Benchmarking Report: Status of CHP in EU Member States

June 2006

Report commissioned by the CHP Policy Group. (Conducted by COGEN Europe)

Contents

1. Introduction

Sustainable Energy Ireland, under the remit of the Department of Communications, Marine and Natural Resources (DCMNR), has established a CHP Policy Group. The objective of the Group is to produce a final report with recommendations that will inform the roadmap and vision for Government policy and action for CHP in Ireland. This report will include inputs from a wide range of interested parties and a detailed analysis of the potential for CHP in Ireland.

The Group agreed that a number of studies need to be conducted to fill gaps in existing knowledge of CHP, one of which is an international benchmarking review to establish the status of CHP in Ireland versus other EU Member States and to establish best practice in the Member States regarding implementation of the Guarantee of Origin mechanism for CHP and in removing barriers to encourage increased CHP generation.

This study has been conducted by COGEN Europe, the European Association for the Promotion of Cogeneration.

1.1 Background – CHP development in Ireland and the EU

According to SEI, Ireland had installed 105 CHP units totalling 131.5 MWe by 2002. The growth rate had been 7.5% per year over the previous decade, based on mature technologies, though not all of it is currently operational. The National Climate Change Strategy (NCCS) set a target of 0.25 Mt of CO_2 savings from CHP by 2010. There have been a variety of support mechanisms for CHP in the past and specific provisions are made for CHP in the existing electricity markets and are proposed in the new Market Arrangements for Electricity. The NCCS target may not be reached without some additional stimulus.

The Irish energy market, in common with the rest of the EU, has been undergoing substantial changes which have influenced the development of CHP. These include: the liberalisation of the electricity and gas markets, introduction of the Directives on Integrated Pollution, Prevention & Control and Large Combustion Plants, the Renewable Energy Sources Electricity Directive, Emissions Trading, energy performance of buildings and recently, the Cogeneration Directive. For the period from 1998 to the present, the CHP market has been depressed, mainly due to market uncertainty arising from legal changes brought on by the Directives, falling electricity prices caused by the opening of the electricity market to competitive pressures and rising gas prices caused by global upward pressure on oil prices. It is not the purpose of this report to give a complete assessment of these Directives and other factors. However, all Member States have been subjected to the need to modify their energy sectors and each country has adopted a different approach.

1.2 Objectives of the Report

The purpose of the international benchmarking review has been to evaluate European policy and market practice on CHP against three key objectives:

1. Establish Ireland's position versus other EU Member States, in terms of:

   - CHP market penetration (capacity, energy, fuel use);
   - National CHP policy and targets.

COGEN Europe has also analysed the European statistics for the development of CHP and updated these data to the most recent information from National Governments and its national associations. In addition, a SWOT analysis was undertaken on the status of the European market as a whole and a pen portrait of each country.

2. Examine best practice in at least 3 other representative EU Member States, in the following areas:

   - Introducing the Guarantee of Origin system for CHP generators;
   - Means of monitoring useful heat from CHP installations.

COGEN Europe analysed 4 Member States: the UK, the Netherlands, Portugal and Belgium. Each of these countries CHP is subject to proactive policies, which will provide useful lessons for Ireland.

Concerning the monitoring of useful heat, COGEN Europe has drawn on the experience of the UK's CHPQA scheme and the CEN Workshop Agreement on the methodologies for assessing CHP.

3. Review the approaches taken by at least 3 other representative EU Member States to remove barriers to CHP and establish the best market conditions to encourage increased CHP generation capacity. The review will pay particular attention to the following areas;

   - Electricity system: Market arrangements for electricity including terms/tariffs (back-up, top-up, buy-back), network charges;
   - Support schemes in place: Fiscal measures, direct support;
   - Administration procedures, including licences and permits.

COGEN Europe analysed 4 Member States: the UK, the Netherlands, Portugal and Belgium.

4. Examine the Public Service Obligations for the promotion of CHP.

An analysis was made of France, Belgium, Denmark and Portugal.

2. Benchmarking Ireland's CHP Progress

2.1 CHP market development – capacity and generation in Ireland and the EU

For the past 14 years the European Commission, through Eurostat, has been collecting statistics on CHP. This project has been fraught with problems and not least because the methodology and collection agents have changed frequently. There have been many discussions and COGEN Europe, among others, is now unhappy about the data collected for 2000, the last year that has been completed. The concern is that the 2000 data overestimates CHP capacities and production due the inclusion of some plants that operate in dual mode of CHP and non-CHP.

The data for CHP capacities for the survey years 1994-1998 in the EU15 is presented in table 1. This data is broadly consistent with other sources available to COGEN Europe, through National Associations and other market actors.

Table 1: Installed capacities of CHP by Member State (Source: Eurostat CHP Working Group Report for 1994-1998)

	Maximum capacities, MW							
	1994**		1996		1997		1998	
Member State	Electricity	Heat	Electricity	Heat	Electricity	Heat	Electricity	Heat
Belgium	728	3085	630	3048	721	3254	797	3189
Denmark	5214	9180	5489	9581	5946	10152	7027	10999
Germany***	26183	46563	22542	40728	20666	41263	22160	35869
Greece	218	552	218	552	218	552	257*	709
Spain	1533	4706	2279	4275	3016	5130	3558	5313
France	2920	11190	3170	11531	3346	13405	3485	18837
Ireland	67	339	82	401	87	327	114	464
Italy	6328	17507	8034	19430	9519	20577	9802	23337
Luxembourg					31	61	98	204
Netherlands	6148	12055	6809	13673	8358	16558	8500	16912
Austria	3246	6001	3134	7257	3409	7284	3416	7346
Portugal	991	4188	961	4292	921	4297	965	3978
Finland	4085	12669	4265	13721	5018	14397	5097	14778
Sweden	2808	8480	2837	9407	3063	10627	3205	12440
United Kingdom	3042	14765	3525	15189	3694	15651	3842	15338
EU-15	63511	151280	63974	153085	68013	163535	72323	169713

* *Eurostat estimation*
** *The German figures are for 1995.*
*** *Figures for Germany are the gross capacity.*

Since 1998, the trend is more difficult to follow. Table 2 gives data for 2000.

Table 2: CHP by Member State in 2000 (Source: Eurostat CHP Plant Statistics in the EU 2000, 2003)

	Capacities MWe		Usage	
Member State	Electricity	Heat	Electricity GWh	Heat TJ
Belgium	1512	4324	5445	47013
Denmark	5885	10336	18971	116494
Germany	18747	40755	60836	451825
Greece	706	910	1137	11560
Spain	3457	11726	20706	164996
France	4861	17849	16280	222628
Ireland	118	459	576	4357
Italy	11994	27814	23030	215571
Luxembourg	45	119	208	1418
Netherlands	9092	12671	33657	232668
Austria	2879	6347	6408	69214
Portugal	923	4196	4375	55709
Finland	5502	14800	25510	251484
Sweden	3333	7708	8546	104035
United Kingdom	6460	10350	23053	205763
EU-15	75514	170364	248737	2154914

The problem of the new statistics is illustrated by the United Kingdom, where the reported capacity is 6460 MWe whilst the UK Government's own figures state that only 4800 MWe were installed. This report will not investigate these issues further. However, further changes to the statistical methodology will occur once the CHP Directive is brought into force in each Member State and the statistics reporting is undertaken.

As a general summary of the EU15 situation (see also Figures 1, 2 and 3):

- CHP electricity generation in the EU in the year 2000 totalled 248.7 TWh, which was 9.6% of total gross electricity generation.
- More than half of the CHP electricity, 145.3 TWh, was produced in industrial plants whilst public supply plants recorded CHP electricity generation of 103.5 TWh.
- The chemical industry (39.4 TWh), the pulp and paper industry (34.0 TWh) and refineries (22.9 TWh) were the largest industrial CHP electricity generators. Two-thirds of the CHP electricity in industry was generated in these three sectors.
- Germany was the largest CHP electricity producer with 60.8 TWh, but Denmark had the largest share of CHP generation in total gross generation, 52.6%.
- CHP heat generation in the EU in the year 2000 was 2155 PJ. About 21% of the CHP heat in the EU was produced in Germany.
- The principal fuel consumed in CHP was natural gas, which took 47.0% of the total fuel combustion in CHP plants. The share of renewable fuels was 11.6%.

Figure 1: **CHP electricity generation as a share of total electricity generation and total fossil fuel generation in 2000**

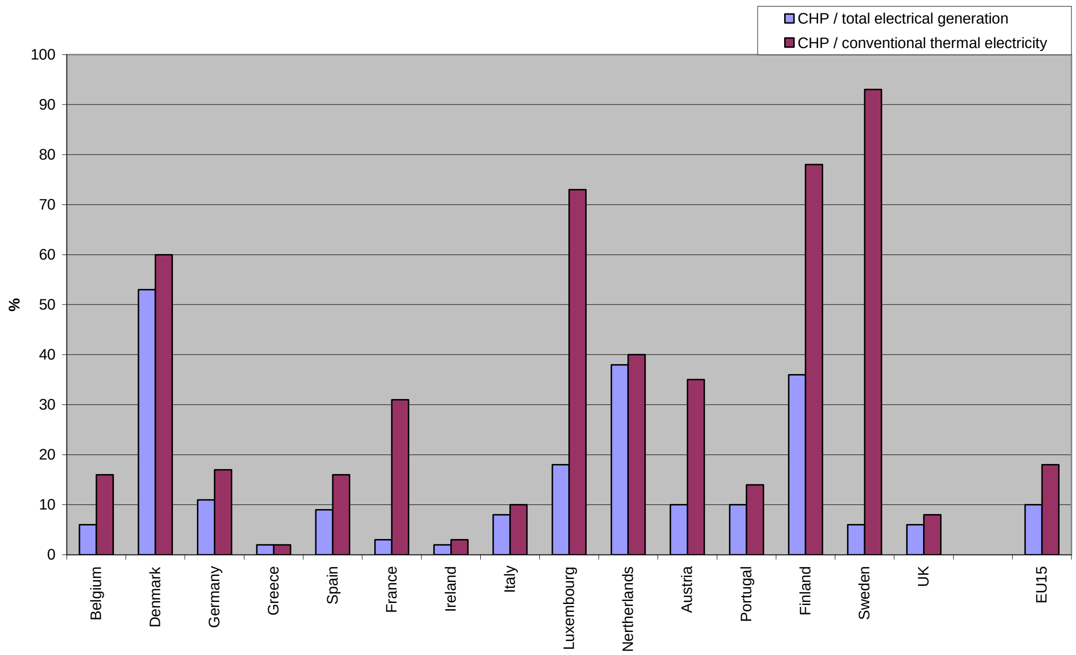


Figure 2: **Breakdown of European CHP capacity by type of generation in 2000**

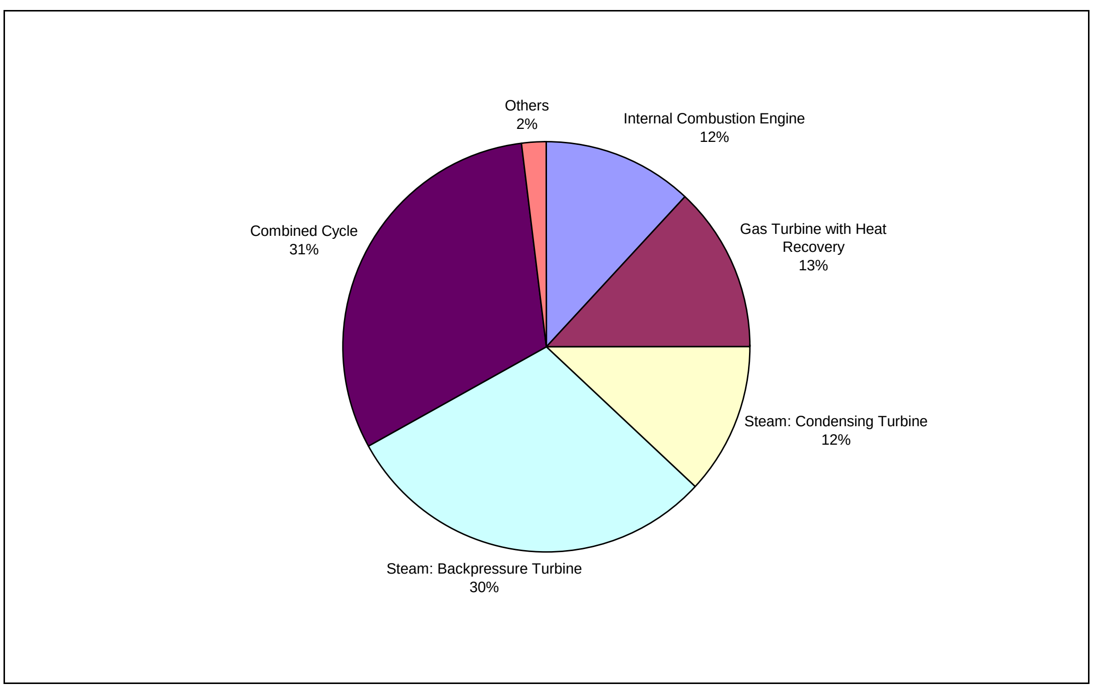
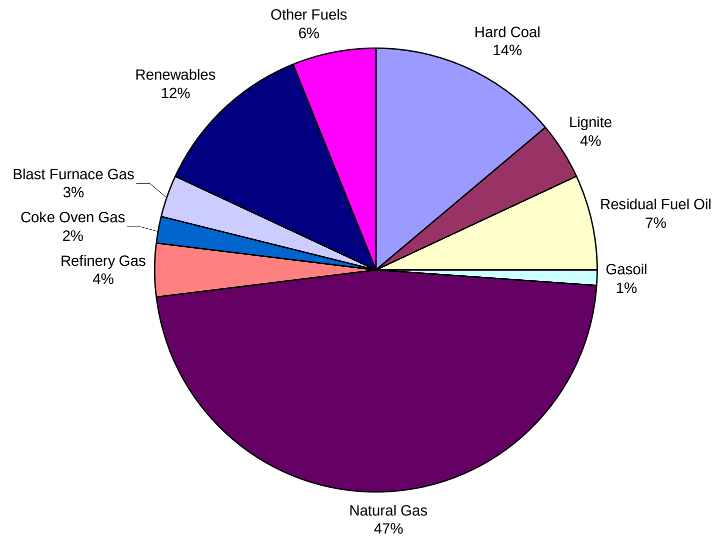


Figure 3: Fuels use of CHP operation in 2000



In Ireland, CHP is a relatively new concept, really only starting to grow after 1990. The installed capacity in 2002 was 131.5 MWe from 105 installations, generating some 630 GWh of electricity. The development of the sector is adequately covered in the report "Combined Heat and Power in Ireland, trends and issues 1991-2002", from Sustainable Energy Ireland, 2004. Since 2002, the capacity has grown by 6.5 MWe according to the ESB and its generation may have slightly reduced, due to economic conditions.

