REPORT

# European Potential for Cogeneration

## Progress against the Directive's objectives at European level


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# Member State reporting under the Cogeneration Directive - including cogeneration potentials reporting

**CODE project report**

**Northern Europe Region**

www.code-project.eu

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# Contents

## CODE Project

The CHP Directive 2004/08/EC outlines an enabling policy framework for the European Union to expand the deployment of cogeneration in member states. The Directive was passed by the European Parliament in 2004 encouraging the use of cogeneration in the production of heat and power as a successful and well developed techniques for primary energy saving. The background policy objectives in 2004 were security of supply and energy saving. The climate agenda which has emerged since 2004 has added further impetus to wider use of CHP. CHP is a highly energy efficient, technologically mature approach to generating electricity and providing useful heat. It is key enabler for improving the efficiency of electricity production on fossil fuels.

One of the main achievements of the CHP Directive has been to codify for Europe what is meant by high efficiency cogeneration. Any plant now carrying this status will in operation save a minimum of 10% primary energy compared to separate production of heat and electricity on the same fuel. Using the framework of the CHP Directive, promoting CHP to meet additional electricity needs, gives a member state a quantifiable primary energy saving per unit of electricity generated.

This quantifiable energy saving is achievable in several sectors by encouraging users of heat who have a significant heat demand to also generate electricity. This requires that they change from a traditional boiler to provide heat only, to a cogeneration unit which will produce both heat and electricity for an additional amount of fuel. Suitable heat demands are in many sectors. All of industry, agriculture, commerce, leisure, district heating and domestic housing can today self – generate electricity in cogeneration. Hence the search for additional cogeneration potential is a search for heat demand.

The guaranteed energy saving within the framework of the Directive makes cogeneration a uniquely quantifiable energy saving measure for member states striving to improve overall energy efficiency and reduce CO emissions.

The CODE project was established in October 2008 by COGEN Europe under the IEE program funding structure. The objectives of CODE are to have stakeholders in the sector independently monitor the implementation of the CHP Directive and to use stakeholder input to assess the progress being achieved through member state initiatives. The project runs from 2008 to 2011 and will report in sequence on the identified European potential for CHP, the barriers and support mechanisms for CHP existing across the member states, the Best practise and progress in member states and finally a draft CHP roadmap for Europe. This report is concerned with the first two areas and is restricted to the Northern Region of Member States

## Executive summary

For the purposes of this study, the Northern Region consists of Austria, Belgium, Denmark, Finland, Germany, Ireland, Netherlands, Sweden, and United Kingdom. In these countries, CHP and District Heating associated with it are well established but the Potential Reports from the Member States (MS) show that there is considerable scope for further deployment.

The implementation of the Directive 2004/8/EC is limited to the following:

- A report analysing the application of high-efficiency cogeneration, including high-efficiency micro-cogeneration.
- A report including a separate analysis of barriers, which may prevent the realisation of the national potential for high-efficiency cogeneration.
- The member state must also provide a progress report on the implementation of the Directive including progress towards realising national potentials for high-efficiency cogeneration.
- The member state must ensure support for cogeneration in the context of this Directive are based on the useful heat demand and primary energy saving.
- The member state must put in place mechanisms to support the introduction and procedures for Guarantees of Origin.

The legal structures required to support these obligations do not require primary legislation within the member state and are almost exclusively transposed by the adoption and modification of regulations.

We have been disappointed that whilst it as a requirement of the directive for member states to lodge reports with the Commission in a timely way at the time of starting our analysis the Commission website only contained six of the twenty seven member states reports. The CODE team have endeavoured to close this information gap by seeking the required information direct from the member state or its recognised trade association. The Commission has also been helpful in providing documentation which was hard for us to find.

We have also been disappointed to find that it has proved difficult to extract data on installed, technical additional and economic additional capacity from the reports and the legislation that facilitates barrier removal etc. is rarely referred to. We recommend that for future reporting rounds the Commission provide member states with a standard template to member states for both reporting and performing calculations.

Whilst in some cases we have had to make additional calculations and estimates so as to complete the analysis, we are confident that for the Northern Region we have estimated the total installed capacity of CHP to be 62 GWe with an additional technical capacity is estimated at 97 GWe and an additional economic capacity of 87* GWe.

Throughout this report "the Directive" means Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC[1]."Compliance documentation" means the documentation that must be provided under Article 10 of the Directive 2004/8/EC, namely Member States shall, not later than 21 February 2006, publish a report with the results of the analysis and evaluations carried out in accordance with Articles 5(3), 6(1), 9(1) and 9(2) and Member States shall not later than 21 February 2007 and thereafter every four years, following a request by the Commission at least six months before the due date, publish a report with the result of the evaluation referred to in Article 6(3).

Member States must also submit to the Commission, for the first time before the end of December 2004, data for the year 2003, and thereafter on an annual basis, statistics on national electricity and heat production from cogeneration, in accordance with the methodology shown in Annex II. They shall also submit annual statistics on cogeneration capacities and fuels used for cogeneration.

[1] This is heavily influenced by the German Potential report which assumes both a significant introduction of DH and modest discount rates.

# 1. Introduction to the region

For the purposes of this study, the Northern Region consists of Austria, Belgium, Denmark, Finland, Germany, Ireland, Netherlands, Sweden, and United Kingdom. In these countries, CHP and District Heating associated with it is well established but the Potential Reports from the Member States (MS) show that there is considerable scope for further deployment.

It has, however, proved difficult to extract data on installed, technical additional and economic additional capacity from the reports. In some cases we have had to make additional calculations and estimates so as to complete the analysis but we are confident that:

Total installed capacity is estimated to be 62 GWe

Total additional technical capacity is estimated to be 97[1] GWe

Total additional economic capacity is estimated to be 87[1] GWe

* This is heavily influenced by the German Potential report which assumes both a significant introduction of DH and modest discount rates.

**Energy markets in the European Union**

The status of energy markets can have a significant effect on development of energy based projects but this is particularly true for CHP plants. This is because a CHP developer is exposed to the spark spread risk as well as the heat market price risk. If energy markets are fully liberalised then financial instruments can be employed to hedge the risk. If markets are non-liberalised then those in control of the energy supply can encourage or discourage the adoption of CHP through setting of fuel, power and heat tariffs. Markets in transition or those seen to be dominated by a few players can prove to be problematic to investors.

The following is a description of the state of the EU Energy Markets drawn from the Commissions own research.

