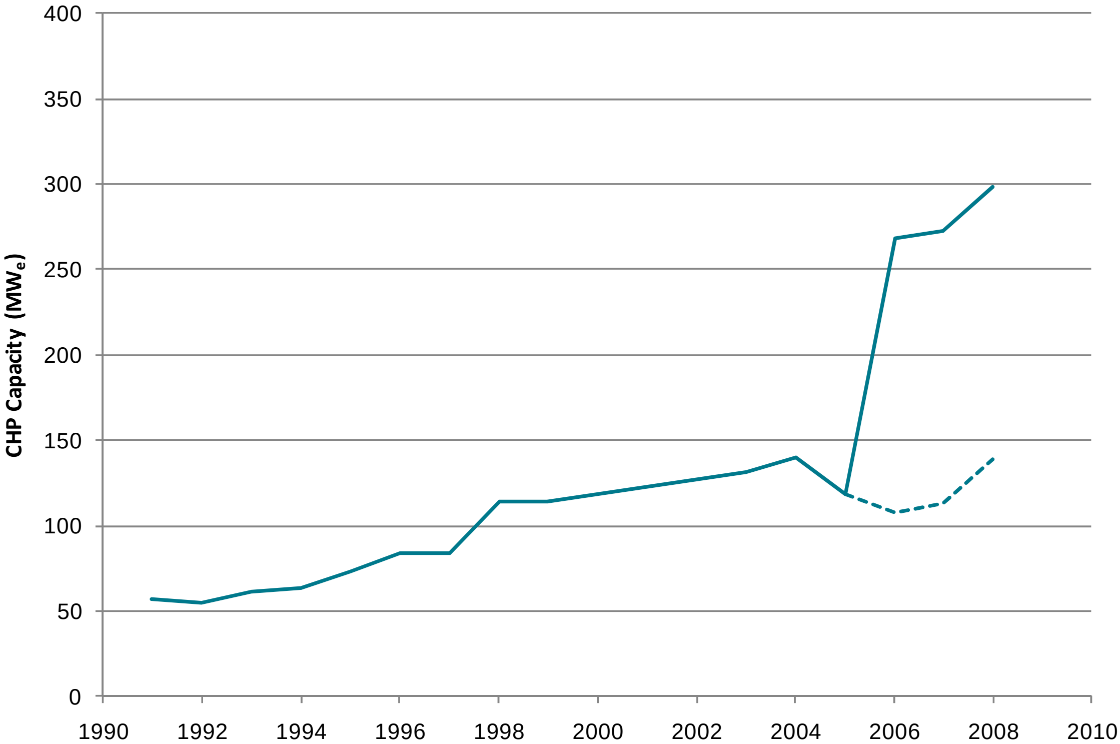
4.1 Overview

Since the early 1990s SEI, its forerunner the Irish Energy Centre, and the ESB carried out surveys of CHP in Ireland. In addition, since the late 1990s more detailed assessments[24] of the market for CHP have been carried out in order to identify the main barriers to the uptake of CHP and the options for improving its prospects.

SEI's Energy Policy Statistical Support Unit (EPSSU) maintains a database of all CHP sites in Ireland, including those that are inactive. For the purposes of the current study, we have developed a database of CHP sites in Ireland using a 'bottom-up' approach, with input from IBEC's CHP Group, individual ESCos, CHP equipment vendors and direct contact with large industry sites. As part of this process, we identified a total of 255 CHP units of which 241 were identified as active. This database was cross checked by EPSSU against its most recent survey results.

The total active installed capacity stood at 298.7 MW_e at the end of 2008. Figure 4 shows the trend in installed CHP capacity since 1991. As can be seen from this figure, there has been an increase in active installed capacity between 2006 and 2008, although the underlying growth rate, excluding the contribution from Aughinish Alumina, remains low.

Figure 4: Installed (Active) CHP Capacity: 1991 – 2008



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[24] An Examination of the Future Potential of CHP in Ireland – A Report for Public Consultation (December 2001)
Combined Heat and Power in Ireland – Trends and Issues 1991-2002 (February 2004)
Combined Heat and Power in Ireland – 2007 Update

The dashed line shows the trend without the contribution from the Aughinish Alumina CHP plant, which indicates that the installed capacity in 2008 would have declined to the level of the late 1990s and, due to plant closures, would only have returned to the 2004 level of 140 MW_e by 2008.

It should be noted, however, that it is necessary to distinguish between installed capacity and active capacity. The data in Figure 4 only relates to active CHP capacity and does not include the 41.5 MW_e of inactive capacity that was identified by SEI in 2006 or the 10 MW_e of inactive capacity identified in this study at the end of 2008.

However, for ease of comparison with the results of previous CHP studies, the data in the tables in Sections 4.2, 4.3 and 4.4 refers to all installed CHP capacity, whether active or inactive. A full list of identified CHP units is included in Annex C, which differentiates between active and inactive units.

4.2 Summary of Installed CHP Capacity

Annex C summarises the findings from our survey broken down by unit size (micro, small and large scale). For ease of comparison with previous reports (refer to Annex A), Table 2, Table 3 and Table 4 below summarise the status at the end of 2008 against 2006 in the same format as the 2007 update report.

In Table 2, the breakdown of the installed CHP capacity by general fuel categories are those reported in SEI's report *Combined Heat and Power in Ireland – 2007 Update*. Oil products are comprised of LPG and heavy fuel oil, gas includes refinery gas and natural gas and biomass refers to renewables and includes both biomass (including wood) and biogas (including sewage gas from anaerobic digestion). As stated in Section 3.2.5, landfill gas and the associated plant with no heat recovered or where there is no *economically justifiable demand* for the heat is not considered as CHP in this report and is not included in the following tables. However, anaerobic digestion CHP units identified are included within the following tables, as the heat generated in these units provides a useful heat input to the overall WWTP process.

Table 2: Number of Units and Installed Capacity by Fuel

	2006		2008		% Change	
	No.	**Installed Capacity kW_e**	**No.**	**Installed Capacity kW_e**	**No.**	**Installed Capacity**
Gas Fuels	161	288,497	239	290,039	+48.4	+0.5
Solid Fuels*	3	18,200	2	5,600	-33.3	-69.2
Biomass	1	1,830	9	12,483	+800	+582
Oil Fuels	2	990	5	431	+150.0	-56.5
Total	***167***	***309,517***	***255***	***308,552***	***+52.7***	***-0.3***

Table 3: Number of Units and Installed Capacity by Sector

	2006		2008		% Change	
	No.	Installed Capacity kW_e	No.	Installed Capacity kW_e	No.	Installed Capacity
Services	131	34,581	212	54,492	+61.8	+57.6
Industry	31	273,195	35	248,008	+12.9	-9.2
Other	5	1,741	8	6,053	+60.0	+247.7
Total	***167***	***309,517***	***255***	***308,552***	***+52.7***	***-0.3***

Table 4: Number of Units and Installed Capacity by Capacity Size Range

	2006		2008		% Change	
	No.	Installed Capacity kW_e	No.	Installed Capacity kW_e	No.	Installed Capacity
Micro	2	76	23	211	+1,050	+177.6
Small	125	22,399	182	33,181	+45.6	+48.1
Large	40	287,042	50	275,160	+25.0	-4.1
Total	***167***	***309,517***	***255***	***308,552***	***+52.7***	***-0.3***

4.3 Industrial Sector

Table 5 summarises the installed CHP capacity within the industrial sector at the end of 2008, compared with 2006. As can be seen from Table 3, the industrial sector dominates the installed CHP capacity (80%), and in turn the industrial sector is dominated by Aughinish Alumina (in the category of other in Table 5), accounting for 64.5% of the capacity. The average size of a CHP unit in industry is 7,100 kW_e, including Aughinish Alumina, but is only 2,600 kW_e if the Aughinish Alumina site is excluded.

Table 5: Number of Units and Installed Capacity by Industry Sub-Sectors

	2006		2008		% Change	
	No.	Installed Capacity kW_e	No.	Installed Capacity kW_e	No.	Installed Capacity
Food	14	81,590	16	52,023	+14.3	-36.2
Manufacturing	5	6,610	11	17,946	+120.0	+171.5
Mining	2	5,200	0	0	-100.0	-100.0
Pharmaceutical	6	11,560	5	11,169	-16.7	-3.4
Other	4	168,235	3	166,870	-25.0	-0.8
Total	***31***	***273,195***	***35***	***248,008***	+12.9	-9.2

4.4 Commercial/Services Sector

Table 6 summarises the installed CHP capacity within the commercial/services sector at the end of 2008, compared with 2006. As can be seen from Table 3, while the sector only accounts for 18% of the installed capacity it accounts for 83% of the number of individual units. The average size of CHP units in the commercial/services sector is 260 kW_e, with the largest unit being 2,935 kW_e at Dublin Airport and due for completion in 2009.

Table 6: Number of Units and Installed Capacity by Services Sub-Sectors

	2006		2008		% Change	
	No.	Installed Capacity kW_e	No.	Installed Capacity kW_e	No.	Installed Capacity
Hospital	23	5,765	39	7,658	+69.6	+32.8
Hotel	64	9,070	86	12,001	+34.4	+32.3
Public Sector	3	2,452	6	2,016	+100.0	-17.8
Airport	3	4,380	4	7,316	+33.3	+67.0
Education	6	4,234	14	5,343	+133.3	+26.2
Office	9	4,716	11	7,602	+22.2	+61.2
Other	2	1,108	17	8,197	+750.0	+639.8
Leisure	21	2,856	35	4,360	+66.7	+52.7
Total	***131***	***34,581***	***212***	***54,492***	***+61.8***	***+57.6***

4.5 Residential Sector

There is virtually no CHP used in the residential sector at present. At the end of 2008 there was only one dedicated residential site (Charlotte Quay Apartments) with two CHP units installed accounting for 11 kW_e of the total installed capacity. There are also a number of mixed use developments that include residential areas. However, the breakdown of heat and electricity within these sites is not available.

4.6 Aughinish Alumina

CHP in Ireland is dominated by the plant at Aughinish Alumina which has an installed capacity of 160,000 kW_e in two gas fired units and accounts for almost 52% of the total installed national capacity. The site with the next largest *combined* CHP capacity is the St. James's Gate Brewery with an installed capacity of 14,400 kW_e from three 4,800 kW_e units. The next largest *single* train CHP unit is at the Whitegate Refinery with an installed capacity of 6,870 kW_e.

Clearly, the presence of such a large plant as Aughinish Alumina is beneficial from a number of aspects:

- It is a significant contribution to the White Paper CHP targets.
- It displaces a considerable electrical load from the transmission and distribution network, thereby improving the efficiency with which electricity is provided to the site.
- It displaces heavy fuel oil which, in the absence of the CHP plant, would be the primary fuel in the site's boilers and which would significantly increase the CO_2 emissions from the alumina plant and add to Ireland's Greenhouse Gas Emissions.

In addition, there is still potential to back out further thermal energy at Aughinish Alumina once economic conditions stabilise. We understand that the site has already considered an increase in its power generation capacity by a further 75 MW_e. This is likely to be highly dependent on recovery of global economy and of global aluminium demand

However, the presence of such a non-typical plant in the overall CHP capacity also highlights the difficulties in meeting the White Paper targets. The average installed CHP capacity per individual unit is approximately 1,250 kW_e, including the plant at Aughinish Alumina. However, without this plant the average installed capacity is only 580 kW_e. As it is unlikely that another site of comparable size will materialise within the timeframe considered in this report, an additional 175 units of the average (580 kW_e) capacity are required in 2009 and 2010 (on the basis that the target is to be met by the end of the target year), with a further 690 units needed between 2011 and 2020. The average size of CHP unit supported in the recent CHP Deployment Programme was 208 kW_e, with the largest fossil fuel fired unit being 999 kW_e (a 3 MWe biomass fired unit received grant aid during the first half of 2009 and is currently under construction).

5. Potential for New CHP Sites to 2010 & 2020

5.1 CHP Uptake Scenarios

In assessing the potential for the uptake of CHP out to 2010 and to 2020, we have considered three scenarios: Low Uptake, Medium Uptake and High Uptake rates. The basis for these uptake rates is described in the following subsections.

5.2 Scenario 1 – Low Uptake

The Low Uptake scenario is based upon the current rate of CHP capacity growth (excluding Aughinish Alumina's 2006 contribution) and the current supports in place (refer to Section 7). It acknowledges that some existing sites may close down within both the 2010 and 2020 horizons and assumes that there is little or no replacement of lost CHP on a like-for-like basis. This scenario also takes a more pessimistic view in terms of a short-term economic recovery, the confidence of industry to invest in large capital projects with uncertain economic prospects and the uncertainties surrounding fuel prices, in particular the recent volatile oil markets.

However, it is recognised that even in the current climate, advances are being made in small and micro CHP units and that the uptake of CHP in recent years has been dominated (in the number of units rather than in installed capacity) by the commercial and leisure sectors. Therefore, the Low Uptake scenario includes an allowance for a modest breakthrough in residential micro-generation, aided by the recently announced Feed-in-Tariff support, albeit in a much reduced new-build housing market compared to the recent building boom years. There may be opportunities for some retrofitting of such micro CHP units but this is unlikely to contribute significantly to the uptake in this scenario. Similarly, there may be some retrofit projects in commercial and public sector sites (hotels and hospitals).

It is assumed that Aughinish Alumina does not expand CHP at its site.

In the longer term (post 2016), this scenario assumes that Dublin City Council rolls out its Waste-to-Energy and District Heating Plans, with an electrical output of 56 MW_e and up to 150 MW_{th} of thermal output. In the initial years we understand that the heat capacity is likely to be limited to 55 MW_{th}, sufficient to service 20,000 houses. However, it is unlikely that the full potential would be utilised on start-up of the plant.

5.3 Scenario 2 – Medium Uptake

The Medium Uptake scenario is based upon more favourable market conditions for CHP. However, while the rate of uptake is greater than in the Low Uptake scenario, the majority of growth is expected to occur in the latter half of the 2010 to 2020 period, and beyond. Sites that have completed or are in the process of completing feasibility studies are expected to install the plants, where practicable and economic, between 2015 and 2020. Other, as yet unidentified, sites will carry out feasibility studies from 2012 onwards and, where feasible, the plants *may* be constructed before 2020.

Aughinish Alumina invests in 75 MW_e of extra CHP capacity in the longer term. However, this plant is not constructed until the end of the 2010 to 2020 period and may be completed just in time to contribute to the 2020 CHP target of 800 MW_e.

The Medium Uptake scenario also assumes that the construction industry recovers towards the middle of the 2010 to 2020 period but at a rate significantly lower than the peak of recent years. New developments are more favourable to CHP, although the growth is from a relatively low (capacity) level of new build activity. There is also a recovery in the residential building sector, although new build housing is not expected to be greater than 30,000 houses per annum[25]. Technological advances in micro-CHP allow for the retrofitting of such units into existing houses from 2015/2016 onwards.

Dublin City Council rolls out its Waste-to-Energy and District Heating Plans by 2016 and the initial heat capacity of 55 MW_{th} is available and is fully subscribed to by 2020.

5.4 Scenario 3 – High Uptake

The High Uptake scenario is the most optimistic is terms of economic recovery, improvements in the market for CHP (both in terms of existing and new sites) and the support structures (both informative and financial) from the Government and financial institutions.

This scenario is based upon economic recovery within three to four years, with economic growth returning to the pre 2008/2009 levels, although it does not reach the peak rates experienced during the early part of the 21st century.

The majority of sites identified in our survey that have the technical and economic potential for CHP install it, or commence installing it, by 2016. New sites begin feasibility studies and invest progressively over the 2010 to 2020 period.

Aughinish Alumina invests in a new 75 MW_e CHP plant sometime after 2015.

The advancements in micro-CHP allow for a higher rate of installation in a more buoyant housing market (approximately 60,000 houses per annum) and the retrofitting of these units in the existing housing stock.

The growth in new build commercial developments returns to pre-2008 levels, although at a more cautious level than the early 2000s. Existing commercial buildings look favourably on the retrofitting of CHP and invest in the technology, with growth between 2016 and 2020.

5.5 Closure of Existing Sites

In assessing the potential for the growth of CHP out to 2020, we must also take into account the potential for existing sites to close under all scenarios. The potential for sites to close down within the coming years is evidenced from the closures of relatively high capacity CHP sites in recent years.

5.5.1 Closures since Previous Reviews

Since SEI (and its forerunner) commenced the annual surveys of CHP capacity, a number of sites with a significant CHP capacity have closed down, including the Irish Sugar Plants in Carlow (14.8 MW_e) and Mallow (11.2 MW_e) and the ADM Ringaskiddy site (5 MW_e). It is also clear from the tables in Section 4 that other, albeit smaller, sites have also closed between 2006 and 2008 and it is likely, even in buoyant market conditions, that some sites with CHP will close.

[25] Based upon statistics and low growth population projections from the Central Statistics Office.

In addition, the closure of the Irish Steel/Irish Ispat and the Irish Fertiliser Industry plants in Arklow and Cork removed the potential for CHP to be installed (or at least considered) for these highly energy intensive sites.

5.5.2 Potential Closures

As outlined above, we believe that it is prudent to account for the fact that some existing sites with CHP plants will close down within the time period considered in our assessment (to 2020). While some of these sites may close for purely economic reasons (such as the Irish Sugar Plants referred to above), others may consolidate activities from a number of sites, while others may continue to operate but without the use of CHP[26].

Other sites with current CHP capacity which could face reducing output in the longer term include Bord na Móna's peat briquetting plants. These plants are likely to face a reducing demand for solid fuels in the future as the natural gas grid expands and as the trend towards the use of more convenient fuels such as gas continues on its current path. In addition, there is some level of uncertainty regarding the operation of the Whitegate Refinery beyond 2016[27]. As the refinery has an installed CHP capacity of 6,870 kW_e, there is the potential for this to be lost if refining were to cease between 2016 and 2020.

In addition to the potential loss of CHP capacity in the short term, it is reasonable to base our projections on a continuing loss of CHP capacity out to 2020. The effect of this loss will be different in each of the three Uptake scenarios. In the Low Uptake, there is expected to be little replacement of lost capacity and therefore there would be a net loss or, at best, no net gain. In the Medium Uptake scenario, the loss of CHP capacity is expected to be offset by an approximately equal uptake, while the High Uptake scenario is based upon a growth in CHP capacity substantially exceeding CHP plant closures.

5.6 Growth Areas

In the following subsections, we describe the potential for growth in each of the main target sectors, together with additional sub-sectors where we believe there is a particular growth potential:

- Industry
- Commercial
- Waste Management
- Hospitality
- Healthcare
- Residential
- Biomass/Wood Processing

Table 7 summarises the heat to power ratios in the industrial, commercial, public services and residential sectors, based upon the 2008 Provisional Energy Balance.