Ireland's CHP development can be summarised as follows:

- Little or no history of CHP prior to 1990;
- Monopolistic electricity market;
- The geographical distribution of natural gas has been limited and natural gas is a relatively recent fuel;
- The economy has very limited continuous process industries;
- There is no tradition of communal / district heating.

Subsequently, the CHP in Ireland is mostly small scale and fired on natural gas. Those schemes that use solid fuel or oil are old and were installed before 1990 and so all growth has been using natural gas. The average size of plant is 1.25 MWe and the predominant technologies are steam turbines with 28% of capacity, gas turbines around 50% and reciprocating engines the balance at 22%. In terms of numbers of installations reciprocating engines dominate with a share of 50%.

Relatively speaking Ireland's CHP sector has outstripped the rest of the EU with a growth of 76% between 1994 and 2000, compared with an EU average of 20%. However, the share of the total electricity generation is still only a modest 2.6%, the second lowest in the EU after Greece and so this rate of growth is slightly misleading. In comparison the EU average share of electricity production is around 10%, with three countries in the range of 35% or more.

2.2 National CHP Policy & Targets – summary examples of successful strategies and measures throughout the EU

Most countries of the EU-15 have some specific policy towards CHP. In some cases these are extensive, including growth targets, fiscal measures and promotional campaigns. In other cases they are small piecemeal measures.

The policies that can influence the development of CHP can be broken down into the following categories:

Strategies and Targets
A number of counties have developed CHP Strategies. In some cases, such as the UK, these strategies have evolved from commitments made by Governments and eventually formalised into a strategy. In other cases, such as Ireland they were developed afresh. The benefit of a strategy is that it provides clarity and focus for the Government and the market actors alike. One successful outcome of the early strategy in the UK was that barriers to CHP development brought about by the privatisation of the electricity sector, such as licence conditions, could be tackled in an effective way. In Spain in the mid-1990s the Government had a strategy to substantially increase the amount of CHP. This strategy was implemented through a series of decrees that provided good prices for the electricity produced. Indeed these were so successful that by 1998 the Government tried to limit further growth in CHP. In Germany, the policy towards CHP was governed by the commitments to CO_2 reductions. After a number of iterations the support of CHP was linked to maintaining existing capacity during the liberalisation of the energy market and encouraging plant modernisation. This was broadly successful, but there was little support for new CHP schemes.

Concerning targets, a number of countries have these, including the UK, the Netherlands, Belgium, Germany and Ireland. In the UK, in the early 1990s, the target was useful in helping Government and its agencies focus support and in removing barriers. Crucially, this target, originally a doubling by 2000, was challenging and led to a strong development CHP. Since 2000, and with the introduction of the NETA framework, the target for 2010 of 10,000 MWe quickly became discredited and thus serves no policy purpose. The same is true for the Netherlands where the official target of 15,000 MWe by 2010 has long since been irrelevant and is widely ignored. In contrast the NCCS target for CHP growth in Ireland is both credible and achievable to serve as a focus for Government action and a stimulus for the CHP sector.

Fiscal Measures
Most countries in Europe provide some fiscal support for CHP plants. These may be in the form of tax breaks, feed-in payments for electricity export or favourable tariffs. Only a few countries provide loans or grants on capital investment for CHP. These are also often limited to special projects. In Greece, capital grants and loans have been available for many years, with support of the EU Structural Funds. Despite these subsidies CHP has not developed at all in Greece, because the barriers to CHP are more substantial than the capital subsidy can offset.

Feed-in laws such as those in place in Germany have proven to be very effective for renewable energy development, but less good for CHP. The principal issue is that the feed-in rewards only exported power. Most CHP plants are designed and operated on the basis of satisfying internal electricity demand, with only a small proportion of export. Thus feed-in tariffs are generally not effective in these cases. Where they do work is for CHP schemes feeding district heating networks. In these cases all the power is exported as there is no internal demand.

Favourable tax treatment can be effective. For example in the UK and Denmark there are exemptions from carbon taxes. In Germany there are fuel taxes for which CHP is exempt. In the Netherlands and the UK CHP investments benefit from enhanced capital allowances, which enable all or part of the capital costs to be written off against taxes in the first year of investment, bringing a significant improvement in the IRR of projects.

Incentives for the Incumbents

One of the major barriers to the development of CHP is the market position and incentives of the electricity industry. CHP is often viewed as a competitive threat and a loss of operating revenue by large utilities. However, there have been a number of instances where the incumbents have become the principal CHP developers and operators. In the Netherlands, the electricity distribution companies became the principal actors as they were prevented from developing large projects. The same occurred in the UK during the moratorium on gas-burn consent. The ESI, instead of proposing CCGT projects, instead switched to CHP.

Promotional Campaigns

Promotional campaigns work well if they are long-running and backed by favourable market conditions. They provide market actors with relevant information to assist decision making for investments. However, a campaign without favourable market conditions will fail.

Discussion in later sections deals with four countries: the UK, the Netherlands, Belgium and Portugal. Thus the remainder of this section will discuss examples from selected CHP policies for Germany, Denmark and France.

Germany

Germany has had a long tradition of CHP, with significant development of both industrial CHP and district heating. There are around 800 municipal energy utilities and a small number of super utilities. The governmental attitude to CHP has been ambivalent, with strong support from the Ministry for the Environment, but opposition from the Ministry of Economics which is responsible for energy policy.

In 1999, Germany developed a quota model that aimed to increase the share of CHP in steps from 10% to 20% of national electricity production. The basis was to oblige all suppliers of electricity to source a proportion of electricity from CHP. At the last minute this system was blocked by the Ministry of Economic Affairs. In the place of the quota system a new CHP law was passed in 2001. This provided a bonus on top of the price paid for exported electricity from CHP plants. The bonus system was limited to existing plants, refurbishment of old plants and new smaller scale CHP below 2 MWe. The German CHP Association has been critical of this law and there are some valuable lessons from this process:

- The development of new plants has been limited; some refurbishment has taken place and only a few new small-scale plants developed.
- Utilities have revised the CHP electricity price, with the result that the price now paid is reduced by around €c1.4/kWh, which is broadly equivalent to the bonus price. Thus CHP operators are no better off than before.
- The bonus only supports CHP exported electricity and thus own consumption is not rewarded.
- The public impact of the bonus system has been that CHP is perceived as expensive. This is because electricity users directly pay for the bonus through their bills, and it has a separate line highlighting the cost. The CHP export price that was originally paid was not shown on individual bills.

Denmark

Danish CHP development has been very strong over the last 20 years. This development was stimulated by the oil shocks of the late 1970s and early 1980s and was based on extensive governmental and municipal planning. The opening of the Danish energy sector to liberalisation at the end of the 1990s was done in a careful way to protect the CHP sector. CHP energy prices were ring-fenced and CHP was given a favourable status in the carbon taxation system. This is in marked contrast to the Netherlands, for example, where CHP was subjected to the full force of market changes without consideration of the impact on CHP investments. Consequently the Danish CHP sector is still profitable and operating well, whereas the Dutch CHP sector has suffered a sharp decline in fortunes.

The relevance to Ireland of this illustration is that the Danish government, although it did not have a CHP strategy, did account for the impacts of market changes and provided a safety net for the transitional effects of market liberalisation. Thus Denmark, probably alone in Europe, has demonstrated its long-term commitment to the use of CHP. This commitment is shared by the whole government structure, including Finance, Environment, Energy and Industry Ministries.

France

In France, the electricity sector is dominated by nuclear power and to a lesser extent hydro. The use of thermal power is for mid-merit and peaking electricity. In 1997, the French government introduced a special regime for CHP that paid a premium price for CHP electricity. The regime was specifically designed to displace aging thermal power plants.

The special regime caused a frenzy of activity in France with a large development of CHP over 2-3 years. After November 1998 the regime was unavailable to new projects ordered after that date. The result was a boom and bust cycle of development that has not been good for the equipment supply industry, the technical support services nor the electricity industry. A longer-term strategy for development would be likely to ensure a moderate but sustainable development.

Table 3: A Summary of Support Policies in the EU15

Country	CHP Share of Electricity Production	Capital Grant	Capital Subsidy	Capital Loans	Feed-in Tariffs	Competitive Tender	Certificates/ Purchase obligations	Tax/ Fiscal Incentives	Public R&D
Austria	26%		Umweltförderung Programme 30% for biomass		Länder-specific feed-in rates for CHP electricity Solid biomass: 10.2-16¢/kWh Biogas: 10.3-16.5¢/kWh Waste: 3-6¢/kWh				
Belgium	4/5%	Pre-feasibility study subsidies up to 75% (Wallonia)	Flanders: 10% (20% if SME) investment subsidy Wallonia: Private sector: 20% ceiling Public sector: 30% (+10%) ceiling		2¢/kWh premium for biomass [to be checked]		Regional certificate schemes: Tradable green certificates for CHP or direct subsidies in Wallonia Tradable CHP certificate scheme in Flanders	Flanders & Wallonia: 13.5% tax deduction from taxable income Wallonia: 15% tax braek for replacement of boiler by microCHP (max €590)	
Denmark	50%	Investment grants from green taxes Grants for new CHP-DH and rehabilitation if compulsory	Investment subsidies for central heating in old houses (from CHP) Investment subsidies for conversion of DH to CHP		Prioritised Production tariffs for small-scale CHP (average 28-37 ø/kWh)		Small-scale CHP electricity is prioritised production with purchase obligation	Reduced tax for small-scale CHP	
Finland	34%		30% investment subsidy for biomass CHP		€1/GJ subsidy for biomass heating fuels			Tax exemption for biomass CHP Exemption from renewable energy tax	multi-million multi-year R&D programme
France	5%				Specific remuneration contracts Specific tariffs for non-gas fuelled CHP	For biomass and biogas only (CHP unlikely to win)	Purchase contracts for 12 years	Exceptional amortisation on 12 month period Tax exemption from internal taxes on natural gas consumption and petroleum products Exemption from local business tax	
Germany	10%		Investment subsidy for biomass and biogas		Degressive bonus payment for CHP over time Special biomass and waste tariffs			Ecotax exemption Full exemption from mineral oil tax and environmental tax for biofuels in heating	
Greece	3%	35-40% grants		Yes, but no details	Special compensation rates	Investment grants after public calls	Purchase obligation and priority of dispatch		Financing of demonstration projects
Ireland	2/3%	Public sector investment support				AER tendering scheme	Priority of dispatch		CHP and DH R&D demo programme
Italy	18%	Theoretical regional funds					Tradable green certificate for biomass Priority dispatching of CHP	Tax break on natural gas consumption Exemption from carbon tax Exemption from renewable purchase obligation	
Luxembourg	N/A		25% subsidy for individual investment		Special tariff for biomass and biogas for 10 years				
Netherlands	40%				Special feed-in tariff for CHP <2MWe Specific tariffs for biomass and waste		Purchase obligation	Tax deductible investments (55% max) Ecotax rebate	
Portugal	13%	MAPE support scheme and SIME schemes	MAPE support regime and SIME schemes	MAPE and SIME interest-free loans	Special remuneration formula				
Spain	14%		Investment support for biomass CHP	IDAE: low interest loans for up to 70% of costs	Special regimes Remuneration formula Premium prices for installations <25MWe Preferential tariffs for biomass			Hydrocarbon tax exemption for oil-fuelled CHP	
Sweden	6/7%						Electricity certificates for biomass and biofuels	Waste tax (370 SEK/tonne in 2003) Energy tax exemption for biomass and biogas CHP Environmental tax exemption for biomass CHP	Multi-year R&D energy programme
United Kingdom	5/6%	Development grant support and capital support Biomass grants		Loan schemes for Northern Ireland and Scotland				Climate Change Levy Exemption 100% first-year capital allowances Exemption from business rate of power VAT reduction for domestic CHP	Carbon Trust support schemes Energy Savings Trust initiatives DTI's New and Renewable Energy R&D Programme

2.3 CHP market SWOT analysis for each Member State

The EU market for CHP in recent years has been highly uncertain. Most countries have been busy with the implementation of the Directives on the Internal Market for Electricity and Gas. In the long-term, this should be beneficial to the future development of CHP, but in the short term, and with a few exceptions, it can be said that the market has been paralysed.