The liberalisation of the EU's electricity and gas markets, which began several years ago, has contributed to the rejuvenation of the energy sector. It has helped to develop entrepreneurial potential in this sector, with beneficial effects on a variety of energy-related activities ranging from the production of diverse forms of renewable energy to the creation of financial markets for energy derivatives. Market participants are now better prepared to adapt to the rapid economic and environmental changes – particularly in dealing with the specific challenges that climate change poses to the energy sector. The present reports bears witness to the fact that, over the past five years, significant improvements have taken place in the EU electricity and gas market.

While these developments are encouraging there are still a number of areas and Member States where the existing legislation (second internal market package[2]) has not yet been properly implemented or where the need for new legislation has become apparent. The Commission has been taking action to ensure the correct implementation of EU legislation at national level

Information on Market liberalisation is drawn from national reports which were submitted to the Commission in the second half of 2008 and they mainly cover 2007 as well as Eurostat data which were available for the first half of 2008.

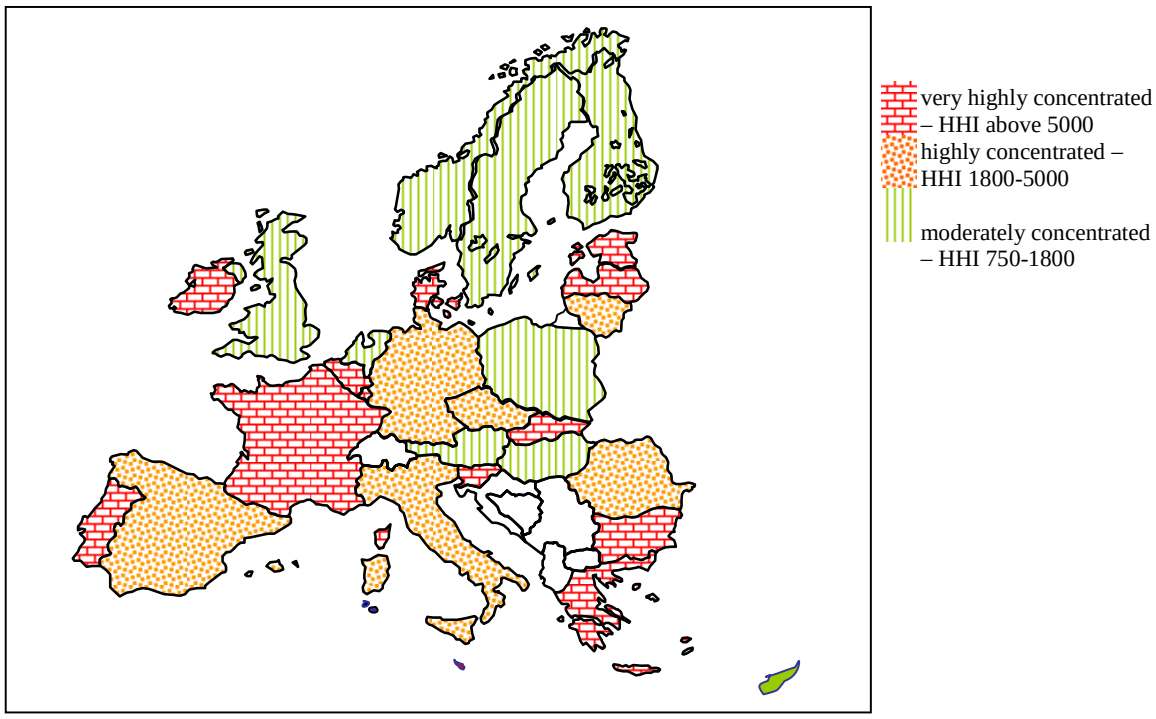
More than four years after the deadline (1 July 2004), implementation of the second Electricity and Gas Directives[3] is still not entirely complete.

Several Member States, including DK, LU and NL, have now correctly implemented both Directives through appropriate national legislation. There has also been progress in other Member States: CZ, FI, DE, GR, LV, LT, SI and UK brought their national laws into line with EU legislation after a reasoned opinion was issued by the European Commission. In the case of some other Member States, the Commission has had to take legal steps to ensure the full and correct implementation of certain provisions

On the electricity wholesale market, the three biggest generators still control more than 70% of generation capacity in 15 Member States. The high level of concentration on the electricity wholesale market is confirmed by the fact that there was a moderately concentrated market in only eight Member States.

[2] Directive 2003/55/EC was adopted in August 2003. The Directive had four main objectives. First, it assures a more effective separation between markets actors (distribution, transmission, generation and supply) with the aim of limiting the risk of cross subsidisation and discrimination between incumbents and new entrants. Second of all, it attempted to improve access to the network, assuring all market operators more rights to access the network. The Directive also provides a timetable for the different market opening stages, giving consumers freedom of choice over suppliers. And finally, it establishes the obligation for Member States to create an effective regulator with a major degree of independence from market operators but, not from national governments. Directive 2003/55/EC was repealed by Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009.

[3] Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC.



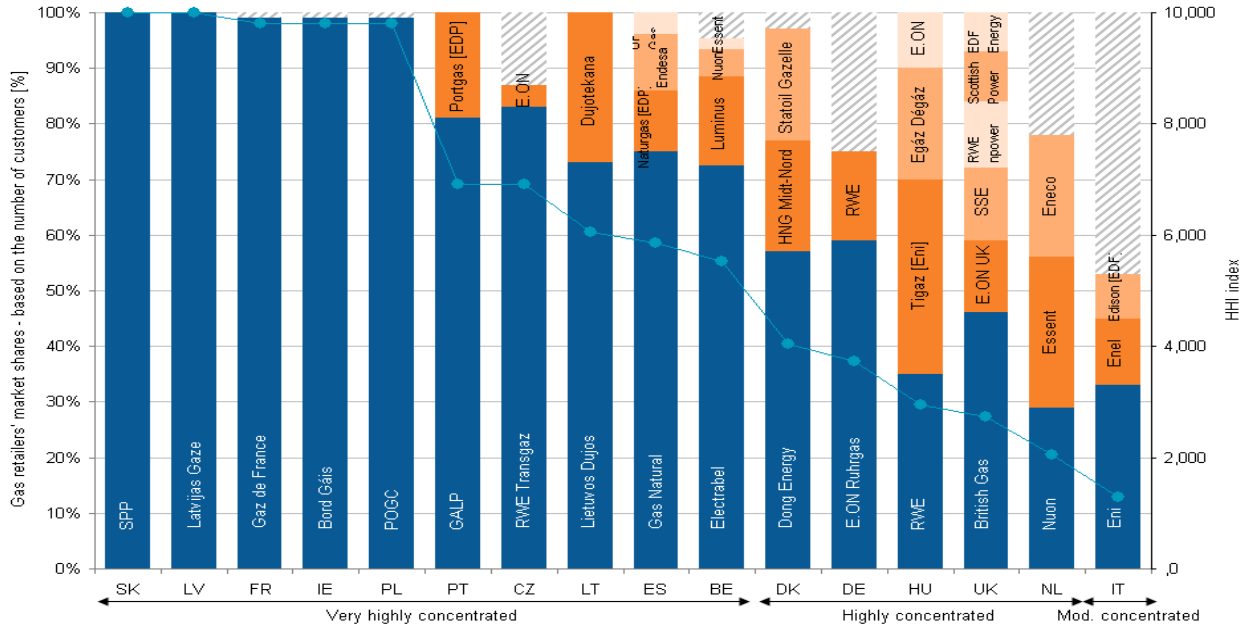

*Source: Regulator's data*

***Figure 1 Market concentration of electricity wholesale market (by HHI)***

In the gas wholesale market, the concentration is even greater. The three largest wholesalers have a market share of 90% or more in 12 Member States.

