



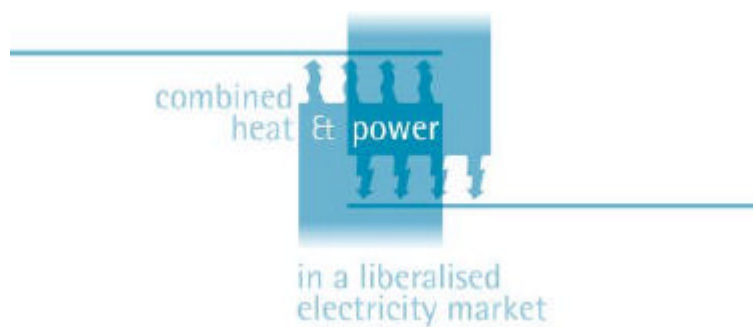
IRISH ENERGY CENTRE

**An Examination of the Future Potential  
of CHP in Ireland**

**A Report for Public Consultation**

**Prepared by  
Irish Energy Centre**

**December 2001**



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





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## Executive Summary

This report was commissioned by the Government, in its Green Paper on Sustainable Energy and examines the status of combined heat and power (CHP) in the current Irish market, its potential for future growth, the barriers to that growth, and possible measures to assist CHP achieve the target laid out in the National Climate Change Strategy.

CHP, in the right circumstances, is an economic means of improving the efficiency of energy use and achieving environmental goals. There are already 78 CHP installations, totalling 122 MWe of capacity, and contributing 2% of Ireland's electricity requirements. This compares with a contribution of about 9% of electricity needs being met by CHP in Europe as a whole.

The Government clearly indicated its aspirations for CHP in the National Climate Change Strategy published in October 2000 in response to the Kyoto Protocol. This strategy allocates 0.25Mt CO<sub>2</sub> per year saving from the use of CHP by the year 2010. This equates approximately to the installation of an additional 250 MWe of CHP plant, a tripling of current capacity. These targets exclude the proposed 310MWe CHP installation at the Aughinish Alumina Plant, which is therefore not considered further in this report. In Europe as a whole there is a target to double the CHP contribution to 18% of electricity generation by the year 2010.

There has already been a modest Government programme to promote the deployment of CHP in Ireland resulting in the doubling of installed capacity during the nineties. This was stimulated mainly by the incentives under the Alternative Energy Requirement (AER) scheme and the Irish Energy Centre's Energy Efficiency Investment Support Scheme. The expansion of CHP took place against a background of significant business growth for certain sectors, in particular the hotel and some manufacturing sectors. The generally high level of investment in these sectors for new or upgraded buildings and manufacturing facilities, allowed for greater investment opportunity in CHP. Also the increasing availability of natural gas, particularly in the south and east of the country, further assisted CHP growth with virtually all the capacity installed during this period being based on natural gas.

This CHP growth during the nineties has come to a virtual halt with little or no additional capacity expected in 2001. This is due, in part, to changing market conditions and increased risks to investment due to uneven opening of the electricity and gas supply markets under liberalisation. Specifically, the large increase in the price of gas available to fuel CHP plants at a time when the prices of electricity from competing conventional electricity generating plants had been effectively capped has made the economics of gas fired CHP unattractive. Recent increases in the ESB Public Electricity Supplier (PES) tariffs are to be welcomed and should improve the economics of CHP in the medium term.

A market appraisal was undertaken by the Irish Energy Centre during the summer of 2000 to examine the future potential for CHP in Ireland to contribute towards the Climate Change Strategy target. It concluded that:

- there is a potential market for CHP of around 700 MWe where the theoretical economic return and payback period are sufficiently attractive for companies to make the investment necessary;
- however probably only between 50-100 MWe is likely to be built in the coming years under the prevailing, uncertain market conditions even assuming that gas and electricity prices return to equivalent market levels.



There are a number of significant barriers to be overcome if CHP deployment is to be increased and the Climate Change Strategy target achieved. These barriers include:

- high gas prices to industrial CHP plants making CHP economically unattractive compared with separate production of heat and conventionally generated electricity when electricity prices are capped;
- the uncertainty about future fuel prices;
- the uncertainty about future heat and power requirements of companies inhibiting companies decisions and banks willingness to provide finance;
- lack of availability of long-term contracts for the export of electricity from CHP plants at what are perceived by the companies to be equitable prices and the negative impact this has on the willingness of the banks to finance projects;
- the marked preference by companies to invest in their core business rather than CHP which they see as peripheral (this may be alleviated to some extent by the increase in energy service companies (ESCOs));
- lack of awareness of CHP and its potential benefits;
- a variety of issues around licensing, connection to the distribution network and charges for the use of the electricity transmission system.

If the Climate Change Strategy target of 0.25 Mt CO<sub>2</sub> savings / year is to be achieved then it will be necessary to consider ways to stimulate the deployment of CHP. To be effective stimulation would need to include some or all of:

- equivalent pricing basis for fuels to the CHP and conventional electricity generating market<sup>1</sup>;
- financial incentives such as tax relief or direct grants;
- full liberalisation of the electricity and gas markets allowing CHP plants to supply heat and electricity to any customer<sup>2</sup>, and allowing third party access to the gas market;
- equitable long term contracts for the export/import of electricity from CHP plants, for example in an AER-type scheme for the exported electricity;
- a campaign to raise awareness of CHP;
- facilitating the development of appropriate codes and guidelines for the cost and technical considerations associated with use of the national grid;
- a requirement in planning and/or EPA licences to carry out CHP feasibility studies to identify suitable opportunities ;
- introduction of priority dispatch for electricity produced from CHP plants, taking account of the link to industrial production processes ;
- removal of detailed administrative barriers.

The cost of providing financial incentives to stimulate the installation of 250MWe of CHP plant, based on the costs of the previous AER IV, is estimated to be around IR£175 million over 15 years. This approximately equates to the worst-case economic analysis of CHP vs. conventional power generation (Section 3.1). However, the same analysis based on possible average fuel costs and discount rates gives a far lesser cost of IR£11.3 million or IR£45/tonne CO<sub>2</sub> saving which is comparable with other Government energy incentives.

In summary, CHP is recognised as being one of the key technology responses to Ireland's achievement of its Kyoto protocol commitments and significant potential exists for its expansion. However the 0.25Mt/CO<sub>2</sub> target saving for CHP will not be achieved by action of the market alone. Financial incentives would have to be provided and other barriers removed to achieve the target.

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<sup>1</sup> This is a market intervention and would require State Aid clearance. It may also raise other market related issues.

<sup>2</sup> The Government has recently amended the Electricity Regulation Act, 1999 allowing CHP full access to the electricity market.



## 1. Introduction

### 1.1 Context

In September 1999, the Government published its Green Paper on Sustainable Energy. Within this paper, the Irish Energy Centre has been given the role of producing this report for the Minister of State, Department of Public Enterprise and the Commission for Electricity Regulation on the future potential of CHP in Ireland in the light of market liberalisation, technology advances, fuel sources, extension of gas grid and financial incentives. The report comments on the economic and financial aspects of CHP as well as CO<sub>2</sub> abatement costs.

The report also considers the continuation of competitions for CHP, particularly involving the advancement of novel CHP technology with a relatively high environmental benefit.

### 1.2 Technology

Combined heat and power systems generate electricity and useful heat simultaneously from the same plant. CHP covers a range of technologies but always includes a prime mover (an engine or turbine) driving an electrical generator, plus a heat recovery system. In most CHP installations, the heat recovered supplements heat from the site's boilers and the electrical output displaces some (or all) of the electricity bought from the local supply network.

This combined production of electricity and heat results in a highly efficient system. Conventional, centralised power generation is normally only 30-40% energy efficient. More recent combined cycle generation gas turbine (CCGT) plants can improve this to 55%, excluding losses for the transmission and distribution of electricity.

By utilising the heat that is always produced in electricity production the efficiency of a CHP plant will typically be 20-25% more efficient than heat-only boilers and conventional power stations. This reduces the amount of CO<sub>2</sub> released into the atmosphere significantly (see Section 3).

CHP can offer significant energy savings compared with the supply of electricity and heat from conventional power stations and on-site boilers.

### 1.3 European Policy

Increasingly the greater penetration of CHP is recognised as a measure for reducing CO<sub>2</sub> emissions while delivering the same amount of useful energy.

The EU Commission document "*Energy Efficiency in the European Community - Towards a Strategy for the Rational Use of Energy*" (**COM(98)246 final**), states that:

"The use of combined heat and power in industry, the domestic and tertiary and the power sectors is critical for energy efficiency and must continue to be promoted by the Community and the Member States."

The Commission's strategy document on CHP, has as its aim the doubling of CHP penetration (**COM(97)514 final**). This strategy was endorsed by a council resolution in December 1997 and states that:

"the development of CHP offers high energy conversion rates and lower emissions of CO<sub>2</sub> which is the most important greenhouse gas. Another opportunity that CHP



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offers is the development of decentralised forms of electricity generation providing high efficiency and avoiding transmission losses. Summarising, optimised CHP is an environmentally friendly method of energy production reducing fuel need and increasing competition in generation; for this reason it could be considered as a vehicle for promoting liberalisation in energy markets.”

The **Directive 96/92/EC** of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity, provides that:

“A Member State may require the system operator, when dispatching generating installations, to give priority to generating installations using renewable energy sources or waste or producing combined heat and power.”

Currently CHP plants generate some 9% of EU electricity. The target is to raise this to 18% by 2010. In some countries, such as the Netherlands, Finland and Denmark, CHP already supplies more than 30% of their electricity requirements. Ireland, however, has the lowest level of electricity generated from CHP in Europe at approximately 2% of the total electricity produced.

## **1.4 Irish Policy**

### **1.4.1 Green Paper on Sustainable Energy**

The Department of Public Enterprise’s Green Paper on Sustainable Energy indicates how Ireland will progress towards meeting its energy requirements in an economically and environmentally sustainable way and lays out Ireland’s policy for limiting energy related CO<sub>2</sub> emissions. Specifically, it recognises that CHP offers energy efficiency advantages.

The Green Paper proposes that increased market research, raising of awareness and the identification and removal of market barriers are essential to maximising CHP development.

### **1.4.2 National Climate Change Strategy**

In October 2000, the Department of Environment and Local Government published its National Climate Change Strategy. This strategy provides a framework for achieving greenhouse gas emissions reductions in the most efficient and equitable manner while continuing to support economic growth.

The efficiency gains of CHP have been recognised within the strategy and one of the measures proposed in the energy sector is the maximisation of CHP.

The strategy sets a CO<sub>2</sub> reduction target of 0.25Mt below business as usual attributable to CHP by 2010.

### **1.4.3. Electricity Regulation Act 1999**

The Electricity Regulation Act, 1999 implements into law certain provisions of the EU Council **Directive 96/92** and provides the regulatory framework for the introduction of competition in the generation and supply of electricity in Ireland. The Act, in conjunction with the European Communities (Internal Market in Electricity) Regulations, 2000, provides for the establishment of the Commission for Electricity Regulation and gives it the necessary powers to license and regulate the generation, distribution, transmission and supply of electricity.



The Act provided that licensed CHP suppliers may supply electricity to their main heat customers and into what is called 'the eligible customer market' which comprises the largest 400 electricity users in the country (see definitions in Section 2.3.1).

#### **1.4.4 Electricity (Supply) (Amendment) Act, 2001**

Section 9 of the Electricity (Supply) (Amendment) Act, 2001 amends the Electricity Regulation Act, 1999 in relation to the treatment of CHP.

In particular, section 14 of the Electricity Regulation Act, 1999 is amended to allow for the electricity produced from a CHP plant to be sold to any final customer. This essentially puts CHP electricity on a similar footing to electricity produced from renewable sources.

#### **1.5 Role of the Irish Energy Centre**

The Irish Energy Centre was established in 1994 as an EU funded initiative of the Department of Public Enterprise. As Ireland's national agency for energy efficiency and renewable energy information, advice and support, the Centre's mission is to promote the development of a sustainable national energy economy.

The Centre provides guidance on the potential for more efficient use of energy in the home, office, industry and municipal activities and on the development of renewable energy resources. Practical information and advice is offered to each sector through targeted conferences, seminars, workshops and publications. In addition, the Centre offers advice on potential sources of funding for sustainable energy initiatives.



## 2. CHP Development in Ireland

### 2.1 Capacity pre-1993

CHP is not a new technology in Ireland. Most CHP in the period before 1993 was steam cycle based, and used coal, peat or heavy fuel oil as fuel. In nearly all cases it was installed on sites where the steam demand was high, and where requirements for electricity were large in relation to grid capacity e.g.

Large scale brewing	– Guinness
Sugar Extraction	– Irish Sugar Company
Peat Briquette Manufacture	– Bord na Móna

This period was characterised by very little growth and no incentivisation. By the end of 1993 there was just under 55MWe installed in 13 CHP units in the country representing approximately 1% of the total national electricity production capacity.

### 2.2 Capacity 1993 - 1999

In this period of growth, the more widespread application of CHP became apparent. Hotel and hospitals were now the fastest growth areas for CHP due to the availability of small, reliable gas engine based CHP units.

A number of incentive schemes were in place during this period.

**Thermie** was the demonstration component of the Non-Nuclear RTD Programme managed by the European Commission Directorate-General for Energy (DG XVII). The Thermie programme promoted key energy technologies in the Rational Use of Energy. Under this programme 14 Irish sites received financial assistance for the installation of CHP.

The **Energy Efficiency Investment Support Scheme** of the Irish Energy Centre provided financial assistance for priority technologies including CHP. In October 1995, the small end of the CHP market was targeted for funding under this scheme and IR£300,000 was made available for schemes up to 300kWe. This resulted in approximately 1.2 MWe of new capacity.

In July 1998 large industry was targeted for funding. Up to IR£500,000 per project was available and this resulted in a further 18MWe of installed capacity.

The Government launched the **Alternative Energy Requirement (AER)** in 1994 to promote renewables and CHP. The first of the Alternative Energy Requirement competitions (AER I), acted as a means to transfer the autoproducers existing electricity sale contracts onto a longer-term footing. Producers with contracts under AER I could secure a payment of up to 3.6 p for day hours of electricity exported plus up to 1.0 p for the capacity related to those kWhs exported.