Looking at the EU as a whole, the following strengths, weaknesses, opportunities and threats can be seen. Here are the 'top six' in each category:

Strengths
- Experience with CHP is widespread
- Functioning equipment industry and service network
- EU CHP Directive
- Strong commitment to meeting climate change targets will drive clean production and so should stimulate CHP
- Widespread gas pipeline system
- CHP gets tax breaks in some countries and State Aid guidelines allow support for CHP

Weaknesses
- Some EU countries lack experience or willingness to develop CHP and support for CHP is often split across Government departments, leading to inconsistent policy support
- Structure of the electricity utilities does not give focus to CHP in most cases, especially the incentives for DNOs are wrong. DNOs are often paid by volume transport of kWh across network, therefore no incentive to encourage CHP
- No co-ordinated RTD on gas engines, gas turbines and emerging technologies in Europe
- Planning rules are weak and the provisions in the LCPD are not strong enough to force CHP
- Current overcapacity in the electricity market, leading to low price signals from fully amortised coal plants, hydro and nuclear
- Gas prices are high due to link with oil prices, leading to the spark spread for CHP being poor, making CHP uneconomic

Opportunities
- CHP Directive requires Member States to evaluate potentials and remove barriers
- Important role of CHP in emissions trading because of carbon constraints
- Domestic CHP is just starting to come to the market and has tremendous potential
- Phase out of older power plants, through LCPD and ETS, and opportunity for new capacity from CHP, resulting in several GW of new capacity may be brought on line from 2008 to meet growing demand and to replace existing plants
- No need to reinforce grids because of decentralisation and CHP will reduce strain on grids and so help to prevent grid failures
- The DG market is growing fast, especially wind and photovoltaics; this may help all DG options including CHP

Threats
- Strength of utilities is increasing through consolidation – the super-utilities are not supportive of CHP
- EU adopts a NETA type of electricity market, which kills smaller generation and new capacity is built but only large CCGTs
- The price of natural gas continues to rise
- Poor market for CHP has meant that suppliers and ESCOs have left the market
- Perception of DG and thus CHP is dominated by large wind, so the public in some countries has a negative reaction and the attitude of utilities is negative due to the perception that all DG is considered unreliable as it is viewed as intermittent
- Companies need high volume sales for economical reasons but this is never achieved because:

- Each project is different
- Too many small companies, resulting in a fragmented supply side with little visibility for individual companies
- Negotiations for grid access are protracted
- Planning burdens

The following pen portraits give a short overview of the market in each of the EU-15 countries.

Austria
CHP is well known in Austria. According to government statistics it represents a share of 26% of the electricity production, and 75% if only thermal production is taken into account (65% of the electricity production in Austria is hydro). Most of this capacity has been developed by the utilities for the district heating networks. The legal framework is generally positive and the emissions trading Regime will reward CHP and the key opportunity will be in biomass.

Belgium
Addressed later in this report.

Denmark
Denmark is the biggest European performer in CHP development. According to the Danish Energy Authority, 50% of the electricity production comes from CHP. The previous governments were very keen to continue to support its development and kept most of the advantages for CHP schemes in the law liberalising the energy markets. Purchase of electricity from CHP remains compulsory. However, there is not much further potential left, except a small amount in industry (but there is little energy intensive industry) and obliging buildings to connect themselves to the district heating networks if they aren't already. The new Government is showing much less willingness to provide support for CHP.

Finland
As with Denmark, Finland is one of the highest CHP performers, with 35% of the electricity production. Its development presents an interesting case, since it has been achieved without government support. In Finland, however, the development of CHP has been, almost exclusively, in large-scale schemes in the pulp and paper industry and district heating. Small-scale CHP is rare and faces obstacles for grid connection and fuel supply. A big problem at the moment is the low prices for electricity –partly due to the large hydro production in Norway and Sweden.

France
Due to high nuclear and hydro capacity (especially the former) and the existence of a vertically integrated monopoly, CHP has not developed strongly in France (it represents about 2% of the electricity production). However, during the years 1997-2000, France was probably the best market in Europe and more than 1,000 MWe was developed. This was due to the existence of the possibility of signing a 12-year contract with EdF. This possibility is over, and uncertainty and adverse market conditions have returned.

Greece
As France, Greece has been one of the worst performers in CHP development, but the situation may improve with the arrival of piped natural gas, and the electricity market will have to be liberalised.

Germany
There is plenty of CHP in Germany already, but the full potential is far from being developed. The market is fully liberalised, but competition has not developed, mainly because of the legislation on access to the network, local monopolies and strength of the main power companies. The Government introduced advantages to ensure that CHP develops, such as exemption from fuel taxes and a feed-in support for existing and small-scale CHP. However, these measures have been largely ineffectual.

Ireland
Discussion on Ireland is covered elsewhere.

Italy
CHP is well developed in Italy but there is still plenty of further potential. The market situation in the last six years has been very bad, since the obligation upon ENEL to purchase electricity from CHP was cancelled in 1997 and the Government has been busy trying to implement the Electricity Directive. Uncertainty still persists and the authorisation procedures are very difficult.

Luxembourg
Until recently, the country needed to import about 95% of its electricity needs, and therefore the Government encouraged the use of CHP strongly. The prices paid to electricity from CHP were higher than the price to be paid when purchasing electricity from the utilities. In the last few years, with the development of a large CCGT and concerns over CO_2 emissions the Government has reduced its support for CHP.

The Netherlands
Addressed later in this report.

Portugal
Addressed later in this report.

Spain
CHP has experienced an important development in Spain in the last year (now it represents 14% of the production); despite the efforts of the Government to slow down its development. In the past, rapid development created a "state of alarm" and there has been a lot of uncertainty. Everybody knew that the legal framework would change, and would be less favourable than the existing one. The uncertainty has now decreased, with a new legal framework, though this makes the viability of projects in the service sector problematic.

Sweden
As France, Sweden has high nuclear and hydro capacity, and this has been an obstacle in the development of CHP. The market is fully liberalised now, and the government has committed itself to phase out nuclear. If this is done, prospects for CHP development will be bright, but it is not clear when and whether it will be done. Lack of availability of natural gas in most of the country is a potential obstacle, but Sweden is a world leader in the use of biomass and this could be the future fuel for CHP here.

United Kingdom
Addressed later in this report.

2.4 Assessment of Ireland's progress against other countries

Ireland is at the early part of the diffusion curve for the adoption of CHP, with a very low share of total electricity production coming from CHP. This is partly caused by the late arrival of natural gas to Ireland and the lack of heavy continuous process industry or large district heat potential. The CHP capacity that has developed has been relatively small at 1.25 MWe per scheme and there has been an absence of any large scale CHP schemes. Recently, Aughinish Alumina has been developing a large scheme of 150 MWe, but this is the only potential site of its kind in Ireland. Nevertheless Ireland has displayed steady growth through the 1990s and into this decade. It also has a reasonable potential, which is being targeted as part of the National Climate Change Strategy.

Compared to other EU countries Ireland has a rapidly developing economy that has driven demand for electricity much faster that most of the EU-15. In this respect it is comparable to Portugal, with 4.5% demand growth a year. This gives space in the market for CHP, RES and conventional projects to develop. In countries where the growth in power demand is more modest, CHP is seen as a much greater competitive threat to the existing system.

Ireland is a relatively small economy and the number of potential sites for CHP will also be low in comparison with say Spain of Germany. In addition it is an island on the edge of Europe and so it suffers for its geography to a certain extent. Nevertheless, it is apparent that suppliers are willing to set up subsidiaries or employ local agents/contractors to service the market. These operations are often linked to activities in Northern Ireland and Great Britain.

In terms of the market for CHP in Ireland, the current economic conditions are tough, but that is true for most of Europe. In some countries, though, the economics are helped by favourable fiscal regimes or certificate support systems. These are currently not available in Ireland.

Regarding grid interconnections, Ireland is rather behind the developments in the UK and the Netherlands for standard connections for micro-scale projects. But the connection costs and conditions are no worse than anywhere else in Europe.

The energy pricing regimes in Ireland are not that favourable for CHP. Firstly the gas price is charged at a high rate to smaller customers than to the large CCGT projects. Whilst this is generally true elsewhere, the differential is large and it should be possible to narrow the gap by giving tax incentives and making the gas system truly cost reflective. Tax breaks are given in the Netherlands, Germany and the UK, for example, for CHP in this way. Attention could also be given to electricity export prices and top-up prices. Export is currently only paid a around 2.5-3 €c/kWh. This is at or below the generation cost and does not reward the CHP operator for avoidance of grid losses or any environmental benefit. Here Ireland could refer to the UK, which pays embedded benefit to CHP plants, or the Portuguese system or a feed-in system could be considered. It is the view of COGEN Europe that the best system is one that rewards both onsite electricity consumption and export in an equal way. In this case some form of obligation with a guaranteed minimum price may be most appropriate.

Finally, CHP is a complex policy challenge. The use of CHP normally sits on the boundary between supply and demand. Its true benefits come from displacing on-site heat supply from boilers with a power plant with heat recovery. Therefore the development of CHP is affected by governmental policies that are directed towards energy consumers as well as energy supply side policies. This makes the development of a CHP strategy and support policies quite different to renewable energy ones. To deal with this challenge it is important to engage with many actors, both governmental and private/public sector. In this respect the CHP Working Group and the earlier CHP Strategy that Ireland has are effective tools for planning a route forward. Here Ireland is well placed compared with some European countries. Nevertheless, it would be worth Ireland looking at the outcomes of the UK's Distributed Generation Coordinating Group. In addition the Dutch CHP platform, which is a grouping of industry, energy sector and CHP representatives, regularly meeting with Government is also a reasonable model. This type of arrangement has proven valuable for the development of the Blue Certificate scheme in the Netherlands.

3. Guarantee of Origin

3.1 Summary of the Guarantee of Origin (GoO) Concept

The guarantee of origin concept emerged in the late 1990s as a tool to facilitate the promotion of CHP projects that could meet certain efficiency or quality criteria. It has subsequently been defined at the EU level in the Directive as a means of distinguishing cogenerated electricity with other supplies and so providing a mechanism through which CHP can receive policy benefits. The Directive states "To increase transparency for the consumer's choice between electricity from CHP and electricity produced on the basis of other techniques, it is necessary to ensure that, on the basis of harmonised efficiency reference values, the origin of high-efficiency CHP can be guaranteed."

The Directive obliges Member States to introduce GoO mechanisms that fulfil certain conditions, in particular that it should enable producers to demonstrate that the electricity they sell is produced from high efficiency CHP.

3.2 The CHP Quality of Assurance Scheme - the UK

The UK's CHP Quality Assurance Programme (CHPQA), introduced in 2001, forms the basis on which progress towards the UK's CHP target is monitored. It is the most advanced system in existence for defining a certain quality of CHP, elaborating a means of 'guarantee of origin' and laying down guidelines for assessing useful heat output from CHP.

The scheme is a Government-driven initiative whose main aims are to:

- Provide a mechanism for attributing policy / fiscal incentives to qualifying CHP schemes directly in proportion to the electrical output of the project.
- Define, assess and monitor the quality of CHP schemes on the basis of energy efficiency and environmental performance.

In essence, the CHPQA is a voluntary scheme that provides a methodology for assessing the quality of CHP schemes, and their qualification as good quality CHP for all or part of their inputs, outputs and capacity. Certification issued under the CHPQA is used for determining the eligibility of schemes for fiscal or other benefits.

CHPQA assesses schemes based upon two thresholds. The first is the Power Efficiency threshold – which should normally be greater than 20%. If the scheme exceeds this, then all fuel entering the scheme boundary qualifies as 'good quality'. The second threshold is the Quality Index (QI) threshold. This is an index that considers both power and heat efficiency along with multiplying factors which effectively reward good environmental practice. The QI definitions cover the wide range of technologies, applications, scheme sizes and fuels which are found in the UK. The methodology behind this is based on the principle that electrical power is of greater value and 'harder won' than heat.

While the methodology is complex, and therefore presents something of a challenge in its application, the CHPQA has now been widely applied in the UK and covers around 90% of schemes. To the extent that there is complaint in the UK, it concerns the overall state of the UK market, not the challenge of assessing the QI of a project.