[26] While the closure of CHP sites is almost entirely driven by economics, there is a distinction between the economics of operating the CHP plant (driven by, for example, the spark gap) and the economics of operating the site, which is served by the output from the plant.
[27] Review of the Security of Ireland's Access to Commercial Oil Supplies, report by Purvin & Gertz – Byrne Ó Cléirigh for the Department of Communications, Energy & Natural Resources, 2008.

Table 7: Sectoral Heat to Power Ratios

Sector	Final Electricity Demand (MWh)	Fossil Fuel Demand (MWh)	Heat to Power Ratio
Industry	8,037,021	19,737,807	2.46
Commercial	6,676,194	6,455,205	0.97
Public Services	2,640,237	4,815,234	1.82
Residential	8,525,523	27,553,839	3.23
Total	***25,878,975***	***58,562,085***	***2.26***

5.6.1 Industrial Sector

Examination of the current CHP capacity breakdown highlights the dominance of the industrial sector in meeting Ireland's CHP targets. Any substantial future growth in CHP capacity is likely to come from this sector and therefore considerable emphasis must be placed on investigating the potential for additional or new uptake.

The Provisional 2008 National Energy Balance provides a useful indicator of the potential for the uptake of CHP, with the total (final) electrical and thermal demands for the main sectors identified. Of the fuels used for the generation of heat, those with the potential for CHP application are natural gas, biogas, LPG, refinery gas, biomass, peat and waste (refer to Section 5.6.5).

Table 8: Breakdown of Final Energy Consumption in Industrial Sector (2008)

Sub-Sector	Final Electricity Demand (GWh)	Total Fossil Fuel Demand (GWh)	Renewables Fuel Demand (GWh)	Portion of Fuel Demand Suitable for CHP (Note 2 (GWh)
Non-industry mining	663	861	0	372
Food, beverages & tobacco	1,989	3,385	686	2,501
Textiles & textile products	93	198	0	35
Wood and wood products	349	174	1,082	1,117
Pulp, paper, publishing & printing	372	326	0	244
Chemicals & manmade fibres	1,186	1,907	0	1,268
Rubber & plastic products	372	174	0	116
Other non-metallic mineral products	640	5,234	0	593
Basic metals & fabricated metal products	872	5,850	0	2,094
Machinery & equipment n.e.c.	198	233	0	163
Electrical & optical equipment	1,326	1,151	0	919
Transport equipment manufacture	105	116	0	81
Other manufacturing	302	233	0	35
Total *(Note 1*	***8,037***	***19,738***	***1,768***	***9,537***

Note 1: There are statistical differences associated with the National Energy Balance which account for the differences in the total summations.

Note 2: The fuels with CHP potential in industry are natural gas, biogas, LPG, refinery gas, biomass and peat.

In examining the types of industries that use these fuels (based on EU ETS verified emissions data, and other sources), we identified a number of specific sectors that showed the potential for CHP. The sub-sectors within the industrial sector that we consider to have significant potential for new or additional CHP are:

- Pharmaceuticals
- Food & Drink (including dairy)
- ICT & Electronics
- Manufacture of Wood Products
- Secondary Minerals Processing

Pharmaceuticals

There is already a considerable installed CHP capacity within the pharmaceutical sector (approximately 11.2 MW_e, representing 13.2% of the industrial sector, excluding that from Aughinish Alumina), with the nature of the manufacturing operations generating both substantial electrical and heat demands. During our direct discussions with the pharmaceutical sector, we were made aware of at least one site that is planning to install CHP, another that is pursuing the prospects of CHP but is not connected to the natural gas grid (refer to Section 6.6.2), while a third has carried out a pre-feasibility study and is currently examining its options. Each of these sites has, or may have, the potential for CHP units in excess of 1 MW_e, while IBEC's Pharmachemical Ireland Group lists a total of forty-one members which could be considered for the further potential uptake of CHP.

Food & Drink Sector

There is currently in excess of 51 MW_e of CHP capacity installed across the food and drink sector, including over 36 MW_e in seven dairies and 14.4 MW_e at a large drinks manufacturer. The remainder of the capacity consists of small scale units at a variety of other food production sites. An additional 5 MW_e capacity is due to be commissioned at an eighth dairy site before the end of 2009, while at least one further large dairy has carried out a feasibility study into the potential for CHP at its site. However, due to poor economics, it is unlikely to proceed in the near future.

Due to the nature of the processes involved across the dairy industry, requiring significant heat and electrical loads during the milk intake season, it would suggest that CHP may be viable at other dairies, albeit on a smaller scale than the current installations at the larger dairies.

ICT & Electronics

There are currently no CHP units installed in the ICT/electronics sector in Ireland, primarily due to the lack of a sufficient balance between the electrical and heat loads within the production process, although tri-generation may provide a balance between electrical consumption and cooling loads. However, at least one of the largest ICT/electronics manufacturers has carried out a number of feasibility studies into the potential for CHP at its site over the last number of years and considers that it may be *technically* feasible. Other sites in the sector have also shown a strong interest in the potential benefits of CHP.

Manufacture of Wood Products

Three wood processing sites in Ireland[28] currently use biomass to fire large scale CHP units (in the range of 1.8 to 3.3 MW_e). We have identified a further three large sites with similar or greater *technical* CHP potential. Two of these sites are currently pursuing the prospects of CHP based upon more advanced biomass technology (gasification) and, if the system proves to be feasible, the two sites could contribute significantly to the CHP targets. The remaining site also has a technical potential for CHP and has

[28] The biomass fired CHP units at wood processing sites in Northern Ireland are not included in this report.

investigated it in the past, although it has not pursued this in recent years in light of the expected payback period.

In the first half of 2009, SEI approved a 3 MW_e biomass fired CHP project at a wood processing plant (which had been identified in our survey and is included in the tables in Section 4.2 and in Annex C.

Secondary Minerals Processing

The potential for the uptake of CHP within the gypsum and building products sector is mixed due to the variety of processes that are carried out. However, a number of sites that we contacted within this sector have carried out pre-feasibility studies into the potential for CHP at their sites.

While the primary production of minerals (cement and lime) does not lend itself to the uptake of CHP, the secondary processing of minerals, such as the production of end-use building products from the refined minerals, e.g. plaster board, is more promising in terms of its CHP potential. At least one manufacturer of such products has commissioned a pre-feasibility study into the potential at its site. The production of such mineral based building products generally carries a high steam load, thereby indicating that CHP may have some benefit in terms of energy cost savings.

However, we also identified sectors that consume significant quantities of electricity and fossil fuels, but where CHP is not feasible (e.g. the cement manufacture and lead/zinc mining sectors). These sub-sectors are described in more detail under the Barriers to CHP in Section 6.

5.6.2 Commercial/Services Sector

Although the overall heat to power ratio in this sector is low by comparison with others, the commercial sector has shown considerable interest in the recent SEI support scheme and accounts for over 84% of the total number of CHP units installed under the Deployment Programme at the end of 2008. However, while this sector has a high number of CHP units, the nature of the energy requirements means that many of the units are only operated for approximately 5,200 hours per year (during the night time the electricity prices tend to be less than the cost of generating electricity from the CHP plant, while in some instances there is no demand for heat or electricity during night time hours).

Despite their general small scale use, CHP in the commercial/services sector is still an important contributor to Ireland's CHP targets. It has shown the largest growth in the number of units since 2006 and a substantial increase in installed capacity. While this has been aided by growth in the hospitality (hotels) and leisure sectors, there is a reasonably diverse mix of end users, not all of which are reliant on strong economic growth for uptake[29]. The current economic downturn is expected to reduce the strong growth in the uptake of CHP in certain areas of this sector (in particular hotels).

Hospitals and other care facilities, for which CHP is ideally suited, can however be expected to continue to increase their share of the CHP market, either through new builds or retrofitting, particularly in older, less energy efficient buildings (see Sections 5.6.3 and 5.6.4).

5.6.3 Hospitality

The hospitality sector formed a very buoyant and receptive market for CHP in recent years, partly due to recent growth in the Irish tourism market and partly on the basis of the stimulus provided by the SEI CHP Deployment Programme. Between 2006 and 2008, the number of CHP units in hotels rose from 64 to 85, with installed capacity rising to 12 MW_e, an increase of 30% in installed CHP capacity in 2 years. Over the same period, the hotel population increased from 814 to 905, although the average occupancy rate remained close to 50%.

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[29] While all CHP projects require economic justification, certain services infrastructure, such as hospitals, nursing homes, schools, universities and public service buildings are required irrespective of strong economic growth, in contrast to private office or leisure developments that are driven entirely by economic return.

It is interesting to note that while the capital allowances scheme for hotels was phased out at the end of 2006, the hotel population grew from a low point in 2006 over the next two years.

Whilst the building of new hotels may have peaked for the foreseeable future, we are of the opinion that there are opportunities for retrofitting CHP in the current hotel stock. A targeted programme for the sector together with case studies and awareness programmes involving the CHP vendors, ESCos and the Industry Representative bodies would therefore be beneficial.

5.6.4 Healthcare

The most recent Budget (April 2009) has cut property related accelerated capital allowance schemes for private hospitals, registered nursing homes, convalescent homes and associated residential units as well as mental health centres. Up until that point, we would have considered the healthcare sector as a strong candidate for new CHP capacity given its 24-hour occupancy and seven day per week operation, particularly in hospitals and nursing homes. This was reflected in the growth in hospital based CHP of 22% up to 7.1 MW_e in 2008 from 5.7 MW_e in 2006.

However, while the rate of new build private healthcare facilities may decline, there remains considerable scope for the retrofitting of reasonably sized CHP units in existing facilities. The Health Service Executive (HSE) lists a total of forty-nine hospitals throughout the country, with only thirteen having some level of CHP. These forty-nine hospitals do not include private hospitals or other healthcare facilities.

5.6.5 Waste Management

In contrast to some sectors which may face competitive challenges over the period to 2020, the waste management sector is one where CHP prospects are improving, with definite prospects for power generation and associated CHP deployment. Dublin City Council has published advanced plans for a Waste-to-Energy Plant in Dublin Port, which envisages the use of heat from a major CHP plant in an extensive district heating mains network to be developed over a number of years. The indicative capacity of the Dublin City Council WTE plant would be very significant in terms of Ireland's CHP targets, with a projected electrical output of 56 MW when in maximum power generation mode and supplying 55 MW of heat energy in the initial phase until the potential district heating network is fully established.

Initially, the thermal output could serve 20,000 homes if such a number could be identified and retrofitted with heating systems suitable for connection to district heating. Targeting of heat users has already begun and the Spencer Dock complex has agreed to connect to the system, when available, with some of the district heating mains already in place. However, the downturn in construction may delay part of a major mixed use development planned for the former Irish Glass Bottle site in Ringsend/Irishtown which would have served as a natural market for the thermal output from any potential CHP development in the area. At full output and in full CHP mode the plant will be capable of supplying 150 MW_{th}, sufficient for 60,000 homes.

Two further WTE plants have been proposed, one in Carranstown in Co. Meath (currently in construction) and one in Ringaskiddy Co. Cork. However, the prospects for CHP in these areas is less certain; there is no existing thermal demand in the Carranstown area, although there may be potential for the export of steam to the industrial areas within Ringaskiddy.

5.6.6 Residential

There are approximately 1.9 million dwellings in the country with 1.46 million households. The Provisional Energy Balance for 2008 indicates that the residential thermal demand, taking into account all forms of fuel[30], was 2,396 ktoe (27,870 GWh), yielding an average thermal demand of 1.64 toe (19 MWh) per household. The (final) electrical demand within the residential sector was 733 ktoe (8,525 GWh), yielding an average (final) demand of 0.5 toe (5.8 MWh) per household. It is clear, therefore, that the residential sector offers considerable potential for the use of CHP (the associated barriers are discussed in more detail in Section 6).

[30] Excluding heat provided by electrical sources, e.g. storage heaters.

However, while there is potential within this sector there has been very limited uptake of the technology to date. Individual CHP units at a domestic scale have only come on to the market in recent years. Prior to the downturn in the housing sector, larger scale developments (apartment blocks and mixed use developments) would have provided ideal opportunities for small scale CHP units. While existing developments still offer this potential through retrofit schemes, the uptake is likely to be less than would occur in new builds.

Despite these difficulties, the residential sector is considered an important growth area over the period covered by this report. However, in terms of installed capacity the sector is unlikely to contribute significantly more than 10% towards the CHP targets (refer to Section 8).

5.7 Beyond 2020

The Grid Development Strategy (GDS) undertaken by Eirgrid plans the development of the transmission system, in an optimal long-term manner, to cater for anticipated demand and generation requirements in 2025, as requested in the Government's White paper on energy[31]. The scenarios modelled within this strategy extend out to 2025 and include a total of 400 MW_e of CHP capacity from a total of four installations (each of 100 MW_e). In this study, we have identified four large potential CHP installations with a total capacity of 251 MW_e (Aughinish Alumina at 75 MW_e, Dublin City Council at 56 MW_e, Indaver Ringaskiddy at 20 MW_e and a potential 100 MW_e power station[32]). We have included each of these potential CHP plants in our Medium and High uptake scenarios, but not in our Low uptake scenario.

[31] Source: Eirgrid and CER

[32] Mayo Power proposed a 100 MW_e co-fired CHP generating station to be located at Killala, Co. Mayo. We consider that it is unlikely for this plant to source a sufficiently large heat demand to be considered CHP. However, it is possible that a similarly sized generating station could be located close to a sufficient heat demand for it to be considered as CHP.°

6. Barriers to CHP

In the following subsections, we discuss the potential barriers that have been identified as part of the current study, through discussions with stakeholders, a review of the uptake of CHP to date, and the barriers identified in previous studies. Where a barrier was previously identified but has been removed (or partially removed), we have provided an outline of our assessment of the impact that this may have on the uptake of CHP and, therefore, whether it was in fact a barrier.

The following subsections also present our assessment of *potential* barriers. Due to the nature of the infrastructural context in which CHP must operate in Ireland, some of these potential barriers may not materialise in reality or there may be a link between a number of barriers and the removal of one will have a positive knock-on effect to the uptake of CHP.

An example of this is the current economic climate. At the time of finalising this report (July 2009), the economy had contracted sharply and therefore the prospects for significant new capital investment was considered limited. Many of the industries with whom we spoke were strongly interested in CHP. However, payback times of 3 to 5 years were identified by several sites as a result of feasibility studies and these did not meet corporate finance criteria. Consequently, the projects were not expected to proceed based on currently projected economics (without financial support).

6.1 Socio-Economic Structure of Ireland

6.1.1 Industrial Population

Ireland has not attracted large numbers of heavy industry with continuous steady heat loads, which are normally a prerequisite for large scale industrial CHP. In addition, the heavy industry that has been present in Ireland has been in decline in recent years, with the loss of actual and potential CHP capacity (refer to Sections 4.3 and 5.5.1), while some of the largest scale heavy industry in Ireland (a world scale cement industry that consumes approximately 19% of fossil fuel energy in Irish industry) is not suited to the uptake of CHP (refer to Section 5.6.1).

Consequently, we consider that the lack of a significant industrial population, especially of energy intensive plants, limits Ireland's potential to meet the White Paper's CHP targets, as it is these larger sites that can contribute most, or have the possibility to do so.

6.1.2 Services/Commercial Structure

The services/commercial sector in Ireland is a significant consumer of electricity and fossil fuels, although much of this is accounted for by offices and retail units. Thus, while the electrical and heat demands may appear to be suitable for the application of CHP, the occupancy pattern of offices and commercial property presents a barrier. A typical five day working week, with primarily a daytime energy use pattern, reduces the running time for the operation of CHP installations to approximately 3,000 hours per annum out of a potential of 8,760 hours. This generally results in longer payback times than for similarly sized CHP units in buildings with a more constant demand, such as hotels, hospitals and nursing homes.

There has been a significant level of new build offices since 1990. However, an indication of the low level of penetration of CHP in the office sector can be seen in Table 6 in Section 4.4, with CHP in offices declining from 4.7 MW_e in 2006 to 3.6 MW_e in 2008, a drop of 24% over 2 years. This drop in active CHP units occurred notwithstanding the availability of CHP grants during the period.

The global economic downturn is likely to mean a lower rate of new build offices for the foreseeable future with limited demand for new CHP capacity. While existing offices offer an outlet for the retrofitting of CHP, the nature of the occupancy and potentially unfavourable payback periods presents a barrier.

6.1.3 Housing Market & Population Distribution

The preference of property owners in Ireland has, until recently, been primarily for individual detached or semi-detached houses with front and back gardens, even in urban areas. In rural areas, bungalows and detached and semi-detached housing has been the norm, which has led to very low housing densities. Even in substantially urban areas, Ireland's population density is low compared to Continental Europe, where apartment living is far more common. In addition to Ireland's aversion to the use of WTE projects (refer to Section 3.4), this low population density has been and remains a barrier to the use of district heating schemes connected to CHP plants.

There are an estimated 1.9 million houses in Ireland, including primary residences, holiday homes, other occupied dwellings and finished but unoccupied dwellings. At the last census there were 1.46 million households identified (dwellings occupied on the day of the census). The current number of households will be somewhat in excess of this.

The Central Statistics Office has presented recent population growth projections covering a number of growth scenarios. Under the low growth population projection, referred to by CSO as Scenario M0F1[33], the population of Ireland is expected to grow from 4.233 million in 2006 to 4.884 million in 2026. This low growth scenario represents an increase in population of 437,435 over the 17 years from 2009 to 2026. Assuming a relatively linear rate of growth, the population in 2020 is likely to reach approximately 4.72 million, up from the 4.42 million reported by CSO for April 2008 (an increase of 300,000).

At the current average occupancy of 2.81 persons per household, this projection of an increase in population to 2020 would infer a need for an extra 99,000 new dwellings over the 11 years from 2009 to 2020. Thus, around 9,000 new houses will be needed annually from 2009 to 2020 to accommodate the additional population. However, it is estimated that there are currently 35,000 completed but as yet unoccupied houses in Ireland. This will mean that in the short term the anticipated increase in population will be partly accommodated by the take up of existing houses which have been built but which have not yet been occupied. Therefore, the market potential for micro-CHP, when the technology becomes available within the next couple of years, is likely to be relatively small in new build houses (refer also to Sections 6.6, 6.8 and 6.9).

The degree of penetration will ultimately depend on four factors:

- The speed at which domestic scale CHP technology is brought to market and when such units achieve market acceptance in Ireland (Section 6.5);
- The level of grant supports which will be provided to cover the increased costs of installing domestic CHP units compared to efficient condensing boilers (and other competing technologies) particularly in retrofit or boiler replacement projects (Section 6.8);
- The extent to which home owners will benefit from a suitable tariff for any power sold to the grid and the number of years for which the incentive tariff will apply (Section 6.7.8);
- The extent that future building regulations will make the use of CHP and/or renewables mandatory for an increasing percentage of a building's energy requirement (Section 7.4).

The overall economics for the householder (including any Government supports) will determine how many householders will be prepared to adopt what is a new and as yet unproven technology in Ireland.