The Alternative Energy Requirement IV was launched on 22 September 1997. The objective of this competition was to secure 25 MWe of newly installed electricity generating capacity using CHP and a further 10 MWe of electricity generating capacity from existing similar systems. In actual fact, only 18.35 MWe was commissioned.

This initiative was supported by EU grant aid of IR£1.8M (under the Economic Infrastructure Operational Programme funded by the EU) and the units were to be built by the end of 1999. Winning competitors secured a 10 to 15 year Power Purchase Agreement with ESB Power Contracting. The maximum installed capacity for projects bid for the AER IV competition



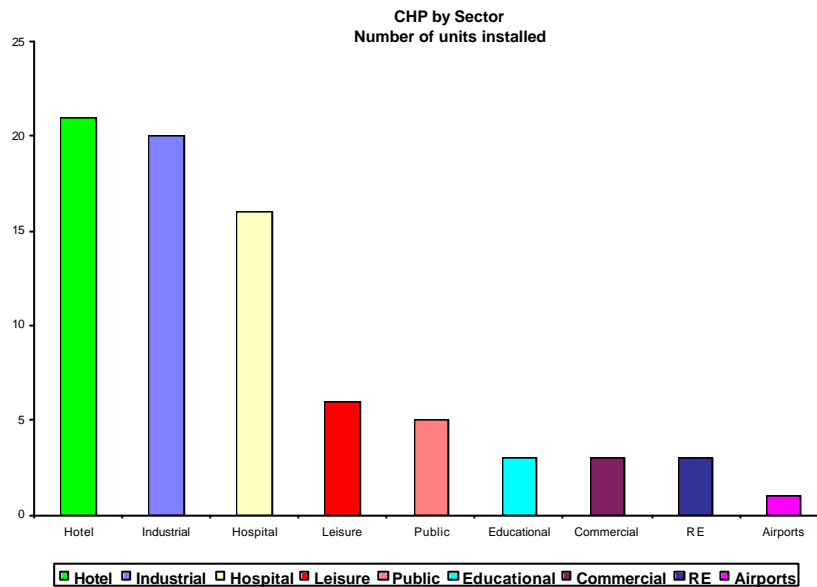
was 10 MWe per site and the beneficial ownership of any legal entity could not exceed a cumulative AER IV installed capacity of 15 MWe per site.

The bid price ceiling was 3 p per kWh. Prospective generators were to bid below this price ceiling. Successful projects under the 25 MWe category were offered a capital grant aid of approximately IR£40,000 per MWe installed.

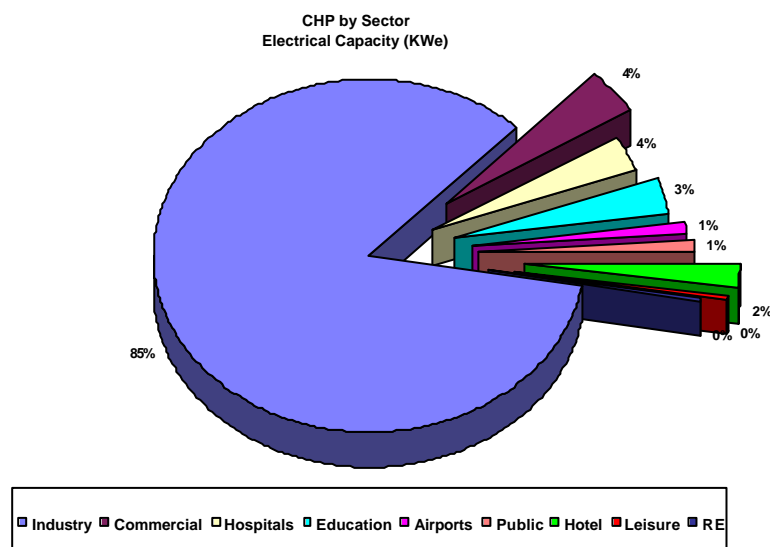
This period of incentivisation resulted in slow but continuous growth and by the end of 1999 122 MWe was installed in 78 plants around the country.

### 2.3 Current Situation

The following chart indicates the sectors where the most activity has taken place, by showing the amount of CHP units installed per sector (as of end 1999):



The following graph indicates where the largest amount electrical capacity is installed. This also gives an indication of where we can expect our target to be met.



RE = CHP with renewable energy fuel source



### 2.3.1 Regulatory Environment

The Electricity Regulation Act, 1999 implements into Irish law certain provisions of Council Directive 96/92 of 19<sup>th</sup> December 1996 concerning common rules for the internal market in electricity. The Directive requires the introduction of competition, within certain limits, to the European electricity market by requiring Member States to permit generation and supply of electricity by independent private undertakings and to allow certain classes of electricity consumer within each Member State to choose their electricity suppliers.

Under the Act, licences are required to:-

- a) generate electricity
- b) supply electricity to eligible customers
- c) supply electricity produced using renewable, sustainable or alternative forms of energy
- d) supply to the single premises of the main heat customer, electricity produced from CHP

The Act defines CHP as “the simultaneous production of utilisable heat and electricity from an integrated thermo-dynamic process where the overall process operating efficiency, based on the gross calorific value of the fuel used and defined as the ratio of energy output usefully employed to the energy input, is greater than 70%”. Electricity produced from CHP plants may be supplied to their main heat customer, which is defined as the person who has entered into a contract with a CHP plant to “purchase in a calendar year, an amount of heat produced by that producer, which amount is greater than that contracted to be purchased in that year from that producer by any other person”.

Another outlet for electricity produced from CHP plants is to eligible customers. These are defined as customers with an annual electricity demand of over 4GWhrs. These 320 eligible customers comprise 28% (in volume) of the total electricity market. The final option for the sale of electricity from CHP is to ‘spill’ power surplus into the National Grid.

Furthermore, the Electricity Regulation Act makes provision for the continuation of Alternative Energy Requirement (AER) type competitions.

**NB.**

*The recent amendment to Section 14 of the Electricity Regulation Act, 1999 allows CHP operators to “ supply electricity to final customers which in aggregate does not exceed the amount of electricity which is available to the supplier and which is produced using combined heat and power or electricity purchased, in place of such electricity, in accordance with the trading arrangements provided for in regulations to be made by the Commission”.*

*This in effect gives CHP complete access to the electricity market.*

Statutory Instrument 445 of 2000 provides for the establishment of an independent Transmission System Operator (the TSO) called Eirgrid, which is to be independent of the ESB. The ESB will continue to own the transmission system assets but Eirgrid will manage its operation and development

### 2.3.2 Market Liberalisation

The recent partial liberalisation of the electricity market will undoubtedly influence the development of the CHP market in Ireland. As of the 19<sup>th</sup> February 2000, eligible customers were allowed to purchase electricity from suppliers other than the ESB.



The EU Directive requires that 33% of the market be opened fully by 2003 with a further review in 2006. Ireland is ahead of this deadline with a plan to open 40% of the market in 2002, which would create almost 1,400 eligible customers, and 100% in 2005.

Experience gained from liberalisation throughout Europe is that the ensuing competition can lead to a reduction in electricity prices for some customers. This could have the effect of slowing down the rate of CHP development as it erodes the savings attributable to CHP and creates a climate of uncertainty with respect to fuel and electricity pricing.

### 2.3.3 Fuel and Electricity prices

The table below shows the comparison of energy costs from a range of commercially available fuels.

**Comparison of Energy Costs**  
(August 2001)

Fuel	Form	Unit of Supply	Average <sup>7</sup> Price per Unit (IR£)	Gross Calorific Value (kWh/unit)	Delivered Cost		Percentage change since 1-Nov-00
					IR£/GJ	pence/kWh	
Peat <sup>1</sup>	<i>Brickeens</i>	Tonne	66.00	5362.5	3.42	1.23	+2.9%
Coal <sup>1</sup>	<i>Industrial Fines</i>	Tonne	42.95	7759.2	1.54	0.55	0
Oil	<i>Gas Oil</i>	Litre	0.3762	10.55	9.91	3.57	-3.7%
	<i>Light Fuel Oil</i>	Litre	0.3159	11.21	7.83	2.82	+3.8%
	<i>Medium Fuel Oil</i>	Litre	0.2938	11.32	7.21	2.60	+5.6%
	<i>Heavy Fuel Oil</i>	Litre	0.2787	11.45	6.76	2.43	+7.8%
L.P.G.	<i>Bulk L.P.G. (0-3 tonnes)<sup>2</sup></i>	Litre	0.327	7.09	12.81	4.61	+5.5%
	<i>Bulk L.P.G. (3.1-40 tonnes)</i>	Litre	0.299	7.09	11.71	4.22	+4.9%
Natural Gas <sup>3,6</sup>	<i>(Usage / 2 months)</i>						
	<i>0 - 6,000 kWh</i>	kWh	0.0249	1.0	6.92	2.49	0
	<i>6,001 - 15,000 kWh</i>	kWh	0.0230	1.0	6.39	2.30	0
	<i>15,001 - 30,000 kWh</i>	kWh	0.0211	1.0	5.86	2.11	0
	<i>30,001+ kWh</i>	kWh	0.0192	1.0	5.33	1.92	0
Electricity <sup>8</sup>	<i>Unrestricted Space Heating<sup>3</sup></i>	kWh	0.1114	1.0	30.94	11.14	0
	<i>Night Space Heating<sup>3</sup></i>	kWh	0.0332	1.0	9.22	3.32	0
	<i>Industrial Maximum Demand<sup>4</sup></i>	kWh	0.0493	1.0	13.69	4.93	0
	<i>H.T. (10kV) 1,000kW Load</i>						
	<i>Industrial Maximum Demand<sup>5</sup></i>	kWh	0.0832	1.0	23.11	8.32	0
	<i>L.T. 500kW Load</i>						

Notes:-

1. Ex-works price. Delivery costs are not included. Actual prices also depend on quality purchased.
2. Prices are available on request from suppliers for quantities over three tonnes
3. Standing charges for electricity and natural gas are not included. These must be included in all total cost calculations.
4. M.D.=1,000kW; L.F.=80%; Day/Night units 60/40; P.F.=0.95(mean Summer/Winter M.D. charge rate)
5. M.D.=500kW; L.F.=30%; Day/Night units 75/25 P.F.=0.95.
6. These prices represent the Standard Commercial/Industrial tariff. Customers using in excess of this amount would usually be advised to apply for one of the Demand & Commodity Tariffs
7. All prices include 12.5% V.A.T. Accurate as of 1 August 2001. Based on the list price only
8. Electricity increases as of October 1<sup>st</sup> 2001, are not reflected here

Source Irish Energy Centre, Industrial/Commercial Fuel Cost Comparison Sheets



If we were to examine the price of heavy fuel oil and include the additional costs of sulphur removal, storage, trace heating, etc., it becomes apparent that, especially for large users, natural gas is the most cost effective fuel. Indeed based on simple payback periods, it is unlikely that CHP projects based on liquid fuels would meet current financial criteria in the absence of any intervention. The recently published National Climate Change Strategy comments that “where feasible, the option of fuel switching will be pursued in the sequence: - electricity – coal – heavy fuel oils –light oils – gasoil – gas – green electricity. Maximum conversion of industrial use of fuels towards the least greenhouse gas intensive will be encouraged, inter alia, through the market mechanisms of emissions trading and greenhouse gas taxation.”

At present, the supply market for renewable fuel sources is not fully developed and so it is not possible to include these fuel sources in any cost comparison.

Nevertheless, the estimated future market potential from renewable fuel sources may well be considerable in the long term as outlined in Section 5.4.

Natural gas fuels 65% of the current CHP capacity in the country (87% of projects). Indeed, due to the availability and pricing of natural gas, virtually all recent projects are based on this fuel source.

The standard tariffs available to large Industrial and Commercial customers are summarised in the table below;

<b>Tariff Name</b>	<b>Consumption (k Whs / annum)</b>	<b>Gas Price (p / kWh) ex VAT @12.5%</b>	<b>Standing Charge (IR£ per annum)</b>	<b>Extras</b>
<b>Demand &amp; Commodity 1</b>	450,000 – 2,400,000	1.501	1,200	£60 per additional gas meter
<b>Demand &amp; Commodity 2</b>	>2,400,000	1.398	3,600	£60 per additional gas meter

*Source: Bord Gais, January 2001*

Very large gas users are able to negotiate either fixed contract gas tariff rates with Bord Gais or move to a floating rate.

Negotiated fixed rate contracts are taken for a fixed term and are based on the expected demand level and profile. Although these rates are confidential and site-specific, they are understood to have been in the order of 0.7 p/kWh up to 1.36p/kWh during 2000, but due to market volatility they have risen since.