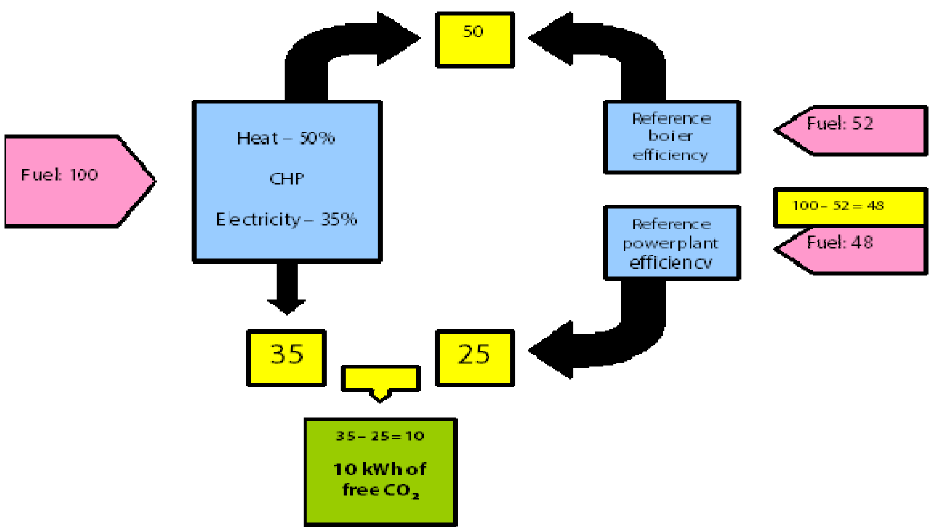
3.3 The Blue Certificate Scheme - the Netherlands

The Dutch Ministry of Economic Affairs has introduced a new certificate-based mechanism, as of 1 July 2004, in support of CHP. The system cannot yet be described specifically as providing a 'guarantee of origin' for CHP and the degree to which it complies with the requirements of the EU Directive is still to be fully explored. It nonetheless does represent a means of enabling a policy support measure to be directly applied to electricity derived from CHP plants. The system is summarised in Figure 4 below.

The system applies to all CHP plants and to all the electricity generated by those plants, whether used onsite or exported to the grid. Each kWh of 'free CO_2' benefits from a generous premium payment of €c2.6. To calculate the benefits, gas turbine plants will be subject to a comprehensive monitoring protocol (not yet finalised) and implementation methodology, while gas engine plants can refer to published CO_2 indices that supply data according to the type and age of engine.

It is estimated that around one third of electricity supplied by CHP in the country will be identified as carbon-free and will therefore benefit from the premium. As the national market presently stands, however, it is expected that the scheme will stabilise the commercial viability of existing plants but is not sufficient to incentivise new plant investment.

Figure 4: The Blue Certificate System in the Netherlands



3.4 The Belgium Certificate Systems

Despite being a relatively small country Belgium has four certificate schemes. These are:

- Green Certificates covering both CHP and renewables for Wallonia, in force since 2003
- Green Certificates covering both CHP and renewables for Brussels Region, to be introduced in second half of 2004
- Renewable Energy Certificates for Flanders, in force since 2002
- High Quality CHP Certificates for Flanders, to be introduced in January 2005

The certificate systems are based around governmental targets for CHP and renewable energy based on the economic potential, the responsibility for which is a matter for the regional administrations not the Federal Government. The issue is further complicated by the fact that the development of CHP and RES through certificates is linked to CO_2 reduction targets and Belgium's commitments to the EU Burden Sharing Agreement on Greenhouse Gas Emissions, which is a Federal Commitment.

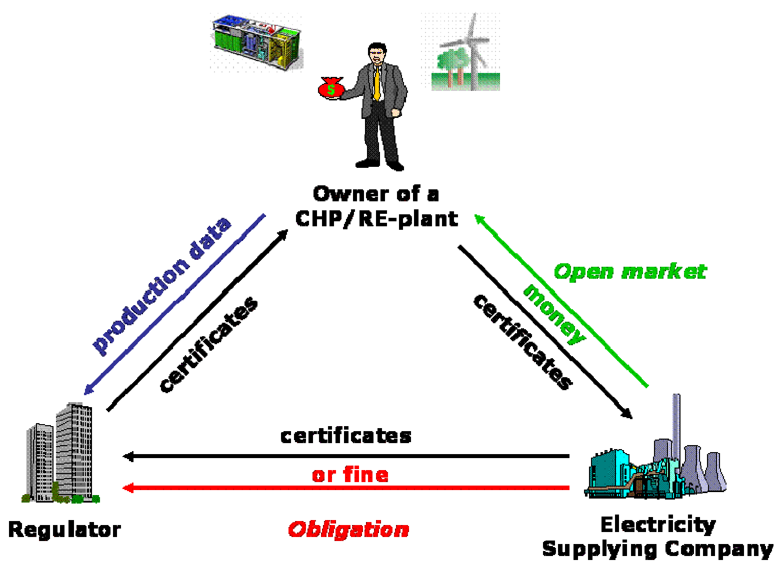
Due to the political nature of all of this it has resulted in delays in implementation of the schemes, especially the CHP Certificates in Flanders.

To reach these targets:

- Certificates are granted for electricity production for qualifying CHP and/or renewable energy sources;
- Obligations are placed on the electricity supply companies to hand in a certain number of certificates every year, proportional to the amount of electricity supplied;
- The electricity supply companies will be fined if they don't hand in enough certificates;
- This then, in theory puts pressure on the electricity suppliers to stimulate the development of new CHP and RES.

Each of the schemes is slightly different, with varying thresholds for reference plants, coverage of CHP and renewables, economic instruments and the levels of fines. As the Walloon system is already in place a short outline of this scheme is given.

Figure 5: The basic concept of Belgium Certificate Schemes



Green certificates apply for:

- High-quality CHP
- Renewable energy sources

There is a need for a common basis for calculating CO_2 emission savings, which are compared to the best available technology for separate production (reference emissions).

The references situation is based on emission factors for fuels used in the CHP plant (or RES), the displaced power plant and displaced boiler plant.

- The emission factor for natural gas: 251 kg/MWh (70 kg/GJ), which includes combustion in the CHP plant and preparation, handling, transport, etc of the fuel
- The reference boiler plant emission factors are 279 kg CO_2 /MWh for natural gas and 340 kg/MWh for diesel fuel (natural gas is preferred) based on a boiler efficiency of 90% (NCV)

- The reference power plant is a Combined Cycle, using natural gas with an efficiency of 55% (NCV), with an emission factor of 456 kg CO_2/MWh.

One green certificate is equal to 456 kg of avoided CO_2 emissions, which is equal to emissions when making 1 MWh of electricity with the reference power plant.

The emissions savings are calculated using the following formulae:

$$\tau = \frac{E + Q - F}{E}$$

Where:

E = emissions of the reference power plant per MWh of electricity produced
Q = emissions of the reference boiler when producing the same amount of heat as the CHP does per MWh of electricity produced
F = emissions of the CHP plant per MWh of electricity produced

And the number of certificates obtained:

certificates = τ * electricity production (MWh)

To qualify schemes must deliver a minimum of 10% savings and only the first 20 MWe of any CHP plant is included. There are fines of €100 for each missing certificate and the targets are based on 3% of total electricity supplied in 2003 rising to 7% in 2007. For RES there is a guaranteed price of €65 per certificate, but there is no guarantee for CHP.

In all three regions and the four schemes it is too early to tell how effective these certificate schemes will be. In Wallonia there has been a slight shortage of certificates with the average market price being 92% of the fine, i.e. €92/MWh of CCGT electricity.

A couple of observations on the Belgian approach. Firstly, the CHP certificate scheme in Flanders has been subjected to tremendous delays and has steadily become more restrictive in scope. This is because of strong lobbying from the electricity sector about interference in the functioning of the marketing – internationally and from industry about pass through of electricity price rises to cover the costs of the scheme. Secondly, in all cases the reference plants are based on unsubstantiated claims of efficiencies of plants (CCGT efficiency of 55% is not currently achievable on an annual basis). In Wallonia and Brussels no account is taken of grid losses and boiler efficiency in all cases is not corrected for heat grade supplied. Finally, the three schemes are not transferable outside the particular region. Thus, a CHP plant in Flanders can not sell its certificates in Wallonia or vice versa.

Nevertheless the Belgian CHP organisations, Cogen Vlaanderen and Cogen Sud, both believe that the certificate schemes are likely to be a boost to CHP.

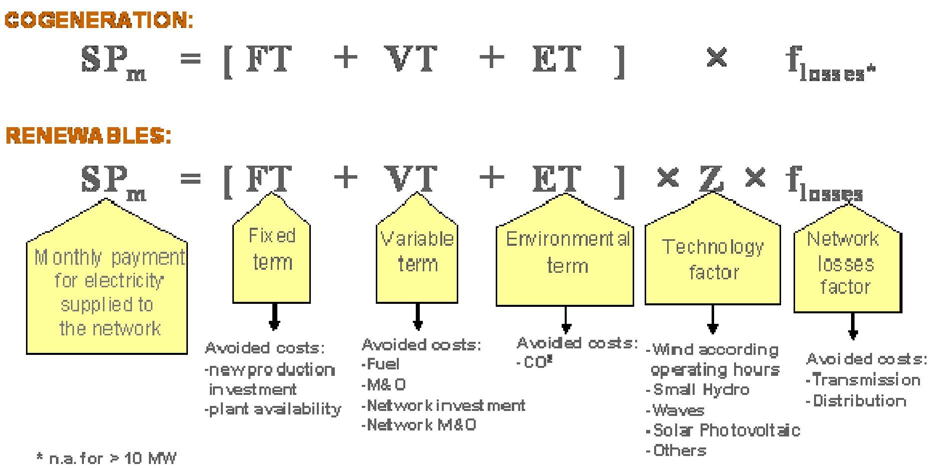
3.5 The Portuguese CHP Law

The Portuguese legal framework for supporting CHP is based on the avoided costs of central production in respect of:

- New investment to increase production capacity
- Electricity production (fuel, operation and maintenance)
- Electricity transmission and distribution (new investment in networks, network operation and maintenance, losses)
- Carbon dioxide emissions

Producers of CHP and RES have the right to sell their electricity to SEP (the Public Electricity System). The system is summarised in Figure 6.

Figure 6: The Portuguese Tariff Framework for CHP (Source: COGEN Portugal, 2003)



The system is very complex, with each element of the equations governed by another set of factors. Despite this the CHP lobby in Portugal describes the method as transparent and fair. It applies over the whole lifetime of the installation. The last revision of this framework occurred in 2001, whereby the total electrical production (excluding ancillary loads) is rewarded not just electricity that is exported from the site. In this respect the system is superior to feed-in systems.

The avoided carbon dioxide is compared with the most efficient technology for new power capacity, a CCGT with an efficiency of 55% (NCV) and emissions of 370 kg CO_2/MWh.

The performance of CHP is based on the concept of Electrical Equivalent Efficiency (EEE), which is defined as:

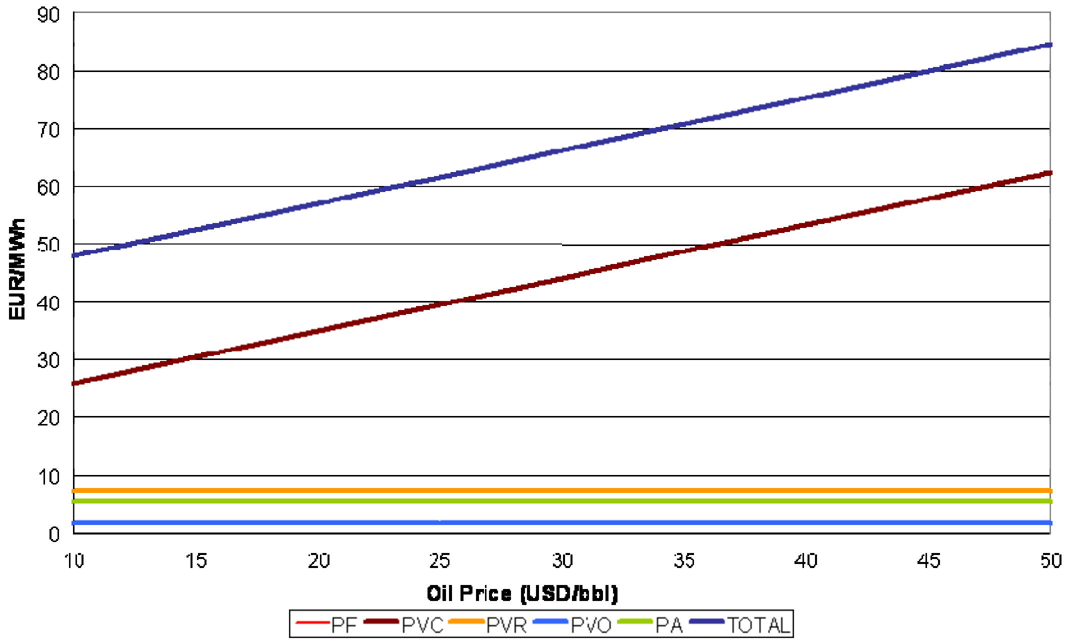
$$EEE = E / (C – (T/0.9))$$

Where:

E = useful electricity
C = fuel
T = useful thermal energy

The EEE must be greater than 55% for natural gas-fired CHP, >50% for fuel oils, and >45% for plants that burn more than 50% biomass annually. The prices are indexed to oil prices and Figure 7 gives the payments a CHP plant would receive for its power output.