Further improvements are needed too, in order to have a properly functioning retail market. As far as the electricity retail market is concerned, the market share of the three largest companies in the whole retail market was over 80% in 14 Member States. The HHI shown in the figure below indicates the level of concentration on the gas retail market. In only one Member State, the market is moderately concentrated[4].

[4] This introduction is taken from COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT Report on progress in creating the internal gas and electricity market {SEC (2009) 287} Brussels, 11.3.2009 COM (2009). Click here to read.




Source: Capgemini

***Figure 2 Concentration on gas retail market***

Overview of reporting status of member states under CHP Directive:

The compliance documentation required under Article 10 of the Directive 2004/8/EC, namely the analysis and evaluations carried out in accordance with Articles 5(3), 6(1), 9(1) and 9(2) and the result of the evaluation referred to in Article 6(3) are referred to within the following sections of this report. A table providing a summary of this documentation is below

## 2. Overview of completion of requirements under the Cogeneration Directive

As the previous section notes, the implementation of the Directive 2004/8/EC is limited to the following:

- A report analysing the application of high-efficiency cogeneration, including high-efficiency micro-cogeneration.
- A report including a separate analysis of barriers, which may prevent the realisation of the national potential for high-efficiency cogeneration. As part of this requirement member states or the competent bodies appointed by the Member States shall evaluate the existing legislative and regulatory framework with regard to authorisation procedures or the other procedures laid down in Article 6 of Directive 2003/54/ EC, which are applicable to high-efficiency cogeneration units.
- The member state must also provide a progress report on the implementation of the Directive. The report shall consider progress towards realising national potentials for high-efficiency cogeneration referred to in Article 6 and assess the extent to which rules and procedures defining the framework conditions for cogeneration in the internal energy market are set on the basis of objective, transparent and non-discriminatory criteria taking due account of the benefits of cogeneration.
- The member state must ensure support for cogeneration in the context of this Directive are based on the useful heat demand and primary energy saving. This should be established using a common or harmonised method for calculation of electricity from cogeneration.
- The member state must put in place mechanisms to support the introduction and procedures for Guarantees of Origin.

The legal structures required to support these obligations do not require primary legislation within the member state and are almost exclusively transposed by the adoption and modification of regulations. The European Commission website contains a link to the Member States compliance documentation[5]. At the time of undertaking our analysis this link only contains six of the twenty seven member states reports.

The CODE team have endeavoured to close this information gap by seeking the required information direct from the member state or its recognised trade association. The Commission has also been helpful in providing documentation which was hard for us to find. This is in tern then logged on the CODE website[6]. This has not been possible in all cases. The Netherlands is one such example. Where gaps do exist, these have been highlighted throughout this report. It is also worth noting that as result of these enquiries, member states have published compliance documentation that was previously unseen by the Commission[7] .

[5] Please click here to view the six member states reports.
[6] Please click here to view the CODE project website.
[7] An example is publication of "Combined Heat and Power (CHP) Potential in Ireland", a Report prepared for Sustainable Energy Ireland by consultants Byrne Ó Cléirigh in August 2009

| Reporting obligations of Cogeneration Directive 2004/8/EC (situation up to 05/10/2009) | | | | |
|---|---|---|---|---|
| MS | Progress Report | Analysis of National Potential | Barriers for CHP / administrative - procedural situation | Guarantees of Origin Scheme |
| | [Art 10(2) - Art 6(3)] | [Art 10(1) - Art 6(1)] | [Art 10(1) - Art 9(1&2)] | [Art 10(1) - Art 5(3)] |
| | due on 21/02/2007 and then each 4 years | due on 21/02/2006 | due on 21/02/2006 | ~~due on 21/02/2006~~ ; due on 21/06/2007 (6 months after adoption of harmonised reference values - Commission Decision 2007/74/EC of 21/12/2006) |
| BE | received | received | received | received |
| BG | received | received | received | received |
| CZ | received | not received | not received | not received |
| DK | received | received | received | received |
| DE | received | received | received | received |
| EE | received | received | received | received |
| IE | not received | received | received | not received |
| EL | received | received | received | not received |
| ES | received | received | received | not received |
| FR | received | not received | received | received |
| IT | waiting for translation | received | waiting for translation | received |
| CY | received | received | received | not received |
| LV | received | waiting for translation | waiting for translation | waiting for translation |
| LT | received | not received | waiting for translation | waiting for translation |
| LU | not received | waiting for translation | not received | not received |
| HU | not received | not received | not received | not received |
| MT | received | received | received | received |
| NL | received | received | received | received |
| AT | received | received | received | received |
| PL | received | received | received | received |
| PT | not received | not received | not received | not received |
| RO | received | received | received | received |
| SI | received | received | received | received |
| SK | received | received | received | received |
| FI | received | received | received | received |
| SE | waiting for translation | waiting for translation | waiting for translation | waiting for translation |
| UK | received | received | received | received |

***Table 1 Status of Member State reporting (December 2009)***

**Austria.** Austria submitted its compliance documentation within the time frame that the Directive sets out. Whilst only a limited proportion of the compliance documentation was provided in the required languages of the Commission it has largely been possible to assert that at a Federal level[8], Austria has been able to implement the Directive.

**Germany.** Germany submitted its compliance documentation within the time frame that the Directive sets out and was submitted in the Spring, 2008. There have therefore been delays in putting in place

[8] Austria adopted its national efficiency reference values for separate production of heat and electricity before the introduction of the harmonized values. However, there was a delay before they accept the Commission's harmonized efficiency reference values because whilst it was reported that this had happened in Austria's progress report (in accordance with article 6) under their EIWOG (Energy Act), these efficiency reference values had still to be transposed by each of the Austrian provinces. It is not been possible to analyse the harmonized efficiency reference values for separate production of heat and electricity established by the Member state clear from the existing compliance documentation.

mechanisms to support the introduction and procedures for Guarantees of Origin, explored below, it is clear that Germany has made great efforts to ensure that it has fully implemented and transposed the Cogeneration Directive. In addition, the extent of the documentation provided in the required languages of the Commission has enabled a much better appreciation of this counties compliance with the Directive, the potential that exists and identify the remaining barriers to its further development.