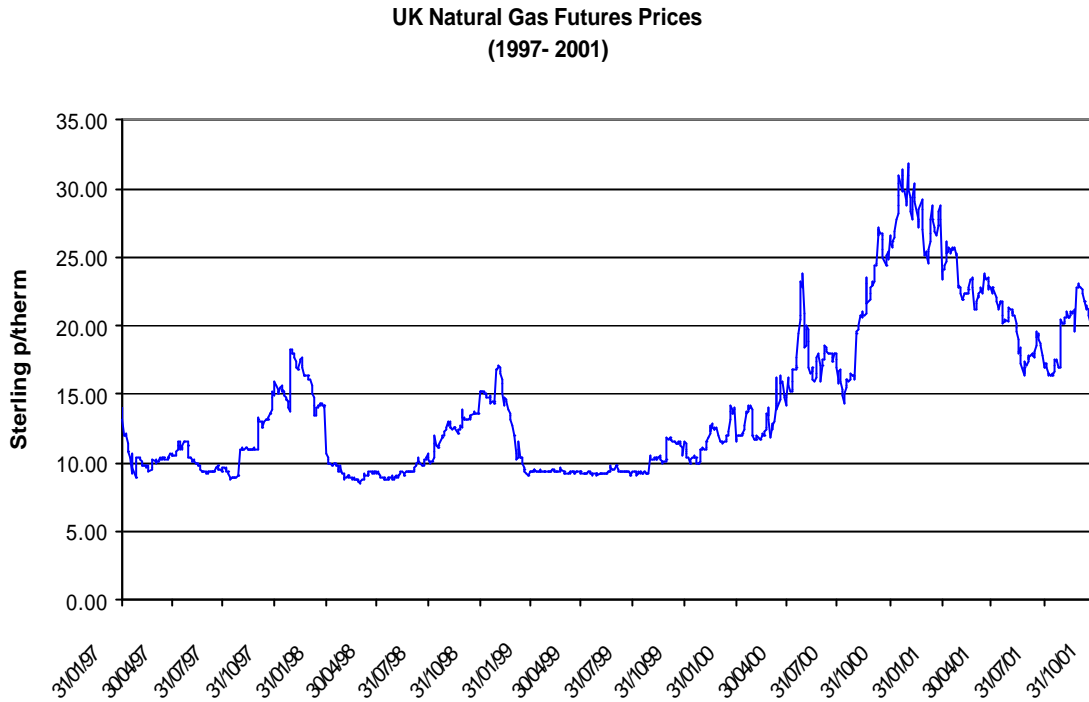
The floating rate comprises variable elements such as the International Petroleum Exchange (IPE) rate for gas, and the exchange rate for currency, which may be calculated quarterly or monthly. On top of this are the fixed elements such as gas transportation price, swing premium (i.e. the costs incurred for non-uniform take-off) and the supplier margin.

As gas prices have increased over the past year, those customers on a floating rate have seen their delivered price increase accordingly, however it is understood that these prices have been capped at a rate comparable to the D&C 2 tariff rate (1.398p/kWh).

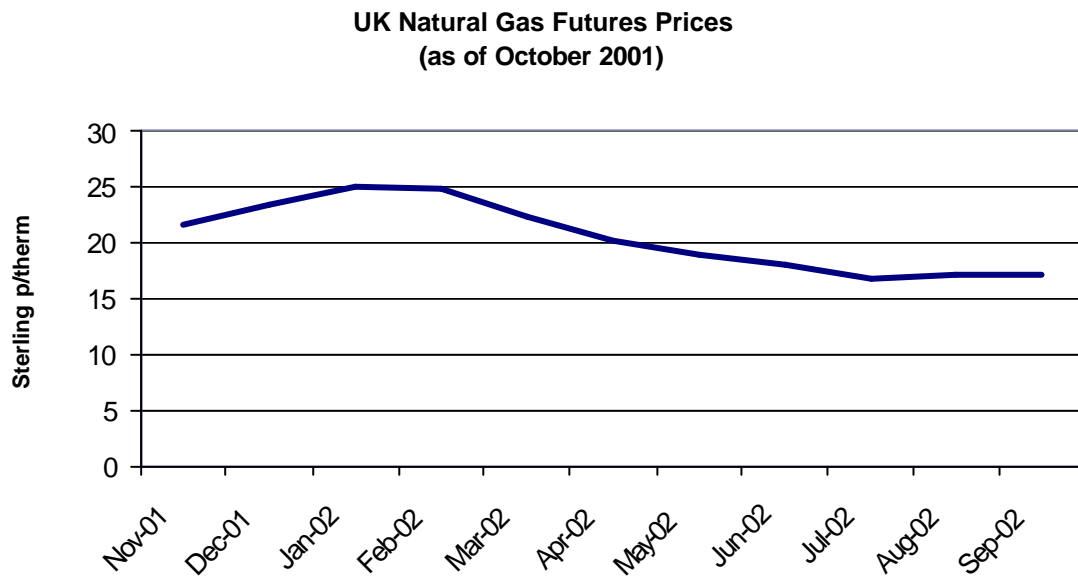
Currently customers consuming at least 9 million therms (264 million kWhs) on a single site are eligible to apply for Third Party Access (TPA) to the open gas market and can therefore purchase their gas from suppliers other than Bord Gais. As the market continues to open this threshold will fall to 18,000 therms (527,000 kWhs).



The following graph illustrates that the UK price for natural gas rose sharply during 2000. But has fallen during the first half of 2001.



Natural gas futures prices from the International Petroleum Exchange of London, taken in October 2001 show that prices are expected to rise again for the remainder of 2001 and predict a price of 17p/therm (sterling) by September 2002.



As can be seen, those gas customers that came out of fixed-price contracts during December 2000, faced significant increases in their gas price. Although the trend has since fallen, there has still been a step-change in the price of gas compared to September 1999.



Prior to liberalisation, electricity prices had been fully transparent to the market due to the existence of a single supplier - the ESB. Indeed the ESB still supplies over 75% of the total market and apart from increases totaling 3.5 % in 1996/1997 there have been no increases in Irish electricity prices since 1986. Partial liberalisation of the electricity market and the subsequent introduction of new suppliers, resulted in electricity prices for some large users falling by up to 10%.

The recent increases in the ESB (PES) tariffs announced by the CER are to be welcomed and should improve the economic attractiveness of CHP for the future. The CER considered the impact of imposing fully cost reflective tariffs immediately and concluded that price increases should be phased in over a three-year period.

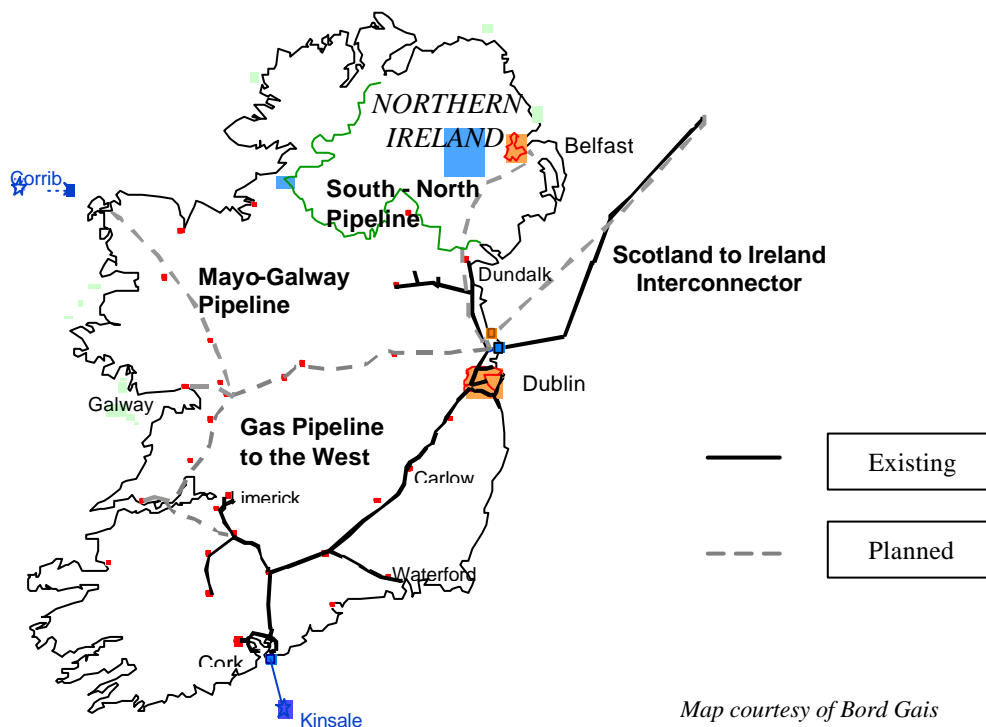
In summary, while the contract price of the main fuel source for CHP, namely natural gas, has increased by up to 87% for gas to be consumed in 2001, the price for purchased electricity in the same period remained the same or in some cases fell. This results in a severe deterioration in the key economic ratio, namely fuel to electricity prices, and fundamentally affects the decision to proceed with a CHP project (see Section 6.2).

It is worth noting however that the gas to electricity price ratio is very different for small-scale projects and despite rising fuel prices, steady growth in capacity in the hotel sector in particular, has continued.

### 2.3.4 Extent of Natural Gas Grid

The existing natural gas grid is supplied from gas fields off the Kinsale Head in Cork and from the North Sea gas fields through a sub-sea interconnector pipeline to Scotland from Loughshinny in North County Dublin. The current network provides gas to the major towns and cities along the route from Cork to Dublin, including Mitchelstown, Kilkenny, Carlow, Waterford, Portlaoise, Naas and also into Limerick, Navan, Drogheda and Dundalk.

A second interconnector with Scotland has been sanctioned by the Department of Public Enterprise and a new pipeline from the Corrib gas fields will provide gas to the midlands and the west of the country and will eventually result in a ring main system.

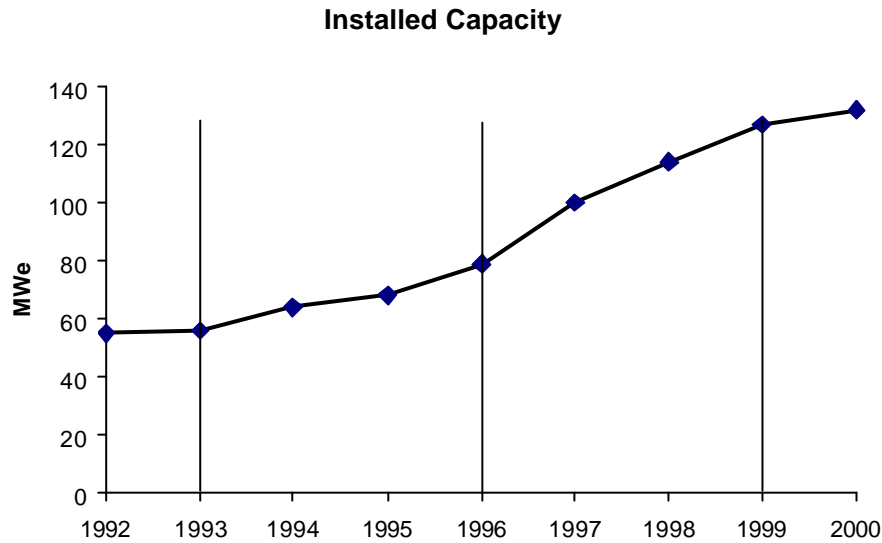




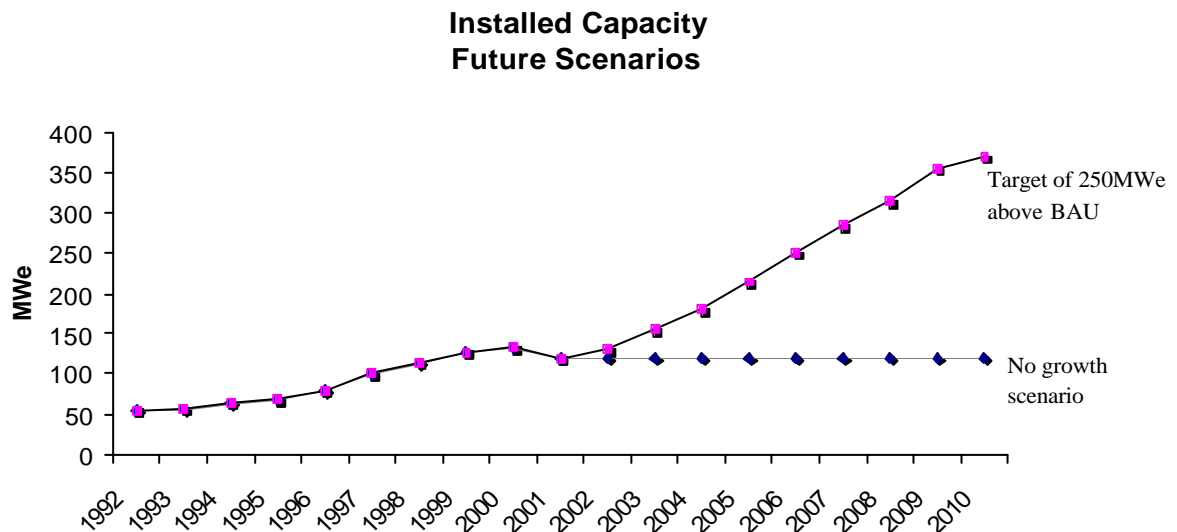
The availability of natural gas will undoubtedly influence the expansion of CHP. However, if the proposed Aughinish Alumina project is excluded, the majority of large industrial units – the main potential for CHP – already have access to the gas grid. Nevertheless, such potential loads constituted by hotels and hospitals are likely to be numerous albeit not very large. However some large towns are to be added to the network such as Galway and Athlone, and the extension to Moneypoint will enable some large projects to proceed.

### 2.4 Future Growth

As can be seen in the graph below, the CHP market has grown from an installed capacity of 55 MWe in 1992 to 132MWe at the end of 2000. This growth appears to have occurred in two distinct phases; the periods 1993 – 1996 and 1996 – 1999.



These two periods have coincided with incentivisation of the market (Section 2.2). The average growth per annum between 1996 and 1999 was 12.8MWe. However between 1999 and 2000, the market only grew by just over 10MWe.



\*Excludes Aughinish Power project



The National Climate Change Strategy sets a target of 0.25 Mt reduction of CO<sub>2</sub> attributable to CHP. At a figure of 1000Kg saving per MWe, this is approximately equivalent to an additional 250MWe installed over business as usual. However, due to the uncertainty and the barriers mentioned in Section 6, the CHP market is starting to constrict and predictions for 2001 estimate that the market capacity may shrink by 12MWe. To achieve the target set by the National Climate Change Strategy therefore requires a significant change in the growth rates of the industry

## **2.5 Aughinish Power**

Aughinish Power is a joint venture between Aughinish Alumina Ltd. (AAL), Bord Gais and ATCO Power. It is proposing to build a 310MWe CHP plant at the Aughinish Alumina site in Askeaton, Co. Limerick. As AAL is the largest electricity user in the country at 40MW and has a significant heat demand, over 400 tonnes per hour of steam, which is currently produced from burning Heavy Fuel Oil, it is highly suitable to the application of CHP.

The Climate Change Strategy has included this project under the Business As Usual Scenario, however a firm decision to proceed has not yet been made.

Due to the scale of this project, it has been excluded from any analysis of future market potential or growth. Clearly however, it is potentially a very significant project and would greatly increase the installed capacity of CHP. Should this project proceed, it is estimated that it would reduce national greenhouse gas emissions by 1%.