Figure 7: **Prices received by a 5MW gas-fired CHP plant (Source: COGEN Portugal)**



Notes: Natural Gas cogeneration of 5MW
EEE = 65% & 8.000 working hours in the year
PF – Fixed Term, PVC – Fuel Variable Term, PVR – Upstream Network Variable Term, PVO – Maintenance & Operation Variable Term and PA – Environmental Term

This policy has been effective in Portugal in safeguarding the economic performance of existing CHP plants and stimulating new capacity to come on stream. Since 1997, when natural gas became available in Portugal, 270 MWe has been installed with a further 32 MWe due to come into operation in 2004.

4. Monitoring of useful CHP heat

4.1 Summary of the concept and its importance

To define a certain quality of a CHP project requires accurate assessment of both the electricity and the useful heat produced. The measurement of the former is straightforward. That of the latter can be extremely difficult given the scope for CHP plants, especially industrial schemes, to be highly complex. For this reason, the development of a methodology to monitor useful heat is correspondingly arduous. Nonetheless, without such a methodology an effective means of providing a guarantee of origin or defining the quality of CHP cannot be developed. The UK has made the most progress in establishing such methodologies through its CHPQA scheme.

At the European level, a manual has been developed in the CEN/Cenelec standards arena. This is an adaptation of a District Heating CHP calculation method used in Germany for the CHP law. In many other countries, such as Spain and the Netherlands CHP definitions were based on an overall threshold efficiency of 60% or 65% comprising all electricity produced and ⅔ of the heat used. This concept was designed, in part, to cope with the heat measurement issue and the problem of ensuring heat is used and not rejected. In implementing the CHP Directive, this simple approach will not be possible to use; and thus a more sophisticated system will be needed.

4.2 Assessment of CEN Workshop Agreement: Manual for the Determination of CHP

In 2003 Euroheat and Power, the European District Heating Association, sponsored the development of a CEN Workshop Agreement on CHP methodologies (a copy of the CWA Manual is given in Annex 2). The purpose of the project is to develop a standardised methodology for assessing what is CHP and what is not. This has been a thorny issue for many years, since some, and especially larger, CHP schemes can operate in a variety of modes from full CHP to power-only. Assessing the contribution of these plants to the production of CHP and thus environmental and energy saving benefits is the heart of this document. It is very similar is many respects to the UK CHPQA system and indeed many of the sections are taken from the UK approach.

The objective of the CEN/CENELEC Workshop Agreement is to present a set of transparent and accurate formulae and definitions for determination of CHP energy products and the corresponding energy inputs. The CEN/CENELEC Workshop Agreement formulates the procedure for quantifying CHP output and inputs, such as CHP electrical energy, CHP mechanical energy, CHP heat energy and CHP fuel energy. It does not include quality rankings such as assessments of fuel savings or environmental impact.

This section is relatively long and contains a considerable amount of technical detail. It is included here because it gives a comprehensive system for the heat monitoring and what should included in the CHP system and what not.

Gathering statistics and monitoring developments for CHP is difficult and can contain a considerable number of uncertainties. Some CHP plants may decouple the generation of heat and power at certain times or to a certain extent and thus CHP and non-CHP electricity and heat may be generated in the same plant.

The Resulting CEN Workshop Agreement (CWA) is designed to provide guidance for the implementation of Annex II of the CHP Directive and the determination of the power-to-heat ratio

The Manual makes following definitions:

- Combined heat and power (CHP) or "cogeneration" is the simultaneous conversion of primary energy into mechanical and/or electrical energy and useful heat energy in one (the same) plant. 'Simultaneously' means that the energy content of a fuel is used for the generation of both heat and electrical/mechanical power at the same time within a thermodynamic process (the CHP process) (see Article 3 (a) in the CHP Directive).

- CHP plants are plants that simultaneously can generate electrical/mechanical power as well as useful heat power. Thereby all or at least a certain extent of generated useful heat power and electrical/mechanical power can be CHP useful heat power and cogenerated (CHP) electrical/mechanical power.
- Full CHP Mode for the purpose of this document is the operation mode of a CHP plant with maximum overall efficiency of capacities which attains or exceeds the threshold values fixed in Annex II a) of the CHP Directive. In cases where CHP plants can operate in different configuration there may be more than one full CHP mode. This applies for example for combined cycles with the possibility to operate with and without steam and/or gas turbine.
- Heat rejection facilities are devices for the diversion of heat energy by means of which heat energy is discharged unused into the environment, e.g.:
    - Waste heat condensers
    - Compression air coolers not connected to a heat recovery system
    - Bypass facilities
    - Steam condensers not connected to a heat recovery system
    - Radiators
    - Cooling air coolers not connected to a heat recovery system
    - Lube oil coolers not connected to a heat recovery system
    - Charge air coolers not connected to a heat recovery system
    - Stacks
    - Auxiliary coolers not connected to a heat recovery system

  The term "bypass" is used for the direct diversion of the flue gases into the environment, avoiding the waste heat boiler / flue gas heat exchanger. The consequence is incomplete use of the heat in the flue gas.
- CHP useful heat energy (qCHP) is the heat energy (thermal energy) supplied by a CHP process to a network or a production process in a reporting period. It is heat energy that would otherwise be supplied from other sources (see Article 3 (b) in the CHP Directive).
- Non-combined useful heat energy (qNON-CHP) is the heat energy (thermal energy) supplied by a CHP plant to a network or a production process, which is not generated in direct relation to the generation of CHP electrical/mechanical energy in a reporting period.

Non-Combined useful heat energy generation occurs in processes with generation of useful heat energy without upstream generation of electrical/mechanical energy, e.g. applying:

- Live steam extraction (steam extraction prior to generation of electrical/mechanical energy)
- Steam boilers without downstream (back-pressure or extraction-condensing) steam turbines
- The extra heat produced from waste-heat boilers with auxiliary / supplementary firing without downstream additional generation

The CHP plant boundary is also not a trivial issue. Auxiliary heat or electricity production equipment such as heat only boilers and electricity only power units that do not contribute to combined generation of heat and power must not be included in the CHP plant boundary. Therefore auxiliary (top-up) boilers, standby (back-up) boilers, process waste heat boilers and standby generators have to be excluded. In case of chilling processes, there also should be placed outside the CHP boundary limit. The meters should be placed on these boundaries.

The auxiliary or parasitic consumption of heat energy and mechanical energy of a CHP plant do not belong to its energy outputs.

However, some sites will have secondary steam turbines driving pumps or compressors delivering mechanical energy and also provide heat to the consumer area. In these cases the steam turbines and its energy outputs do not belong to the auxiliary consumption of the CHP plant but to the energy outputs. Possible determination methods for the heat and electrical/mechanical energy output are those outlined for prime movers. The secondary steam turbines must be included in the CHP Plant boundaries. The electrical/mechanical energy outputs have to be included as energy outputs from the CHP Plant. The heat energy required to produce these additional electrical/mechanical energy outputs must be deducted from the useful heat energy output.

Where steam turbine-driven pumps or generators are driven with steam from the CHP plant, the energy flow from the CHP plant should be included in the CHP energy flow if they supply the energy to the consumer area and do not belong to the auxiliary energy consumption. For example, the steam heat power used by the steam-driven pumps or generators should be deducted from the CHP plant heat power outputs to the process and, similarly, the mechanical/electrical power output from the steam-driven pumps or generators should then be added to the CHP plant power outputs if they do not contribute to the auxiliary power consumption of the CHP plant but supplied to the consumer area.

CHP plants must measure and monitor all fuel inputs and power and heat outputs. Where heat is not sold to third party, it is not always monitored. The recommendation for the Manual is that it should be metered and only in the exception that it is too expensive should it be estimated. The Manual further specifies that the metering should include steam/hot water output, condensate return and make up water. This may be quite a heavy burden on some smaller CHP plants. Therefore, in the case of small scale CHP, less than 1 MWe, in series produced models can this be simplified to just a metering of electrical output.

4.3 Assessment of UK CHPQA scheme

The means by which the CHPQA system defines the guidelines for monitoring useful heat are detailed. In summary, the qualifying heat output from a CHP scheme is that which is demonstrably utilised to displace heat that would otherwise be supplied from other sources. The CHPQA excludes any heat rejected to the environment without any beneficial use.

Since April 2004, metering of all steam and heat flows that contribute to the useful energy outputs of the CHP Scheme has been required, with certain dispensations. This may involve metering steam at several pressure levels. The guidelines make clear that metering stations must be located so that the steam used for parasitic heat loads within the scheme (for example, de-aeration, feed-water heating, gas turbine steam injection) are excluded and steam that is vented or dumped to atmosphere is also excluded. If the main meter includes any such elements, these must be metered separately and deducted from the heat outputs.

For circulating hot water systems smaller than 2 MWe, heat metering may be achieved by computation using measured flow and return temperatures and the measured fluid circulation rate. Schemes that have a dump (or trim) cooler may also calculate the heat output from the flow temperature and the return temperature upstream of the dump cooler, assuming a fixed circulation rate; alternatively, where the circulation rate may be variable, the useful portion of the total heat recovered needs to be calculated through the installation of two matched pairs of platinum resistance.

4.4 Summary of means of monitoring useful heat in the UK, Netherlands, Portugal and Belgium

The UK system is described in 4.3 above. The Dutch monitoring protocol is not yet agreed, but is expected to become so soon given that the blue certificate scheme came into effect on 1 July 2004.

In Belgium and Portugal there are no elaborate systems of monitoring heat output. The requirements simply state that the operator needs to measure the heat supplied by the CHP plant. With the introduction of the CHP Directive this will need to change.

5. Identification of Best Practice: Strategies to Promote National CHP markets

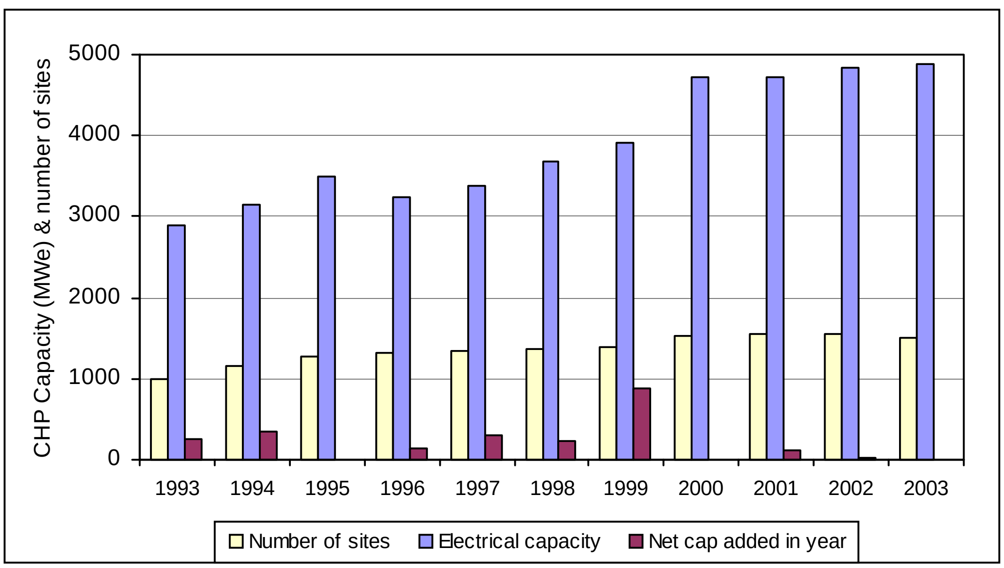
This section of the report examines national strategies to promote CHP in four EU countries: the United Kingdom, the Netherlands, Belgium and Portugal.

5.1 United Kingdom

5.1.1 CHP development trends

CHP market growth in the UK since the early 1990s has been significant but not dramatic. In the ten years between 1993 and 2003, installed capacity increased by 64%, with almost half of this growth taking place in 1999. CHP now accounts for 6% of total installed capacity. Since 2000, the market has been flat. Indeed, since 2000, 800 MWe of capacity has stopped operating because of unfavourable market conditions. Figure 8 summarises the development of CHP since 1993.

Figure 8: CHP Capacity Growth in the UK (Source DUKES, 2004, DTI)



In terms of installed capacity, over 90% of CHP is located in the industrial sector, with 75% accounted for by chemicals, oil refineries, paper/publishing and food/drink. 1,236 of the total number of 1,539 projects are in the commercial/residential sectors (including agriculture). There are only a handful of district energy/CHP schemes. Fuel use for CHP is dominated by natural gas, which holds a 74% share of the market.

5.1.2 The impact of CHP policy and targets

The development of CHP in the UK has taken place firmly in the context of privatisation, market restructuring and changing regulations, all of which have been overseen by the Department for Trade and Industry (DTI). Against this dominant background, direct policy responsibility for CHP has resided with the Environment Department, now known as the Department for Environment, Food and Rural Affairs (DEFRA), which has set three CHP targets since 1990. The 1990 Government White Paper on the environment, 'This Common Inheritance', set a target for CHP of 4,000 MWe of installed capacity in the year 2000 – doubling the then existing capacity. In 1993, the target was increased to secure the installation of 5000 MWe by 2000. In 2000, as part of the UK's response to climate change, a third target was set by government to achieve 10,000 MWe of 'good quality' CHP by 2010. The 2004 UK CHP Strategy has indicated that, on present trends, the 2010 target is unlikely to be achieved.