The competitive landscape is also not static. Gas boilers, solar panels for hot water heating, biomass boilers and heat pumps are all on a continuing improvement trajectory based on ongoing research and development and these will pose strong competition for domestic scale CHP units for the foreseeable future (refer to Section 6.8).

[33] M= Migration F= Fertility

6.2 Economic

6.2.1 Economic Viability

The economic viability of a specific CHP unit is dependent upon fuel and technology costs, together with site specific factors, including:

- Power to natural gas (or other fuel) ratio (the spark gap).

- The investment cost per kW_e. These costs vary both in terms of scale of unit (the typical cost for a micro to small scale CHP unit is in the order of €4,000 per kW_e, while that for a larger gas fired unit can decrease to the order of €1,000 per kW_e) and type of fuel (natural gas fired CHP units tend to be significantly cheaper than biomass fired units of equivalent output).

- The operating costs. We understand that the non-fuel running costs on gas engines tend to be much lower than for the same engines fired on kerosene or gas oil, primarily due to a higher frequency of maintenance required and the associated costs.

- The sizing of the CHP unit to correctly match the heat (and electrical) load at the site.

- The spill back price for export of electricity to the grid where the project depends on electricity revenues, assuming it obtains the necessary grid connection permits.

The low uptake of CHP, despite a number of initiatives in recent years, indicates that the economics of CHP are still poor in Ireland compared to our European counterparts, where CHP is much more dominant. As discussed at the beginning of this section, it is difficult to isolate particular barriers as the sole reason for the lack of uptake of CHP, and this is particularly the case in relation to the economic barriers.

6.2.2 Corporate Investment Criteria

The factors set out in Section 6.2.1 yield a projected payback period for the CHP project, which can be anywhere from one year or less to greater than ten years. As described in Section 6.2.1, it is not possible to assess the economic viability of a CHP project without knowing the site specific conditions. Similarly, different organisations that are considering CHP have different investment criteria, and one organisation's criteria for payback may differ significantly from another.

This diverse range of corporate investment criteria, generally expressed in terms of the payback period, has also been borne out in our discussions with industry. The typical payback period that we have identified for sites considering CHP and where it is *technically* viable is 5 years, based on the feasibility studies undertaken by interested site owners.

However, many corporate investors will only consider capital projects with payback periods in the order of three to four years, with some organisations requiring even shorter payback periods. While the difference may be marginal, we have found that this is a significant barrier to the future uptake of CHP and these projects will not progress in the absence of some form of stimulus to bridge the gap between projected payback times and what corporations are demanding of their investments.

The role of ESCos in removing, or partially removing this barrier, appears to have been limited to date. One of the sites contacted in our survey indicated that they had been approached by ESCos but that the investment was still not seen as economically viable when assessed against the Corporate Criteria, even though the investment risk would be largely borne by the ESCo.

6.2.3 Availability of Funding

In discussions with stakeholders and industry, the availability of finance or funding was not considered to present a significant barrier. It was noted that if a potential CHP project meets the corporate investment criteria then it would be likely that the funding would be made available. However, the recent sharp downturn in the Irish and world economies may impact on the availability of funding for otherwise economically viable projects.

6.2.4 Grant Assistance

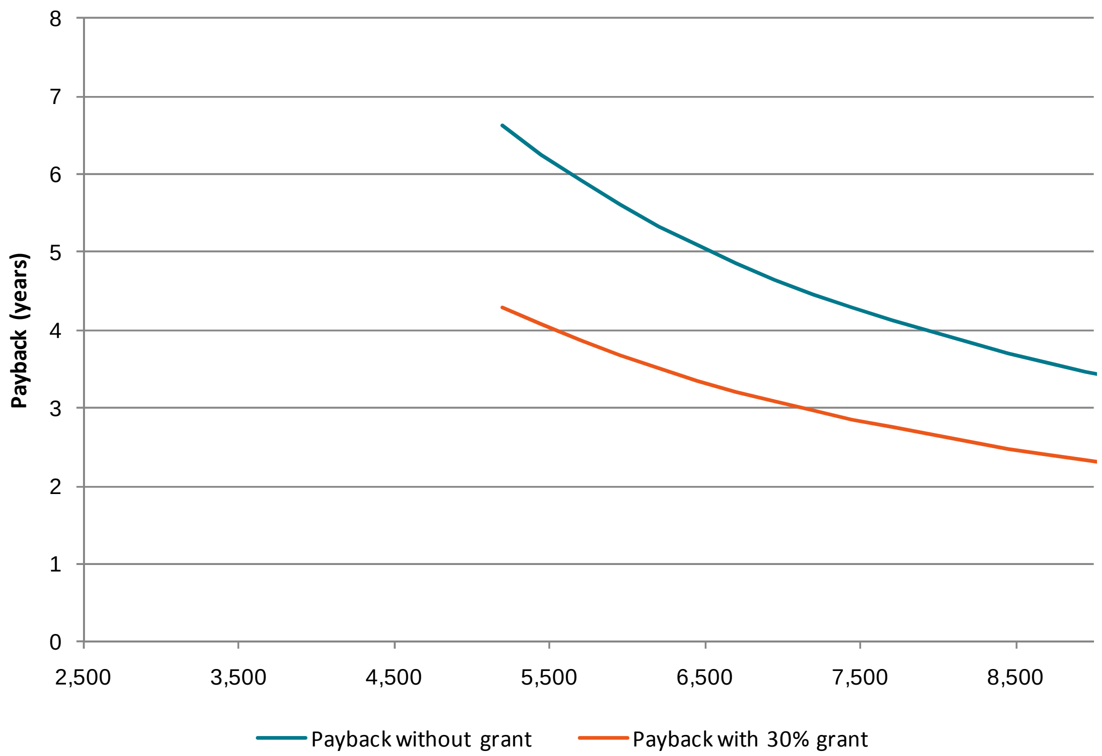
Grant assistance is clearly an incentive for the uptake of CHP (or any) technology. As an example, a 30% grant (such as is currently available for fossil fuel fired units of less than 1 MW_e and for biomass fired units of any size) could reduce the payback period from 4 – 7 years to 3 – 5 years.

Figure 5 shows the decrease in payback period for a hypothetical project unsupported by grants and the same project which is grant supported, based on a sample unit (999 kW_e), against the number of operational hours per annum. While this is a simplified example, it demonstrates the sensitivity of the economic viability of CHP. For example, the simple payback period for a sample natural gas fired unit could be reduced by 30% if it were to operate for 5,200 hours per annum rather than 4,000, while it could be reduced by over 50% if it also received 30% capital grant aid.

The current SEI grant scheme for fossil fuel fired CHP is capped at units with an electrical output of 999 kW_e, although there is no capacity cap for biomass fired units. Given the lack of penetration of biomass units to date and the likelihood that fossil fuels (natural gas) will remain the dominant fuel in the short to medium term, if Ireland is to meet its ambitious CHP targets then CHP units larger than the 999 kW_e threshold will be required. In addition, as discussed in Section 6.2.2, corporate investment criteria for CHP units may be too stringent in the current climate. One means by which owners of industry could be encouraged to install CHP, while meeting corporate payback criteria, is by raising the threshold for grant assistance above 1 MW_e.

During our discussions with stakeholders, CHP Ireland suggested that the grant threshold of 999 kW_e for fossil fuel fired units was a particularly significant barrier for larger projects. It was also noted that some sites supported under the CHP Deployment Programme have installed 999 kW_e units. This approach may suit the particular site in terms of the size of unit required, or it may have been adopted to make maximum use of the grant scheme. In the case of the latter, this approach may impact on the optimum plant configuration and the overall economics of the project. The extent of such impacts would be site specific. It would be useful for SEI to discuss with the four sites which installed this size of unit what capacity they would have installed in the absence of a grant cap.

Figure 5: Payback Period & Operational Run Hours (sample case)



6.3 Fuel Prices & Spark Gap

6.3.1 Spark Gap Overview

The economics of CHP are dependent on the price of fuels for the combustion process, the system efficiency and the savings made on electricity purchased. There are several variants which determine this:

1. Whether the project only produces electricity for its own use (no export to the grid).
2. Whether the project needs to export to the grid to be viable. In this case, the Feed-in-Tariff and the permitting/licensing requirements can be critical to a project proceeding.
3. The cost of thermal energy input, whether in the form of natural gas, LPG or biomass, and the value of electricity generated.
4. The annual running hours for the CHP unit.
5. The technology needed to utilise the available fuel (different technologies are required for different fuel types and the investment per kW_e of capacity varies).

In general, the greater the ratio between the price at which the electricity is valued by the end user and the price at which the fuel for the CHP plant can be purchased (the spark gap) the better the economic case for CHP.

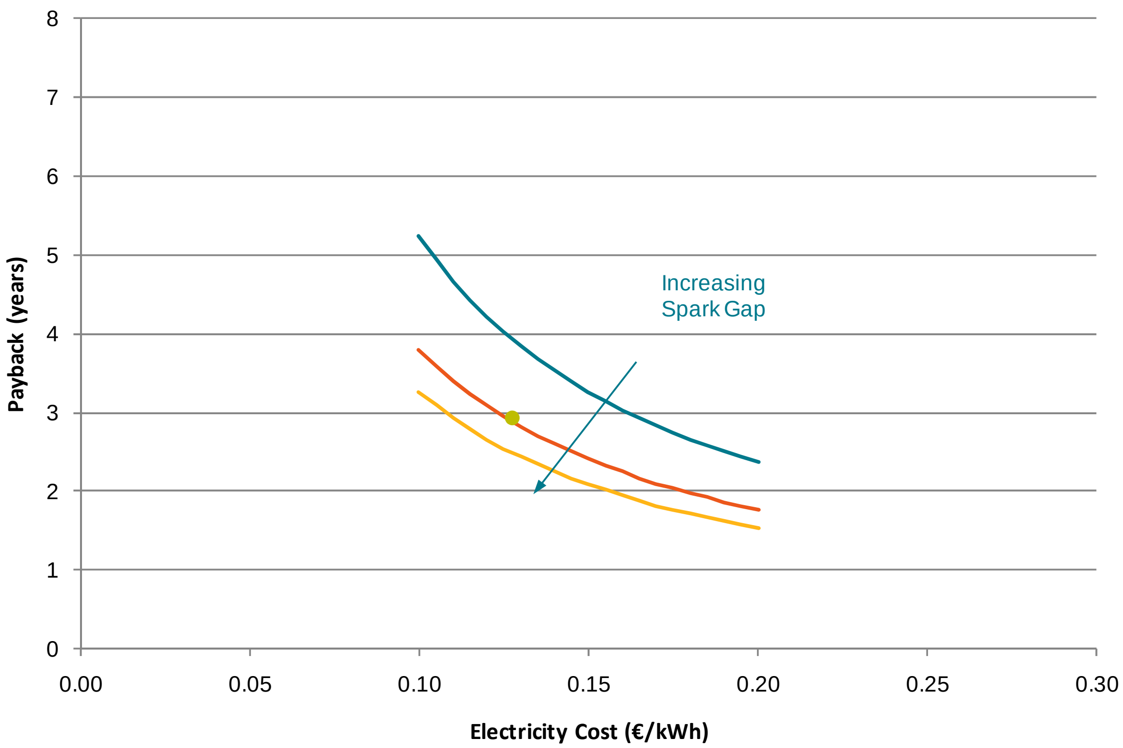
However, the spark gap can be considerably different for similar CHP technologies (e.g. natural gas fired CHP) depending on the installed capacity and even in different sectors, as the market prices for both electricity and thermal input fuels vary.

6.3.2 Industrial Sector Spark Gap

In the industrial sector, large scale energy users have greater opportunity to negotiate on the unit rate of their energy supply than smaller consumers and therefore the standard tariffs for electricity and natural gas are generally not applicable. Since 2008, Eurostat has collected data on energy (electricity and natural gas) prices in Member States for different energy consumption bands. For a medium sized industrial energy user, the spark gap between electricity and natural gas stood at 3.6 (€0.14/$kWh_{electricity}$ and €0.04/$kWh_{natural\ gas}$) for the second half (2[nd] Semester) of 2008.

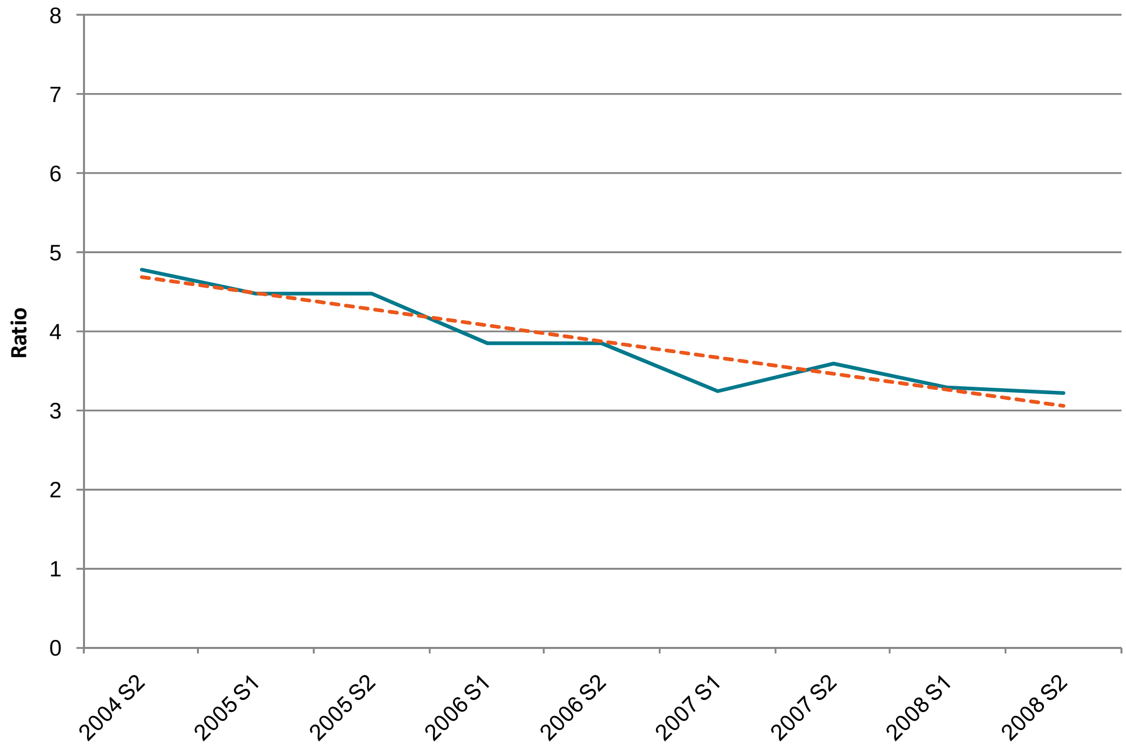
Figure 6 shows the relation between the spark gap, the absolute price of electricity and the simple payback period for a site powered and heated by a sample 1 MW_e CHP unit. The figure shows that as the spark gap increases (from three to five in this figure), the simple payback period decreases, as would be expected. However, it also shows that as the absolute cost of electricity (and natural gas) increases, at a given spark gap ratio, the simple payback period also decreases, potentially improving the economic viability of CHP. The dot shown on the figure corresponds to the spark gap ratio pertaining in Ireland during the second half of 2008 (the latest period for which the Eurostat data is available), corresponding to a simple payback period, for the sample case, of 3 years, before any grant assistance.

Figure 6: Payback Period & (Industrial) Spark Gap



In our discussions with large industry sites where CHP is considered *technically* feasible, it transpired that the typical payback period sought by many of the sites was in the region of three to four years, with some sites requiring a payback period as short as one year. While there is little historical data available for the large energy use sector, the available information for smaller users indicates that the spark gap has typically been decreasing over the last four to five years, as shown in Figure 7, decreasing the economic benefit of CHP.

Figure 7: Spark Gap in the Industrial Sector



It was also the view of IBEC's CHP group that, due to Ireland's heavy dependence on gas fired generating stations, the relative prices of electricity and gas for industrial consumers are not expected to alter significantly in the short term, i.e. that gas and electricity prices are likely to move in approximately the same way in the medium term with no significant improvement (increase) expected in the spark gap ratio.

6.3.3 Commercial Sector Spark Gap

Figure 8 shows the trend in the spark gap ratio three different fuels: natural gas, gas oil and biomass[34] over the last three years in the commercial sector.

It can be seen from this figure that the natural gas spark gap has been decreasing since mid-2008 and therefore the barrier caused by an unfavourable spark gap has been increasing. As the majority of current installed CHP capacity is fired on natural gas, and future uptake of CHP is likely to be dominated by natural gas, the potential for growth appears to be limited for the foreseeable future as it may be more economic to purchase electricity and 'heating' fuel separately. This trend was borne out during our discussions with medium and large scale industry.

Conversely, the gap for both gas oil and biomass has increased, indicating that the spark gap barrier for these fuels is decreasing (i.e. it is becoming more economic than in previous years, solely from a fuel cost perspective, to operate CHP on these fuels). Notwithstanding this improving trend for gas oil and biomass spark gap through 2008, there were no gas oil or biomass CHP approved under the CHP Deployment Programme up to December 2008.

[34] The cost of these fuels is the delivered energy cost. The actual cost per kWh available will depend upon the efficiency of the type of heating system.