### 3. Environmental and Economic Aspects of CHP

#### 3.1 Environmental Benefits

CHP is an efficient energy conversion process that reduces the combustion products per unit of energy produced compared with traditional central heat and power generation systems. Although the installation of CHP results in higher on-site fuel usage, it displaces greater amounts of fuel used and emissions generated by traditional power generating utilities. CHP reduces primary energy consumption in industrial applications by typically 15-20%. Efficiencies of 70% or more are in excess of the average generation efficiency of 40% and still significantly higher than the 55% attributed to CCGT. CHP is therefore attractive on environmental grounds.

Electricity production, can be ranked according to the following order of environmental merit;

**Coal ® Oil ® Peat ® Combined Cycle Gas Turbine ® CHP ® Renewables.**

CHP is a viable generating option and is currently under-utilised despite imparting many positive environmental benefits.

However, the exact amount of CO<sub>2</sub> savings resulting from a CHP project is widely debated, as it is very difficult to prove what electricity is actually displaced. Essentially there are four scenarios that depend on;

- The mix of electricity production in the country
- The most marginal power plant on the system
- The next power plant to be built by the power industry
- The best theoretical power plant available

According to which scenario is used, the savings in carbon dioxide can vary from 100 tonnes per MWh up to 3800 tonnes per MWh.

In Spain, for example, IDAE quote a figure of 430 tonnes per MWh (430g/kWh), however the electricity generating mix in Spain includes 53% generated from hydro and nuclear sources. In the European Commission document COM (97) 514 final, average CO<sub>2</sub> savings attributable to CHP are quoted at 500 kg per MWh (500g/kWh) for the European situation. A comprehensive study undertaken by the Chief Scientists Group of ETSU in the UK in the early 1990's, applied to the current UK generating mix that includes almost 30% nuclear production, suggested emissions savings as per the following table.

Emission	Estimated net reduction in emissions per kWh of electricity produced by CHP (g/kWh)
CO <sub>2</sub>	1,000
SO <sub>2</sub>	17
NO <sub>x</sub>	4.6
CO	(3)
CH <sub>4</sub>	3.9

Ref: R. Evans (1993) *Environmental & Economic Implications of Small-scale CHP*, Energy Policy.



In Ireland a new CHP installation can be compared in terms of emissions simply to the existing generating mix and this would suggest an emissions saving greater than 1000 tonnes / MW of capacity. In practice, when a new CHP unit is introduced it may not in fact displace any existing capacity as system capacity growth is already at a high level. In this case a new gas fired CHP plant is the most preferred option as environmentally it competes favourably with all but renewables. Other than renewables, the best new entrant technology will be CCGT and in this case a reasonable estimate of the savings in terms of MW installed is 1000 tonnes per annum (or 200 g/kWh @ 5000 hours running per annum). This equates the National Climate Change Strategy CO<sub>2</sub> target of 0.25 MtCO<sub>2</sub> to 250 MWe.

Bearing in mind the various scenarios and variables, the figure of 1000 tonnes of CO<sub>2</sub> per MWe would seem to be a reasonable mid-point to use in Ireland.

### 3.2 Cost of Abatement

The ERM report “Limitation and Reduction of CO<sub>2</sub> and Other Greenhouse Gas Emissions in Ireland” points to the need for a range of fuel switching, energy efficiency and renewable energy measures. This point is summarised in their statement “it is certain that the least cost response will involve measures in all sectors and is likely to include a mixture of small and large reductions.”

A summary of the costs of reducing CO<sub>2</sub> emissions in tonnes per annum arising from the introduction of CHP is given in the following table.

		IR£/tonne of CO <sub>2</sub> abated	
Price of Gas (p/therm)	Discount Rate	CHP vs. CCGT	CHP vs. Oil
20	8%	33.82	-49.76
40	8%	8.08	-38.10
60	8%	-17.66	-26.44
20	15%	53.7	-32.49
40	15%	29.41	-22.57
60	15%	5.13	-12.64
20	20%	68.67	-24.55
40	20%	45.38	-15.66
60	20%	22.09	-6.77

Notes:  $I_{therm} = 29.3 \text{ kWh}$

Negative figures imply no regrets measures

The above calculations are based on comparison of 100MWe CCGT or oil power plant and equivalent capacity of gas fired CHP and on the following assumptions;



Notes				
	CHP	CCGT	Oil	Heat only
1	Capital cost = £700/kW	Capital cost = £400/kW	Capital cost = £400/kW	Capital cost = £50/kW
2	O&M costs = 0.8p/kWh	O&M costs = 0.24p/kWh	O&M costs = 0.8p/Kwh	O&M costs = 0.2p/Kwh
3	Electrical Efficiency = 36%	Electrical Efficiency = 55%	Electrical Efficiency = 37%	Thermal Efficiency = 80%
4	Thermal Efficiency = 40%	Distribution losses = 10%	Fuel price 50p/therm	
5	Operating 15 hrs/day	Fixed costs = £14.8/kW		
6	Availability = 95%	Availability = 92%	Availability = 80%	Availability = 60%
7	15 year life	25 year life	40 year life	25 year life

The three prices included in the table cater for a spread of fuel prices, ranging from prices paid a year ago up to the approximate current price paid by a medium size gas consumer.

Comparing these figures with Table 11.1 of the ERM report (see Appendix 2), it can be seen that the maximisation of CHP incurs CO<sub>2</sub> abatement costs comparable to that of Renewables, promoting energy efficiency and replacing older centralised power stations with CCGT.

To look at a specific example ; taking the discount rate as 8%; heavy fuel oil price of 35p/therm; CCGT gas price of 40p/therm and CHP gas price of 60p/therm; we arrive at the following cost implications:-

	Reduction in CO <sub>2</sub> Emissions (tonnes/annum)	IR£/tonne of CO <sub>2</sub> abated
<b>CHP vs. CCGT</b>	84,322	59.56
<b>CHP vs. Oil</b>	372,306	-5.43

If we examine the same scenario but allow the CHP plant to purchase gas at the same price as the CCGT plant we get the following figures:-

	Reduction in CO <sub>2</sub> Emissions (tonnes/annum)	IR£/tonne of CO <sub>2</sub> abated
<b>CHP vs. CCGT</b>	84,322	-48.73
<b>CHP vs. Oil</b>	372,306	-29.96

This quite clearly shows that if CHP was able to purchase gas at similar rates to CCGT plants, it makes good environmental *and* economic sense to encourage the uptake of CHP over CCGT.



### 3.3 Economic Aspects of CHP

To be economic to the developer, a CHP project needs to give the same or better rate of return on investment compared with the alternative (generally heat-only boilers and separately generated/purchased electricity). However, the investment required for CHP is generally larger than the alternative and can restrict operational and investment flexibility and incur higher risks.

To be economic a CHP project generally requires:

1. Fuel costs to the developer to be competitive with the competition,
2. High load factors typically equivalent with a minimum 4000 hrs/yr. full load operation,
3. Heat and electricity requirements to be balanced in volume and timing or,
4. Sales of heat and/or electricity to other parties on assured contract terms and equitable/competitive prices.

Since the investment in CHP is large it is likely that the markets for the outputs will need to be stable or growing and take-off contracts for heat and electricity will need to be long term if the project is financed on balance sheet or even more so if project financed. It is important to note that banks are unlikely to provide finance unless they see an assured cash flow for longer than the loan repayment period.

The simplest scenario is where all the heat and electricity are consumed internally by the autoproducer provided that the demand for heat and electricity is assured into the long term. This condition is often difficult to meet in current market conditions, particularly in manufacturing and the service industries.

The next easiest case is where the electricity utility provides the heat and electricity to its customers since it is able to balance the scheme by supplying or taking electricity into its general portfolio as required. A similar effect may be achieved by energy service companies (ESCO's) with a large enough portfolio of generation and customers to help balance the schemes and spread the risks.

The most difficult case is where a developer, particularly a small developer, needs to sell relatively large portions of the electricity and/or heat output. The scheme is likely to be subject to the uncertainties of short term (and perhaps disadvantageous) contract conditions; have limited ability to influence the terms of the contract and thus be subject to greatest uncertainty. Banks may be unwilling to lend to such projects.

Since CHP will typically require a larger investment and probably more management time than the alternative option, there is a strong disincentive to take on these extra burdens when both capital and management time are in short supply unless the economic returns are high or there is some other incentive.

It follows therefore that historically only the most economic projects or those projects where there has been some inducement have been developed.



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## **4. Market Study**

### **4.1 Definitions**

The Irish Energy Centre carried out a study to determine the potential for CHP in Ireland under the three standard sub-headings of technical, economic, and market potentials:

#### **4.1.1 Technical potential**

represents the total extent of opportunities for CHP based on purely technical criteria, i.e. applications where CHP is a technical option, whether economically attractive or not. For the most part, sites that have the appropriate heat and power usage profiles are amenable to CHP, others or not. Issues that may change this include land-use and infrastructure that accommodates District Heating and development of micro-CHP.

#### **4.1.2 Economic potential**

represents the subset of technical potential that is economically attractive within normal criteria. Moving sites from the technical to economic potential category is largely an issue of prices and legislative framework.

#### **4.1.3 Market potential**

represents the subset of the economic potential that would have been taken up by the market without intervention and prior to the uncertainties imposed by liberalisation. A number of market barriers will, however, intervene to keep some economic potential from becoming market potential, these will be summarised in Section 6. Thus it can be seen that the process of maximising market uptake of economic potential is largely an issue of awareness, incentives, demonstration etc.



## 4.2 Results of market survey

Following a study carried out by the Irish Energy Centre during the summer of 2000, the future potential for CHP in Ireland, by sector, was found to be as per the following table:

**Existing and Future Potential by Sector**

			Existing		Future Potential			Notes
			Installed Capacity Mwe	Number of Sites	Additional Technical Potential	Economic Potential	Market Potential	
A)	Public Sector	Airports	1.66	1	4.9	1.75	1.75	1
		Hospitals	4.69	16	14.4	7.6	3.8	2
		State Buildings	1.64	5	27	9	2	3
B)	Education	2nd Level	0.09	1	6.25	3.1	0.5	4
		3rd Level	4.01	2	40	28	14	5
C)	Commercial	Hotels	2.73	21	22.6	11.3	3.5	6
		Office Blocks	4.02	3	200	60	6	7
		Shopping Centres	0.00	0	33 heating + 40 cooling	3.5	0.5	8
		Swimming Pools	0.59	6	2	1.5	0.7	9
D)	Industry	Large	101.61	18	240	220	40	10
		Medium	0.99	2	314	100	10	11
		Small	0.00	0	315	50	2.5	12
E)	Domestic	0.00	0	20	0.4	0.02	13	
F)	District Heating	0	0	100	50	0	14	
G)	CHP with RE Fuel	Agricultural Waste	0.00	0	64	38	0	15
		Wood Industry Residues	0.00	0	159	48	0	16
		Forestry Residues	0.00	0	92	26	0	17
		Short Rotation Forestry	0.00	0	155	0	0	18
		Landfill Gas	0.00	0	0	0	0	19
		Biogas AD	0.23	3	40	27	1	20
		MSW Combustion	0.00	0	91	44	0	21
<b>Totals</b>			<b>122.26</b>	<b>78</b>	<b>1907.15</b>	<b>729.15</b>	<b>86.27</b>	

Notes:

- Existing as of Dec. 1999
- Excludes the proposed Aughinish Power project
- Please refer to Appendix 1 for explanatory notes.

## 4.3 Conclusions

In summary, investment in CHP is judged by investors, as being marginal, at best. That is, the best simple payback periods are typically in the order of 3½ to 4 years or more. This, coupled with the current uncertainty arising from market liberalisation and deterioration of the gas to electricity price ratio, means that little or no new significant commercial investment in CHP is likely to occur in the foreseeable future.

Yet from a national perspective, CHP clearly has value. By using the typical financial criteria and discount rates of electricity utilities, CHP, while not the least cost option available, would appear to be financially attractive – the problem therefore is clearly a mismatch between the perspectives of owner/managers of CHP schemes and national policy requirements.

To change this situation a proactive approach by Government in favour of CHP is required.



## **5. Opportunities**

### **5.1 Market Opening**

The complete liberalisation of the gas and electricity markets will allow all energy users, including domestic consumers, to choose their energy suppliers. This may result in an expanded range of products and services from energy companies. In the UK, for example, there is an increasing trend towards the provision of bespoke integrated packages of energy services rather than simple fuel and power supply. This integrated approach of energy service companies, who bring with them skills, expertise and the ability to finance projects, provides excellent opportunities for CHP.

### **5.2 Technology Advances**

Traditionally CHP was considered only for large industry with significant heat demands. New technological developments have resulted in smaller units coming to the market that offer the benefits of CHP to smaller applications. CHP units of 10kWe are now marketed and offer opportunities for large domestic dwellings or guesthouses. Patents have been approved for a 1.5kWe gas turbine, which may open up all of the domestic market to CHP.

### **5.3 Waste to Energy**

Energy recovery from waste is a well-established method of obtaining added value before final disposal and represents the best practicable environmental option for many wastes. Recovering the energy from waste features high on the Government's waste hierarchy and CHP schemes using waste as the primary fuel benefit from similar access to the open market as renewable energy sources.

### **5.4 Renewable Fuel Sources**

CHP is one of the most efficient technologies for converting renewable fuels (mainly wood based biomass) to useful heat and power. CHP using biomass has considerable potential in production terms. Consequently, a campaign to develop and subsequently promote and support decentralised bio-power CHP installations throughout Ireland will be required assuming the main identified barriers (see later) have been overcome. Such installations could range in scale from a few hundred kWe to many-MWe and combine different technologies, as appropriate to local circumstances.

### **5.5 District heating**

With higher density housing and an increasing presence of new apartment complexes in the major cities, there are opportunities for development in this sector. New social housing schemes offer valuable opportunities for the Public sector to act as an exemplar in this area. However, community heating with CHP requires substantial investment and a favourable regulatory environment to succeed. Also, district heating in Ireland has a generally poor image as being of low quality in terms of reliability and control. The relatively mild climate in Ireland also limits the economic potential of district heating in comparison to the colder regions of Central and Northern Europe.