**Ireland.** Ireland has been slow to implement the requirements of the Directive. It has largely failed to provide the necessary compliance documentation to the Commission in the timeframe required. The specifics of these shortcomings are highlighted below.

**Finland.** On the 29/4/2009, Finland's Ministry of Employment and the Economy Energy Department published its Analysis of the National Potential for the Application of High Efficiency Cogeneration (Article 6(1)) and the Evaluation of Authorisation Procedures and Administrative Barrier applicable to High Efficiency Cogeneration units (Article 9) (1 and 2) and its Progress report on Increasing the share of High Efficiency Cogeneration (Article 6 (3)). These collection of reports required under the Directive were summated into one document.

**United Kingdom.** Whilst some questions have been raised by the Commission in relation to the reporting for Gibraltar, the UK has been efficient in complying with the requirements under the Directive. The UK complies with Article 12(2)+(3) option, using CHPQA as the 'alternative methodology'. This will has been amended to fulfil the criteria in Annex III (a) by incorporating the harmonised efficiency reference values for separate production of electricity and heat for new Schemes from January 2007. For existing Schemes the UK proposes to continue with the current arrangements until the end of 2010. This was communicated with the Commission by a letter to Mr Alfonso Gonzalez Finat on 21 November 2006.

**Sweden.** Whilst Sweden has completed the CHP potential analysis, only the summary information was supplied in English. This report also contains a summary and high-level analysis of barriers and the Evaluation of Authorisation Procedures and Administrative Barrier applicable to High Efficiency Cogeneration units (Article 9). The Progress report on increasing the share of High Efficiency Cogeneration (Article 6 (3)) has not been provided to the Commission. These areas are discussed in more details below.

**Denmark.** Denmark's compliance documentation is largely in place. On the 21 February 2007 the Danish Energy Authority Ministry of Transport and Energy provided the Commission with a report on the implementation of the Cogeneration Directive. This report set the potential based on a useful heat demand. This report meets the reporting requirements that are incumbent upon the Member States under Article 10.

A parallel statement concerning the implementation of the Directive was submitted with the notification of 31 May 2006. Since that notification in May, a mechanism has been put in place for issuing guarantees of origin for electricity from high-efficiency cogeneration. The Danish Energy Authority issued a notice to this effect on 16 February 2007, to come into force on 1 March 2007.

**Netherlands.** Despite the extent of Cogeneration within the Member state, due to the limitations of the documentation the CODE project team has received from either the Commission or the Member State it has been hard to determine the extent to which the requirements of the Directive have been effectively satisfied. Only the draft report potential report was received and this is not believed to qualify as an assessment of national potential. . However, the requirement for barriers to be listed is complete and it is clear that support mechanisms have been put in place.

**Belgium.** The transposition and implementation of the Directive in Belgium is covered by three separate legislative bodies in Flanders, Wallonia and the Brussels-Capital region. Reporting varies between the three regions. Barriers and incentives have been assessed by all three regions. Generally all sections have been provided.

## 3. Guarantees of origin

**Austria.** The Austrian Regulator for the Electricity and Gas Market in Austria already had a robust electronic registry system for the issuing of Guarantees of Origin under Directive 2001/77/EC. The Austrian Government has now transposed the requirements of the Directive 2004/8/EC to ensure this process is reformed in light of the requirements of Article 5. In terms of measures taken to ensure the ongoing reliability of the GoO, under the EIWOG (Energy Act) the provisional Government's have to monitor the reliability of the GoO system. The process is administered and accredited by an independent body, E-Control[9]. E-Control is accredited under the European Association of Issuing bodies (AIB). What remains unclear from the compliance documentation is the outline of the actual process or the qualification of sites and to what extent these mirror the requirements of Article 5, in particular Article 5.5.

**Germany.** As explained in the previous section, there is a question about the extent to which harmonised efficiency values have been adopted by this member state. Within Germany's analysis of the national potential for the application of high-efficiency cogeneration it states "*In the context of the on-going preparation of an instruction for the Cogeneration Directive, the drawing up of reference efficiency values for the separate production of electricity and cold has been dispensed with. One reason for this is that the primary energy advantage which can be achieved using this technology can be classified as slight"*[10].

There have therefore been delays in putting in place mechanisms to support the introduction and procedures for Guarantees of Origin. As part of a package of measures to ensure the completion of requirements under the Directive, Germany amended its Cogeneration Act, to include rules on the introduction of a guarantee of origin of electricity from cogeneration. This amendment was adopted by the German Government in mid-2008.

The amendment states that operators of high-efficiency cogeneration plants can apply to the Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle), for a guarantee of origin for electricity produced by cogeneration. Using the compliance documentation, it is not known to what extent the scheme is operational within the Member State.

**Ireland.** No information has been provided regarding the mechanisms for implementing the requirement of Article 5 of the CHP Directive and in particular who should be responsible for the implementation of GoO certificates.

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[9] Click here to view the e-control website

[10] An analysis of the national potential for the application of high-efficiency cogeneration, including high-efficiency micro-cogeneration in Germany; Report as per Article 6(1) and (2) of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market; February 2007, Page 15.

**Finland.** Within the analysis of the National Potential for the Application of High Efficiency Cogeneration (Article 6(1)) and the Evaluation of Authorisation Procedures and Administrative Barrier applicable to High Efficiency Cogeneration units (Article 9) (1 and 2) and its Progress report on increasing the share of High Efficiency Cogeneration (Article 6 (3)), the member state makes no reference of putting in place mechanisms to support the introduction and procedures for Guarantees of Origin.

**United Kingdom.** A consultation was carried out on the mechanism for implementing the requirement of Article 5 of the CHP Directive. This consultation was undertaken between 20 March and 14 April 2006. The Statutory Instrument (SI) was been laid before the UK Parliament and came into force on the 28th February 2007.

The UK Government are expecting a low demand for the Guarantee of Origin certificates (CHPGO). This is because CHPGO certificates will not be used in the UK as the basis for providing public support to CHP.

The Government claim the reliability of the CHPGO system is ensured because data submitted to the Combine Heat and Power Quality Assurance Programme (CHPQA) is subject to audits by the CHPQA administrative team. It is hard to determine whether recording of information is in place, as required by the Directive because no Cogeneration generators have has claimed one yet.