Figure 8: Spark Gap in the Commercial Sector

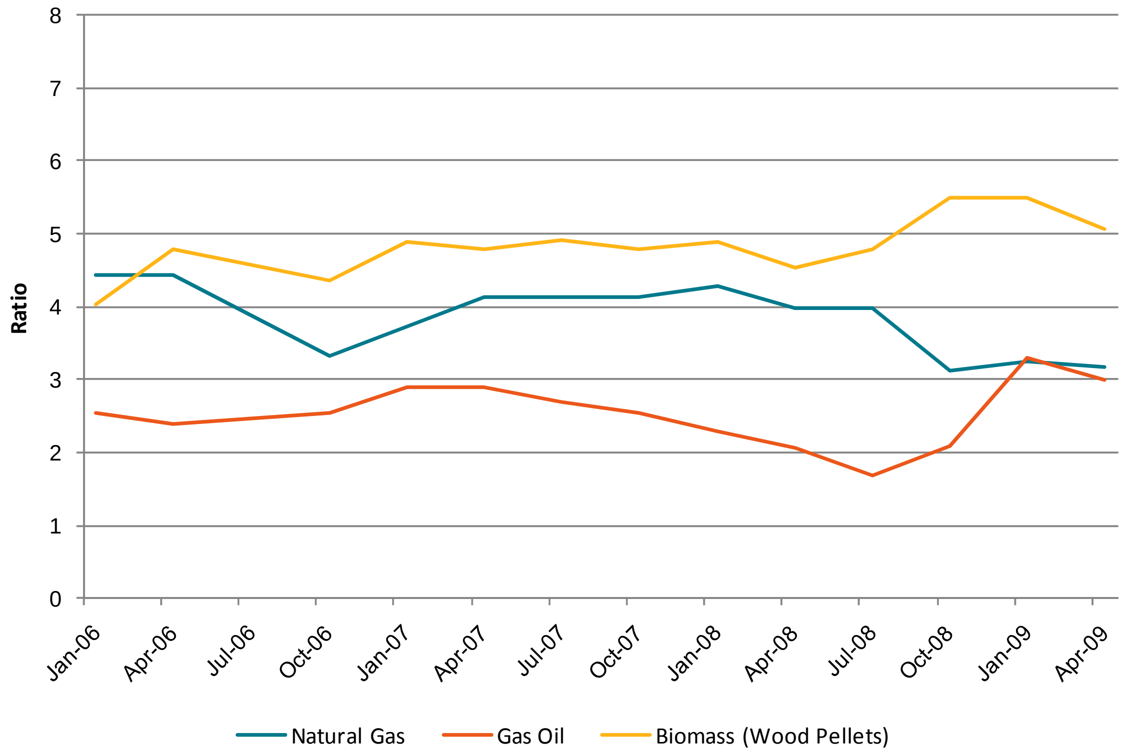
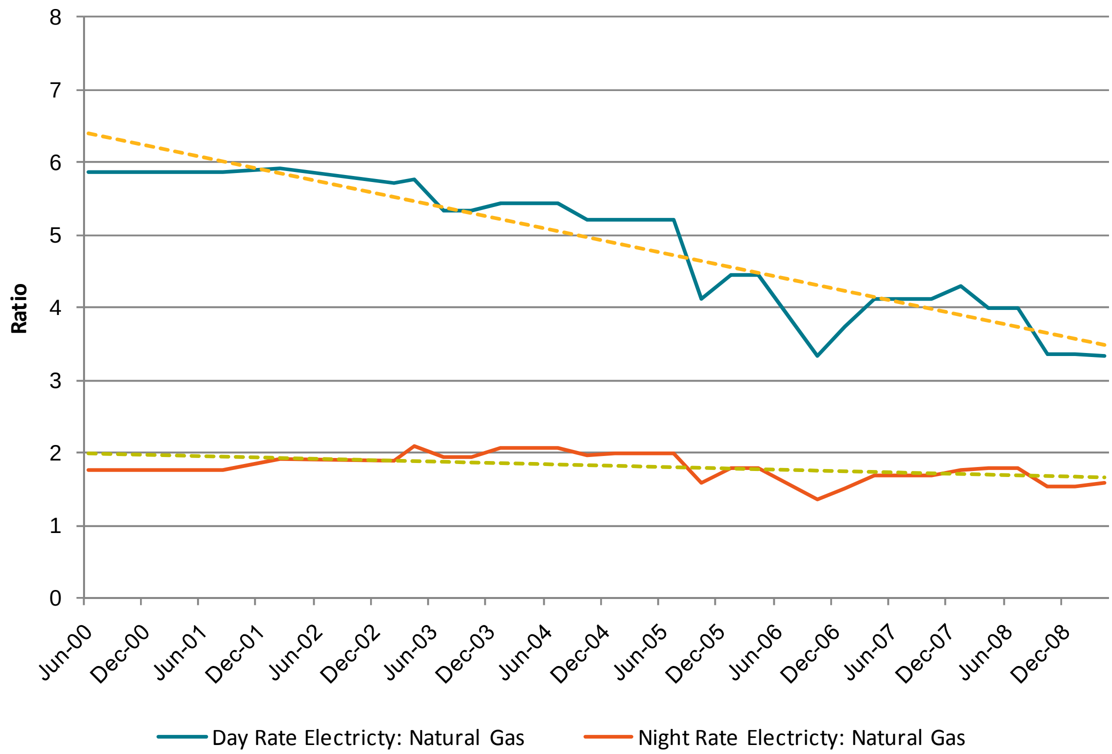


Figure 9 shows the trend in the ratio of day and night time electricity against the cost of natural gas in the commercial sector. Again, it can be seen that the spark gap has been decreasing, increasing the spark gap barrier.

Figure 9: Ratio of Day & Night Rate Electricity & Natural Gas in the Commercial Sector



It was also noted during our discussions with stakeholders that many CHP plants in the Services Sector only run for 5,200 hours per year, i.e. they are not run during the night time hours when the CHP owner can purchase night rate electricity cheaper than they can generate power using their CHP units and when there is reduced demand for heat.

6.3.4 Spark Gap in the Residential Sector

In the domestic sector, the spark gap for each of these three fuels has followed a similar trend to that in the commercial sector, except for kerosene for which the spark gap has increased (improved) more significantly than natural gas and biomass since mid-2008 (refer also to Section 6.3.4). This is shown in Figure 10, while Figure 11 shows the recent trend in electricity to gas prices between 2000 and 2008 for domestic consumers. As can be seen, the ratio is much higher (better) during the daytime electricity tariff than in periods when the night rate electricity tariff applies.

From this trend, it can be seen that the cost ratio of electricity to natural gas price has been trending lower since June 2000. In the first quarter of 2009, CER announced that both electricity and natural gas prices would be reduced by approximately 10% from July 2009. If both energy forms reduce by a similar percentage then the electricity to gas price ratio which existed as of July 2009 may not alter in the short term.

This analysis indicates that, based on fuel price alone, the economic viability for domestic scale CHP has not been improving over the last three years, although the economics of oil fired CHP may have been improving at the end of 2008 (notwithstanding our assessment in Section 6.5.3). It should be noted that the actual economic viability of CHP is site specific; this analysis only provides an indication of whether the situation is improving the prospects of CHP (whether the spark gap barrier is increasing).

Figure 10: Spark Gap in the Residential Sector

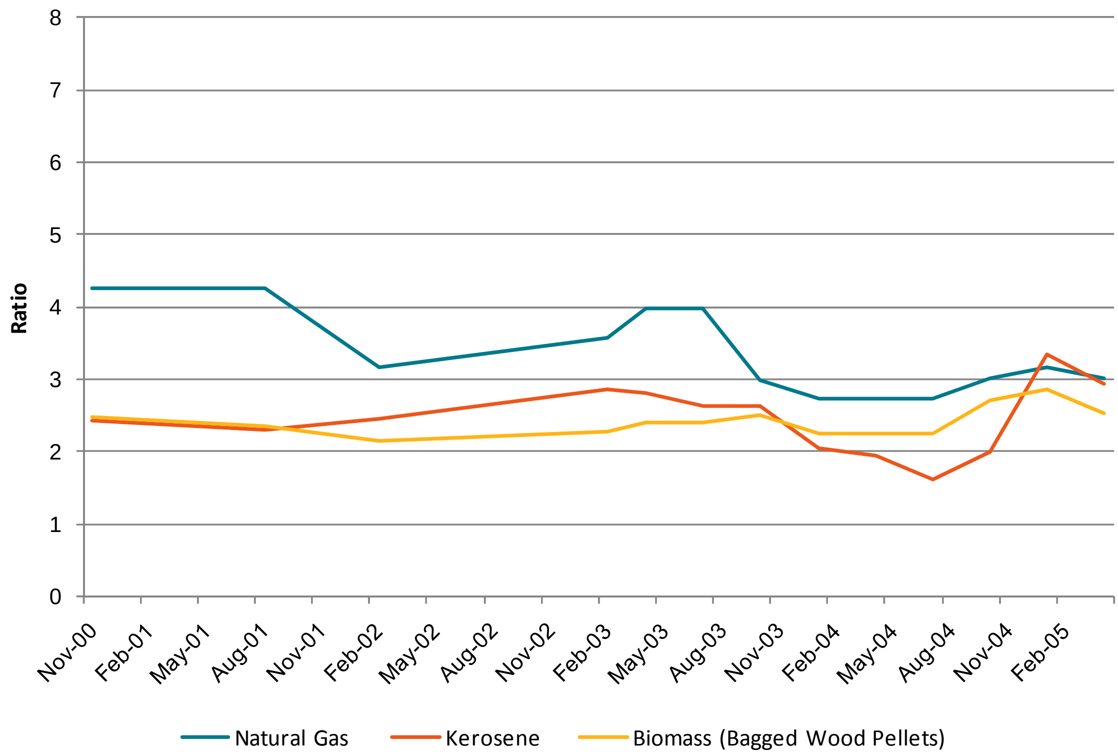
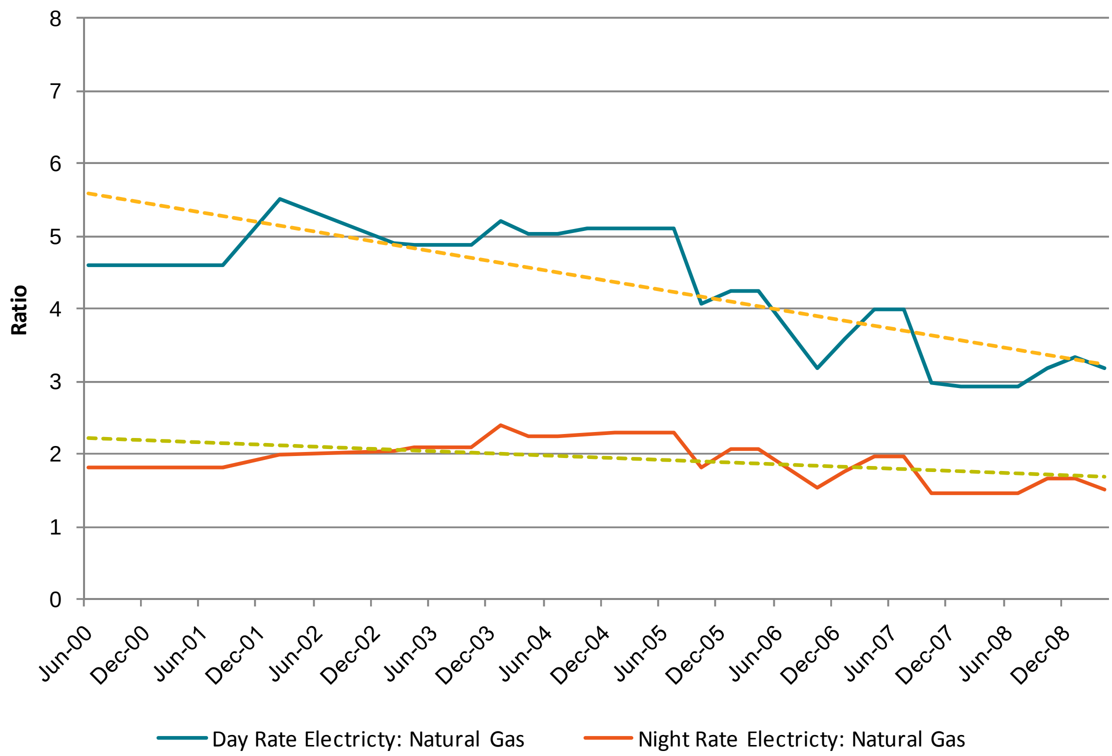


Figure 11: Ratio of Day & Night Rate Electricity & Natural Gas in the Residential Sector



6.4 Availability of Heat Loads

As outlined in Section 6.1.1, Ireland's industrial population is limited in terms of the heat loads available for CHP applications. While some of the largest industries in Ireland (cement & periclase manufacture and mining) consume a significant proportion of industrial fossil fuels and electricity, they are not suited to CHP due to the mismatch between the heat output from CHP plants and the thermal demand from the industry.

In addition, other large scale industries, such as the dairy sector, operate on a seasonal basis and thus, while the substantial heat load may be met by a CHP plant, its seasonal nature means that the economics can become unfavourable compared to plants with a year round 24/7 operating regime. Many of the major dairies have already invested in CHP plants limiting the prospects for major new capacity in the sector.

The barriers associated with the availability of heat loads in these three large industries are discussed in more detail in the following subsections.

6.4.1 CHP in Cement Manufacture

There is a significant electricity load associated with cement manufacture. The specific consumption of electricity is in the order of 100 kWh per tonne of clinker. A plant producing 1 million tonnes per year of clinker[35] will typically use in the order of 10 GWh of electricity per year. The total electricity consumed by the four cement plants in Ireland would, when producing at 4 million tonnes per year of clinker (the rate before the recent building slow down), require approximately 40 GWh per year (3.44 ktoe final energy).

[35] Two of the cement plants in Ireland (Irish Cement Platin and Quinn Cement at Scotstown) are in excess of this scale.

Cement manufacture also has a large thermal demand. In 2008, the use of coal and petroleum coke in industry was dominated by their use in cement kilns amounting to some 367 ktoe, or 4,268 GWh. This equates to 19% of all non electrical energy used by the whole of industry. If this fossil fuel energy were available as a target for CHP it would represent a significant percentage of industrial energy usage concentrated on just four sites.

However, the energy in the coal and petroleum coke is used to fire the cement kilns, which typically operate at 1,000°C and above. All cement plants in Ireland operate modern energy efficient 'dry process' technology. Since 2000, three new, modern cement kilns have been built -the Lagan Cement plant at Kinnegad, Quinn Cement at Scotstown and Irish Cement at its Platin facility (the latest kiln to be installed). It is important to note that in spite of their modern design, none of these kilns have incorporated CHP as part of that design.

From discussions with two of the cement plants in Ireland, and based on the grade of heat required by the process, we see no prospects for CHP in cement manufacture in spite of these high thermal and electrical loads.

6.4.2 Mining

Lead and zinc mining has a large electricity load and also uses substantial quantities of gas oil. From the 2008 Provisional National Energy Balance, we note that NACE Codes 13 (mining of metal ores) and 14 (other mining and quarrying) used 57 ktoe of electricity in 2008 and a further 35 ktoe of gas oil/diesel/DERV. From discussions with the sector, we understand that the major use of gas oil/DERV is for transport fuel for surface and underground trucks used to transport the mined ores. This particular fossil fuel component is thus not amenable to being supplied in the form of heat from CHP.

In recent years, the plant at Tara Mines has changed its ore processing route to one which eliminated the need for significant quantities of heavy fuel oil. The remaining thermal load on site is modest, amounting to approximately 300,000 to 350,000 litres of gas oil per year (depending on degree days in any year). Gas oil fired boilers are used to provide heating for administration and other offices. This represents an annual fuel demand of just 0.25 ktoe compared to approximately 13 to 14 ktoe of electricity[36].

The heat to power ratio is such that there is no prospect for CHP to back out any significant portion of the electricity used at the site. A similar situation on the heat to power ratio is likely to pertain at Lisheen Mine making CHP unlikely. However, this mine is scheduled for closure in 2014 making investment in CHP in the intervening period highly unlikely.

6.4.3 Dairies

Dairies exhibit a seasonal heat load and therefore plants cannot obtain the maximum run time (percentage on line time) for their CHP power generation capacity. In discussions with CHP stakeholders, it was indicated that this capacity could possibly be used for peak load operation in the seasons when dairies are not at full production (i.e. selling power to grid). However, discussions with a number of the individual dairies indicated that where CHP was installed, there has been a tendency not to operate it due to the poor economics of operating such plants on a seasonal basis and based on the current spark gap.

[36] Paper by Tadg Farrell, Boliden 2007.

6.5 Technological

While CHP technology has been available for many years, and has been utilised extensively in Continental Europe, the scale of the technology has tended towards larger CHP units, while the fuel dominating the market place, from a demand perspective, has been natural gas. As a result, the technology for small scale and micro scale CHP has lagged and it is only in recent years that micro-CHP suitable for small multiple occupancy or single dwellings has become available.

6.5.1 Micro-CHP

Micro-CHP units with a single phase electrical supply for use in single dwellings are not currently available in the Irish market. Somewhat larger gas engine units with a three phase electrical supply are available in Ireland and these have dominated the recent SEI Micro Demonstration Project. We note from discussions with the vendors that the German domestic market is based on a three phase supply and so the technology has seen a considerable uptake in the 5 kW_e range in this market.

The pace of development of micro-CHP technology at a scale suitable for installation in individual houses has been slow up to now and it is only within the last number of years that units of a suitable scale for domestic use have been subject to field trials. A number of manufacturers are, and have been, developing micro-CHP units suitable for single dwellings and we understand that these units may become more widely available on the Irish and UK markets between 2009 and 2010.

The modest pace of development of single dwelling CHP technology may also have been due to a lack of any incentive to export power to the grid in times of low electricity demand in the home. Refer also to Sections 6.2.4, 6.7 and 7.1.

6.5.2 Biomass CHP

In our discussions with large sites in the wood processing industry, a preference for the use of more advanced biomass technology was expressed, such as biomass gasification, rather than the more traditional systems currently used in Ireland. Gasification units are seen as having the potential to allow the operation of the unit on a variety of biomass inputs and therefore remove some of the barriers associated with the need to supply a constant grade and quantity of biomass. However, while gasification technology has been available for a number of years and there are several examples of megawatt scale biomass gasification-based CHP plants in Europe, the use of this technology at the scale of interest to major Irish industries is relatively recent.

More traditional biomass technologies (boilers and steam turbines) have been proven and continue to operate, and from this perspective do not present such a barrier to the uptake of this type of CHP; it is the availability of a biomass supply, the economics of the plant and the higher maintenance costs (compared to natural gas) that present the real barriers in terms of additional uptake.

6.5.3 Oil Fuels

The potential for oil-fired CHP to penetrate the Irish market is limited due to the lack of suitably sized units in the micro-CHP range and the higher costs associated with the maintenance of these units (as discussed in Section 3.2.2). Thus, while approximately 46% of houses with central heating in Ireland use oil as the fuel, it is unlikely that traditional oil-fired central heating systems will be displaced, or replaced, to a significant extent by micro-CHP units within the short to medium term.

However, as CHP technology develops, and depending on trends in the spark gap, oil fired units may become more attractive both economically and technically, thereby opening up significant markets in both the domestic and commercial sectors for consumers not connected to the natural gas grid and with little prospects of connection in the medium term.

In the meantime, we have recommended in Section 11 that a small scale pilot programme for oil fired micro CHP units be implemented when such domestic scale units come on to the market or for small commercial applications based on currently available technology. The economic viability of these pilot units will be dependent upon the spark gap between a kerosene heating oil and electricity which, as can be seen in Figure 8 and Figure 10 is lower (worse for investment) than for natural gas.

For larger sites and those in the commercial sector where the availability of space may be at a premium, the storage of oil to fire such CHP systems, if considered economically feasible, is an additional barrier.

6.6 Availability of Fuel

The availability, or otherwise, of fuels appropriate for CHP applications can present a significant barrier to its uptake.

6.6.1 Oil Fuels

In general, oil fuels are readily available throughout the country and, as they are stored at the point of use, are less sensitive to disruptions in distribution/supply channels than natural gas, although this has historically been very reliable. Therefore, we do not consider the availability of oil fuels to present a barrier to the uptake of CHP (although the suitability of such to fuel CHP units is a barrier, refer to Section 6.5).

6.6.2 Natural Gas

As outlined in Section 3.2.1, natural gas is available in 146 population centres within nineteen counties, with the extent of the natural gas pipelines shown in Figure 3. While this is a significant distribution area for natural gas, there remain large areas of the country without access to the grid and in some cases the prospects for the grid extending to particular areas of low population density may be remote within the short to medium term. Therefore, where there is potentially a market for gas fired CHP, for example from large industry in more rural parts of the country[37] or, as has been the case in recent years, the development of apartments or higher denser housing in rural population centres, the lack of a connection to the gas grid presents a significant barrier in these areas.