### **5.6 ESCOs**

Energy Supply Companies (ESCOs) take much of the risk out of CHP investment decisions by financing and installing all the necessary capital equipment to the host site. Electricity and



heat are then sold to the host at favourable rates under the terms of a long-term (typically 15 year) agreement. The savings for the host site are not as significant as they would be had they made the investment themselves, but the risks and level of involvement are significantly reduced. This is an option that may have increasing importance in Ireland.

### **5.7 Increased Demand**

In its Generation Adequacy Statement 2001-2007, ESB National Grid (now known as Eirgrid) states that “Ireland’s generating capacity is substandard, and new generation is immediately required on the system.” As construction times for CHP are considerably lower than for centralised power generating plants, CHP offers a possible, useful short-term solution to the demand problem. CHP, since it is embedded generation, can also provide the added benefit of increasing security of electricity supply and indirectly reinforcing the National Grid.

Whilst ESB National Grid predict that new generation capacity coming on-line from late 2002, will ease the demand problems, they also recognise that “failure to meet CHP and renewable energy generation targets will of course impact directly on generation adequacy.”

This extra demand and the opportunity to sell surplus power on the open market will provide opportunities for CHP plants.

### **5.8 Data Centres**

These are installations with large and powerful computers that handle electronic commerce and host World Wide Web sites for companies. They have significant electrical loads and require extremely reliable, high quality electrical supply. With their high electrical demand and matching high demand for cooling, CHP with absorption chilling may be useful for these applications as it also provides greater security of supply. The IDA has estimated that 20 such ‘web farms’, could be installed over the next 10 years in Ireland, however the recent slow-down in the technology sector may reduce this figure considerably.



## 6. Identified Barriers

### 6.1 Regulatory

- **Licensing Procedure:**

The current Electricity Regulation Act 1999 requires all electricity generators to have a licence. These are to be granted by the Commission for Electricity Regulation (CER) and this partly fulfils their obligation to ensure the safety and security of the electricity network.

A CHP plant is required to have a generation licence and a licence to supply electricity to a party other than itself.

The requirements for a generation licence include;

- a fee based on the size of the plant
- financial statements for the previous 2 years
- an outline 5 year business plan
- maps identifying the location of the unit
- an environmental impact statement
- planning permission
- IPC licence
- Power purchase agreement

This is resulting in a situation where a small-scale CHP plant suffers similar cost and administrative burdens as a large central power station. This makes it far more complicated and expensive for CHP projects to proceed. The introduction of a de minimus limit whereby licensing requirements are simplified (subject to satisfaction of technical criteria) should be considered.

The CER have stated that they, in principle, support the easing of licensing requirements for CHP and further acknowledge that arrangements should be put into place to make it possible for smaller generators to accede to the trading and settlement code without requiring a large security deposit.

- **Imposition of PSO levies**

Public Service Obligations may be imposed on the holders of licences or authorisations and include obligations in relation to; security of supply; regularity, quality and price; environmental protection and use of indigenous energy sources. The costs of these will be recovered by way of a levy on the final consumer.

If CHP were to be exempted from PSOs this would have the effect of favouring CHP output over centralised power production. This does, however create an artificial incentive towards one particular form of generation.

If PSOs apply to the CHP produced electricity, the effect would be neutral as the CHP electricity displaces centralised power, which would be subject to PSOs anyway.

However, as CHP imparts many positive environmental, economic and infrastructural benefits it could be argued that CHP projects should be net beneficiaries of PSOs and the revenue generated from PSOs could be recycled to support CHP production. This would obviously require clearance from the EU Commission under State Aid Guidelines.



- **CHP Definition**

In the Electricity Regulation Act 1999, CHP is defined whereby the “overall process operating efficiency, based on gross calorific value of the fuel used and defined as the ratio of energy output usefully employed to the energy input, is greater than 70%”.

This is only likely to be achievable in process industries and swimming pools where there is a high load factor, stable heat and electrical demands. Applying this definition to the current list of active CHP projects, between 15 - 20% of them would not meet this criterion. This includes some of the largest CHP units in the country.

Countries such as Germany and Finland also look for a 70% overall annual operating efficiency but this is based on the net calorific value. Applying this criterion to the current Irish CHP list, only between 5 - 7% of projects would fail to meet the standard.

Throughout Europe, a range of CHP definitions exist, the majority of which approximate towards a variant of the following formula:

Total electricity output plus 2/3<sup>rd</sup> of the useful heat should be greater than 60% of the total fuel input

This type of definition applies in Spain, Portugal, France, Germany and the Netherlands.

COGEN Europe, has agreed on the following suite of definitions:-

$(2 \text{ (power)} + 1.25 \text{ (heat)}) \geq 100$	- for gas;
$(2.5 \text{ (power)} + 1.25 \text{ (heat)}) \geq 100$	- for solid fuels;
$(3 \text{ (power)} + 1.35 \text{ (heat)}) \geq 100$	- for biomass.

These acknowledge fuel diversity and the technology options that CHP displaces. COGEN Europe suggest that it would be advantageous if all Member States adopted a similar set of definitions for CHP, thus promoting harmonisation of rules and regulations for CHP, in order to realise the benefits of a single market.

This form of standardised definition is being discussed as part of a future EU Commission Directive on CHP.

- **Use of System Charges (UoS)**

Under the current regulations, a CHP plant is required to pay separate UoS charges depending on whether they are exporting to, or importing from the National Grid whilst the CHP unit is non-operational. Under normal operation a CHP plant will only import electricity for as little as 4 – 5% of its operating time. A charge for CHP operators that is in proportion to their use of the systems appears more appropriate. The use of net metering may overcome this.

- **Ownership**

Prior to the introduction of the Electricity (Supply) (Amendment) Act 2001, which provided for 100% access to the electricity market for CHP, Section 14(1)(d) of the Electricity Regulation Act 1999 only allowed the supply to the single premises of the main heat customer with electricity produced using CHP at the station from which the main heat customer is supplied with heat or sale into the ‘eligible customer market’. The main heat customer did not have to own the CHP project or be an eligible customer itself, it was considered to be a single entity and therefore premises occupied by multi-owners such as commercial offices, business parks and District Heating, were not eligible to purchase the electricity produced from the CHP operator.



This barrier has been removed with the introduction of the Electricity (Supply) (Amendment) Act 2001.

- **Comment**

The CER have already issued a consultation document with respect to Autoproducers (which includes all CHP plants) and will shortly be issuing a directive, which will address the following;

- policy with respect to connection to the electricity transmission system,
- policy with respect to connection to the electricity distribution system,
- policy with respect to charges for use of the electricity transmission system,
- policy with respect to charges for use of the electricity distribution system,
- Dispatch of small scale electricity production units.

The CER has also issued a Licence to the Distribution, Transmission owner and Transmission Operator in June 2001, which requires the Licensee to develop codes of practice and technical guidelines which should be of assistance to CHP producers.

Charges pertaining to embedded generators and wheeling are to be reviewed by the CER early in 2002.

The CER welcomes comments on this and all other consultation documents.

## **6.2 Economic**

- **Gas to Electricity Price Ratio**

The differential between the purchased electricity and gas prices is key in the decision making process for developing CHP. High electricity prices and low gas prices make CHP much more favourable.

Over the past 18 months, natural gas prices have risen at a time when electricity prices for large consumers remained stable or in some cases fell. This resulted in a situation where some, otherwise viable CHP plants, were temporarily switched off.

As of October 1<sup>st</sup>, the CER approved an average price increase of 8.6% for ESB electricity tariffs. Large industrial users saw their costs rise by 14% but many of these are 'eligible' customers and as such are free to source their electricity from licensed electricity suppliers other than ESB. Consequently, they should be able to obtain keener prices from the competitive market.

While increasing electricity prices are to be welcomed in that they should eventually result in a situation where prices become fully cost reflective, the changes in the tariff structure may in some cases increase the imported electricity costs considerably. This is due to the increase in the Capacity Charges, which were previously based on a sliding scale of £1.55/kW to £0.85/kW and are now fixed at €3.50/kVA.

Since natural gas is the fuel of choice and CHP will be competing with large-scale CCGT plants for the sale of surplus electricity; it follows that if CCGT plants are able to purchase gas at a lower price due to their significant consumptions, they will enjoy a considerable competitive advantage over CHP.



- **Availability of Finance**

CHP projects will either be financed off the company balance sheet, through borrowings or via a third party supplier. Individual companies will set their own requirements in terms of Internal Rates of Return and banks will generally make money available based on the credit rating status of the borrower. However, since the investment in CHP is large, it is likely that the markets for the outputs will need to be stable or growing and take-off contracts for heat and electricity will need to be long term (i.e. longer than the term of the loan) if the project is to be financed.

Small enterprises raising money for any capital equipment may have more of a problem. Cost savings resulting from the investment are not generally considered but the core business profits of the company would be examined i.e. the company's overall ability to repay a loan.

- **Top-up and spill prices**

For the operators/owners of CHP units exporting electricity it is important that they receive equitable prices from the electricity supply company. Also, electricity that is bought as back up should not be over-priced due to the 'distressed' nature of the purchase.

CHP schemes qualifying under the AER IV scheme of 1997 are able to secure 3 pence (€0.0381) per kWh for sales to the ESB. CHP schemes not qualifying were faced with securing only 1.88 pence, for day hours. This is seen by many of the main players in the market to be one of the main barriers to the expansion of CHP.

It should be noted also that an AER scheme actually removes capacity that would otherwise be available for purchase by suppliers and schemes qualifying under an AER are not affected by top-up and spill pricing.

We understand that the CER is examining the top-up price for both scheduled and unscheduled CHP outages and has invited comments on its draft paper 'Treatment of Top up for the Independent Sector' by December 13<sup>th</sup> 2001.

## 6.3 Technical

- **Heat Load Availability**

A successful CHP application is dependent on the availability of a suitable use for the heat produced. For most industrial application this may not be an issue but for commercial premises this may be more of an issue. Using the heat to produce useful cooling may overcome this. In applications where a renewable fuel source is used, there may be problems locating a suitable heat load close to the production unit.

- **Extent of Gas Grid**

With natural gas being the fuel of choice for CHP, the extent of the gas grid obviously places some limitations on CHP potential. However, the majority of industrial locations for CHP are either already connected to the grid or soon will be and therefore the significance of gas grid availability is not that large an issue for industry. Nevertheless, some sectors, in particular hotels, hospitals and third level education institutions offer significant additional potential to be captured by grid expansion.

- **Run Hours**

The majority of institutions whether industrial, public or commercial require, at best, a minimum payback of 3-4 years when considering investments based on their own resources. It is generally agreed that in order for CHP plant to achieve this simple payback of 3-4 years, then the unit must operate for at least 4,000 hours per year. In commercial premises, education and smaller industries, this threshold may not be achieved. In this case alternate



funding arrangements are usually required including grant support or the involvement of ESCOs.

- **Low Population Density**

This is only an issue in the District Heating and domestic sectors. With increasing agglomeration of heat loads through the growth of apartments and increased housing density, this may be less of an issue in the years to come.

- **Lack of Heavy Industry**

The relatively low presence of suitable heavy industry for CHP in Ireland such as refineries and petrochemical plants, and their associated heat loads, reduces the opportunities for large-scale industrial CHP in comparison to more heavily industrialised countries.

## 6.4 Market & Awareness

- **Utility Deregulation**

Utility markets are being deregulated and there is a subsequent anticipation of lower energy prices. Greater competition should give the consumer more choice and greater influence over the services they require. However an increasing liberalised market with increased competition and perhaps reduced prices can impact negatively on the take up of marginal schemes. That is as outlined earlier due to a mismatch in the price of the input fuel to a CHP in comparison to the price of electricity. Also in times of intense change the existing players tend to focus their attention on core activities and higher profit deregulated activities where possible. CHP operators, as minor players will have relatively little power in the market situation to negotiate beneficial contract terms and favourable connection conditions. Furthermore in this liberalised market, there is a possibility that tariff structures may change or be re-balanced. This could have a significant impact on CHP applications, as it will make it difficult to predict future market conditions.

- **Uncertainty in the market**

The current uncertainty with respect to deregulation, price fluctuations, amendments to existing licensing requirements and gas allocation resulted in a halt in the growth of CHP during 2001. This 'wait and see' attitude will ensure little or no new medium to large CHP projects go ahead this year, however the hotel sector remains relatively sheltered from this uncertainty.

- **Small number of ESCOs**

ESCOs provide energy services or energy management for industries, commercial firms, and public sector institutions such as hospitals and schools. They act through performance contracts under which they assume project risks, pay for the investments and recover the costs through saved energy. When the contracts end, the efficiency improvements and the savings rest with the consumer. These types of arrangement reduce the risk associated with large capital expenditure in an area that is not core to the main business of the host organisation. Experience throughout the EU has shown that a higher number of ESCOs result in greater uptake of CHP. Ireland does not yet have a well-developed ESCO market, but a number of companies are now expressing interest in moving into this area

- **Lack of Awareness**

Many decision-makers are still unaware of the benefits associated with the technology and its use even though CHP has proven levels of reliability and is well established in many sectors.



- **Non-core Business**

The production of electricity on site is not considered 'core-business' for many consumers, especially in the non-industrial sectors. The increase in ESCO's can aid this situation by absorbing any associated risk.

- **Encouragement of CCGT & Dispatch Tolerances**

The installation of large scale CCGT Power Stations should result in cheaper electricity prices. However, the forecasted electricity deficit could be alleviated by the increased uptake of CHP over less efficient CCGT.

For CHP units that are subject to centralised dispatch from the Grid operator, there is a requirement to dispatch within a  $\pm 2\%$  tolerance. At present, any unit greater than 10MWe (or site size greater than 30Mwe) would be subject to central dispatch.

While this is reasonable for a centralised power station, it may impose problems for the CHP plant as its production of electricity is inherently linked with the production of heat, which is used in the industrial process. It is far more difficult for an industrial CHP plant to react quickly to demands for power when to do so may interrupt the production of the industry. The UK has moved to a tolerance of  $\pm 5\%$  to allow for this problem.