**Sweden.** As noted in the previous section, only a summary document has been provided to the Commission and the CODE project team in English[11]. Within this document little information has been provided regarding the mechanisms for implementing the requirement of Article 5 of the CHP Directive and in particular who should be responsible for the implementation of GoO certificates.

**Denmark .**A provisional set of calculations has been produced for cogeneration in Denmark on the basis of the reference values for separate production published by the European Commission on 6 February 2007. The Danish Energy Authority issued a notice to this effect on 16 February 2007, to come into force on 1 March 2007.

Until the end of 2010, a guarantee of origin may be issued without a specific calculation of the primary energy saving for current electricity production, provided that it can be proved that, at national level, cogeneration production is generated with an average saving of primary energy of at least a 10%. In these cases, the electricity producer may choose to have a primary energy saving of 10% shown on the guarantee of origin. If the electricity producer wishes to have a specific calculation carried out, the enterprise responsible for the system will carry out this calculation. Energinet.dk will issue the guarantees, at the request of the electricity producer.

[11] Fjärrvärme och kraftvärme i framtiden, Betänkande av Fjärrvärmeutredningen, Statens Offentliga Utredningar, Stockholm 2005

**Netherlands.** No information has been provided by the government of the Netherlands to the European Commission regarding the mechanisms for implementing the requirements of Article 5 of the CHP Directive and in particular who should be responsible for the implementation of GoO certificates.

**Belgium.** Little information has been provided regarding the mechanisms for implementing the requirement of Article 5 of the CHP Directive and in particular who should be responsible for the implementation of GoO certificates. However other reports have indicted that in Flanders and Wallonia regions, the primary legislation, regulations, the issuing body and registry of GoO certificates is in place[12].

[12] Interim report on the current status of the implementation of CHP-GO in Europe prepared under D3 or Work Programme 4 from E-tack II project, November 2008. Click here to view the report.

## 4. Barriers identification

The barriers that have been identified through-out the region within the compliance documentation are unsurprisingly varied and multi-facetted. Where possible, updates have been provided to the member states barrier reports, so as to include the latest developments in relation to the challenges effecting Cogeneration.

These barriers are explored below, country-by-country. It is possible however to extrapolate common features. These are as follows:

- The degree to which liberalisation has undermined the economic viability of CHP by reducing the wholesale price of electricity and introducing additional volatility in the gas wholesale market.
- The additional cost to cogeneration generators (within the traded sector) of the EU Emissions Trading Scheme compared to those outside of the scheme.
- Barriers associated with grid connection and access.
- The degree to which CHP is exposed to regulatory risk (regulatory risk occurs when a technology is, or is likely to be subject to a support mechanism which may be amended or removed by in the short to medium term by government or regulatory action).

**Austria.** Due to the brevity of the executive summary of the potential and barriers report, only a brief assessment of barriers in Austria is made. For micro and small scale CHP there is a general comment that practical experience is a barrier for a higher implementation of this technology. They also note a concern regarding financial support schemes in Austria; under the current renewable electricity act. This act only supports existing and modernised units. New units are not supported by the act. For Industrial Cogeneration within the European Emissions Trading Scheme (EU ETS), the report notes the impacts of additional costs. The report highlights that these sector specific concerns are compounded by an "information deficit" regarding the application and advantages of Cogeneration.

**Germany.** The compliance documentation that was provided to the Commission in February 2007 contains a comprehensive set of barriers.

The most significant obstacle to the further deployment of CHP and District heating is the low payback period compared to the risk involved. The report states "*yields* (interpreted as IRR*) which can be achieved by expanding cogeneration and district heating are regarded as being too low by many decision makers* (interpreted to mean investors or developers of all scales)*, both in industry and in the energy sector. The high expectations in terms of the payback period, the risk involved and the profit which can be achieved can be satisfied more easily by other forms of investment"*[13]*.* The report goes on to note that

[13] An analysis of the national potential for the application of high-efficiency cogeneration, including high-efficiency micro-cogeneration in Germany, 22 February 2007, p.39.

the requirement for higher returns has been exacerbated by the initial reduction of wholesale and retail electrical prices, caused by the liberalisation.

The availability and competition of fuels is analysed in detail within the report. The report notes the dual challenges of increased demand for natural gas in the heating sector, compounded by the increased demand for gas in power production, because of the demand for "cleaner", less emitting fuels. The report notes that this increased in demand might have implications with regards to price volatility of fuels (renewable and fossil).

The report also notes the additional costs of the EU ETS as a further barrier to Cogeneration deployment which is captured by the scheme.

The report also sights barriers resulting from administrative and approval procedures. This is complemented by listing the way in which these barriers are being overcome. The report also contained barriers that were presented by a study compiled by the German District Heating Association entitled "Pluralistic heat supply" [2000]. These barriers included the following:

- high economic risk based on uncertainty regarding the development of the electricity market, reduction in the demand for heat,
- in the industrial sector in the low-temperature heating area, inadequate obligation to accept and pay for electricity from cogeneration,
- unfavourable provisions concerning back-up electricity supplies decrease the credit items of cogeneration producers from the avoided network charges,
- technical barriers in the case of gas turbine combined heat and power stations and counter pressure machines, which have a fixed ratio of electricity to useful heat,
- High fixed costs associated with cogeneration plants and heating networks require the longest possible contractual commitments between customers,
- industrial cogeneration has to contend with particular obstacles: a lack of interest, a lack of in-house know-how,
    - high transaction costs for information,
    - overly high amortisation expectations and a lack of capital,

**Ireland.** Sustainable Energy Ireland has now published an analysis of the potential for CHP in Ireland[14]. Within the report, produced by consultants Byrne Ó Cléirigh, an extensive list of barriers is listed.

The report first considers a number of physical barriers to the further adoption of CHP; for example the lack of a mature energy intensive industry and Ireland's population and urban density. They also list sector specific constraints which make Cogeneration impractical. A number of examples are cited but an example is cement manufacture were despite a high heat and power demand, the cement kilns, which typically operate at 1,000°C, require a high grade heat which is beyond that produced by CHP plant.

Of particular interest to the CODE study was that the definition of CHP under the Cogeneration Directive was perceived to be a barrier, in particular the definition of the term, "economically justifiable demand"[15]. This is because the financial support mechanisms that were previously in place to reward a CHP generator, may have to be "scaled back" to reflect the proportion to which they qualify under the requirements of the Directive. This makes some CHP schemes which receive operational incentives less economic and in effect reduces installed capacity within the member state.

As explored in some detail within the UK barriers summary, the Irish report includes statements around variability and volatility of the "sparks spread" affecting the viability of the economics of CHP.