However, it should be noted that where particular sites are not connected to the grid but are close to it, it may be *technically* feasible to obtain an individual connection to the grid at the discretion of Bord Gáis. In this case, the cost of installing the connection may have to be borne by the end user rather than Bord Gáis. This can add another layer to this particular barrier.

[37] We are aware of at least one large pharmaceutical plant with a considerable potential for CHP but not currently connected to the natural gas grid.

6.6.3 Biomass

Biomass is considered to offer significant potential for renewable energy generation and in the context of CHP the Energy White Paper placed particular emphasis on the development and uptake of biomass fuelled CHP.

During the discussions when drawing up Ireland's National Plan for meeting our Kyoto obligations, a large number of hectares (14,000 ha per annum) were planned for planting out to 2020, and beyond, although only short rotation coppice and other relatively fast growing biomass crops will be available within the 2020 timeframe. This indicates that over this period there should be sufficient availability of biomass to meet the needs of any CHP plants. The wood processing sector already uses a substantial quantity of biomass for its boilers while two wood processing sites have installed biomass based CHP with a total installed capacity of 5.13 MW_e, with a third site recently provided with grant assistance under the CHP Deployment Programme.

A study by Electrowatt and Byrne Ó Cléirigh into the prospects for co-firing of biomass in power stations assessed the total potential energy available from biomass in 2010.

Table 9: Potential Energy Available from Biomass in 2010

Biomass Source	Available Energy (GWh)		Electrical Generation (MW_e)	
	Theoretical	Technical	Theoretical	Technical
Pulpwood	2,808	728	139	36
Sawmill Residues	2,389	624	118	31
Harvesting Residues	2,111	443	102	22
Meat & Bone Meal	552	276	27	14
Chicken Litter	340	86	17	4
Short Rotation Coppice (willow)	1,155	99	57	5
Straw	5,001	400	247	20
Spent Mushroom Compost	199	63	10	3
Tallow	705	328	35	16
Total (Note 1	**15,259**	**3,048**	**753**	**150**

Note 1: The total figures may differ due to rounding.

This study concluded that there would be the potential for approximately 150 MW_e to be generated from biomass. However, not all of this biomass would be available to CHP units. This is due to the competition for biomass supplies from other applications including, *inter alia*:

- Co-firing in Moneypoint and the peat fired[38] power stations;
- Use in boilers on rendering plants (tallow, MBM);
- Existing biomass CHP units;
- Biomass boilers (e.g. at current wood processing factories);
- Cement kilns.

The stakeholders in the wood processing sector have expressed the view that biomass availability is currently quite tight and that it may not be that easy to obtain the necessary supplies on which to base large CHP plants of the scale they might otherwise consider. It was also noted during our discussions with the large wood processors that these operators would not be self sufficient in supplying biomass if they were to install CHP. This highlights the barrier of biomass availability, as it indicates that even if these sites were not to install CHP themselves, they do not currently have spare biomass capacity and would not be in a position to supply significant quantities of biomass to other sites planning biomass CHP. If they were to install biomass fired CHP, they could place a significant strain on the biomass supply market, inevitably impacting on the cost of this fuel.

[38] Target for 30% of the thermal input to be from biomass so in competition with CHP for biomass fuels.

In our view, this is an area which requires further joint investigation by SEI, COFORD, Teagasc and the wood processors[39]. Biomass CHP has been identified as having significant potential for the last 10 years or more. However, with just 5.13 MW_e having been built to date (and with SEI support), with a further 3 MW_e due for completion in 2009, it is clear that barriers to the uptake of biomass CHP still remain. The other barriers, including economic and technical, are discussed in more detail in Sections 6.5 and 6.10.

In our discussions with the wood processors who are actively investigating the potential for CHP at their sites, it was noted that there may be other barriers associated with the biomass supply chain besides availability and supply shortages. The two barriers, which are closely related, are:

- The lack of brokerage services in Ireland for (large scale) biomass. While we recognise that there are biomass brokers operating in Ireland, there is a reported lack of demand for large scale biomass transactions at present and therefore the scale of the brokerage services may not be sufficient to service large scale biomass CHP plants.

- The (perceived) requirement to maintain a consistent quality of biomass. Certain CHP technologies can be sensitive to the biomass used to fire them and therefore, in order to ensure the efficient operation of such plants, a consistently high quality biomass may be required. The supply of such biomass may be difficult to source without access to larger biomass markets (such as the UK, Europe and Canada), and therefore a broker with experience in supplying biomass in large volumes internationally would be required.

6.7 Electricity Market

The generation of electricity in Ireland is governed by the Electricity Regulation Act, 1999, as amended, and applies to CHP operators whether they export to the grid or not. For those sites that install CHP solely to meet their own demands, the only requirements are to apply for authorisation from the CER to construct or reconstruct a generating station (refer to Section 6.7.1) and obtain a licence to generate electricity (refer to Section 6.7.2).

However, for those sites intending to export electricity to the grid, further barriers must be overcome, in particular securing a connection to the grid. In certain cases, the CHP project may also be subject to the European Communities Utilities Directive[40] (refer to Section 6.7.3).

6.7.1 Authorisation to Construct or Reconstruct a Generating Station

In September 2008, CER clarified the position in relation to the requirement to apply for an authorisation to construct or reconstruct a generating station[41]. Sites generating less than 1 MW_e are not *required to notify the Commission in order to stand duly authorised and/or licensed*. Sites generating greater than 1 MW_e are still required to apply for authorisation. However, the process is relatively straight forward and does not constitute a significant barrier, other than an administrative one.

[39] SEI is currently engaged in a bioenergy resource study which is due for completion in 2009.
[40] Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 co-ordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors
[41] Revised Process for the Authorisation and Licensing of Generation Stations – Clarification of Decision CER/07/128

6.7.2 Licence to Generate Electricity

In order to generate electricity in a CHP (or other) plant with a capacity greater than 1 MW_e, a licence must be obtained from the CER. In assessing the licence application, the CER may take into account *the availability of sufficient appropriate financial, managerial or technical resources to ensure that the generator is able to comply with the terms and conditions that govern the electricity generation licence*. Again, we do not consider that the requirement to obtain such a licence presents a significant barrier, other than the administrative procedure. However, this is based upon the premise that the CHP plant for which the application is made is meritorious. Generating stations with a capacity less than 1 MW_e are considered to stand *duly licensed*.

6.7.3 Utilities Directive

The Utilities Directive applies to both heat and electricity supplies, as follows:

(a) the provision or operation of fixed networks intended to provide a service to the public in connection with the production, transport or distribution of heat or electricity; or
(b) the supply of heat or electricity to such networks.

Thus, where a CHP operator intends to supply electricity to the grid, or heat to a district heating scheme (where one exists), the requirements of the Directive may apply, including the requirement to advertise in the Official Journal of the European Union. While the Directive is unlikely to affect the majority of CHP operators, and only a small number of those intending to export electricity or heat, the Directive is a significant administrative barrier, although this may be alleviated somewhat through a central information/advisory system (refer to Section 10).

6.7.4 Grid Connection

Connection to the electricity grid for export purposes is a significant barrier to the uptake of CHP where export is required to ensure the economic viability of the project. In order to supply electricity to final customers, a CHP operator must apply for a CHP Supply Licence.

Applications for connections greater than 500 kW_e are processed in a gate system whereby all applications deemed complete by a given date are processed in one batch. Based on their level of electrical interaction with each other and their geographic location, the applications within each gate are divided into specific groups by Eirgrid (the Transmission System Operator) and ESB Networks (the Distribution System Operator) for processing purposes. Due to the nature of this application system, a developer who submits an application today may face a multi-year wait before the project is connected to the network. The extent of the delay is dependent on the location of the project with respect to electrical load and other generators, its scale and the technology proposed.

However, there is a special provision for bypassing the lengthy Group Processing Approach for applicants seeking connections of less than 500 kW_e. Such applications are treated *on a case-by-case basis as deemed appropriate by the System Operators (ESB Networks) and approved by the Commission (CER)*. The applicant must demonstrate that processing the application in an accelerated timeframe would be in the public interest as distinct from a benefit to that individual generator. Furthermore, the application must not interact (electrically) with any other applications. The allocation of a connection is at the discretion of ESB Networks and the CER.

Therefore, under the current arrangements, the requirements for obtaining a connection to the grid for large scale CHP is a significant barrier, while the connection of small and micro-CHP is less hampered.

In addition, the CER recently consulted on the *Treatment of Small, Renewable and Low Carbon Generators outside the Group Processing Approach*[42]. This consultation set out to determine the criteria by which certain renewable and low carbon generators should be treated outside the Group Processing Approach (GPA) and also to make proposals regarding the treatment of small conventional generators. The Commission published its Decision Paper on this Consultation on 24th July 2009, with the revised treatment of these generators outside the group processing approach set out in Table 10[43].

Table 10: Treatment of Small, Renewable & Low Carbon Generators outside the GPA

Renewable – Non-Wind[Note 1]		**Conventional Projects**	
Processed through non GPA Process – must fulfil public interest criteria.		Processed through non GPA Process	Offers issued under the proposed Direction on Conventional Offer Issuance Criteria[Note 3]
≤ 5 MW	**> 5 MW**	**≤ 5 MW**	**> 5 MW**
Connection offers made without performing interaction[Note 2] studies	Interaction studies are performed. If no interactions, then connect. If interactions exist, then look at public interest benefits and the impacts of interaction on other applicants in the queue. If CER approves, then connect. If CER does not approve, then option to buy out interaction or remain in the GPA queue.	Interaction studies are performed. If no interactions are found to exist then they can proceed to be given a connection offer. If interactions exist then the conventional project will remain in the queue.	Exception: conventional autoproducers that are not in first 500 MW tranche. These could be processed through the non GPA process. Process allows for public interest criteria to move up the queue projects such as clean coal and includes high efficiency CHP.

Note 1: Non-Wind Renewable projects are defined as renewable projects that have a fuel source other than wind power and include biomass, hydro, high efficiency CHP and autoproducers (renewable including wind).

Note 2: Interactions: two applications are deemed to be interacting if progressing an earlier application outside the GPA results in an additional cost being incurred by other applicants in the GPA queue. Interaction studies relate to shallow connection.

Note 3: Proposed Direction on Conventional Offer Issuance Criteria, CER/09/114 (closing date 11th September 2009).

While the Decision has eased the barrier associated with obtaining a grid connection for certain types and scales of CHP project, large scale conventional (and non-high efficiency) CHP projects may not meet the criteria and therefore the barrier may remain, although the introduction of defined public interest criteria (diversity of fuel mix, predictability and power system support, environmental benefits and experiments/research) provides an opportunity for CHP projects to 'move up the queue' within the Group Processing Approach. Refer also to Section 7.14.

[42] Consultation Paper CER/09/044, closed on 30th April 2009. The Commission issued its Decision Paper on this consultation on 24th July 2009 which removes the administrative barriers associated with certain types and scales of CHP project in obtaining a grid connection. Reference should be made to Decision Paper CER/09/099 available from the CER website.

[43] Table 10 is an extract from CER Decision Paper CER/09/099.

6.7.5 Single Electricity Market

In consultation with IBEC CHP group the view was that the SEM has been neutral in terms of the uptake of CHP.

6.7.6 Public Service Obligation Levy

The Public Service Obligation (PSO) levy is an additional charge on electricity bills relating to the costs to ESB Public Electricity Supply (PES) of purchasing peat generated electricity and the output of renewable, sustainable or alternative forms of energy purchased under various Government schemes. The ESB is obliged by government to make these purchases in the interests of security of supply and environmental protection.

The PSO levy is charged to all electricity customers and is designed to recoup any additional costs incurred by ESB PES in meeting this obligation. There is no PSO levy currently imposed on electricity bills and therefore it was not specifically identified as a current barrier during consultation with the stakeholders. However, the mechanisms are in place for a non-zero PSO levy to be applied as the need arises, and it could therefore become a barrier if, for example, the support of particular higher cost technologies, such as wave power, were to lead to higher electricity prices. In this case, the imposition of the levy on CHP operators is considered a barrier by the industry as it is based solely on the maximum import capacity (MIC) of the site.

In general, most CHP sites which are set up to export to the grid will also need to maintain an import connection from the grid appropriate to their needs in order to provide sufficient back up. In normal operation of the CHP plant, the site may import little or no electricity from the grid but, as it has the *capacity* to import electricity up to its MIC, the PSO levy is imposed even at times when the site is not making (direct) use of the network.

Furthermore, the PSO levy is intended to support renewable, sustainable or alternative forms of energy. As the environmental and security of supply benefits of high efficiency CHP are recognised by the CER as being in the public interest[44] and the development of CHP is supported by the Government through the Energy White Paper and the CHP Deployment Programme, the current method of application of the PSO levy on sites with CHP is considered unhelpful, either directly or through the perception of sites interested in developing CHP capacity.

6.7.7 Use of System Charges

Transmission Use of System (TUoS) Charges and Distribution Use of System (DUoS) Charges are levied on generators that are connected to the transmission and distribution systems respectively. TUoS Charges are location-specific, i.e. they are calculated based on the precise location of the generator on the system. DUoS Charges are not location-specific; instead they are determined by the type of connection to the network. The tariffs are updated annually and are approved by the CER.

In general, Use of System Charges increases the cost of electricity and therefore may increase the spark gap, potentially improving the economic viability of CHP projects. However, tthese charges also impact on CHP installations, with the impact being different depending upon the specific operating mode of the site (MEC to MIC ratio, auto-producer status). While the current use of system charges take into account sites that both import from and export to the grid, the use of system charges are still considered by some industries to present a (potential) barrier to the uptake of CHP.

[44] Treatment of Small, Renewable and Low Carbon Generators outside the Group Processing Approach

6.7.8 Support Price for Sale of Electricity

There is currently only a limited support price for the sale of electricity to the grid from CHP installations. These support prices relate to biomass fired CHP plants, which are eligible under the Renewable Energy Feed in Tariff (REFIT) at a rate of €0.12 per kWh, and micro-CHP which is eligible for a feed in tariff of €0.19 per kWh within the domestic sector.

Larger scale fossil fuel fired CHP operators are not provided with any support prices for the sale of electricity to the grid, which is considered by some stakeholders to present a barrier to the uptake of CHP. However, as in other areas of exporting to the grid, this will only affect a small number of CHP operators, albeit at a potentially greater capacity.

6.7.9 Private Wire Networks

Private Wire Networks, whereby a generator sells electricity to a third party without using the ESB distribution (or transmission) system, are strictly controlled by legislation in Ireland[45]. This has been suggested as posing a significant barrier to particular CHP applications where a developer/landlord considers installing CHP with the intention of supplying electricity and heat to tenants or other adjacent premises. Under the current regulations for the supply of electricity, a CHP operator must make use of the electricity distribution (or transmission) system.

We are aware of at least one large scale CHP project for which this barrier is considered to exist. We also understand that smaller scale CHP installations in communal housing (apartments) have been installed but the scale of power generation has been limited to match the demand for the landlord controlled/maintained areas (i.e. the tenants are supplied with heat from the unit but must purchase electricity from the network). While it is clear that this has the potential to present a barrier to the uptake of CHP (for the reasons set out in Sections 6.7.4 to 6.7.7), at present it only applies to a limited number of projects.

It is acknowledged, however, that (new build) apartments present an opportunity for the uptake of CHP as they have both a heat and electrical demand. The increased experience of apartment living with the collection of service charges by managing agents makes the prospects of bill collection for electricity and heat more attractive to ESCos or management companies than would have been the case historically.

6.8 Competition with Other Technologies

In addition to setting out the objectives for the uptake of CHP, the Energy White Paper also sets out the objectives for other energy saving technologies and schemes, including the use and development of renewable energy.

SEI supports a range of other technologies in addition to CHP, some of which directly compete for the same market. In the residential and services sector the other programmes include grants for high efficiency boilers, for ground source heat pumps, geothermal energy and biomass boilers. While competition in the market place is advantageous in reducing the costs associated with the technologies in the longer term, it has the potential to result in inefficient prioritisation of supports for these technologies in the absence of a detailed comparison of the benefits and drawbacks associated with each.

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[45] Section 37 of the Electricity Regulation Act, 1999, provides scope for direct line (private wire) systems to be installed at the discretion of the CER.

6.8.1 High Efficiency Natural Gas Boilers

Domestic scale CHP units will face significant competition from modern high efficiency condensing boilers, many of which can achieve seasonal efficiencies of over 90%. The balancing of domestic electricity and thermal demands may also prove difficult to control, and without the appropriate balance, CHP units in individual houses may be used for electricity generation with the heat being wasted when not needed. In this case, natural gas boilers combined with electricity purchased from the grid may prove to be more viable for the end user.

It is acknowledged that, in general, domestic CHP units are sized to meet the heat demand of the household, but with an attractive feed in tariff of €0.19 per kWh, the balance between electrical and heat output may adjusted to improve the economic viability for the dwelling owner without maintaining the definition of high efficiency CHP for periods of the year. In addition, if the CHP unit is used primarily for electricity generation with little or none of the heat utilised, it may no longer qualify as a CHP unit (refer to Section 3.1).

6.8.2 Geothermal, Biomass & Solar Thermal Energy

Geothermal energy (direct and indirect use), solar thermal energy and biomass (including anaerobic digestion technologies) are targeted at the same market as small and micro scale CHP (and to a certain extent, the larger scale CHP market). (We are not considering geothermal or biomass fired CHP in this section.) Biomass boilers are a proven technology and are widely used at all scales in the Irish market, while anaerobic digestion units are proven in Europe and are present in a small number of municipal waste water treatment plants in Ireland. In addition, biomass boiler technology is relatively simple compared to CHP as it does not require electrical interconnection or smart metering.

Similarly, while geothermal energy applications are not as widely utilised in the Irish market, they also have the potential to compete for the CHP market, while solar energy units have increased their market share in recent years in providing hot water in both the commercial and domestic sectors.

However, while these technologies compete with CHP and can therefore be considered as a barrier, they are a positive factor in terms of Ireland's overall energy policy and efficiency targets, although the merits of each technology should be formally established in terms of efficiency and CO_2 savings.

6.9 Competition with Energy Saving Programmes

Recent years have seen a large focus on energy efficiency across the industrial, commercial and residential sectors, driven by increasing energy costs and legislation (the 2008 Building Regulations, the Energy Performance of Buildings Directive, the IPPC Directive and the EU Emissions Trading System).

These energy saving drivers and programmes are clearly beneficial to Ireland, but may prove to be a barrier to the uptake of CHP. In short, the reduction in energy demand will reduce the demand, and thereby the potential savings, from existing or potential CHP units, while in some cases energy savings may eliminate the potential for CHP entirely, as the economic viability tends to reduce on a declining scale.