- **Resistance to Domestic Centralised Heat Supply**

Traditionally, centralised heat supply in Ireland has been associated with social housing and has not been successful. The prevailing attitude is that this form of heat distribution is a poor substitute for local units with subsequent greater control.



## **7.0 Future Strategy Options**

CHP throughout Europe faces generally similar barriers to those identified in Ireland. Market liberalisation is ongoing throughout the EU and National Governments are required to find ways to encourage CHP within the State Aid guidelines. A summary of measures either currently in place or recently completed, in a number of European countries is included in Appendix 3.

However, there are few instances of outright success in any particular country and indeed the current situation facing CHP throughout Europe has changed from a period of rapid growth in the 1990's to the current position where CHP is facing serious difficulties.

The measures that follow represent a suggested suite of actions designed to reduce the obstacles to the maximisation of CHP in Ireland and allow the Government target to be met. There is no one single solution and the incentivisation of CHP, within State Aid Guidelines, should involve an integrated set of actions to actively favour CHP.

### **7.1 Incentivisation**

#### **7.1.1. Capital Grants**

The Green Paper on Sustainable Energy states that “capital grants for CHP encourages otherwise marginal projects, allows reference sites to be established in specific sectors and promotes awareness of CHP. On the other hand, recourse to grants alone as a stimulation mechanism can create a ‘stop-go’ type of development rather than a continuous stable environment”.

CHP is considered a mature technology and so the provision of capital funding in most cases is not seen as appropriate. There are, however, areas where the potential for CHP may be large but due to lack of awareness or technological barriers some seed capital may be beneficial. Specific examples will be outlined in Section 7.6 - Research & Development. Possibly of more importance however is the strong statement of Government support that the provision of capital aid makes.

#### **7.1.2 Enhanced Capital Allowances & Preferential Loans**

Other opportunities for capital funding include measures such as those in operation in the Netherlands and in the UK.

In the UK, Enhanced Capital Allowance (ECA's) are made to business for investment in low carbon technologies under the climate change levy package. The measures being supported are CHP, boilers, motors, variable speed drives, lighting, refrigeration, pipe insulation and thermal screens. Under the scheme, all business can claim ECA's regardless of size; sector or location and businesses may obtain tax relief, in the form of capital allowances, for their investment in the relevant machinery and plant. This relief is normally given at a rate of 25% a year on the reducing balance basis, which spreads the benefit over a number of years (approximately 95% of the cost is relieved in 8 years). ECA's will allow business to obtain relief on the full cost of their investment in the first year.

Countries such as Portugal, Belgium and the UK have introduced preferential or zero interest rate loans for investment in energy efficient technologies. This reduces the simple payback of the project and removes the barrier of sourcing finance from financial institutions with strict investment requirements.



### 7.1.3 Feasibility Studies

The Irish Energy Centre ran a scheme called the Energy Audit Grant Scheme, which provided grant assistance for organisations engaging independent consultants for site energy audits. A grant of up to 40% of the cost of the audit, subject to a maximum of IR£5,000 ex VAT was available.

A similar scheme specifically for CHP feasibility studies would be useful in assisting companies to accurately identify opportunities for CHP.

The UK Government have recently introduced such a scheme called "*Site Specific Advice for Combined Heat and Power*" run by the Government's Energy Efficiency Best Practice Programme. It is designed to support the uptake of CHP Schemes by providing targeted and independent advice to sites at critical stages of project implementation, from design through to actual operation.

Successful applicants can receive 'over the phone' advice or a visit from an independent CHP consultant who will carry out a survey of the CHP project and provide a short report on the findings. A consultant with appropriate expertise will be selected to meet the organisation's requirements. The amount of on site advice available will vary from between 1 and 3 days, depending on the size and complexity of the site.

## 7.2 Pricing

### 7.2.1 AER Scheme

The AER schemes mentioned earlier had perceived advantages in the marketplace. However whilst liberalisation of the market may mean that this type of scheme may not be fully suitable, there is a definite requirement for less uncertainty with respect to pricing and tariffs for projects with considerable investment requirements and medium rates of return.

More appropriate would be an on-going scheme offering a reasonable price for the surplus electricity over a contracted period of time (15 years for example). It has been stated by the main actors in the industry that the price paid for electricity under the most recent AER scheme has been fair and they would welcome continuation of this scheme.

COGEN Europe also recognise the benefit of this type of 'standard contract' as a means to encouraging CHP and have suggested that they should contain: -

- "Export and top-up back up supply formula, indexed to gas price for a fixed contract period;
- Standard conditions for connection to the network;
- Standard legal clauses."

This section considers the potential of any future AER for CHP and these comments are based on the experience of previous AER schemes taking into account market liberalisation and the Climate Change Strategy target for CHP.

AER IV, which resulted in an additional 18.3 MWe installed capacity, showed that a 15 year power purchase agreement was a very attractive element as it provided a stable financial environment for the investment and the extra support of 15% of capital costs made projects somewhat more financially attractive, but more importantly showed the national commitment to CHP as a recognised technology for increasing national energy efficiency.

However, projects offered a power purchase agreement were required to be operational within a very tight drawdown period of 31<sup>st</sup> December 1999, which in some cases was not feasible.



Agreements were offered to 19 projects out of an original 41 expressions of interest and resulted in only 5 commissioned projects. This perhaps indicates that a number of the original proposals were either purely speculative or had not been sufficiently thought through.

The price paid for the exported electricity was considered attractive at the time, but this is not the key financial factor for CHP viability. The ratio of electricity cost to fuel price is the fundamental ratio for CHP and as fuel prices have increased considerably recently, projects that are in receipt of AER IV power purchase agreements find that the economic viability of their projects has seriously diminished.

### **Suggestions for future gas-fired CHP AER scheme**

These have taken into account the outcome of AER IV, in which almost all projects submitted (and all but one of those offered PPAs) used natural gas-fired plant.

- Contracts should be set for 15 years
- Projects should be allowed a 3 year 'build period'
- Due to current economic difficulties it is suggested that the price paid per kWh be linked to the price of gas i.e. the generator receives a premium of a set amount above the current gas price. This differential would need to be determined.
- 'Feasibility' support for smaller generators could be made available.
- Capital grants or 'bonus payments' up to 15% of total project costs could be made available for innovative projects in assisted regions or from SMEs (as per the Official Journal of the European Community guidelines on State aid for environmental protection – Appendix 6)
- A non-refundable bond should be required to deter speculative bids. Consideration needs to be given as to the level of the bond e.g. based on MWe, DNC, total project costs etc. (Under AER IV this was originally intended to be £20/kWe).
- There should be a 'developer cap' on total capacity of projects offered PPAs, to ensure diversity of supply. The cap limit will need to be determined depending on the capacity target for the competition.

### **Suggestions for future renewable fuelled CHP AER scheme**

Many types of combined heat and power biomass installations are not suitable for AER type support and alternative capital subsidy schemes need to be considered instead. This is due in part to the fact that many such schemes would not export significant amounts of electricity and also the fact that the initial capital costs of renewable fuelled CHP plants are often much higher than natural gas fuelled CHP.

Areas that should be targeted for support include, anaerobic digestion of agricultural residues and organic municipal waste, wood industry residues, forestry residues and landfill gas.

### **7.2.2 Gas Price**

Large centralised power generation plants are able to purchase their natural gas at lower rates than a typical CHP plant due to economies of scale. This price discount may be as high as 30% and yet both types of generation plant may compete in the same electricity market. As mentioned in Section 3, allowing all CHP operators to purchase natural gas at a rate comparable to utility gas users eliminates any price advantage to central power production and would greatly improve the economic viability of CHP projects. This may be achieved by a reduction in fuel taxes for CHP users. However, intervention in the price of gas may be difficult to achieve in reality and other incentives, such as AER schemes, may be more acceptable under State Aid Guidelines and would perhaps achieve a similar result.



## 7.3 Taxation

The National Climate Change Strategy announces that “appropriate tax measures, prioritising CO<sub>2</sub> emissions, will be introduced from 2002 on a phased, incremental basis across a broad range of sectors in a manner that takes account of national economic, social and environmental objectives.”

Throughout Europe, CHP has been recognised as a ‘clean’ generator of electricity, and has been given exemptions from energy taxes in a number of countries. It would seem appropriate to include CHP with any exemptions that may be allowed here.

### 7.3.1 Climate Change Levy

In the UK, the **Climate Change Levy** is a tax on the business use of energy. The UK Government introduced it to encourage the more efficient use of energy and to reduce emissions of CO<sub>2</sub>. The levy will, on average, increase energy costs by 15% but it is intended to be revenue neutral for business. This is achieved by reducing the employer Insurance Contributions by 0.3%. Within this scheme, several exemptions are allowed for. These include; ‘good quality’ CHP, electricity generated from renewable sources and fuels used to generate electricity for sale to third parties. Also, all signatories to the Climate Change Levy are obliged to investigate the feasibility of CHP at their premises.

In Denmark there are exemptions from their carbon tax for CHP, especially small-scale CHP. In The Netherlands, CHP plants are exempt from paying a tax on the gas used for electricity production and their Ecotax does not apply to heat supplied by CHP.

In Germany, CHP with an annual overall efficiency of 70% is exempted from the increase of the tax on gas and fuel oils and autoproducers of over 700kWe are exempt from tax on electricity production.

### 7.3.2 Exemptions

Section 62 of the **1998 Finance Act** allows for tax “relief for investment in renewable energy generation”.

The Act defines a renewable energy project (including a project successful in the Third Alternative Energy Requirement Competition (AER III — 1997) initiated by the Minister) as a project in one or more of the following categories of technology - (a) solar power, (b) windpower, (c) hydropower, and (d) biomass.

Recognising CHP’s national environmental benefits and particularly in the industrial sector, it would be useful to include CHP as one of the qualifying technologies in this Act.

## 7.4 Regulation

Legislation / regulation has a role to play in ensuring a transparent and equitable framework for the parties in the energy markets.

It is historically the case that small players outside of the main utilities are disadvantaged since they are outside of the main concern of the legislative framework. Also the utilities are not incentivised to consider CHP. It follows then that in a new framework these issues have not been the major focus of attention and hence inequities or lack of suitable codes and guidelines may exist.



### 7.4.1 Licensing

The current **licensing regime** requires that all electricity generators be subject to similar requirements. In real terms this means that a 10kWe CHP plant must suffer the same administrative and cost burdens as a 400MWe power plant. To overcome this situation, the UK, have revised their electricity-licensing regime to make it easier to export surplus power from on-site generation. In particular the Electricity Order 1995 introduced the following changes, meaning that many more CHP operators became exempt from licensing requirements and payment of the fossil fuel levy:-

- Increasing the level of supply at which a generation licence is required from 10 to 50 MWe
- Allowing the temporary supply of power above 50MWe in certain circumstances
- Relaxation of the 51% own use rule

The Department of Trade and Industry announced plans for a further relaxation of the exemption conditions in the run-up to full supply competition in 1998 to allow exempt suppliers to supply on-site, or over private wires, up to 100MW, to any commercial or industrial customers. Of that amount, up to 1MWe may be supplied to domestic customers subject to the condition that prices charged do not exceed a certain figure.

France and Spain have demonstrated significant impact on the uptake of smaller CHP projects through their use of Standard Contracts. Further details on these are included in Appendix 4.

Given the amount of administrative procedures involved in setting up a CHP plant, a simple guide from the CER setting out clearly what is required would be useful in the short term.

It is suggested that a possible deminimus limit of less than 10MWe per unit or less than 30MWe per site be granted much simplified licensing and regulation procedures.

### 7.4.2 CHP Definition

The current CHP definition in the Electricity Act is seen as difficult to achieve under most CHP applications and may indeed not be measurable accurately. Countries such as Germany and Finland also look for a 70% overall annual operating efficiency but this is based on the net calorific value. Adopting a definition similar to that suggested by COGEN Europe may be a more appropriate measure.

### 7.4.3 Priority Dispatch

The EU Electricity Directive 96/32/EC states in Article 8.3, “a Member State may require the system operator, when dispatching generating installations, to give priority to generating installations using renewable energy sources or waste or producing combined heat and power.”

Most countries have decided to make use of this possibility and some go even further, and require the utilities to purchase electricity from CHP, in most cases; this is limited to a certain maximum installed capacity of the scheme. Some examples are:

- The Netherlands requires the distribution company within the area of supply to buy electricity from CHP from installations with an installed capacity up to 2 MWe;
- Spain has introduced the same obligation for installations up to 25 MWe;
- France is likely to introduce it up to 12 MWe;
- Denmark keeps it for all decentralised CHP and, under certain conditions, district heating CHP

The CER have advised that there may be potential difficulties with large-scale CHP having priority dispatch, and they will be giving this issue further consideration.



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#### **7.4.4 System Charges**

An expert committee comprising representatives of the various industry sectors should be formed to negotiate fair and equitable system charges for embedded generators similar to the UK's Joint Government Industry Working Group on Embedded Generation.

#### **7.4.5 Planning Constraints**

COGEN Europe advise that Member State Governments should develop planning constraints that discourage the development of energy inefficient power plants and heat only boilers. These constraints should encourage the use of CHP in all cases where new investment is being made and where it is technically and economically feasible to develop CHP.

This process mirrors to some extent the situation in the UK and the Netherlands and follows the principle set out in the revision of the Large Combustion Plant Directive. It also will assist Member States to maximise the reductions in Carbon Dioxide emissions and help them meet Kyoto commitments. In implementing the IPPC Directive, the EPA requires companies to consider the use of CHP.

#### **7.5 Promotion**

In any new field, the simple lack of awareness of the opportunities, knowledge of how to proceed, and potential available by developing new technologies, markets and systems will restrict take up. This is equally so for CHP which is a specialist complex area largely unknown to those outside of it.

If Ireland is to achieve the target set by the National Climate Change Strategy for CHP, it is important that suitable promotional programmes and institutions are in place to inform the market place, reduce uncertainty and provide relevant advice.