Despite this series of targets, the development path for CHP has been highly erratic. In the early 1990s, policy in the developing privatised electricity and gas markets was generally supportive of CHP. This support included, for example, providing exemptions from electricity pool membership and the Non-Fossil Fuel Levy and other secondary legislation. This was enhanced by a positive spark spread for developers and the presence of a government target for CHP growth.

However, trends in CHP market growth since the 1996 Strategy have continued to track the spark spread balance, rather than any specific policy initiatives towards CHP, which has been much less favourable in the context of electrical over-capacity and increasing gas prices. The specific effectiveness of government policy has therefore been limited largely because of the separation of policy responsibility for CHP (within the Environment Department) from policy responsibility for energy market regulation (within the DTI). Policies for CHP have generally been too weak to overcome the more profound conditions in the electricity and gas markets.

The 2004 Strategy represents a continuation of this process. There are a wide range of issues defined that influence the development of CHP, but most of this either relates to measures already in place or describes barriers that might be addressed at some point in the future. The Strategy indicates that the 2010 target will not be achieved but does not include a commitment to introduce measures to ensure that it can be.

5.1.3 Best-practice strategies to remove barriers and establish positive market conditions

The positive aspects of the UK experience are as follows:

- It has led to the creation of specific targets for CHP growth that have enabled both government and the CHP industry to measure progress and seek to respond accordingly.
- It has led to some pioneering initiatives, including the official national database of CHP projects and the definition of high quality CHP (through the CHPQA), that have helped to raise awareness of the technology and its potential. The CHPQA currently stands as the best worldwide methodology for fairly attributing policy benefits to CHP.
- It has enabled occasional consideration to be given to regulatory change that benefits CHP.
- It has led to the creation of the Distributed Generation Co-ordinating Group (DGCG). This is a joint Government / industry group that has been set up to address the technical, commercial and regulatory barriers to the deployment of generation within the local distribution network. Much of this relates to CHP.

Specific measures that would be likely to deliver positive results in a less unfavourable market environment include:

- Licence Exemption Regime. This is a mechanism that can be used to promote CHP by increasing the number of schemes that can qualify for exemption from the holding of supply licences, a burden for small generators. The last of these relaxations took place in October 2001.
- Climate Change Levy Exemption. The CCL is charged on the supply of energy to non-residential users. Supplies of CHP from qualifying plants are exempt from the levy.
- Enhanced Capital Allowances. ECAs were introduced as part of the CCL package in April 2001. They are 100% first-year capital allowances on investments in certain energy-saving equipment, including qualifying CHP.
- Exemption from business rates. From April 2001, CHP plants and machinery used at least partially to generate electricity are exempt from business rates, ensuring equal treatment with the power sector.
- VAT reduction for domestic CHP. In the 2002 Budget, the Government announced a reduction in VAT for certain grant-funded domestic installations of micro-CHP. This may be extended following proposals made by the Chancellor in April 2004.
- Climate Change Agreements. These were established with 44 industry sectors to provide an incentive to achieve energy saving targets. For sectors with little experience of CHP, targets were initially set on the basis that CHP could not be applied. When market conditions improve, targets will be revised to take account of the potential for CHP application.

- Community Energy Programme. This promotes the development of community / district heating schemes through capital and development grants.

However, set against these positive features, the UK approach has also had several important drawbacks for market development:

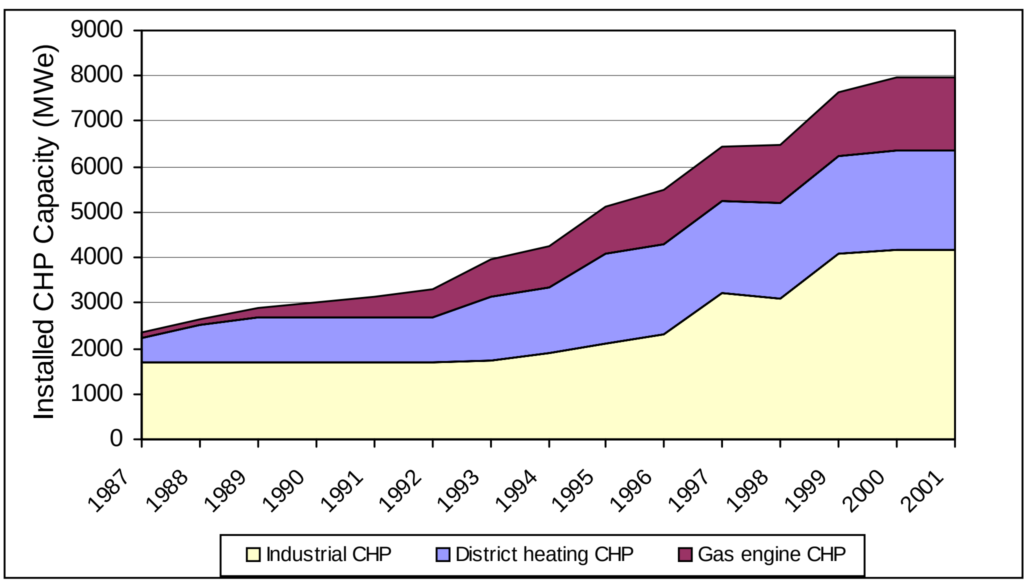
- It has not led to any significant policy or regulatory initiatives that have had a marked positive impact on the CHP market.
- It has failed to effectively review and assess the real barriers to CHP in the energy market and has been unable to respond with the most effective policies for removing them.
- It has not been able to effectively address the short-term nature of energy policy development in a liberalised environment.

5.2 Netherlands

5.2.1 CHP development trends

In 1972, CHP capacity in the Netherlands stood at around 11% of total national capacity. Since that time, the country has been the most effective promoter of CHP in the world, in particular during the period from the late 1980s to the late 1990s. The share of CHP in total national generation now lies at around 38%, compared to a European Union average of 9.6% and a world average of 7%. Figure 9 summarises the level of market growth.

Figure 9: CHP Capacity Growth in the Netherlands (Source Future Cogen Project, 2001)



Since 2000, very little new plant has been developed because of unattractive market conditions. Indeed, some plants have been mothballed and so it is likely that the level of installed CHP capacity has fallen since 2000. In essence, with the introduction of energy market liberalisation measures in 1998, electricity prices have fallen and have stayed low. The Netherlands has become an importer of low cost electricity from Germany and Belgium.

Alongside this, gas prices have risen in line with oil prices (the two are linked in continental Europe). The spark spread for CHP has therefore been hit from both ends with the result that there has been no commercial incentive to invest in new projects and the pressure on existing projects has been acute.

Reserve margins have again dwindled after five years of low power sector investment and power prices are beginning to rise again. During the summer of 2003, demand reached new heights. For the first time in several years, developers are again looking at the opportunity to construct new plant, including CHP.

5.2.2 The impact of CHP policy and targets

Through the 1990s, the government had a specific CHP target to reach an installed capacity of 8,000 MWe by 2000. This was just about achieved. There are five main reasons to explain the Dutch success with CHP development during this period:

- The development of a government pro-CHP strategy in the early 1990s (see below);
- The country is highly industrialised with abundant demand for process heat;
- Widespread availability of natural gas;
- Strong public opinion against nuclear power after the Chernobyl explosion in 1986;
- The active involvement of electricity distribution companies in CHP, in partnership with industrial hosts.

In 1998, a more informal target was put forward, as part of the Dutch climate change efforts, to reach a level of 15,000 MWe by 2010. At current levels of progress, and with current national CHP policy being almost fully 'hands-off', this is extremely unlikely to be achieved.

5.2.3 Strategies to remove barriers and establish positive market conditions.

There were four main elements to the Dutch government strategy to promote CHP through the 1990s:

- The creation of Projektbureau Warmte-Kracht (PWK), the Office for CHP Promotion, in 1999. This agency was well resourced and staffed with highly trained CHP specialists. It served as a single source of information and advice for all those who had a practical interest in mobilising CHP projects. PWK also succeeded in recommending a range of incentive policies and developing concepts for effective joint venture partnership between distribution companies and industry.
- The introduction of discounted gas prices for CHP. The price was brought down to levels comparable with those paid by large central CCGT plants and was advantageous for all projects, but particularly for smaller schemes in buildings. These prices were available until 2000.
- Government investment subsidies for CHP projects of up to 7.5%, available until 1995.
- An obligation upon power generators to buy CHP electricity at the same cost as that required to generate electricity from new central plants. This gave an opportunity, for the first time, for CHP projects to be sized according to the heat demand of the site, rather than the electricity demand, giving a more optimal opportunity for energy saving. This incentive was available also until 1995.

Two separate developments, which should not be considered as an integral part of the co-ordinated government CHP strategy, also contributed greatly to the development of the CHP market during this same period:

- The energy efficiency agreements between government and large energy consuming industries. These were established as part of wider national environment programmes and CHP was rapidly identified by participants as an important means of achieving the goals.
- The active participation of distribution companies in the CHP market. The separation of the distribution and production of electricity was enforced through the Electricity Act of 1989. Under this framework, distribution companies had an incentive to secure supplies of least cost electricity and were allowed to invest in CHP schemes no bigger than 25 MWe in size. However, if the companies established a joint venture with an industry partner, as promoted

by PWK, this threshold could be broken. Many large industrial CHP schemes were developed in direct consequence.

Since 1998, Government policy has been non-interventionist as far as CHP is concerned and there is little in the way of best practice. Relevant aspects include:

- Obligations on licence holders to buy electricity at preferential rates from CHP plants smaller than 2 MWe.
- Various fiscal measures, including:
    - Tax deductions of up to 55% of the investment costs where the overall efficiency of the plant (electric efficiency + 2/3 heat efficiency) is 65% or more.
    - Exemption for CHP plants from the Ecotax payable on natural gas.

The Netherlands has therefore achieved dramatic success through direct policy intervention on the basis of an informal CHP strategy. Critical to this success has been the fact that the department responsible for energy market regulation, the Ministry of Economic Affairs, has also been responsible for CHP development and has used regulatory intervention to drive the CHP market. However, this formula is fallible – in more recent years, the MEA has had the overriding objective of implementing EU-driven liberalisation legislation and CHP, along with other matters, has been sidelined. The Dutch approach to CHP, therefore:

- Has demonstrated, by intervening in CHP gas and electricity prices, the overriding importance of energy market conditions as the key driver of CHP.
- Has effectively used the capacity of negotiated industry agreements on energy efficiency to promote CHP investment.
- Has highlighted the significant potential interest of electricity distribution companies in investing in CHP as a means of securing a share of the generation market.
- Is pioneering the potential use of 'blue certificates' for CO_2-free electricity from CHP.

5.3 Belgium

5.3.1 CHP development trends

Belgium has a relatively low share of CHP in the generation mix. This is partly due to the structure of the electricity industry, the high share of nuclear generation and the attitude of the dominant market players. Currently CHP provides around 5.5% of the electricity, 4,511 GWh out of 80,500 GWh. In the 1990s and through to this century the growth has been steady; however it came to a halt from 2001 onwards. (Unfortunately the statistics do not show this market stagnation, but it is confirmed through discussions with Cogen Vlaanderen and Cogen Sud.)

Figure 10: CHP Generation in Belgium (Sources: Eurostat and Cogen Vlaanderen)

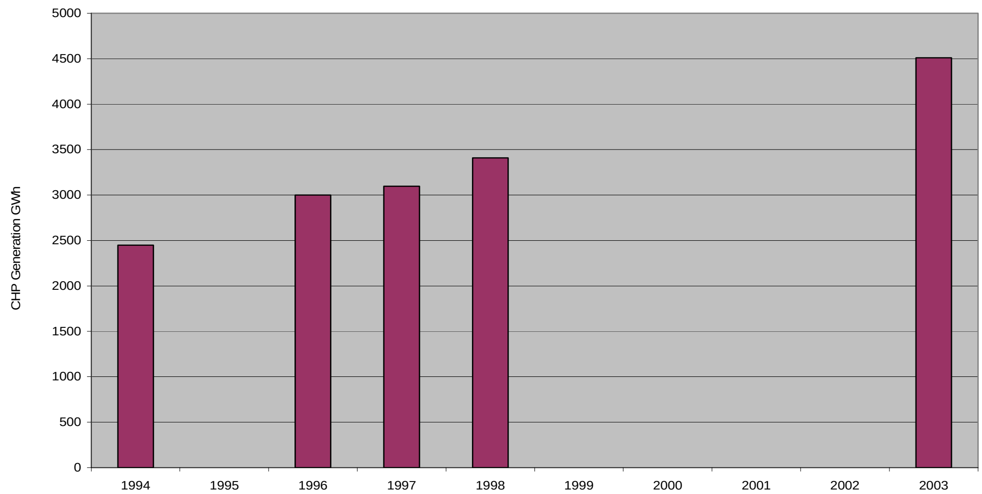


Table 4: CHP Electrical Installed Capacity (MWe) in 2000 (Source: Future Cogen)

Sector	Plant size	Coal + products	Gas	Oil	Coal, oil and gas	Multi fuel	Total
Domestic	< 15 kW						
Commercial	15-100 kW		12.83	6.43			19.26
	100kW-1MW		20.33	4.00			24.33
	1-5 MW		5.94	1.88	184.58		192.39
Industry	1-5 MW		23.75	17.75	61.38	1.40	104.27
	5-50 MW	7.44	476.88	41.60	212.20	107.0	845.12
	> 50 MW		53.0			75.0	128.00
Total	-	7.44	592.68	71.71	458.15	183.4	1,313.37

The market is dominated by schemes developed by Electrabel, more that 70% of capacity and size is concentrated around the 40 MWe gas turbine projects. The industrial sector dominates the capacity and operation with more than 75% of both and the vast majority of the capacity is in Flanders, reflecting the economic structure of Belgium.