6.9.1 Industrial Energy Reduction Programmes

Large scale energy users have the opportunity to make significant energy savings through efficient use of existing plant. In our discussions with individual sites, the use of such measures is considered a more logical first step compared to the installation of new technology, with the associated capital cost, to meet inefficient energy demands. In terms of achieving a reduction in Ireland's overall energy demand, we agree. Although this approach is a barrier to the uptake of CHP, it can be seen as a positive barrier (as can the use of competing technologies, Section 6.8) but, in the medium to longer term (2015 to 2020) once the efficiency of existing plant has been improved, CHP may then become more attractive to meet the remaining energy demand of the site, albeit on a smaller scale than current demand might warrant.

6.9.2 Home Energy Saving Scheme & Warmer Homes Scheme

The Government has embarked on a Home Energy Saving Scheme (for private middle income homes) and a Warmer Homes Scheme (for low income private homes and rented local authority housing), which will provide €100 million in grants for a range of energy efficiency measures (€50 million for each of the two schemes).

The Home Energy Saving Scheme includes the retrofitting of insulation (both roof and wall), improvements in heating controls and a grant of up to €700 for installing a high efficiency gas or oil fired boiler with upgraded heating controls (refer to Section 6.8.1). For the homeowners that avail of this scheme, the energy demand of their houses will decrease and therefore the advantages of CHP may decline, particularly as the scheme is aimed primarily at a reduction in thermal demand, although there are electricity saving schemes in place. As the development of micro-CHP technology is still at a relatively early stage, reducing the domestic energy demand will require yet smaller scale CHP units. However, extending the Home Energy Saving Scheme to include micro-CHP units would (partially) remove this barrier.

The Warmer Homes Scheme assists homes in or at risk of fuel poverty and provides funding to Community Based Organisations for the installation of energy efficiency measures in low income dwellings, including insulation (attic and wall), draft proofing, lagging jackets and low energy light bulbs.

6.10 Management & Operation

In general, CHP is not a core activity within industry and therefore the installation of a CHP plant would require external expertise to develop the plant and to train the site operators in its operation. The alternative to owning and operating the plant by the site operator is to enter into agreement with an ESCo to manage and operate the unit. While the lack of expertise in the operation of a CHP plant is a barrier, the majority of industrial sites would be expected to have the resources to expand their in-house expertise in this area, while the commercial sector can make use of ESCos to manage this process (the majority of CHP units that have been installed in the commercial / services sector have been promoted by and undertaken by ESCos).

6.11 Interaction with Regulatory and Promotional Agencies

In our discussions with CHP Ireland and with individual sites who expressed interest in the potential for CHP, the interaction between the stakeholders and State Agencies was considered to be a barrier, although this was mainly the case where sites intended to export electricity to the grid and therefore required the appropriate licences and permits from the CER and Eirgrid / ESB Networks (refer to Sections 6.7 and 6.12).

6.12 Availability of Information

One of the recurring barriers identified during our discussions with CHP stakeholders and industry was a (perceived) lack of a centralised source of information encompassing all aspects of CHP. The marketing (or absence of marketing) of CHP was also seen as a barrier[46].

The main outcomes from the consultations were:

1. There is no central source of information regarding grants, other supports, licensing, and relevant agencies.

2. One site consulted was studying a CHP plant but was unaware of CHP grant availability in spite of the fact that data is readily accessible on the SEI website.

3. There is no 'road map' to guide prospective CHP installations in the process of installation CHP.

4. There is a degree of uncertainty regarding the level of permitting needed if developers do not intend to export to the grid, although this may be due to the presentation of information rather than the availability of it.

6.13 Definition of CHP

The definition of CHP and the associated requirements for considering electricity and heat generation as cogeneration is summarised in Section 3.1. These definitions may present a barrier to the uptake of CHP.

The term *economically justifiable demand* defined in the Cogeneration Directive may present a barrier to the uptake of CHP if this uptake is to be promoted through financial support mechanisms. The question arises as to whether the use of a specific technology only when supported by a (partial) grant meets an *economically justifiable demand*. It may be argued that the economic justification is to be viewed from a national perspective and therefore grant aid to encourage the uptake of energy efficient technology is justifiable, particularly as the Directive is intended to encourage such uptake.

6.14 Risk Aversion

During our consultations with stakeholders and industry, one site considering CHP expressed reluctance to supply heat to a specific third party (a hospital campus) due to corporate concerns (liability) relating to the reliability of the heat supply. The generating site's concern related to the potential adverse impact on the hospital and patients/residents if the heat supply were to be interrupted. While we recognise that this may be perceived as a barrier by potential heat suppliers, we do not consider that it is significant and that if a hospital (or other customer) were to source heat from a CHP installation, sufficient technical (standby) and contractual safe guards could be provided to protect both parties[47].

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[46] We are aware of at least one large site with the potential for, and interest in, CHP that was unaware of SEI CHP Grant Scheme. While the barrier may not rest with SEI (or CHP Ireland) in this particular case, it highlights the fact that not all industry is aware of the resources or CHP supports available to it.

[47] The district heating model including supplying heat to hospitals is well proven in Europe and we do not see this as an insurmountable barrier.

6.15 Summary of Identified Barriers

Table 12 summarises the status of the barriers identified in the current and previous CHP studies. The five status ratings are defined in Table 11.

Table 11: Definitions of Barrier Status

Status	Definition
Removed barrier	No longer considered to present a barrier to the uptake of CHP, all other barriers being removed.
Remaining barrier	Still considered to present a barrier irrespective of whether other barriers are removed.
Partial barrier	A barrier that has been partially removed, either through direct measures (e.g. extension of the gas grid) or indirect measures (changes in electricity grid connection process), but still presents an obstacle to the uptake of CHP in certain cases.
New barrier	A barrier that has been identified in the current study (which may have been present previously) and is limiting the potential uptake of CHP.
Perceived barrier	The barrier was identified (either in this report or in previous studies) but, in our opinion, does not present a significant practical obstacle to the uptake of CHP.

Table 12: Summary Status of Identified Barriers

Area	Barrier	Status
Socio-Economic Structure Of Ireland	Industrial Population	Remaining Barrier
	Services / Commercial Structure	Partial Barrier
	Housing Market & Population Distribution	Partial Barrier
Economic	Economic Viability	Remaining Barrier
	Corporate Investment Criteria	New Barrier
	Availability of Funding	Removed Barrier
	Grant Assistance	Partial / New Barrier
Fuel Prices	Spark Gap	Partial Barrier
Availability Of Heat Loads	Cement Manufacture	Remaining Barrier
	Mining	Remaining Barrier
	Dairies	Partial Barrier
Technological	Micro-CHP	Removed Barrier
	Biomass CHP	Partial Barrier
	Oil Fuels	Partial Barrier
Availability Of Fuel	Natural Gas	Partial Barrier
	Biomass	Remaining Barrier
Electricity Market	Authorisation to Construct or Reconstruct a Generating Station	Removed Barrier
	Licence to Generate Electricity	Removed Barrier
	Utilities Directive	Partial Barrier
	Grid Connection	Partial Barrier
	Single Electricity Market	Removed Barrier
	Public Service Obligation Levy	Partial / Removed Barrier
	Use Of System Charges	Partial Barrier
	Support Price For Sale Of Electricity	Partial Barrier
	Private Wire Networks	Partial / Perceived Barrier
Competition With Other Technologies	High Efficiency Natural Gas Boilers	New Barrier
	Geothermal Energy & Biomass Boilers	New Barrier
Competition With Energy Saving Programmes	Industrial Energy Reduction Programmes	New Barrier
	Home Energy Saving Scheme	New Barrier
Other	Management & Operation	New Barrier
	Interaction with Regulatory and Promotional Agencies	Partial Barrier
	Availability Of Information	New Barrier
	Definition Of CHP	Partial Barrier
	Risk Aversion	New Barrier

7. Supports for CHP

Before considering the measures required to remove or ease the existing barriers identified in Section 6, it is important to consider the existing supports, either direct or indirect, for the uptake of CHP. In the following subsections, we provide an overview of the significant supports currently available. It should be noted that some of the barriers identified in Section 6 may also be considered as supports in particular circumstances. For example, while technological developments may limit the current and short term uptake of CHP, the development in this area will ultimately support the medium to longer term uptake of CHP. Similarly, while the current SEI Deployment Programme is a barrier to larger scale fossil fuel fired CHP projects, it is clearly a strong supporter of small scale CHP and biomass / anaerobic digestion fired CHP.

7.1 SEI CHP Deployment Programme

As described in Section 6.2.4, there is currently an SEI Deployment Programme providing grant support for CHP units with a capacity of 999 kW_e or below for fossil fuels and with no cap for biomass CHP. The Programme has been allocated €11 million for both fossil fuel and biomass / anaerobic digestion fired CHP in both capital grant aid and support for feasibility studies. A significant portion of this funding has been ear marked for biomass CHP schemes.

7.2 Accelerated Capital Allowances

The Accelerated Capital Allowances (ACA) scheme, introduced under the Finance Act (No. 2) 2008, is an incentive to encourage businesses to invest in certain qualifying energy efficient equipment and technology, including co-generation (CHP) and trigeration equipment. The scheme allows for the capital investment on qualifying equipment to be deducted from the pre-tax profit of the business in the year in which the investment was made, thereby reducing the overall (corporation) tax burden. In addition, wear and tear allowances for machinery or plant that are generally given over an eight year period at an annual rate of 12.5% of the capital expenditure incurred is accelerated for eligible equipment and the entire allowance can be claimed in the first year.

In the case where the eligible equipment is purchased on the basis of capital grant support, the portion of expenditure not covered by grant aid can still be claimed for under ACA.

In order to qualify under ACA, the minimum investment required for CHP (and trigeneration) equipment is €1,000 in a 12-month period, which can provide savings of just under €110 per €1,000 invested over the equivalent expenditure on non-eligible equipment. An example of this is shown in Table 13.

Table 13: Example of Savings under ACA

	Non-Eligible Equipment (Standard Capital Allowance)	**Eligible Equipment (ACA)**
Pre-Tax Profit	€100,000	€100,000
Capital Investment	€24,000	€24,000
Allowance	12.5% €3,000	100% €24,000
Taxable Profit	€97,000	€76,000
Corporation Tax (@ 12.5%)	€12,125	€9,500
Saving	-	***€2,625***

The criteria that apply to CHP equipment in order for it to qualify under ACA are set out in Table 14.

Table 14: CHP Eligibility Criteria under ACA

	Condition
1	All equipment and/or components must be CE marked as required by the specific EU directive(s).
2	Appropriate operating and maintenance manuals must be available for the end user as part of the main contract of sale in order to optimise the achievement of any potential efficiency improvements.
3	The CHP unit must be a packaged unit with the power generation section and heat recovery section contained within a single enclosure, and should consist of a single prime mover.
4	Units must have a minimum overall efficiency (thermal + electricity) as specified below: ≤ 400 kW_e 89% > 400 kW_e 87%
5	The unit must have installed software to record levels of electricity and heat generated over a running period.
6	The CHP Unit must include one main heat output system i.e. a single system recovering heat from the prime mover and the exhaust gasses, and must have no inbuilt facility to dump heat.
7	Must comply with IEC 60034-1:2004 "Rotating electrical machines - Rating and performance". **and** Reciprocating engine CHP units must also comply with ISO 3046- 1:2002 "Reciprocating internal combustion engines - Performance - Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use".
8 [Note 1]	The heat & power element of the Trigeneration system must comply with the eligibility criteria for CHP units.
9 [Note 1]	The Absorption chiller must use the CHP heat source as its primary energy input. (The chiller should be an "indirect fired" Absorption chiller).
10 [Note 1]	The Absorption chiller must have a minimum COP of 0.7
11 [Note 1]	The Absorption chiller must meet and be tested according to the standard ARI (ANSI/ARI) 560-2000 "Absorption Water Chilling and Water Heating Packages".
12 [Note 1]	The units must have installed software to record levels of cooling achieved.

Note 1: Conditions 8 to 12 only apply to trigeneration equipment.

More information on the Accelerated Capital Allowances scheme and the eligible equipment is available from Sustainable Energy Ireland and the Office of the Revenue Commissioners.

7.3 Energy Performance of Buildings Directive

The EU Directive on the Energy Performance of Buildings (EPBD)[48] contains a range of provisions aimed at improving the energy performance of residential and non-residential buildings, both new-build and existing. The Directive requires that:

> *For new buildings with a total useful floor area over 1,000 m^2, Member States shall ensure that the technical, environmental and economic feasibility of alternative systems such as:*
>
> - *decentralised energy supply systems based on renewable energy,*
> - *CHP,*
> - *district or block heating or cooling, if available,*
> - *heat pumps, under certain conditions,*
>
> *is considered and is taken into account before construction starts.*

The requirements under this Directive for residential buildings are set out in the Building Regulations 1997 – 2008 (refer to Section 7.4). In addition, a Building Energy Rating (BER) certificate, which is effectively an energy label, is required at the point of sale or rental of a building, or on completion of a new building. As CHP qualifies as an energy efficient technology, the use of this technology will improve the BER rating for the building.

7.4 2008 Building Regulations

Technical Guidance Document L (Conservation of Fuel and Energy – Dwellings), 2008, provides guidance on the implementation of the Building Regulations 1997 – 2008. In relation to renewable energy technologies, this guidance document states, in Section 1.2:

> *As an alternative to providing 10 kWh/m^2/annum thermal energy (or 4 kWh/m^2/annum electrical energy) from renewable technology sources, the use of a small scale combined heat and power (CHP) system which contributes to the space and water heating energy use would be acceptable. This approach may be appropriate in some high density developments, e.g. apartment and mixed use developments.*

7.5 Turnover of Housing Stock

In addition to the construction of new houses needed to accommodate increased population, there is also an additional potential market for CHP energy in other new houses. This is the group of new houses which are continually being built to replace older, obsolete houses on existing plots where an old house is demolished to accommodate the new house. To estimate the number of such houses in this market, we have assumed an obsolescence and replacement rate for existing houses at a conservative 1% per annum[49]. This assumes an average building life of 100 years to replacement and leads to a value of approximately 19,250 new houses being built annually as replacement dwellings on existing plots.

We estimate that the total number of new houses constructed annually under the CSO low population growth scenario to be approximately 28,250. A higher rate of population growth or a higher turnover of the housing stock, or a move towards a lower average occupancy per household could clearly increase this number of new build houses.

[48] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.
[49] Based on total house numbers 1.925 million at end 2008 (not just occupied households of which there were 1.46 million identified in Census 2006).

There may also be significant potential opportunities for installing domestic scale micro CHP as retrofit projects in situations where home owners elect to upgrade or replace their existing gas boilers. This can be where old boilers are low in efficiency or which break down and are in need of replacement. Table 15 summarises the potential target opportunities for domestic scale CHP.

Table 15: Potential Target Markets for Micro-CHP in 2020 – CSO Low Growth Scenario

Potential Target Markets for CHP Micro Generation	Annual Rate 2009-2020	Total Market Opportunities 2009 to 2020
New Build Houses to meet population increase	9,000	99,000
"Brownfield" replacement of existing houses (obsolescence)	19,250	211,750
Replacement / Upgrading of Gas Fired Central Heating Boilers/Systems	31,500	346,500
Total Number of residential projects where Micro CHP could be considered in theory.	***59,750***	***657,250***

The current surplus of housing already built but not sold has not been specifically factored into the above growth forecast and this may dampen demand for new house building in the medium term but should not impact on the rate of turnover of old gas boilers.

The main targets for micro-CHP are the three groups in the above table. We have sought to estimate the likely percentage penetration and to derive the potential for CHP energy in these different market segments. In our view, the percentage penetration of CHP could vary somewhat between new build houses. In new houses, the cost of a CHP unit may be seen as a small percentage of the total project cost. In a replacement/refurbishment project, the cost of a CHP unit will be compared directly with the alternative which, in many cases, will be a switch to a condensing gas fired boiler.

We would consider a high success rate if 5% of the opportunities in the table above elected to install CHP by 2020. This would represent approximately 33,000 houses by 2020 under the CSO low population growth forecast which, in turn, would represent an electrical generation capacity of 33 MW_e from CHP. These units would invariably be installed in houses connected to the natural gas grid, although with developments in micro-scale oil fired CHP units they may also penetrate into housing which is not connected to the natural gas grid.

7.6 Implication of Higher Population Growth

In our assessment of the potential growth in the domestic / residential sector, we have adopted the CSO's low growth scenario in light of the current economic climate. However, if the economy were to recover with a subsequent return to the CSO's traditional growth rate scenario, the uptake of CHP may improve, with the potential as set out in Table 16.

Table 16: Potential Target Markets for CHP in Residential Sector in 2020 – Traditional Growth Scenario (CSO)

Potential Target Markets for CHP Micro Generation	Annual Rate 2009-2020	Total Target Market 2009 to 2020
New Build Houses to meet population increase	26,032	312,384
"Brownfield" replacement of existing houses (obsolescence)	19,250	231,000
Replacement / Upgrading of Central Heating Boilers/Systems	31,500	346500
Total Number of domestic scale projects where micro CHP could potentially have a role.	***76,782***	***889,884***

7.7 EU Emissions Trading System

The economics of CHP may vary depending on whether the site which is considering the technology is inside or outside the EU Emission Trading System. For smaller sites which are outside the system, the EU ETS has several impacts. Firstly, the price of electricity now includes the cost of electricity generators buying carbon credits if their emissions exceed their allowances permitted under the system. Therefore, a site generating electricity in a CHP plant would reduce the quantity of electricity purchased from the grid and therefore reduce the cost associated with the buying of carbon credits by electricity generators. However, the overall economics of the CHP installation would need to be considered.

For sites within the EU ETS there is a CHP set aside allowance of emissions for new CHP capacity. This enables promoters of new CHP capacity to obtain carbon credits from the Environmental Protection Agency to compensate them for the fact that they are generating electricity on site.

7.8 Carbon Tax

The Government has tasked the Commission on Taxation to advise it on the introduction of a carbon tax. The Commission is due to deliver its findings in the latter half of 2009 and, in light of comments made during the supplementary budget in April 2009, it appears that there is strong support for the introduction of this tax. While the mechanisms surrounding its implementation are a matter for the Commission, it is expected to take the form of a cost per tonne of CO_2 emitted from the combustion of fossil fuels.

As different fossil fuels have different CO_2 emission factors per available energy, such a tax will favour the 'cleaner' fuels such as natural gas, while carbon neutral fuels such as biomass are likely to fall outside the scope of the system. As CHP provides a highly energy efficient method of electricity and heat generation, this technology may receive more interest following introduction of the carbon tax.

7.9 CO_2 Savings

It is recognised in the National Climate Change Strategy that the use of high efficiency CHP can offer savings in the order of 1,000 tonnes of CO_2 per annum per megawatt of installed CHP electrical capacity (the precise savings will vary from installation to installation, dependent on the scale of the plant, the technology and the annual operating hours). Ireland has been set an emissions limit ceiling of an average of 63 million tonnes of CO_2 equivalent for the period 2008 to 2012. In 2008, Ireland's emissions were in the order of 70 million tonnes of CO_2 equivalent. Thus, while the installation of such CHP technology will not contribute significantly to meeting the emissions ceiling, it is a positive contribution.