##### **7.5.1 Irish Energy Centre**

The Irish Energy Centre under its Best Practice programme has been promoting CHP for a number of years and regularly runs workshops and seminars for interested parties and publishes case studies. It is intended that as the Irish Energy Centre expands, it will be in a stronger position to provide a wider range of services. These would include the continuation of workshops and the publication of cases studies but may also include training courses for potential users and energy auditors, publication of best practice guides and simple evaluation packages. Evaluation software exists in Europe and it is hoped to develop a package relevant to the Irish market. The Centre runs an annual Boiler Awards scheme that includes a category for large and small scale CHP. The intention is to expand these Awards over the coming years to include a greater number of CHP schemes. This raises awareness of the technology and rewards the most efficient schemes.

##### **7.5.2 CHP Association**

It has been recognised at EU Commission level and with a number of Member states that the presence of a CHP association provides a valuable resource for advice and promotion. Ireland, despite eagerness on the part of the main players in the industry, lacks any such body. It has been suggested that an independent body such as the Irish Energy Centre could play a useful role on facilitating the formation of CHP association here.

In the UK, the CHPA aims to promote the wider use of high efficiency Combined Heat and Power (CHP) and Community Heating. The Association, along with its Members who comprise the key organizations at work in the UK CHP sector, work with national and local and devolved government to address the barriers that currently face CHP and Community Heating; ensure that when Government policies are developed they allow CHP and Community Heating to play their full role in delivering economic, social and environmental



benefits to the UK and educate and inform Government, business and the wider community about the benefits of CHP and the potential that exists in the UK to take advantage of it.

On a European level COGEN Europe tracks the development of EU legislation, makes the voice of the CHP industry known in Brussels, and educates the power industry, legislators and the European business community on the benefits of CHP.

## **7.6 Research & Development**

If Ireland is to achieve the target set out in the National Climate Change Strategy, an underpinning, research, development and demonstration programme will be required. Such a programme is also likely to have to undertake the necessary investigatory work to find solutions to barriers identified in the regulatory framework.

Demonstrations will be required where market penetration is low or where advancement of the technology would open up the market, for example waste-to-energy schemes or shopping centres. Demonstration of specific technology areas such as micro-CHP that may be applicable in the domestic sector, or absorption chilling, would also benefit from demonstration projects.

Specifically, the Irish Energy Centre will develop and implement support programmes to promote innovative / developing CHP technologies thereby working towards the fulfilment of their market potential. To this end the Irish Energy Centre intends to provide financial support for innovative / developing CHP technologies in the form of:

- Grant aid for project feasibility studies;
- Capital grant aid for pilot / demonstration plants.

When integrated into high efficiency, good quality CHP projects, the following technologies could benefit under these support programmes:

- Micro CHP (< 20 kWe). Potential applications for this technology include small hotels, guesthouses, farms and groups of domestic dwellings.
- CHP with absorption chilling. There are opportunities for the development of CHP with cooling in office buildings, commercial / retail developments and in data centres (web farms).
- CHP with district heating. Limited opportunities may exist for this technology in new apartment blocks, public housing developments and holiday village / leisure complexes.
- RE based CHP. This technology group includes CHP fired on waste wood, agricultural waste, biogas and municipal solid waste.
- CHP incorporating fuel cell technology.



## 7.7 Conclusions

Summary of the preferred measures for the incentivisation of CHP: -

	Issue	Measure	Method	Category
<b>Necessary</b>	Lower gas prices available to large power plants makes smaller gas fired CHP schemes un-competitive with purchased electricity and therefore gives an inadequate return to investors	Gas price for use in CHP plants to be made comparable to that paid by utility users via legislation <b>Or</b> Subsidy to CHP user	Primary/secondary legislation requiring equivalent gas prices to CHP users * <b>Or</b> Payment of subsidy to CHP users e.g. via AER type mechanism*	Incentivisation
	Uncertainty/risk in the absence of long-term demand/contracts for electricity/heat prevents CHP schemes being financed	Introduction of long-term power purchase contracts for electricity to facilitate financing.	Secondary legislation for an AER type scheme to offer long term contracts at equitable rates*	Incentivisation
<b>Enabling</b>	<i>CHP restricted by not having access to franchise market</i> <b>COMPLETED</b>	<i>100% access to CHP to the franchise market</i>	<i>Primary legislation</i>	<i>Barrier Removal</i>
	Licensing requirements too arduous for small schemes	Easing of licensing requirements for CHP - especially for less than 10MWe	Secondary legislation	Barrier Removal
	Rate of return on most CHP investment too low	Tax relief for investment in CHP	Secondary legislation to Finance Act 1998 *	Incentivisation
		CHP exemption from any future climate change taxes	Legislation*	Incentivisation
		Introduction of Enhanced Capital Allowance scheme	Provision of funds to enable cost of investment in CHP to be recouped faster *	Incentivisation
	CHP efficiency definition too restrictive to result in significant market potential	Modification of CHP definition in Electricity Regulation Act	Secondary legislation	Barrier Removal
	Lack of awareness of potential for CHP	Increased promotional programmes & expansion of RTD programmes	Expansion of existing IEC programmes	Barrier Removal
		CHP feasibility studies	Payment of grant to companies for CHP feasibility studies	Incentivisation
	Uncertainty/risk too great for financiers unless output from CHP scheme guaranteed	Priority of dispatch for CHP	Secondary legislation	Barrier Removal
	Individual CHP users not sufficiently powerful to argue their case	Formation of CHP Association	IEC to provide initial secretariat	Barrier Removal
Connection and tariff conditions for embedded generators may be inequitable to generators	Formation of Embedded Generation Working Group	Utilise existing CER advisory members and IBEC CHP group to begin process	Barrier Removal	
CHP not covered explicitly in planning procedures/development plans	Development of planning requirements for CHP where feasible	Inclusion in planning permissions and EPA licensing procedures	Barrier Removal	

\* Measures may be subject to State Aid approval



It is fair to say that achieving the target set out in the National Climate Change Strategy of 250,000 tonnes CO<sub>2</sub> reduction, below business as usual, attributable to CHP poses a significant challenge. Given the market conditions facing CHP at the moment it is highly unlikely that this target will be achieved in the absence of suitable incentives and the removal of market barriers

This may necessitate suitable market intervention to positively discriminate in favour of CHP. One of the main barriers to the future of CHP at the moment is gas pricing; by adopting the incentive of allowing CHP users to purchase gas at similar rates to utility users, the market would shift in favour of CHP. This is key to the fulfilment of the Government target.

The absence of such intervention will require a lowering of the Government's target. Certainly adopting the other measures as outlined in the above table will increase the rate of uptake for CHP, but the realistic target may now only be half the intended figure.

Although the duties and powers of the CER specify that it should not discriminate unfairly between the players in the market, it also has a duty to take account of the protection of the environment and to encourage the efficient use of electricity. This may allow the CER to make suitable provision for the encouragement of CHP.

The **European Community Guidelines on State Aid for Environmental Protection** (Appendix 6) recognise that state aid may be required in certain circumstances in order to promote wider environmental policy objectives.

These guidelines, which have been adopted following close cooperation with the Member States, are an effective tool for promoting measures to protect the environment while preventing any state aid that is not justified. They are also fully consistent with the draft European Parliament and Council Directive on the development of renewable energy sources and the promotion of CHP.

The guidelines essentially treat renewables and CHP in the same light and provide Member States ample opportunities for incentivising renewables and CHP.

Paragraph 24 of the Guidelines states:-

“Member States have also taken action in recent years to promote the use of renewable sources of energy and combined heat and energy production, which has the encouragement of the Commission given the major advantages for the environment. The Commission therefore takes the view that, where measures to promote renewable sources of energy and the combined production of electric power and heat constitute State aid, they are acceptable subject to certain conditions.”



## Appendix 1. Notes on Market Study

1. Additional potential in some cases requires heat distribution to associated industrial estates / business parks. The market potential here will eventually reach economic potential. However, this will not occur within the time horizon of this study unless a stimulus is applied to accelerate the rate of refurbishment of plant and therefore the rate of CHP uptake.
2. A further 4.5MWe technical potential could be expected if the gas grid was extended.
3. The low running hours combined with other factors greatly reduce the economic potential.
4. This includes boarding schools only as virtually all other schools would not have sufficient running hours to make CHP economically viable.
5. Running hours are an issue here; additional activity on campus greatly improves the economic potential.
6. This is a good sector for CHP. The addition of a swimming pool makes these even more attractive. The main opportunity will come from new build or major refurbishment. There has been a lot of activity in both of these areas in the recent past, but any slowing of this activity will reduce the uptake for CHP. Therefore the market potential in the period in question is considerably less than the economic potential.
7. Very large technical potential but the market potential is much lower due to short run hours and a lot of buildings not being owner occupied. This may provide opportunities for ESCO's to operate in this sector. The market potential will also reduce due to a predicted slow down in new build.
8. Any significant potential is in the larger shopping centres and malls. This is due to the low heat loads in general. There is a slow renovation rate of sites and new build, with only three significant centres/malls predicted to be built within the time frame of this study. The market potential prediction is for one of these centres taking up CHP. There is still generally an economic barrier of using the heat generated to produce useful chilling. If this could be overcome, the potential could increase considerably.
9. This is a good sector for CHP. There are already a number of recently built leisure centres that include CHP. However, they are generally small units (100 kWe average) resulting in a low technical potential and correspondingly low market potential. Refurbishment is an opportunity.
10. This sector contributes over 83% of the total, current installed capacity. The majority of the technical potential is fuelled with Natural Gas with approximately 10% 'off-grid'. The potential here does *not* include Aughinish Alumina due to the exceptional size of their proposed project. The economic potential is high due to generally high heat loads and long run hours. The negative issues here are in the areas of fuel prices, uncertainty, financing, existing tariff structures and turnover of plant.
11. Medium and small-scale industry generally has lower run hours and heat loads. Smaller projects will entail higher costs per MW and this results in higher management costs. The latter point gives an opportunity for ESCO's in these sectors.
12. Small-scale industry includes business parks where there are opportunities for common CHP units with shared heat distribution.
13. The domestic sector currently has effectively no CHP installed. There is still a key technology limitation whereby it is only fully economic for units of 20 kWe. The average household continuous load is in the order of 1-2 kWe. The fundamental limitation is the low heat and power demand. However, micro CHP generation is being seriously examined by a number of EU countries. This may allow a technical potential to be



- 
- defined within the next five years. A small market has been identified in large bed and breakfasts or country homes accommodation.
14. Although the existing installed capacity is quoted as zero, there is District Heating associated with the Civic Offices schemes in Dublin. Here the office block and a number of small hotels are the main recipient of the heat but a proportion of the heat is distributed to domestic apartments also. District heating offers some potential due to the aggregation of domestic loads. However, in Ireland, less than 10% of the population live in apartments at present. Nonetheless, this figure is likely to increase, perhaps greatly, over the coming decade and new build will offer major opportunities. Another possibility is community housing schemes, but there is a historic distrust of the provision of central district heating. The economic potential is quoted as 50% of the technical potential due to the absence of small economically available CHP units. Market potential is zero due to regulation and ownership issues.
  15. Agricultural wastes include straw, chicken litter, mushroom compost, etc. There are very good prospects for CHP development in this area as there is a wide base of international experience to draw on. Market potential is depended on suitable incentive schemes as the technologies are typical of most renewable energy technologies – low operating costs but high initial capital costs.
  16. For wood industry residues there are very good prospects for CHP development as there is a wide base of international experience to draw on. Market potential is depended on suitable incentive schemes as the technologies have low operating costs but high initial capital costs.
  17. For forestry residue the situation is similar to wood industry residues. Fuel collection and transportation methods have to improve before more of the technical CHP potential can be realised.
  18. SRF is not a feasible sector due to a variety of economic reasons including land use.
  19. There is little technical potential envisaged here due to absence of local significant heat sinks.
  20. The technical potential is estimated to be a significant proportion of the total biogas plants producing heat and power. The market potential is a tripling of the current installed capacity – without any AER incentive.
  21. For Municipal Solid Waste Combustion, public perception is a major barrier. However refuse derived fuels [RDFs] can be recovered from MSW and used in a CHP plant. Market potential also depends on suitable incentive schemes as the technologies have low operating costs but high initial capital costs.



## Appendix 2. Summary of Emission Saving Potentials from a Range of Policy Options

### From 'Limitations and Reductions of CO<sub>2</sub> and Other Greenhouse Gas Emissions in Ireland'

by Environmental Resources Management

Table 11.1

Sector	Measure	Cost (£ tonne of CO <sub>2</sub> Equivalent)	Total Reducible ('000 tonnes CO <sub>2</sub> Equivalent)
All	Carbon Tax	(1)	
	Tradeable Permit		
Energy	Replacing Moneypoint with CCGT	-0.53	3342
	Replacing Peat Plants with CCGT	-27.91	1447
	Replacing Oil Plants with CCGT	-23.82	769
	CHP	38-286	54-271
	Renewables	44.90	1390
Industry	Energy Efficiency	low cost	300-1,000
		<200	1,000+
Commerce	Energy Efficiency	low cost	350 <sup>(2)</sup>
		<1,200	25
Transport	Efficiency Improvements	-11.11	up to 550
	Alternative fuels	0 to -521	<sup>(3)</sup>
Residential	Energy Efficiency	low cost	-400
	Building standards	72	210
	Fuel switching	74	146
Agriculture	Reducing herd size		
	Dairy	322	<sup>(4)</sup>
	Other cattle	163	
	Sheep	155	
	Biogas from Manure	57	

*Notes:*

Cost relating of Efficiency Programmes include a cost of £14.33 / tonne of CO<sub>2</sub> as a programme cost

<sup>(1)</sup> The costs of emission reductions associated with a carbon tax (or permit) would be expected to increase with the total emissions reduced: and the level of costs would be expected to be below that for the same emission reduction via another means.

<sup>(2)</sup> These Figures represent total technically achievable at zero or negative cost (i.e. no regrets), although this does not take account of the cost of putting incentives in place nor the level of up-take in practice.

<sup>(3)</sup> We are unable to give precise figure for CO<sub>2</sub> saving as there is a great deal of uncertainty about up-take and lead time for investment in infrastructure, however, the savings are potentially large.