The report also carries out analyses on the economic viability of a specific CHP within different classes of investors. It states that corporate investors will only consider capital projects with payback periods in the order of three to four years, with some organisations requiring even shorter payback periods. On larger industrial sites where CHP is considered technically feasible, typical payback period sought by many of the sites is in the region of three to four years, with some sites requiring a payback period as short as one year. CHP projects often fail to make these required "hurdle rates"[16].

The report also list onerous administrative procedures caused by Utilities Directive[17]. The report states that where a CHP operator intends to supply electricity to the grid, or heat to a district heating scheme, the requirements of the Directive may apply, including the requirement to advertise in the Official Journal of the European Union. This is considered a significant administrative barrier because these requirements add delay and costs.

Grid connection delays are also cited; the report indicated that due to the nature of the application system, a developer who submits an application today may face a multi-year wait before the project is connected to the network. It is noted that for large scale CHP is a significant barrier, while the connection of small and micro-CHP is less hampered.

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[14] Combined Heat and Power (CHP) Potential in Ireland, Report prepared for Sustainable Energy Ireland by Byrne Ó Cléirigh, August 2009. Click here to view the report.
[15] Directive 2004/8/EC, Article 3
[16] This will be explored in more detail in Work package 5 of the CODE project.
[17] Utilities Directive (2004/17/EC). Click here for the Explanatory Note.

The incentive framework for CHP also creates some regulatory barriers. During discussions with stakeholders, CHP Ireland[18] suggested that the grant threshold of 999 kWe for fossil fuel fired units created an artificial distortion which acted as a particularly significant barrier for larger projects. Summarily, there are distorting effects created by the introduction of support for biomass fired CHP plants, which are eligible under the Renewable Energy Feed in Tariff (REFIT) to receive a payment rate of €0.12 per kWh, and micro-CHP which is eligible for a feed in tariff of €0.19 per kWh within the domestic sector.

In addition, the Irish CHP Association has noted concerns about the introduction of Ireland's Market Arrangements for Electricity (MAE). According to the Trade Association, the proposed limits for dispatch are similar to the existing system whereby any unit over 5MWe requires central dispatching. The level of penalties for not meeting agreed dispatch rules does not reflect the constraints CHP operates within.

**Finland.** Respondents to a questionnaire sent out to active Cogen and DH generators at the time of the analysis of the Barriers and Potential report indicated grid issues (connection and use of system etc were only viewed as "minor barriers" to the further uptake of CHP. Respondents to the questionnaire also suggested that rules governing investment funding for Cogen were sensitive to "policy risk" and this undermined potential/ investor confidence. Some respondents to the aforementioned questionnaire believed that "policy risk" and some aspects of the "energy tax" policy had and continue to have a negative impact on the potential growth of CHP.

The report also states that due to the attraction of tax rebates for the use of renewable fuels within electricity generation projects, availability and volatility in the price of renewable fuels is a significant barrier.

**United Kingdom.** Within the progress report, produced in order to comply with Article 6.3, the UK Government states that "*in recent years the CHP industry has faced serious economic difficulties mainly due to the high price of gas and low market price for electricity. The Government recognised that, in the light of the adverse economic circumstances, further interventions in the market would be needed to help support this sustainable energy technology*"[19]. This incentive framework is described in the following chapter.

Within the potential report the UK Government stated a range of typical market obstacles faced by CHP. Particular attention is paid to unfavourable gas and electricity prices, volatile fuel prices and uncertainties, uncertainty about how a particular site's heat demand will evolve over time; and the need for high initial capital investment.

The UK's compliance documentation also highlights that, as noted in the case of Germany and Ireland, price volatility for fuels has negatively affected the "spark spread", a standard term in the power

[18] CHP Ireland is the IBEC group which represents combined heat and power developers and users.
[19] The UK Progress Report to comply with Article 6.3 of Directive 2004/8/EC on the Promotion of Cogeneration, page 6.

industry referring to the difference in the price of a MWh of wholesale power compared to the price of the wholesale gas. Whilst this issue is not specific to Cogeneration, this volatility is not felt to the same extent with other forms of power only energy production, such as power only CCGT's. This is because the CCGT operator is able to only run his plant when the difference in the price of a MWh of wholesale power compared to the price of the wholesale gas make it attractive to run (this is referred to across Europe as the "spark spread"). This is at odds with the CHP operator who is compelled (contractually) to provide onsite power or provide heat in the form of high pressure steam or hot water, or a combination of the two.

The UK was one of the first MS to fully liberalise their energy markets and separate generation, transmission, distribution, and supply. This, coupled with the introduction of market driven, cap and trade scheme to reduce CO2 emissions, first introduced in the UK and subsequently adopted by Europe, and the competition within vertical integrated utilities to support projects with higher returns, has led to the following statement "there are obstacles to the installation of CHP that either cannot be removed or for which it would be inappropriate to make interventions to remove"[20]. In addition, the report states "incentivising the potential identified in the presented analysis may involve considerable effort and cost, possibly outweighing the benefits from lower energy use and carbon emissions from CHP"21.

The policy landscape is both complex and incremental. It therefore creates a high degree of political and regulatory risk and particularly in respect of CHP projects. An example of this is the proposed Renewable Heat Incentive (RHI).

Powers for the government to introduce a Renewable Heat Incentive were included within the 2008 Energy Act, passed by Parliament in November 2008. The RHI is intended to reward producers of heat from renewable sources and will be funded by a levy on those using fossil fuel to produce heat.

The introduction of the levy could be used to create an incentive for CHP or could act as a disincentive.

- By consuming more fuel than a boiler to produce heat the CHP plant operator may be liable to pay more of levy than a simple boiler.
- The government could reward a CHP plant for the reduced emissions associated with the primary energy savings made by exempting a fossil fuel fired plant from the levy. This would incentivise the use of CHP in preference to a heat only boiler.

The UK Potential report also notes that the approach used by the UK Government's in Phase 1 of the EU ETS allocation was unfavourable to CHP plants and this was partially reformed for phase 2.

[20] The UK Progress Report to comply with Article 6.3 of Directive 2004/8/EC on the Promotion of Cogeneration, page 13.
[21] Potential for CHP in the UK, Prepared by AEA Energy & Environment, BRE and PB Power, page 1

**Sweden.** The summary note only provides a very brief overview of a fuller discussion of the barriers that is provided in Chapter 8, in Swedish. Most of the relevance of this section is focussed on the technical, regulatory and commercial barriers which exist to allow for third-party access to the district heating networks. However, within the summary document some non specific references are made regarding changes to taxation, regulation and the electricity market which will affect the profitability of an investment.