5.3.2 The impact of CHP policy and targets

The development of CHP has been a regional matter in Belgium since 1989 and the support for CHP has been a priority in the framework of the National programme to reduce CO_2 emissions. The policy for many years has been based on the avoided costs principle, in that CHP avoids the next investment in the power industry. At times this policy has set the thresholds for support at very high levels, so that only a limited amount of the potential could pass the threshold. More recently these have been revised and are now easier to comply with. Also in the late 1990s the threshold were used to determine the tariff structures applied to each installation. If the threshold were passed a preferential tariff was available. If not then heavy costs could be incurred. Consequently for quite some time the only schemes developed were built by Electrabel in the industrial sector, based on 40 MWe gas turbines. In addition, top-up and back-up tariffs were expensive, with back-up charges made up of the first two elements of a normal non-CHP tariff, below:

- 20% annual capacity charge, impossible to avoid by installing a CHP plant;
- 20% monthly capacity charge, payable in each month when the CHP is unavailable for any moment;
- 60% energy charge, avoided by the installation of CHP.

Moreover, back-up and top-up of electricity is prohibitively expensive. With these tariffs in 1999, the Belgian arrangements will make the plant twice as expensive as in the Netherlands over a ten-year life.

Since 1999, the situation has started to improve. The Belgian Government linked to its Kyoto commitments and the decision to phase out nuclear power became more supportive of CHP.

Although there is not a national target for CHP, there are regional targets for CHP and RES, based on the certificate schemes discussed earlier.

- In Wallonia, the quota targets are 3% of all electricity supplied in 2003 and 7% in 2007 must come from CHP and RES. There is no sub-target for CHP.
- In Brussels, the quota targets are 2% in 2004 and 2.5% in 2006 of all electricity supplied must come from CHP and RES. Apparently this is believed to be above the potential in Brussels and thus some import will be needed, but it is yet to be specified how this will be done.
- In Flanders, the quota is specified for CHP separately and it is based on achieving a doubling of capacity between 2005 and 2012. In 2005, 1.09% of electricity supplied will come from CHP and in 2012 it will be 5.25%. This only applies to CHP plants installed after 1 January 2002.

It is expected that these new systems will facilitate a growth in CHP in Belgium over the next decade, with somewhere in the region of a doubling of capacity, from around 1,350 to 2,500 MWe.

5.3.3 Strategies to remove barriers and establish positive market conditions

In Belgium the complex legal framework and the inertia caused by the dominant market actors in the energy sector have resulted in slow development of CHP. Nevertheless, the policy commitment to phase out nuclear power, 60% of Belgian generation, and the need to meet greenhouse gas emission reduction targets has stimulated a change of policy towards the support of CHP. The philosophy behind this support is firmly wedded to the use of market based instruments to achieve growth. Consequently, there is now a noticeable optimism in the CHP community.

All support for CHP in Belgium is linked to high quality CHP, meeting CO_2 and energy saving criteria. This approach was the one adopted by the European Commission in draft the CHP Directive and is the basis for Annex 3 of the Directive.

The certificate schemes will provide the export price mechanisms for CHP. In all three regions there is no guaranteed minimum price level, but there is expected to be a scarcity of certificates and therefore the price level will approach the level of the fines, which are €100 in Wallonia, €75 in Brussels and €45 in Flanders.

The following table gives an indication of the improvement in the economic performance of a CHP plant in each region when around 90% of the fine level is achieved by the CHP certificate.

Table 5: Support for CHP from Belgian certificate systems (source Cogen Vlaanderen)

Gas: Gas Engine 1MWe

	Simple PBT	IRR (after taxes	NPV (after taxes)
No support	7,3 years	4,0 %	-6,01 €/MWh
Walloon Region	3,2 years	19,0%	2,43 €/MWh
Brussels	3,8 years	15,2%	0,13 €/MWh
Flanders	3,1 years	18,4%	1,96 €/MWh

Economic analysis for a 1 MWe gas engine, with

- electrical efficiency: 35%
- thermal efficiency: 50%
- operation time: 3500 hours/year

All calculations for a ten year period, interest rate for the calculation of NPV: 15´%

Licensing of CHP plants in all of Belgium is straightforward and does not require any lengthy procedures. Registration is necessary with regional regulators and pollution authorise for larger plants.

5.4 Portugal

5.4.1 CHP development trends

Portugal's energy system is characterised by a strong dependence on external sources of primary energy, with more than 85% of total consumption reliant on imports, and a very high energy intensity per unit of production - the worst among the EU-15. Portugal's energy intensity is also increasing, with negative effects on the competitiveness of its economy.

Continuing economic development, the utilisation of new processes and technologies and access by a large part of the population to higher comfort standards are the main reasons for both a national electricity consumption growing at around 4.5% per year, and the increasing energy intensity. According to this trend, electricity demand may reach 50 TWh by 2010, a four-fold increase on 1994.

CHP capacity has grown from 530 MWe in 1990 to around 1,150 MWe today. The majority of this growth has been in gas turbines and reciprocating engines, with a total of 650 MWe added, replacing some of the pre-existing capacity and well as increasing the overall capacity.

Figure 11: CHP capacity installed each year

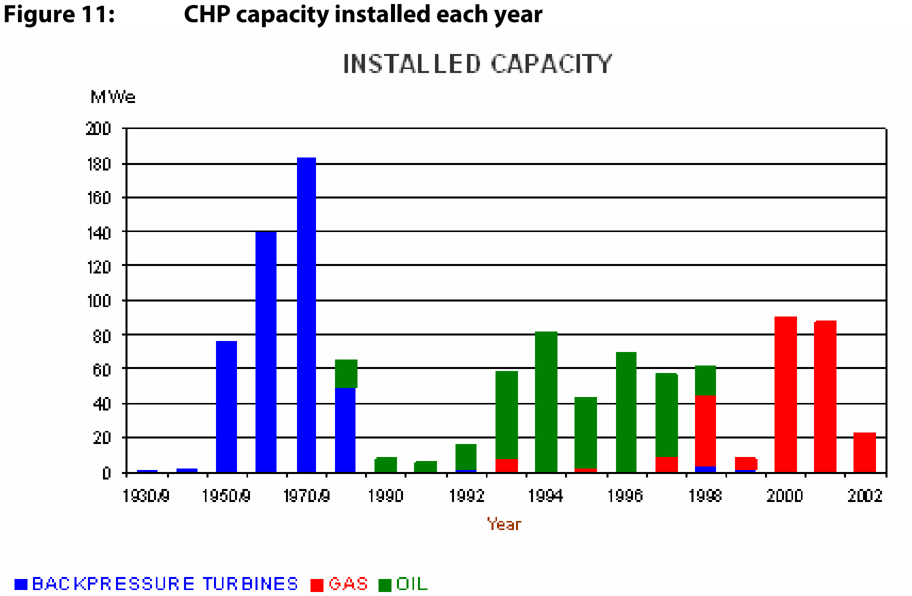
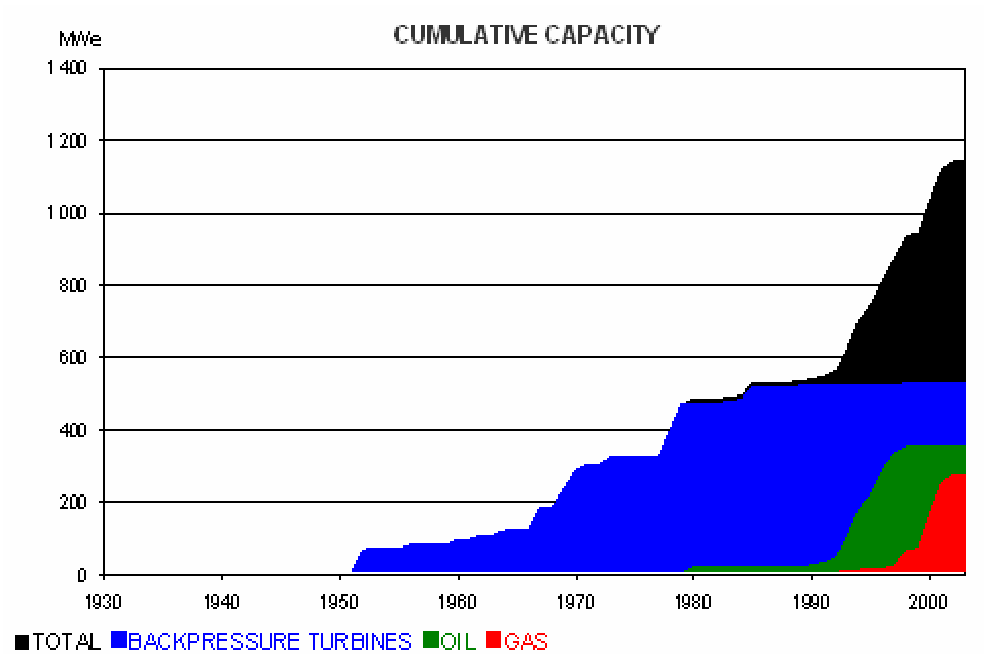


Figure 12: CHP cumulative growth



The legal framework is supportive of the development of new CHP plants and thus this trend can be expected to continue, with at least another 30 MWe added in 2004.

5.4.2 The impact of CHP policy and targets

Portugal has been a bright spot on the European map for CHP. It has a favourable legal basis and broad Government support. The basics of the CHP law were outlined in section 2. The Government has targets for both CHP and RES. The CHP target is 18% of total electricity consumption by 2010. In 2000, Eurostat estimated that CHP's share of electricity production was 10%, having grown from 8.4% in 1998. In a recent article COGEN Portugal stated that the share of consumption stood at 15%. Which of the figures is correct is questionable; however, even to stand still between now and 2010 will still require quite a lot of new CHP capacity with demand for electricity growing at 4.5%. COGEN Portugal estimates that at least 500 MWe more capacity could be added by 2010.

The development of CHP policy and subsequent targets is based in the context of the opening of the electricity market, a non-liberalised gas market (Portugal has a reserved market until 2008) and the desire to monetise the external costs of conventional production. With this background the CHP Law of 1999 was enacted.

The tariffs paid to CHP producers were established considering:

- The avoided costs for SEP, include investment, transport, operation, maintenance and fuel costs;
- The environmental benefits of CHP;
- The necessity to pay during a period sufficiently long to attract investment, without triggering high risk projects.

The remuneration formula is applied for a period of 120 months, except for installations with an input over 11 MWe and that are commissioned after 1 January 2003, which will in that case benefit from guaranteed remuneration until 31 December 2012.

In the case of CHP units smaller than 10 MWe, it is argued that the advantage of decentralised production justifies a specific tariff calculation for smaller units. In this case, the feed-in price is multiplied by a 'loss factor'. The parameter varies between 1.04 and 1.02 depending on whether the installed unit capacity is below 5 MWe or above 5MWe.

As for the connection to the electricity network, the Decree 313/2002 establishes the obligation from the SEP to give access to those producers of decentralised power. This decree also obliges SEP to make the necessary modifications to the grid in order to allocate the new capacity. Since SEP is the public system, ultimately the costs would be paid by the customers through taxes or their tariffs for electricity.

5.4.3 Strategies to remove barriers and establish positive market conditions

In addition to the above systems of measures, Portugal also provides additional fiscal incentives:

- Under the incentive system for energy conservation (SIURE-System for the Rational Use of Energy), based on Decree Law 188/88, CHP plants receive assistance of between 15% and 25% of the capital investment. Between 1994 and 1999, €704 million of funding was made accessible, of which 7.5% went to energy savings while the bulk went toward the introduction of natural gas. The Government decided to continue this programme while giving more emphasis on energy savings. This is currently being done within the scope of the Plano Operacional da Economica (POE) in the SIME and MAPE schemes.
- In January 2001, the Ministry of Economy published a new policy programme, the Energy Efficiency and Endogenous Energies Programme. This programme is set up for the period 2000-2006. Funding of €100 million is covered by the POE and the Global Incentive Programme of the Ministry of Economy.

  Financial incentives include the creation of MAPE, a support regime under the scope of the Third Community Framework Support for Portugal for investment in electricity production equipment from RES, natural gas or RES CHP equipment and operations designed to promote the rational use of energy. MAPE provides support to projects of €25,000 or more.

There are still some barriers to the development of CHP in Portugal. These include:

- Local gas supply does not cover the whole country and some gas utilities charge high prices;
- The opening of the Iberian electricity market will put downward pressure on electricity and open Portugal up to possible control by the larger neighbouring electricity companies;
- Network availability and capacity for interconnecting CHP;
- Planning and authorisations can take longer than in other EU countries;
- It is not known what the impact of the implementation of the CHP Directive will do to the current CHP regime.

Nevertheless CHP support in Portugal is extremely progressive and some of the measures are well worth considering in the development of the Irish CHP policy.