<sup>(4)</sup> No estimates have been made of potential. In theory this is as large as the herd.





### Appendix 3. Table of Incentivising Measures adopted in other Countries

Country	Promotional measures adopted (Current or past)
<b>Austria</b>	<ul style="list-style-type: none"> <li>• Transmission System Operator required to give dispatch priority to CHP supplying the heat network</li> </ul>
<b>Belgium</b>	<ul style="list-style-type: none"> <li>• Fixed minimum prices for electricity from CHP</li> <li>• Grid operators should strive to deliver green and CHP electricity</li> <li>• CHP has priority grid access</li> <li>• Distribution tariffs to be transparent and reasonable</li> <li>• Emergency back up electricity tariffs to be moderate</li> <li>• Funding for CHP associations</li> <li>• Fiscal abatement for investment in energy efficiency including CHP projects</li> </ul>
<b>Czech Republic</b>	<ul style="list-style-type: none"> <li>• Mandatory application of CHP when cost-effectiveness is proven in combination with a stipulated energy audit</li> <li>• preferential interest rate loans</li> </ul>
<b>Denmark</b>	<ul style="list-style-type: none"> <li>• Compulsory purchase of electricity from CHP</li> <li>• Obligation on municipalities to ensure CHP projects are developed</li> <li>• Planning guidelines for CHP</li> <li>• Priority of dispatch for CHP electricity</li> <li>• Financial subsidies for electricity production</li> <li>• Grants for district heating networks</li> <li>• Green tax on trade and industry which is returned in the form of grants and subsidies</li> </ul>
<b>France</b>	<ul style="list-style-type: none"> <li>• Long term power purchase agreements</li> <li>• Compulsory purchase of electricity from CHP up to 12MWe</li> </ul>
<b>Germany</b>	<ul style="list-style-type: none"> <li>• CHP exemption from fuel taxes</li> <li>• Grid operator required to purchase electricity from CHP at a fixed bonus</li> <li>• Favourable use of system rates</li> </ul>
<b>Italy</b>	<ul style="list-style-type: none"> <li>• Compulsory purchase of electricity from CHP</li> <li>• Industrial gas prices lower than domestic prices</li> <li>• Taxation for CHP gas is reduced in proportion to electric efficiency</li> <li>• CHP exempt from carbon tax</li> <li>• Priority of dispatch</li> </ul>
<b>Luxembourg</b>	<ul style="list-style-type: none"> <li>• Favourable price paid to CHP electricity</li> </ul>
<b>The Netherlands (Pre 1999)</b>	<ul style="list-style-type: none"> <li>• Favourable rates for CHP electricity</li> <li>• Special tariffs for natural gas for CHP users</li> <li>• Financial support</li> </ul>
<b>Spain</b>	<ul style="list-style-type: none"> <li>• Spilled electricity is paid a premium</li> <li>• Promotion of third party financing</li> <li>• Legislative adaptations</li> <li>• Provision of technical advice</li> <li>• RTD programmes</li> </ul>
<b>UK</b>	<ul style="list-style-type: none"> <li>• Enhanced Capital Allowances</li> <li>• Exemption from Climate Change levy</li> <li>• Level at which generation license is required has been raised to 100 MWe.</li> <li>• Level at which supply license is required has been raised to 500 kWe.</li> <li>• Electricity used on-site no longer needs to be sold to the Pool due to net trading, thus exempting more CHP users from the fossil fuel levy.</li> <li>• Capital grants for small-scale CHP (&lt;1MWe)</li> <li>• The CHP Feasibility Programme provides grants up to 75% of the cost of a detailed feasibility study for projects of 1-20 MW</li> </ul>
<b>Portugal</b>	<ul style="list-style-type: none"> <li>• Government financial support for new CHP plants consisting of reimbursable loans, interest-free up to 20% of investment costs</li> <li>• CHP plants can receive assistance of between 15% and 25% of the capital investment</li> </ul>





## Appendix 4. Use of Standard Contracts in France and Spain

### *France*

*(Courtesy of COGEN Europe)*

Since March 1997 “Le nouveau contract d’achat” was created with the following objectives:

- Encourage the cogenerators to build the installations of appropriate size (i.e. according to the heat demand and not according to tariff profitability).
- Reflect the avoided costs.
- Provide cogenerators of a certain visibility on the evolution of the tariff.

With all these advantages, the ‘new purchase contract’ is a little bit less profitable in terms of money than the previous system: something between 5% and 10% less.

The ‘new contract’ is applicable to cogeneration installations under 100 MWe. It enables the signing of a purchase contract with EdF for a period of 12 years. The aim is to provide visibility during a reasonable period to get the investment payback. The new contract is optional for installations selling less than 8 MVA to the grid and obligatory for installations selling more than 8 MVA. Existing installations were given the option to switch to the ‘new contract’ before 30 September 1998.

The proposed payment conditions are to be reviewed periodically, in order to adapt them to the evolution of the avoided costs, but not for contracts already signed. Once a contract has been signed, the same conditions apply for 12 years.

The contract can be signed once the investor has taken the final decision and obtained a conformity certificate issued by the General Direction of Industry Research and Environment. He then has 24 months to put the installation into services, once this 24 months have passed, unless it is the fault of EdF, if the installation has still not been put into service, the contract is rescinded and a new contract under the new payment conditions must be negotiated.

Within this purchase contract the cogenerator may choose between a contract to sell its whole electricity production of EdF or only a part of it. This is just a contractual option, no matter how much is actually self-consumed or sold.

Whatever option he takes, the cogenerator has to provide EdF a certain capacity. This capacity can be modified by +/- 5% during the first year of the contract, in order to take account of the real characteristics of the installation. After the year there can be no increase in the capacity, unless a new contract is signed. A decrease in the capacity sold to EdF is possible every three years, but this electricity cannot be put to a different use.

The cogenerator guarantees the capacity during the five winter months (November to March). The entire payment of the fixed premium is given if the cogenerator provides at least 95% of the agreed capacity in winter with a bonus/malus system, but without penalty for breakdown of the plant.

Payment conditions are calculated according to the avoided costs, taking as a basis the production costs of a combined cycle gas turbine. The proposed payments includes:



A fixed premium (in FF/k/We/year) corresponding to the annual fixed costs of a combined cycle gas turbine (annuities plus exploitation charges) plus the fixed part of network economy provided by the cogeneration installation.

An energy price (in ct/kWh) corresponding to the proportional costs of a combined cycle gas turbine (proportional charges of exploitation plus fuel charges) plus the proportional part of network economy provided by the cogeneration installation.

The fixed premium is concentrated on the five winter months (November to March), so as not to penalise installations providing space heating, whose operation is limited to these months.

Both premiums are indexed according to the price evolution:

The part of the energy price corresponding to the fuel charges of a combined cycle is indexed on the evolution of the price of gas, but with a certain ceiling in case the increase of the price of gas is too high. This ceiling depends on how long the installation works (45% in relation to current price for operating 3,600 hours, + 10% for load operation);

The remuneration of the network economy changes depending on voltage and on the capacity fed into the grid, the lease one decreases according to the voltage.

There is an extra premium for more efficient installations. The calculation of the efficiency is based on the equivalent electrical efficiency. It is 1 ct/kWh for installations with an equivalent electrical efficiency of 55% and 2 ct/kWh for installations with an equivalent electrical efficiency of 65% (with a ceiling of 300,000 FF/year for the first one and 600,000 FF/year for the second).

When the 'new purchase contract' was issued, it was agreed that it would be applicable until 1,000 MWe of new installed capacity was achieved. This has already been exceeded and therefore it is no longer possible for new installations to get this contract.

Wheeling can theoretically take place between subsidiaries, but in fact the transport tariffs are old and un-adapted and therefore the possibility is slight.

A new framework compatible with the Directive on the Electricity Internal Market has to be issued. Since the Law implementing the Electricity Directive has so far not been approved, a transitional regime for cogeneration has been agreed.



## Spain

(Courtesy of COGEN Europe)

The Royal Decree 2818/1998, introduced a new 'special regime' for cogeneration and renewables.

To be able to opt for the special regime, CHP installations have to fulfil the following requirements:

- Minimum efficiency requirement. As regulated in the Decree;
- Installed capacity smaller or equal to 50 MWe;
- Auto-consumption of at least 30% of the electricity if the installed capacity is smaller or equal to 25 MWe and at least 50% if the installed capacity is between 25 MWe and 50 MWe.

The minimum efficiency requirement for CHP plants is calculated as follows:

$$R = (E + V)/Q$$

Where:

- Q** = Consumption of primary energy, with reference to the calorific value of the fuel used.
- V** = Thermal units of useful heat supplied to the industries, service enterprises or final consumers for their needs.
- E** = Electrical energy generated measured at the alternator terminals and expressed as thermal energy with an equivalent of 1 kWh = 860 kcal.

Equivalent electrical efficiency is calculated according to the following formula:

$$REE = E/[Q - (V/0.9)]$$

To have access to the special regime, REE must be as follows:

	REE percentage
Liquid fuels in steam turbine plants	49%
Liquid fuels in thermal engines	56%
Solid fuels	49%
Natural gas and LPG in thermal engines	55%
Natural gas and LPG in gas turbines and other technologies	59%

Once the cogeneration installation has the necessary authorisations and is inscribed in the Register, the cogenerator and the distribution company sign a standard contract with a minimum duration of 5 years, which regulates the technical and economic details.

### Rights of the cogenerator under the special regime:

- Get a connection to the grid with the distribution company;
- Transfer its surplus electricity to the grid of the distribution company, whenever this is technically possible, and be paid the average pool price plus a premium;
- Receive, at all times, if it is a client under regulated tariff, all the electricity needed for its activity at the corresponding tariff.

**Obligations of the cogenerator under the special regime:**

- Give and receive the electricity in good technical conditions;
- Abstain from transferring to final consumers the electricity not consumed;
- Sell to the network only the surplus electricity, auto-consuming the rest;
- Pay the tariffs for the use of the network in two cases:
- When they act as eligible consumers and sign contracts for the supply of electricity;
- When they supply to another centre of the same company.

The surplus electricity has to be bought by the closest distribution company with the adequate technical and economical characteristics for the further distribution of this electricity. The distribution company has the right to receive the liquidation for the premiums that it pays to the cogenerators.

***Economic regime (RD 2818/1998)***

Cogeneration installations with an installed capacity equal or under 10 MWe, have the right to receive a premium of 4.10 PTAs/kWh for a period of 10 years since the plant begins to operate;

The Ministry of Economy will adapt this premium annually according to the inter-annual evolution of the interest rates (1/3), of the electricity tariff for captive customers (1/3) and of the gas price (1/3).

As a consequence, the premium has been adapted at the end of 2000 and for 2001 amounts to 4.10 PTAs/kWh.

Installations with an installed capacity over 10 MWe but smaller or equal to 25 MWe will get a premium for as long as the Electricity Companies get money for the stranded costs (see below). The premium must be calculated according to the following formula:

Premium = Premium for smaller installations (40 – Installed capacity of the installation in MWe) divided by 30.

All the premiums regulated by this Royal Decree are to be reviewed every four years. The same applies for installations under the old special regime. Installations with an installed capacity over 25 MWe do not get any premium.

RDL 6/2000 of 23 June introduced the possibility of operating in the liberalized market:

Cogeneration installations under the Special Regime with an installed capacity between 5 MW and 50 MW will be able to make economic offers to the surplus electricity individually or through an Agent. These installations will have the right to receive for their production or for their surplus, the price resulting from the cassation of offers and demand of electrical energy, plus 1.5 pesetas/kWh as guaranteed capacity term (or whatever quantity is determined by regulation) + premium.

Resulting from this, that type of installation between 5 MW and 50 MW will have the choice between operating on market conditions or being part of the Special Regime. It is not clear if the price according to the market may be now more interesting (for example 10 MW under RD2818 are receiving 10 Pta/kWh and if they go to the spot market, they will receive 7.5 Pta/kWh).



Installations over 50 MW will only be able to sell their surplus electricity to the market. They will have the right to receive the price resulting from the system of offers plus 1.5 pesetas/kWh as guaranteed capacity term (or whatever quantity is determined by regulation).

As the electricity demand is growing in Spain and CCGT's will not be operating in 2001, the Government is looking for a solution to increase CHP in the market and for solving the old regime problem.

According to AESA the situation has to be viewed from the background of a transition situation (see below the 1997 law which was established for a transitional period for utilities and stranded costs, which will end by 2007) towards a total liberalization with the internalization of the external costs in a global system. On the other hand, current power plants of the ordinary sector consume fuels that are not influenced by the petroleum price: carbon is 1.3 Pta/te approx., nuclear and hydro. Just 2 % of the ordinary sector consumes fuel-gas, as these plants have low efficiency and the cost is very high (specially because of fuel-gas prices). This is possible thanks to CHP plants, that do consume fuel oil and gas and support this part of the production.

Before the 31 December 2001, the Ministry of Economy (responsible for Energy) has to make a proposal of measures to increase the participation of CHP in the spot market. The reason is, that the promotional policies announced in the last Royal Decree (6/2000) were insufficient to promote this participation. Some of the plants have the obligation to offer in the spot market (more than 50 MW) but this is not happening and the CHP participation is zero. At the time of writing (January 2001) these measures are being negotiated between the government and the electricity industry.





## **Appendix 5. List of organisations who made submissions or who were consulted for this project.**

- ArCoGen
- Aughinish Alumina
- Ballyragget Power
- Bausch & Lomb
- Bord Gais
- COGEN Europe
- Edina
- Environmental Power
- ESB
- Fingleton White & Co
- Flogas
- IBEC
- Wartsilla NSD Ireland Ltd
- European partners through the E<sup>n</sup>R network, in particular
  - ETSU – UK
  - EVA – Austria
  - VTT – Finland
  - IDAE – Spain
- Contributors to workshop “CHP in a Liberalised Energy Market”, March’00
  - Cogen Nederland
  - Helsinki Energy
  - Protermo, Finland
  - Danish Technological Institute
  - Institute Wallon, Belgium
  - DETR, UK





## **Appendix 6. Community Guidelines on State Aid for Environmental Protection**