In the context of the discussion around third-party access, the report highlighted a barrier resulting from the municipal siting requirement set out in the Local Government Act, whereby a municipal activity must be linked to the municipality's own territory or its inhabitants in order to be regarded as legal. It was proposed that this restriction should be removed provided it leads to achieving efficiency in the District heating operation.

The report also highlighted a potential barrier referring to the Pipeline line Act. The Act provides regulations to ensure conservation and environmental protection during the development of pipeline projects. The author proposes that this legislation should not be required for district heating because the main areas of DH development will be in urban areas and the majority of the legislation is written to protect conservation areas etc. It was proposed that this restriction should be removed.

**Denmark.** On the whole, Denmark is held up as an example of a country that has purposefully implemented an aggressive CHP adoption programme. The IEA recently awarded Denmark 5 stars in its IEA scorecard assessment programme. This rating is only given if the country can demonstrate "a world leader in prioritising CHP/DH with a clear and proven strategy for bringing about significant market development and the implementation of at least one global best practice policy measure", few barriers remain.

Grid barriers have largely been removed. Local distribution and transmission companies and system operators are obliged to set up a programme for internal monitoring with the aim of preventing discrimination towards the users of the grid. These companies publish an annual report with a description of the programme. The Danish Energy Regulatory Authority will then check that the internal monitoring programme is in accordance with relevant legislation (including the Cogen Directive). The Danish potential report notes that this programme was implemented to ensure that cogeneration producers receive fair treatment in respect of their connection to the electricity grid.

However, the potential report highlights that analysis by the Danish Energy Agency shows that in the next few years the price of electricity will not be high enough to allow for investment in new Cogen capacity. This is attributed to the fact that the electricity price is below the long-term marginal costs for a new plant. It goes onto note that as older plants are taken out of service, capacity will gradually fall and the price of electricity will rise to a level at which investments may be profitable.

**Netherlands.** As previously mentioned, there have been limitations of the documentation the CODE project team has received and therefore it has been difficult to determine barriers that prevent the further uptake of CHP. However, amongst the common barriers such as suppressed electricity prices

caused by liberalisation and fuel price volatility the report notes that there is an inherent uncertainty in subsidy scheme because it is linked to "spark spread". Whereby the subsidy equals the cost difference between electricity production of CHP, corrected for the avoided costs of heat, and electricity production of conventional sources (non-renewable). This support varies every year.

As mentioned within the introduction to this section, where possible, updates have been provided to the member states barrier reports, so as to include the latest developments in relation to the challenges effecting Cogeneration within the member state. One such example is that following the publication of the Dutch barriers report, in 2008 there was a determination that the subsidy scheme linked to "spark spread" would no longer be used[22]. Due to the relatively recent timing of these events it is not possible that details of the impact of this development is contained within the compliance documentation provided to the Commission.

The building of renewable and sustainable power plants is also being frustrated by a shortage of high-tension grid capacity. As a result of many large scale grid connection applications (a number of new large coal-fired plants), the redundancy has disappeared from the grid and there is no network capacity for CHP plants. This has meant that transmission system operators are rejected or slowing down connection of cogeneration to the networks, this is despite the powers under the Article 8 to extend the concept of priority access to CHP.

Barriers relating to administrative procedures are also researched and in the main, administrative procedures do not appear to be a barrier. The lack of internalisation of external costs in energy prices is also assed in two main areas; the costs of $CO_2$ emissions which are internalised for industrial CHP generators which are caught within the traded sector and secondly, the report looks at external effects on network and system operation.

**Belgium.** At a Federal level the report points to market uncertainty due to liberalisation and fuel price volatility. This is exacerbated by the required capital outlay of CHP projects because it is necessary to purchase back up plant and equipment to ensure that the plant can continue to supply heat and power during maintenance or the event of an outage or fault. This leads to recognition that a stronger incentive is required to meet a number of conditions facing CHP project developers, these are:

- Increased capital costs to meet additional costs of heat recovery plant and heat supply infrastructure (heat distribution, connections, heat exchangers etc);

[22] In June 2008 the Minister of Economic Affairs sent two letters to the Second Chamber of the Dutch Parliament, in which letters she responds to the requests of the Dutch Industry Group for Energy, the Environment and Water (Vereniging voor Energie, Milieu en Water) and an interest group for combined heat and power (CHP), Cogen, to continue granting subsidies to existing CHP installations in 2008. In the letters, the Minister states that she does not intend to continue the subsidies, as calculations made by the Energy Research Centre of the Netherlands Energieonderzoek Centrum Nederland - ECN) indicate that, based on operational costs, there is no "uneconomic top" (onrendabele top) in relation to CHP. To view the letters in Dutch, please click here.

- Increased development costs to identify and secure a commercial/domestic heat off-take contract;

At a regional level, most of the barriers that are included are based on market and geographical issues. Similar issues for Flanders and Walloon; the details of specific barriers for the Brussels-Capital region were dealt with in an annex that was not supplied.

## 5. Support mechanisms in place

Within the following section, support mechanisms are listed county-by-country. Whilst in some of the compliance documentation only limited information is provided, the CODE project has listed what has been reported within the compliance documentation. For the research team within the CODE project has sought to supplement this information by contacting the competent authorities within the member state directly or conferring with its recognised trade association. This process is even more necessary for the purposes of Work Package 3.

**Austria.** There is a limited assessment of support mechanism available in Austria presented within the compliance documentation, however, the English translation of the Progress report according to article 6 (3) contains a section on current support for CHP[23]. One form of support mechanism allows existing or modernised CHP plant that are connected to district heating networks to claim feed-in tariffs combined with regional investment incentives.

The feed-in tariff is combined with an exemption of balancing costs for eligible generators. This allows sustainable energy producers to refrain from complete market participation and the costs are defrayed across all consumers who happen to be connected to those grid-companies.

The report also comments that there is no new incentive schemes planned to support high efficiency Cogeneration. These incentives are based on the high efficiency criteria laid out in Annex III.

**Germany.** Within the report by the German Federal Ministry of Economics and Technology, in accordance with Article 10(1) in conjunction with Article 5(3), Article 10(2) and Article 6(3), the German Government provided an update in regards to the development of cogeneration in Germany. In particular it provides details of the statutory measures, in conjunction with the voluntary commitment by industry, which are intended to double the share of Germany's total annual electricity production accounted for by electricity from cogeneration to approximately 25% by 2020[24]. The details of this package are not clear from the report but do include the following:

1. *The Kraft-Wärme-Kopplungsgesetz14 (the 2002 CHP law)*.

New proposal makes the following changes to the existing (2002) CHP law:

- The obligation for network operators to connect CHP plants and buy their electricity is complemented by a dispatch priority, equivalent to that for renewables.
- The bonus is extended to modernised and new CHP plants starting operation between 2007 and 2016, without capacity limits.