6. The Use of the Public Service Obligation for CHP Promotion in the EU

6.1 Introduction

The majority of CHP incentive policies in EU Member States are required to secure state aid clearance from the Commission prior to implementation since they involve state financial support. In a few cases, however, the costs of CHP incentives are passed through to end consumers rather than being funded by state treasuries. These cases potentially infringe the terms of the EU Electricity Directive but can be allowed on the basis of a public service obligation (PSO).

Article 3 of the EU Electricity Directive defines conditions for the use of PSOs by Member States:

> *"… Member States may impose on undertakings operating in the electricity sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and environmental protection, including energy efficiency and climate protection. Such obligations shall be clearly defined, transparent, non discriminatory, verifiable and shall guarantee equality of access for EU electricity companies to national consumers. In relation to security of supply, energy efficiency/demand-side management and for the fulfilment of environmental goals, as referred to in this paragraph, Member States may introduce the implementation of long term planning, taking into account the possibility of third parties seeking access to the system."*

Article 3 also states that:

> *"Member States shall, upon implementation of this Directive, inform the Commission of all measures adopted to fulfil universal service and public service obligations, including consumer protection and environmental protection, and their possible effect on national and international competition, whether or not such measures require a derogation from this Directive."*

This review summarises three examples of Member States that have introduced CHP incentives on the basis of the PSO and one, Portugal, which has not felt it necessary to do so.

6.2 France

The introduction of Electricité de France (EdF) purchase contracts for CHP in 1997 provided significant new incentives for operating plants. The incentive is a PSO that is justified on the basis of the primary energy savings and the environmental benefits (carbon emissions) of CHP.

The purchase contracts are still valid. The original contract period was 12 years and was based on the avoided costs of CCGT gas plants. They applied to plants sized between 215 kW and 100 MW provided overall efficiency exceeded 65%.

New contracts were approved in 2000 but have since been superseded by the 2000 Electricity Act which limits contract availability to plants no bigger than 12 MWe. The payments are similar to those provided in the earlier contracts but with more stringent requirements for energy savings. These must be at least 5% based on a reference of:

- A 650 MW CCGT plant with an efficiency of 54%.
- A reference boiler with a heat efficiency of between 85 and 91%.
- Network losses of 7% (low voltage), 4% (20kV), 2.5% (63 or 90 kV) and 0% for 225kV lines.

There are both output-related and fixed parts on which the CHP payments are based. The output-related components are linked to:

- The energy delivered.
- The price of natural gas.
- The energy savings.

The fixed allowance represents about 40-45% of total revenue. It varies between €133 and €153 per kWe. The total overall financial benefit of the contract for CHP plants was around €800 million in 2004.

This CHP incentive is financed directly by electricity suppliers and indirectly by French consumers (to whom the costs are passed) through the Contribution au Service Public de l'Electricité (CSPE). The CSPE is the PSO that relates to the power sector in France. This covers the excess costs of EdF's PSO, including equal tariff rates for all customer bands throughout the country and its overseas territories, subsidised social tariffs for the poor and subsidies to CHP and renewables. For industrial consumers, the CSPE amount to around 10% of electricity bills. The CSPE charge is currently €4.5/MWh.

6.3 Belgium

The introduction of the CHP Certificate Scheme in Flanders (Belgium) in 2005 will potentially provide significant incentives for operating plants. Interestingly, while the incentive is not based on a state financial contribution or subsidy, the Flemish government is nonetheless seeking state aid clearance from the European Commission in order to be sure that it would not be vulnerable to legal action from energy consumers in Flanders.

The certificate scheme is a CHP incentive that is justified by the energy efficiency benefit of CHP based on certificates that are linked directly to primary energy savings and to the 'guarantee of origin' defined in Article 5 of the EU Cogeneration Directive.

To obtain CHP-certificates, the installation:

- Must be described as 'High Quality', according to a prescribed definition.
- Must have been commissioned after 1 January 2002.
- Must generate energy savings in Flanders.

Electricity can be consumed on-site, sold to other electricity consumers through direct lines or sold directly to the grid. The VREG (the Flemish regulatory office for the gas and electricity markets) issues one certificate for every MWh of primary energy that has been saved by the CHP installation. The primary energy savings are calculated through the use of a prescribed definition and are based on reference emissions from a 'best available' boiler and a CCGT plant.

For the first four years of operation, a certificate is generated for every MWh of primary energy savings. From year five, the number of certificates issued is reduced gradually to zero.

Each year, all supply companies are required to submit a specified number of certificates, proportional to the total electricity supplied in the previous year. If the required number of certificates is not submitted, the supply company is subject to a fine.

The costs to the supply companies of participation in the scheme are passed through to all end consumers in Flanders.

6.4 Denmark

During the negotiation of the EU Electricity Directive, Denmark was insistent that the new competitive environment should not prevent it from continuing its rigorous policy of promotion of CHP and other sustainable energy solutions. The PSO element of the directive was of vital importance to the country.

Denmark therefore has an extensive tradition of promotion of energy efficiency and sustainable energy research based on the use of PSOs in the electricity, gas and district heating sectors. Implementation of the obligations is managed by the grid operating companies and the distribution companies with the costs of the programme being passed through to all Danish energy consumers. These additional costs are itemised on all consumer bills.

There is no specific application of the PSOs to CHP since this is integrated into the overall obligation to promote energy efficiency and a sustainable energy sector, but the regime of CHP incentive programmes since 2000 have nonetheless been firmly based on the use of the PSO.

Up to the end of 2004, there was a CHP incentive policy (for so-called 'decentralised' and industrial CHP plants) based on a rigid feed-in tariff, the level of which was determined by the voltage level of grid connection (five levels between 0.4 kV and 400 kV). Any electricity from such plants that was supplied to the grid was subject to a €c / kWh incentive tariff.

From January 2005, this purchase obligation has been removed by the Danish government, partly because of the surplus levels of generation that it brought about. It has been replaced by a fixed subsidy system that is indirectly linked to the levels of support of the feed-in system but which is independent of the level of generation and which discourages power generation at times of low electricity prices.

Again, the mechanism is paid for by the grid and distribution companies that pass through the additional costs to all consumers. The new CHP regime remains an important part of the overall use of the PSO in Denmark to promote efficiency and reduce emissions.

6.5 Portugal

Portugal has one of the most innovative CHP incentive mechanisms. It incentivises all on-site CHP plants on the basis of the avoided costs of central generation in respect of:

- Capital investment costs.
- Generation plant fuel and O&M.
- Network costs, including investment and O&M.
- Carbon emissions.

Based on this avoided cost tariff, CHP producers that conform to certain efficiency requirements have the right to supply electricity to the system operator, SEP. The costs of the scheme are in turn passed through to all end consumers.

Significantly, the Portuguese Government has not deemed it necessary to notify the Commission in respect of the PSO. This is because it has not justified the measure on the basis of a PSO since it is an avoided cost mechanism that reflects the 'real' value of CHP in the market, even though a part of the tariff, that relating to carbon emissions, had no real market value at the time of the introduction of the policy.

6.6 Conclusions

The EU Electricity Directive is clear in its allowance of specific policies and measures designed to promote CHP on the basis of its energy efficiency and environmental benefits. These can be implemented on the basis of a PSO and can be specifically targeted at qualifying plants or those that achieve specific primary energy savings defined in the EU Cogeneration Directive.

Three member states described here, France, Belgium and Denmark, have all applied significant CHP incentive programmes, the costs of which are borne by consumers, and can justify them on the basis of a PSO.

Portugal, in contrast, has not deemed it necessary to notify the European Commissions of its CHP support mechanism since, in its view, the tariff ensures that CHP plants simply receive a fair value and is not therefore an incentive.

7. Implications and Recommendations for Ireland

7.1 Issues and potential for implementing best practice in Ireland

With the experience of other countries to build on, Ireland is in a potentially strong position to adopt a range of strong pro-CHP policies and strategies. However, there are some issues that need to be taken into consideration:

- The institutional and policy set-up for energy in Ireland, as with all countries, is unique. Policies and measures from one country cannot always be directly transplanted from one country to another. It will be of critical importance, therefore, that new initiatives in Ireland complement, and dovetail with, existing policy objectives.
- The range of best practice policies in other countries does not represent a comprehensive summary. Other measures, not found in the countries addressed in this report or applied elsewhere in the world, and therefore perhaps yet to be identified, may be more appropriate for the Irish situation.
- A strong and consistent theme of CHP development both in Europe and worldwide is the degree to which market conditions are perceived by project developers to be sufficiently stable to merit investment. If energy prices are volatile or energy policy is subject to frequent change it is unlikely that pro-CHP policy, even if identified as best practice, will be effective. Above all, investors require a stable market outlook.
- While the content of the EU Cogeneration Directive represents a framework for CHP development rather than a stringent diktat to be imposed on Member States, it will inevitably become an increasingly important platform for the development of national policies throughout the EU. Any new measures to be introduced in Ireland will have to be consistent with the new framework. It appears that SEI is aware of this need.

7.2 Potential impact of the implementation of best practice policy in Ireland

A good indicator of the degree to which the implementation of best practice policy in Ireland can deliver effective CHP market growth is to assess the impact of pro-CHP policies in other countries:

- The Netherlands: the Dutch approach to CHP promotional policy was highly effective in creating new market opportunities for CHP. For example, from the time of the establishment of PWK in 1989 to the end of 2000, the CHP market increased from 3000 MWe to 8000 MWe and within the space of a decade the country became the world leader in CHP development. A key factor in this process was that the governmental sponsor of CHP also has responsibility for energy market regulation and management. It introduced regulatory incentives for CHP and separated the generating companies from the distribution companies. The combined impact was dramatic.
- Denmark: Danish CHP development has been very strong over the last 20 years, driven by a series of fiscal and grant-based incentives. Significantly, the opening of the Danish energy sector to liberalisation at the end of the 1990s was done in a careful way to protect the CHP sector. CHP energy prices were ring-fenced and CHP was given a favourable status in the carbon taxation system. Consequently the Danish CHP sector is still profitable and operating well. Denmark, probably alone in Europe, has thus demonstrated the value of a long-term commitment to the use of CHP.
- The UK: CHP policy has in some respects failed. The 1996 CHP Strategy failed to achieve the 5,000 MWe target for 2000 and the 2010 objective may also not be met. Adverse movements in electricity and gas prices since 1998 have been the overriding influence, as has the impact of trading arrangements. Nonetheless, the 1996 Strategy did have some positive impacts. The CHP market did increase in size by about one third between 1996 and 2000 and only fell short of the target by 270 MWe. The policies were important for sustaining the growth from 1996 but the main drivers during the period were market-driven rather than policy-driven. In essence, the UK experience indicates that policy aspiration is no substitute for concrete policy action to secure a strong CHP market.

- The US: the US CHP market has moved ahead strongly over the last six years. It has been driven by a positive balance of fuel and electricity prices and by the fast rate of economic growth. A secondary influence has been the CHP industry Roadmap that has introduced a range of awareness raising programmes. Nonetheless, as with the UK, policy aspiration has not been accompanied by hard regulatory measures that will remove existing barriers.
- Portugal: In its own quiet way, Portugal has taken some significant steps to promote a positive environment for CHP. Its pioneering and proven tariff arrangement, developed on a consensual basis among all key stakeholders, recognises each of the main benefits of CHP. It is also transparent in that each component of the tariff corresponds to a specific feature of the system; this has probably made it more palatable to those groups who do not share the goal of promoting CHP.
- Belgium: All the country's regions have embraced the concept of a certificate mechanism to promote CHP. While it is too early to be certain about the impact, the methodology is consistent with ensuring a fair and flexible system that incentivises CHP according to the benefits it brings. Such systems will directly bring about change of behaviour among the utilities and, through adjustment of the level of fine, can be fine-tuned to accelerate or slow their market impact.

The lessons from these experiences suggest that the implementation of effective policy, as exemplified by the Netherlands and Denmark in particular, can deliver some very profound impacts on CHP markets. Both countries now have over one third of their total generation supplied by CHP. Similar results can be achieved in Ireland given the right range of measures that removes important barriers and delivers incentives that are sustained over the long-term.

7.3 Recommendations for CHP policy in Ireland

For CHP policies and measures to be successful, there are certain key requirements. These are summarised below and represent recommendations to SEI for CHP policy in Ireland:

- As far as possible, the government ministry responsible for CHP should also have responsibility for energy market regulation and should have the commitment to intervene in markets in order to revise adverse regulatory issues and so deliver its CHP commitments.
- A CHP growth target should be set, at a level that is thought to be achievable on the basis of both bottom-up and top-down market analyses.
- The overall policy approach to CHP should represent a long-term vision. This can help to ensure the emergence of policies that have time to take real effect and can bring confidence to investors and developers who will carry the responsibility for delivering projects.
- Policies that deliver a significant financial benefit to CHP projects nearly always work. They will work most effectively if the incentive is related to the energy efficiency or environmental performance of the project (this is, for example, the objective of the UK CHPQA system). Examples of policies that have worked include:
- Tax breaks or incentives;
- Fuel price benefits;
- Electricity price benefits for electricity exported to the grid.
- The policy approach should address each CHP sector (e.g. industrial, district energy, commercial, and micro-CHP) and, in so doing, will address each CHP technology.
- Grid access and interconnection barriers should be identified and tackled head-on.
- A standard for assessing 'high efficiency' or 'high quality' CHP should be drawn up; perhaps based on the UK CHPQA.