7.10 Energy Supply Companies (ESCo)

The role of ESCos has been positive in promoting CHP, in managing projects on behalf of developers and other sites, in providing support and expertise in the operation of the plants and in maintaining the CHP units. They are therefore an important part of the marketing of CHP, while the availability of SEI grants for CHP has been an important selling tool for ESCos to promote interest in developing CHP schemes in all sectors.

7.11 Developing Technologies

As outlined at the beginning of this Section, the barriers identified in relation to CHP uptake also present a support in the longer term. While micro-CHP technologies are still being developed and are not currently widely available for the Irish domestic market, advances in this technology will see the introduction of small scale CHP units in the medium term.

Similarly, the development of more advanced biomass technologies, such as gasification, continues and, although the technology may not be immediately taken up in the Irish market, it will develop and improve in the medium term.

7.12 IBEC CHP Ireland Group

CHP Ireland is the IBEC group which represents combined heat and power developers and users. Its role is to promote the uptake of CHP in Ireland, with a view to realising the full potential of combined heat and power technology as one of the solutions for the achievement of Ireland's energy policy goals to 2020.

The group consists of IBEC, ESCos, CHP technology suppliers and end user representatives. It provides a useful forum for identifying opportunities for the uptake of CHP and contributed to the current study in identifying the barriers to growth in CHP capacity. It is therefore a significant support mechanism for future growth of CHP.

7.13 Irish CHP Association

The Irish CHP Association *promotes best practice in Combined Heat & Power in Ireland*. Its website (www.ichpa.com) contains useful information on CHP in Ireland, guidance on the selection of CHP technologies and an overview of the process required to establish a CHP plant (the licensing / permitting requirements). From this perspective, the ICHPA is a significant support for the uptake of CHP, although some of the information contained in the website is out of date. Refer to Section 10.

7.14 Commission for Energy Regulation

In its consultation document *Treatment of Small, Renewable and Low Carbon Generators outside the Group Processing Approach* published in March 2009, the CER states the following:

> *CHP schemes are able to achieve fuel conversion efficiencies of around 90% and there are also energy and environmental benefits to be realised. The earlier schemes favoured natural gas but this is changing and biomass fuels are now being used. The CHP plant is normally sized to the base heat load demand for the industrial or commercial facility it serves. Such an approach should result in the optimum level of heat utilisation and potentially therefore the greatest environmental benefits.*
>
> *Even where the fuel is natural gas high efficiency CHP would be expected to deliver environmental benefits in terms of the reduction of greenhouse gas emissions as it would be expect to replace less efficient boilers, usually fired on oil. Also it is likely that the main heat customer of a CHP plant would also have a significant electricity demand.*
>
> *The collocation of electricity production and consumption has the benefit of reducing system losses. CHP can also be considered a base load plant which can be predictable and controllable by the System Operator. While the provision of operating reserve by a CHP plant would not be its normal operating mode, the technology is generally capable of providing it. Therefore, in terms of the environmental and security of supply benefits the Commission concludes that high efficiency CHP (even where the fuel source is not renewable) would be in the public interest.*

In its Decision Paper on this consultation, the CER reiterates the benefits of CHP, including natural gas fired CHP. In particular, the CER concludes that *high efficiency CHP (even where the fuel source is not renewable) would be in the public interest.*

8. Future Potential for CHP & Distance to Targets

In assessing the potential growth of CHP in Ireland under the three Uptake Scenarios, we have taken into consideration the historic rate of CHP growth, the barriers discussed in detail in Section 6 and the supports in Section 7. The following tables summarise our view of the realisable potential for (active) CHP out to 2020 under the three scenarios.

Table 17: Projected Capacity of Installed Active CHP (kW_e) – Low Uptake Scenario

Sector	Sub-Sector	2006	2008	2010	2020
Industrial	Aughinish Alumina	160,000	160,000	160,000	160,000
	Other CHP Power Generation	0	0	0	0
	Food	81,590	50,773	50,773	52,000
	Manufacturing	6,610	15,661	14,000	20,000
	Mining	5,200	0	0	0
	Pharmaceutical	11,560	11,169	13,000	16,900
	Other	8,235	6,870	6,870	0
Sub-Total		*273,195*	*244,473*	*244,643*	*248,900*
Services	Hospital	5,765	6,903	6,903	8,900
	Hotel	9,070	11,781	13,136	26,691
	Public Sector	2,452	2,016	1,600	2,100
	Airport	4,380	7,316	7,316	7,316
	Education	4,234	5,338	5,890	7,660
	Office	4,716	3,578	2,440	3,200
	Other	1,108	6,833	9,696	12,600
	Leisure	2,856	4,580	5,442	7,100
Sub-Total		*34,581*	*48,343*	*52,423*	*75,567*
Other	Residential Single Unit	0	0	0	20,000
	Residential & Mixed Use	-	11	16	51
	Peat Briquetting	-	5,600	5,600	2,800
	Waste-to-Energy (incl. district heating)	-	0	0	18,700
	Other Waste*	-	6	12	40
	Agriculture	-	230	230	300
Sub-Total		*1,741*	*5,847*	*5,858*	*41,891*
Total		***309,517***	***298,663***	***302,924***	***366,358***
Target		**-**	**-**	**400,000**	**800,000**
Distance to Target		**-**	**-**	**97,076**	**433,642**

* Use of CHP technology at waste handling sites, not necessarily fired on waste material. It does not include the use of landfill gas for electricity generation (refer to Section 3.2.5)

Figure 12: Potential Installed Active CHP Capacity – Low Uptake Scenario

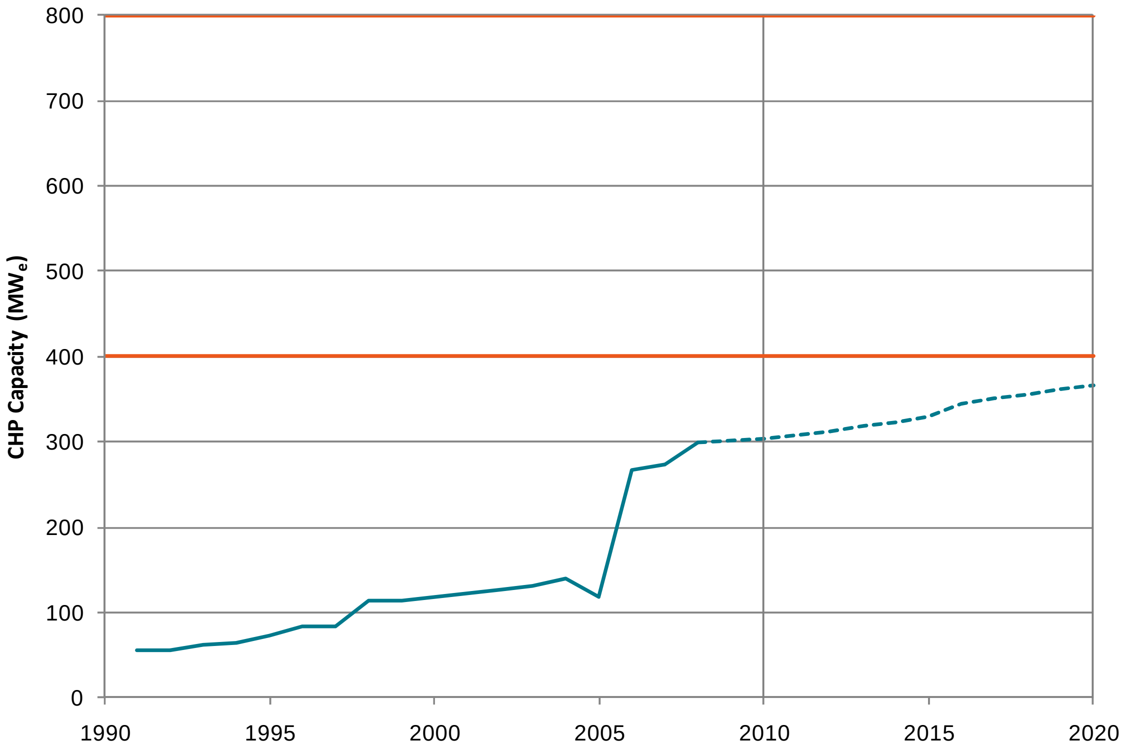


Table 18: Projected Capacity of Installed Active CHP (kW_e) – Medium Uptake Scenario

Sector	Sub-Sector	2006	2008	2010	2020
Industrial	Aughinish Alumina	160,000	160,000	160,000	235,000
	Other CHP Power Generation	0	0	0	50,000
	Food	81,590	50,773	51,000	59,000
	Manufacturing	6,610	15,661	14,800	53,000
	Mining	5,200	0	0	0
	Pharmaceutical	11,560	11,169	13,000	27,000
	Other	8,235	6,870	6,870	6,870
Sub-Total		*273,195*	*244,473*	*245,670*	*430,870*
Services	Hospital	5,765	6,903	7,400	13,450
	Hotel	9,070	11,781	13,800	31,700
	Public Sector	2,452	2,016	1,900	3,150
	Airport	4,380	7,316	7,316	7,316
	Education	4,234	5,338	6,100	8,580
	Office	4,716	3,578	3,000	5,100
	Other	1,108	6,833	9,696	15,800
	Leisure	2,856	4,580	5,442	8,150
Sub-Total		*34,581*	*48,343*	*54,654*	*93,246*
Other	Residential Single Unit	0	0	0	31,000
	Residential & Mixed Use	-	11	24	200
	Peat Briquetting	-	5,600	5,600	5,600
	Waste-to-Energy (incl. district heating)	-	0	0	66,000
	Other Waste*	-	6	21	95
	Agriculture	-	230	230	350
Sub-Total		*1,741*	*5,847*	*5,875*	*103,245*
Total		***309,517***	***298,663***	***306,199***	***627,361***
Target		**-**	**-**	**400,000**	**800,000**
Distance to Target		**-**	**-**	**93,801**	**172,639**

* Use of CHP technology at waste handling sites, not necessarily fired on waste material. It does not include the use of landfill gas for electricity generation (refer to Section 3.2.5)

Figure 13: Potential Installed Active CHP Capacity – Medium Uptake Scenario

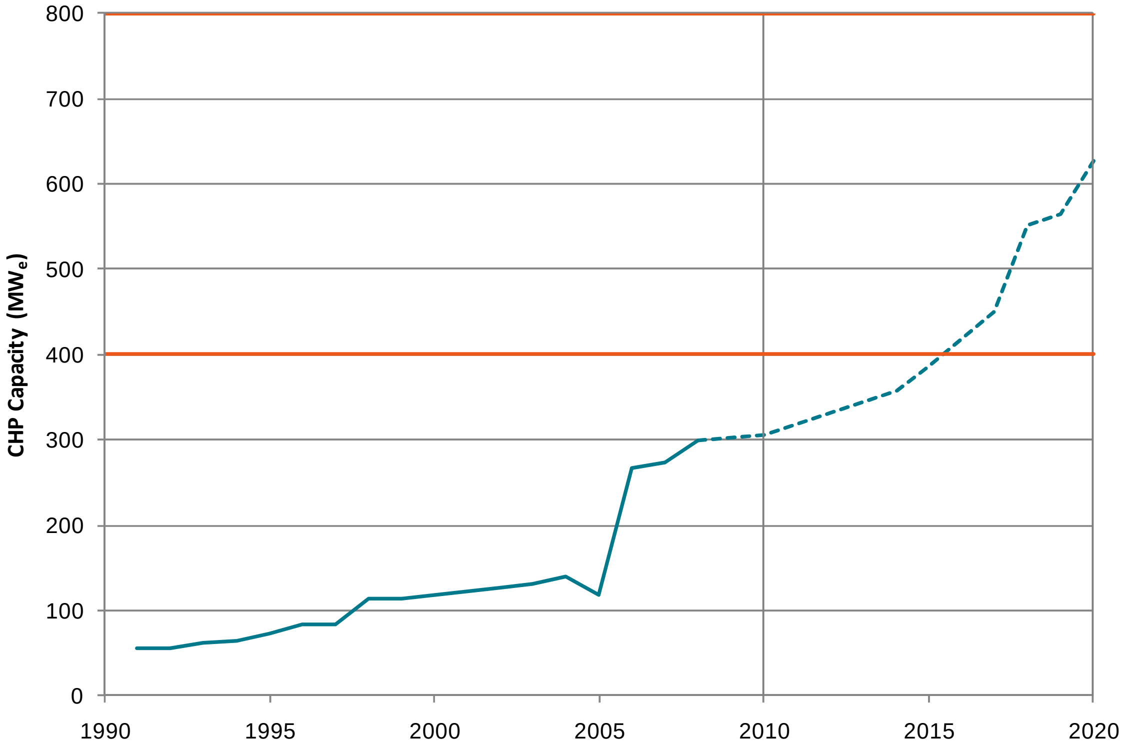


Table 19: Projected Capacity of Installed Active CHP (kW_e) – High Uptake Scenario

Sector	Sub-Sector	2006	2008	2010	2020
Industrial	Aughinish Alumina	160,000	160,000	160,000	235,000
	Other CHP Power Generation	0	0	0	100,000
	Food	81,590	50,773	52,000	66,500
	Manufacturing	6,610	15,661	15,661	87,661
	Mining	5,200	0	0	0
	Pharmaceutical	11,560	11,169	14,000	38,169
	Other	8,235	6,870	6,870	6,870
Sub-Total		*273,195*	*244,473*	*248,531*	*534,200*
Services	Hospital	5,765	6,903	8,041	18,000
	Hotel	9,070	11,781	14,492	36,892
	Public Sector	2,452	2,016	2,200	4,200
	Airport	4,380	7,316	7,316	8,316
	Education	4,234	5,338	6,442	9,500
	Office	4,716	3,578	3,578	7,000
	Other	1,108	6,833	9,696	19,000
	Leisure	2,856	4,580	5,442	9,200
Sub-Total		*34,581*	*48,343*	*57,207*	*112,108*
Other	Residential Single Unit	0	0	0	44,500
	Residential & Mixed Use	-	11	33	253
	Peat Briquetting	-	5,600	5,600	5,600
	Waste-to-Energy (incl. district heating)		0	0	76,000
	Other Waste*	-	6	30	150
	Agriculture	-	230	230	400
Sub-Total		*1,741*	*5,847*	*5,893*	*126,903*
Total		***309,517***	***298,663***	***311,631***	***773,211***
Target		**-**	**-**	**400,000**	**800,000**
Distance to Target		**-**	**-**	**88,369**	**26,789**

* Use of CHP technology at waste handling sites, not necessarily fired on waste material. It does not include the use of landfill gas for electricity generation (refer to Section 3.2.5)

Figure 14: Potential Installed Active CHP Capacity – High Uptake Scenario

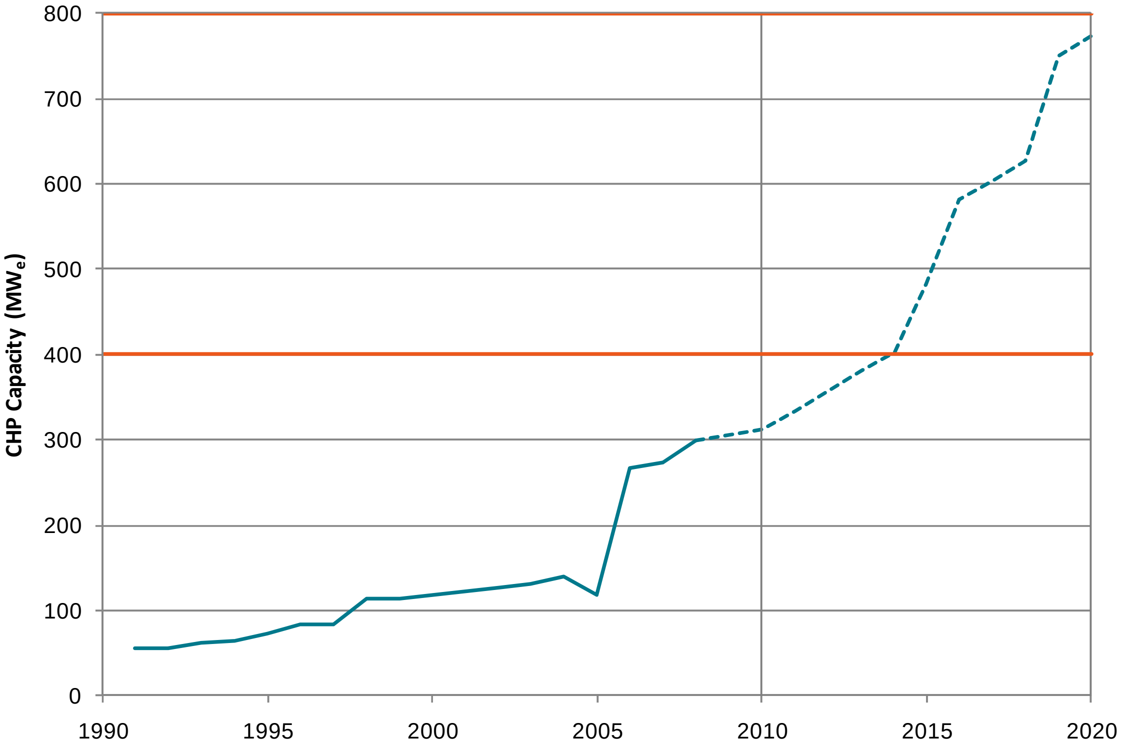
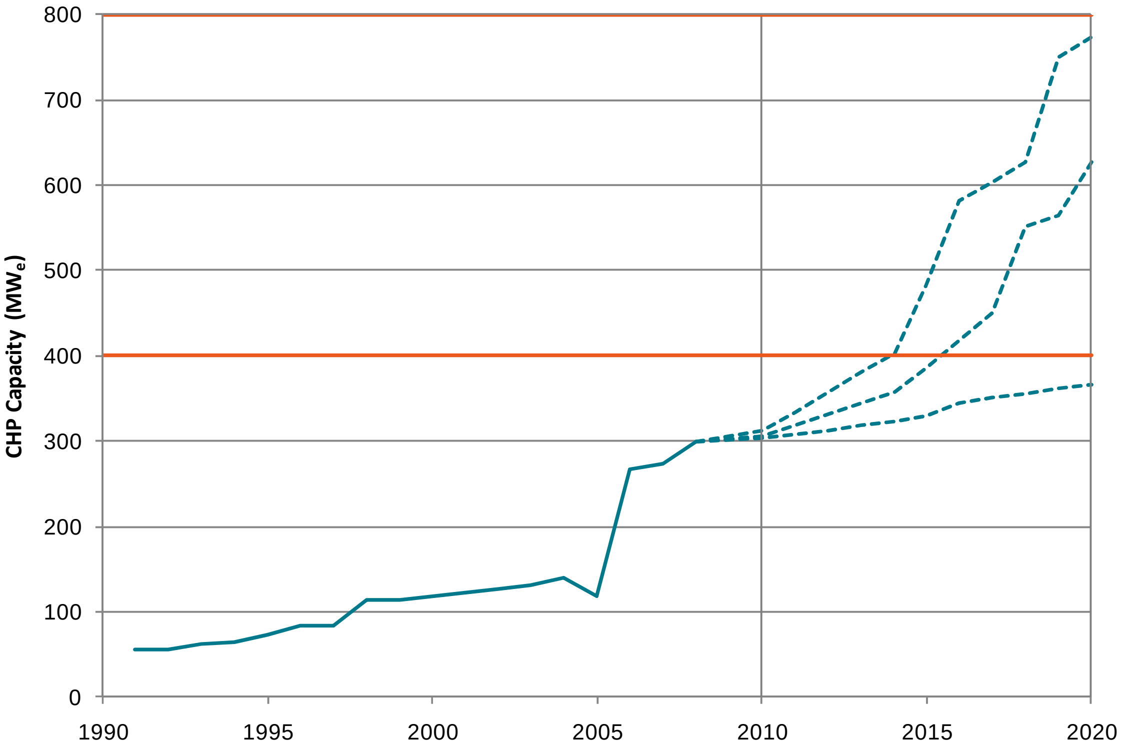


Figure 15: Potential Installed Active CHP Capacity - Three Uptake Scenarios



9. District Heating

There has been very little uptake of district heating in Ireland compared to other European countries, such as Denmark, which has a district heating penetration of over 60%[50]. To date, the largest district heating network being planned in Ireland is the Dublin district heating network by Dublin City Council (DCC). It is proposed that this network will initially supply heat energy from the Waste-to-Energy (WTE) plant in Ringsend to a district heating scheme in the Dublin Docklands area, with a potential annual demand of 76,000 MWh from 2010 to 2011, and 111,640 MWh from 2011 until after 2020. Further expansion could include Dublin Port, the Elm Park Development, Heuston Square, together with other areas in the DCC jurisdiction. Other potential areas for district heating include new high density developments with heat loads throughout the year.

In the short term, with the construction slow down and drop in energy prices, it is unlikely that many new district heating schemes will be built in Ireland.

In the medium to long term, as energy prices recover and more stringent legislation is enacted to reduce greenhouse gas emissions, the use of district heating in high density areas will increase, especially where located close to an existing cheap heat source, such as a Waste-to-Energy plant or power station. Other opportunities may also exist for the retrofit of district heating schemes into high density areas, where suitable heating systems can be retrofitted economically. One major obstacle to district heating schemes is the contractual and operational requirements for supplying electricity and heat to multiple users, with the Electricity Regulation Act prohibiting the use of private wire networks, while natural gas may be a strong competitor in the context of providing the heat output to the end users / customers.

Refer also to Sections 3.3, 5.6.5, 6.1.3 and 6.7.9.

[50] OECD / International Energy Agency, *Denmark – Answer to a Burning Platform: CHP/DHC* (2008).

10. Conclusions

At the end of 2008, Ireland had achieved an installed (active[51]) CHP capacity of 299 MW_e, a decrease of 10 MW_e from a peak of 309 MW_e in 2006. Over 50% of the current installed capacity is located at a single site (Aughinish Alumina).

Through our discussions with industry and stakeholders, we have identified a wide range of barriers to the uptake of CHP, some of which have been identified in previous studies and many of which remain significant barriers to future growth. However, while there is a diverse range of barriers (and perceived barriers) in place, the overriding barrier is one of economic viability. In our discussions with a variety of individual industries, this has been highlighted as the primary barrier to the uptake of this technology. Some of the other barriers identified, and previously highlighted, are only relevant to certain scales of CHP installation, the principal barrier in this case being access to the electricity grid for installations intending to export.

While recent years have seen an overall decline in installed capacity, the current SEI Deployment Programme has seen a large number of CHP units installed, adding 13 MW_e to the national capacity by the end of 2008. However, these are mainly small-CHP units, with an average capacity of 170 kW_e, although some larger units (up to the grant threshold for fossil fuel fired CHP of 999 kW_e) were in the approval process.

Our three growth scenario projections indicate that it is highly unlikely that Ireland will meet the 2010 target of 400 MW_e, with an estimated shortfall in the order of 88 MW_e to 97 MW_e, while even in our High Uptake Scenario we have projected a shortfall of 27 MW_e against the 2020 target of 800 MW_e (in the Low Uptake Scenario the shortfall could be in the order of 434 MW_e).

SEI's current CHP Deployment Programme for both fossil fuel and biomass fired CHP has achieved the 13 MW_e growth at a support rate of €400/kW_e installed. While this programme is targeted at the small scale CHP market, if the Energy White Paper Targets are to be met across all CHP scales, this would require (all other barriers being removed or alleviated):

- Grant support with a budget in the order of €35 to €39 million over two years to meet the 2010 target, over and above the current Deployment Programme budget of €11 million, and

- Additional grant support with a budget in the order of €150 million over ten years to meet the 2020 target, over and above the current Deployment Programme budget of €11 million.

In our discussions with stakeholders, IBEC's CHP Ireland Group stated that for CHP to be a viable energy source in Ireland this would require grant support in the order of 30% of the capital cost for both small and large scale CHP. For natural gas fired CHP this equates to approximately €300/kW_e in support.

However, although the projections from this study indicate that Ireland is unlikely to meet either the 2010 or 2020 targets, there are a number of significant industrial scale projects in the pipeline which if all were come to fruition could contribute up to 251 MW_e between them. These projects include:

- 75 MW_e gas fired CHP at Aughinish Alumina;
- 56 MW_e WTE plant in Ringsend feeding into a district heating network;
- 20 MW_e WTE plant in Ringaskiddy feeding into an industrial district heating network;
- 100 MW_e CHP power station[52].

[51] We have identified a total of fourteen sites where CHP is installed but is not operating due, for example, to closure of sites, poor economic conditions in terms of fuel prices and seasonal demand profiles.
[52] We are aware of a potential CHP power station in the west of Ireland. However, it is not clear where the heat from such a plant could be utilised. Notwithstanding this, we believe that one plant of such a scale could be feasible at a location with a suitable heat demand by 2020.

Each of these projects has been considered in our three uptake scenarios. They are all included, to some extent, in our Medium and High Uptake scenarios, with the main difference between these two projections being in the project timeframes.

It is also positive to note that Irish industry is showing a strong interest in CHP and it appears that it is *technically* viable at large scale across a number of sites in different sectors. However, as highlighted throughout our assessment, the economic viability of CHP is the key to achieving the national targets. At present, the payback times for CHP investments exceed those required to meet corporate investment criteria in many sectors.

The commercial sector has shown the highest growth rate in recent years and the projections indicate that this sector will continue to contribute an increasing proportion of CHP capacity out to 2020. The residential sector has not shown the same level of growth over the same period but we foresee strong growth in light of technological advances in micro scale CHP and in the uptake of heat from WTE projects. The High Uptake scenario projects that the residential sector will see very strong growth out to 2020, contributing a similar CHP capacity to that from the commercial sector (approximately 100 MW_e).

11. Recommendations

In the following subsections, we set out our recommendations for improving the uptake of CHP out to 2020 and in striving to meet the Energy White Paper Targets of 400 MW_e and 800 MW_e.

11.1 CHP Targets

1. Within the current targets of 400 and 800 MW_e, establish sub-targets for the three high level sectors (industrial, services and other) in order to focus support programmes, resources and marketing campaigns. The sub-targets should be established being informed by the three Uptake Scenarios set out in this study.

2. Develop specific targets for fossil fuel fired CHP, biomass fired CHP and anaerobic digestion fired CHP. These targets may be integrated into the targets developed under Recommendation (1).

3. Investigate the merits of establishing further sub-targets for specific industrial and commercial sectors (e.g. pharmaceutical, wood processing, hospitality and healthcare). We believe that the use of the targets solely at the national level is not conducive to focussing on sector specific barriers and improving the uptake of CHP.

11.2 Information & Awareness

4. In consultation with CER and Eirgrid / ESB Networks, develop comprehensive flow charts/road maps for the three different levels of CHP (micro, small and large scale), setting out the process for installing CHP from inception to commissioning.

11.3 Industrial Sector

5. Review the policy for providing grant support to fossil fuel fired CHP installations with a capacity greater than 1 MW_e. We believe that this type of support is required to stimulate the investment in large scale fossil fuel fired CHP where there is already considerable interest. At present, the majority of projects identified in the industrial sector have longer payback periods than those required by Corporate Investment Criteria for the project to proceed.

6. In the short term, extend the availability of grant support for feasibility studies to projects of all scales.

7. Improve the awareness of CHP across all the stakeholders (SEI, IBEC's CHP Ireland Group, the Irish CHP Association and ESCos) to industry through a specific marketing campaign. The success of this campaign will be dependent upon the level of background support provided through financial assistance.

8. Appoint specialist CHP energy advisers to promote the technology in industry, focussing on the pharmaceutical, food and beverage, IT & communications and wood processing sectors.

11.4 Commercial & Services Sector

9. Prepare case studies based upon the most recent CHP projects undertaken in the healthcare sector under CHP Deployment Programme. These should be disseminated to the remaining public and private hospitals and nursing homes which do not yet have CHP. This recommendation should be carried out in association with the Health Service Executive, the Office of Public Works and Nursing Homes Ireland.

10. Prepare case studies based upon the most recent CHP projects undertaken in the hospitality sector under CHP Deployment Programme. These should be disseminated to the remaining 800 hotels in Ireland which do not yet have CHP. This recommendation should be carried out in association with Fáilte Ireland, the Irish Hotels Federation and the Environmental Protection Agency's Green Hospitality Award scheme.

11. Prepare case studies based upon the most recent CHP projects undertaken in the educational sector, focussing primarily on tertiary education. These should be disseminated to the remaining tertiary education institutions in Ireland which do not yet have CHP. This recommendation should be carried out in association with the Department of Education, the Higher Education Authority, the Irish Universities Association and representatives from the Institutes of Technology.

12. Provide technical support to the commercial and services sector, with particular emphasis on the hospitality, healthcare and educational sectors, via a specialist CHP advisor(s) (similar to Recommendation (8)).

11.5 Residential Sector

13. Investigate the mechanisms through which supports could be provided to Dublin City Council for the planned district heating network in Dublin Port. As the project has progressed to date on its own merits, we do not foresee the need to provide grant support for the WTE plant, but the future of the district heating scheme is less certain and may require financial support or incentive to make it feasible.

14. Expand the current micro-CHP demonstration programme once micro-CHP units sized for individual dwellings (1 kW_e) become available to the market. We understand that this scale of technology is being developed and is likely to be more widely available within the next two years. While the technology may already be available, a demonstration project would be required to prove the technology for the Irish domestic market.

15. Establish a small scale demonstration project on kerosene based micro CHP engines in locations outside the natural gas network. This is required to established the feasibility, or otherwise, of such micro-CHP technology. If it were to be demonstrated that it is both technically and economically feasible to operate CHP units on kerosene, there would then be a market amongst the 46% of houses with oil fired central heating.

11.6 Licensing & Permitting

16. Following the outcome of the recent consultation undertaken by the CER on the Treatment of Small, Renewable and Low Carbon Generators outside the Group Processing Approach, SEI should develop a road map / information pack in association with the CER and Eirgrid outlining the new rules for grid connection.

11.7 Biomass CHP

17. Following completion of the Bioenergy Resources Study currently being undertaken by SEI, review the findings in the context of the current report to inform the setting of appropriate targets for biomass CHP as set out under Recommendations (1) and (2).

18. Investigate the requirement for a biomass broker or brokerage network to supply large scale biomass consumers. The lack of such a service was identified as a potential barrier for sites considering very large usage of biomass for CHP.

19. Review the progress in the development of more advanced biomass CHP technology (including gasification) to determine whether it is a viable option for Irish industry. This may require a study tour of gasification facilities in Europe attended by the major wood processing sites. Two such operators have identified biomass gasification as offering significant scope for increasing Ireland's CHP capacity. If the technology is found to be viable, provide support, either through financial or technical assistance, in establishing a medium sized demonstration project. Refer also to Recommendation (4).

11.8 Geothermal CHP

20. Monitor the progress of the two geothermal sites in the Dublin area where district heating is proposed using direct geothermal energy. Assess the feasibility of including small scale CHP units (200 to 300 kW_e) based on the Organic Rankin, Kalina or similar cycles if either of these projects were to proceed.

11.9 Competing Technologies

21. Conduct comparative carbon footprinting of competing programmes for the purpose of prioritising financial supports.

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Annex A: References

1. An Examination of the Future Potential of CHP in Ireland – A Report for Public Consultation, Irish Energy Centre, December 2001.

2. Combined Heat and Power in Ireland – Trends and Issues 1991 – 2002, SEI Energy Policy Statistical Support Unit, February 2004.

3. Combined Heat and Power in Ireland 2007 Update, SEI Energy Policy Statistical Support Unit, December 2007.

4. Evaluation of Legislation and Regulation Affecting New CHP Installations in Ireland, ERM Environmental Resources Management Ireland Limited (ERM Ireland), in association with Arthur Cox Solicitors, June 2006.

5. Benchmarking Report: Status of CHP in EU Member States, COGEN Europe, June 2006.

6. Irish Supply Chain Capability for CHP Applications, Lagan Consulting, June 2006.

7. New Technologies for CHP Applications, Delta Energy & Environment, June 2006.

8. A Guide to Combined Heat and Power in Ireland, Irish CHP Association.

9. CHP in Ireland – Options for a National Policy to 2010, CHP Policy Group, February 2006.

10. Sustainable Energy Ireland

11. Commission for Energy Regulation

12. Eirgrid

13. The Office of the Revenue Commissioners

Annex B: Sources

Abbott Ireland

Analog Devices

Aughinish Alumina

Baxi Group

Boliden Mines

Bord na Móna

Clogrennane Lime

ConocoPhillips Whitegate Refinery

Dairygold Co-operative Society

Diageo

Dublin Airport Authority

Fingleton White

Glanbia Food Ingredients

Gypsum Industries

IBEC CHP Ireland Group

Indaver Ireland

Intel Ireland

Irish Cement Limited

Kinviro

Lakeland Dairies Cooperative Society

Masonite Ireland Limited

Medite Europe

RPS Group (Dublin Waste to Energy)

Schering Plough

Smartply Europe Limited

Sustainable Energy Ireland

Annex C: Breakdown of CHP Units in Ireland

Table C.1: Breakdown of CHP Units by Sector (Active & Inactive Units)

Sector	All CHP Units		Active CHP Units	
	No.	kW_e	No.	kW_e
Manufacture of food and beverages	14	51,818	13	50,568
Other Manufacturing	22	202,754	20	200,469
Sewerage & Waste Collection	8	4,439	8	4,439
Wholesale and Retail trade except of motor vehicles and motorcycles	10	2,675	8	1,311
Transportation, Accommodation (Hotel) and food service activities	91	19,417	91	19,417
IT/Financial/Public Admin/Office support services	20	9,743	15	5,720
Education	12	5,243	11	5,237
Hospital/Care activities	40	7,664	38	6,908
Leisure/Sports Activities	35	4,355	35	4,355
Other	3	446	2	240
Total	***255***	***308,552***	***241***	***298,663***

Table C.2: Breakdown of CHP Units by Size (Active Sites)

Sector	Micro CHP		Small CHP		Large CHP	
	No.	kW_e	No.	kW_e	No.	kW_e
Manufacture of food and beverages	0	0	2	1,404	11	49,164
Other Manufacturing	0	0	3	3,328	17	197,141
Sewerage & Waste Collection	1	5.5	3	409	4	4,024
Wholesale and Retail trade except of motor vehicles and motorcycles	0	0	8	1,311	0	0
Transportation, Accommodation (Hotel) and food service activities	3	16.5	85	12,744	3	6,656
IT/Financial/Public Admin/Office support services	3	16.5	10	3,635	2	2,068
Education	0	0	7	1,213	4	4,024
Hospital/Care activities	11	145	25	4,262	2	2,501
Leisure/Sports Activities	2	11	33	4,344	0	0
Other	0	0	2	240	0	0
Total	***20***	***195***	***178***	***32,890***	***43***	***265,578***

Annex D: Towns Connected to the Natural Gas Network

County	Towns Served		
Cavan	Kingscourt	Virginia	
Donegal	Not served		
Monaghan	Carrickmacross		
Galway	Ballinasloe Claregalway	Craughwell* Galway City	Headford* Oranmore
Leitrim	Not served		
Mayo	Castlebar*	Westport*	
Roscommon	Not served		
Sligo	Not served		
Carlow	Carlow Town & Environs		
Dublin	Balbriggan Balrothery Clondalkin Donabate Dublin City Leixlip Loughshinny	Lucan Lusk Malahide Newcastle Portmarnock Portrane Rathcoole	Rush Saggart Skerries Stepaside Swords Tallaght
Kildare	Athgarvan Athy Ballymore Eustace Caragh Castledermot Celbridge Clane	Johnstown Johnstownbridge Kilcock Kilcullen Kildare Town Kilkea Kill	Leixlip Maynooth Naas Newbridge Prosperous Sallins Straffan
Kilkenny	Kilkenny City		
Laois	Ballylynan* Portarlington	Portlaoise	Stradbally
Longford	Not served		
Louth	Ardee Blackrock Clogherhead	Drogheda Dromiskin Dundalk	Dunleer Termonfeckin Tullyallen
Meath	Ashbourne Bettystown Clonee Donacarney Duleek Dunboyne	Dunshaughlin Enfield Gormanstown Laytown Longwood Mornington	Navan Ratoath Robinstown Stamullen Trim
Offaly	Clara	Tullamore	
Westmeath	Athlone	Mullingar	
Wexford	Not served		
Wicklow	Arklow Blessington Bray Delgany Glenealy	Greystones Kilcoole Kilmacanogue Newcastle	Newtownmountkennedy Rathdrum Rathnew Wicklow Town
Clare	Bunratty Clarecastle Cratloe	Ennis Killaloe Meelick	Shannon Sixmilebridge
Cork	Ballincollig Ballygarvan Bandon Blarney Carrigaline Carrigtwohill Castlemartyr	Charleville Cobh Cork City Crosshaven Fermoy Glanmire Glounthaune	Little Island Mallow Midleton Mitchellstown Passage West Watergrasshill Whitegate
Kerry	Not served		

County	Towns Served		
Limerick	Adare Annacotty Ballyneety	Castleconnell Castleroy Carina	Limerick City Patrickswell
Tipperary	Ballina Ballyclerihan	Carrick on Suir Clonmel	Newport
Waterford	Tramore	Waterford City	

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National Development Plan 2007 - 2013

SEI is funded by the Irish Government under the National Development Plan 2007 – 2013 with programmes part financed by the European Union.

This publication is printed on environmentally friendly paper.