[23] Bundesminterium für Wirtscaft & Arbeit, Progress report according to Article 6 (3) of Directive 2004/8/EC. Click here

[24] Federal Ministry of Economics and Technology, Entwurf eines Gesetzes zur Förderung der Kraft-Wärme-Kopplung, 2007.

- Electricity for own consumption becomes eligible for the bonus, extending the arrangements for power exported to public networks.
- Natural gas, as well as heating oil, used for CHP are exempt from Ökosteuer (Ecotax), creating an incentive for industry to replace heat-only boilers with CHP systems.
- Biogas CHP receives favorable feed-in tariffs under the Erneuerbare-Energie-Gesetz15 (renewable Energy law).
- Fossil Fuel CHP/DHC is recognised as a compensation measure in the "EEWärme-G" (Renewable Heat law) because it helps establish networks.
- The German building code targets primary (not final) energy consumption and therefore allows for proper reflection of efficiency advantages in energy conversion and delivery.

As mentioned above it is not clear the extent to which these incentives are based on the high efficiency criteria laid.

**Ireland.** The potential report prepared in August 2009 lists a number of support mechanisms to support the adoption of CHP at a variety of scales. Sustainable Energy Ireland (SEI) have created a deployment program, providing grant support for CHP units with a capacity of 999 kWe or below for fossil fuels and with no cap for biomass CHP. The program has been allocated €11 million for both fossil fuel and biomass / anaerobic digestion fired CHP in both capital grant aid and support for feasibility studies.

As mentioned in the previous section, under the Renewable Energy Feed in Tariff (REFIT) to receive a payment rate of €0.12 per kWh, and micro-CHP which is eligible for a feed in tariff of €0.19 per kWh within the domestic sector.

CHP and trigeneration plant also is eligible under the Accelerated Capital Allowances (ACA) scheme, introduced under the Finance Act in 2008. In the case where the eligible equipment is purchased on the basis of capital grant support, the portion of expenditure not covered by grant aid can be claimed for under ACA. There are however stringent eligibility criteria for the ACA scheme.

The report notes that one positive effect of the EU ETS has been that as the price of electricity now includes the cost of electricity generators buying carbon credits, this increases the cost of electricity and so a site generating electricity in a CHP plant would reduce the quantity of electricity purchased from the grid and therefore reduce the cost associated with the buying of carbon credits by electricity generators. For sites within the EU ETS there is currently (within phase 2 of the EU ETS) a reserve allowance of emissions for new CHP capacity.

In addition, the Government has tasked the Commission for Energy Regulation (CER) and the Commission on Taxation to advise it on the introduction of a carbon tax. It is thought that this will benefit CHP using natural gas. As the following section goes on to note, it is unclear whether these incentives are based on the high efficiency criteria laid out in Annex III.

**Finland.** Much of Finland's CHP and DH development has been achieved without the introduction of state incentives. One of the main reasons for this is that because of the colder climate, the economic heat demands in Finland are much higher than in many other areas in Europe.

The report states:

*"Modern CHP is competitive on the market in relation to the separate production of heat and power. This is mainly due to the structure of our industry and the climatic conditions". "CHP production is not particularly supported in Finland, with the exception of small-scale CHP production based on renewable energy sources, since small-scale separate production is still relatively more competitive than CHP production".*

*"Aid is no longer awarded to larger CHP plants (bioenergy), since the projects mainly fall under emissions trading and the control impact that this has is considered sufficient for the use of bioenergy to be increased in this class. CHP projects are not considered to be energy saving or energy efficiency projects in themselves in Finland, but CHP will mainly be selected for suitability reasons and competition requirements".*

However the report also states:

*"Aid is still regarded as an important means of control in the non-emissions-trading sector".*

This aid takes the form of investment aid for power plants, tax assistance that is regarded as operational support through the energy tax scheme and joining the small-scale production network has also been made easier by legislation that started in 2007.

The degree to which ETS is supporting Cogeneration is ambiguous in the report. The report accepts that emissions trading might increase the price of electricity and thus improve the competitiveness of electricity production in combined production of heat and power however the report also comments that CHP DH installations covered by EU ETS were not incentivised to add new customers because the generators liability (i.e. emission permits to cover fuel burn) increased when connecting new customers. They went onto comment that this situation was exacerbated by the fact that the new customer carbon benefit (i.e. the carbon savings attributable to switching from individual heating systems to a community scheme) was not rewarded under the current system.

**United Kingdom.** As previously noted, support in the UK is based on the Combine Heat and Power Quality Assurance Programme (CHPQA). The CHPQA was the first of its kind in Europe and is widely recognised as a trailblazer programme. CHPQA aims to define, assess and monitor CHP Schemes on the basis of energy efficiency and environmental performance, so ensuring fiscal and other benefits are in line with environmental performance. Qualification as Good Quality CHP for all or part of their inputs, outputs and capacity is complainant with Directive 2004/8/EC.

In support of the Government target for Good Quality CHP, the Government has set a target of 10GWe of Good Quality CHP and to source at least 15% of electricity for use on the Government Estate from

Good Quality CHP by 2010. The incentive framework in the UK is described in detail within both the potential report and the Progress report.

The support measures the UK Government have put into place include the following support for Renewable and Fossil CHP:

*Renewable Obligation Certificates (RO)*

- CHP schemes that utilise a renewable energy fuel are rewarded with a premium on each MWh of electricity produced under the Renewables Obligation (RO) mechanism. For CHP, if you meet the Good Quality CHP thresholds, based on the adoption of the Directive's harmonised efficiency reference values, you can claim 2 ROC's. This incentive is based on the high efficiency criteria and is administered by CHPQA.

*Climate Change Levy (CCL) Exemptions*.

- This tax is usually chargeable on taxable commodities for lighting, heating and power by consumers in Industry, Commerce; Agriculture; Public administration; and other services. Good Quality/high efficiency cogeneration CHP is exempt from the CCL on both fuel inputs and exported electricity. If CHP plants can capture the full CCL benefit then it can be worth £4.41 per MWe for electricity and £1.54 per MWe for gas. On the 22 April, the UK Chancellor confirmed that the Government will extend the climate change levy exemption for indirect sales of electricity from combined heat and power (CHP) beyond 2013 to 2023, subject to State aid approval, and also commits to continue other levy exemptions for CHP. This incentive is based on the high efficiency criteria and is administered by CHPQA.

*Enhanced Capital Allowances (ECAs)*

- The ECA put simply support the cash flow for a project. ECAs are 100% first-year capital allowances on investments in certain energy-saving equipment. Businesses are able to write-off the whole cost of their investment against their taxable profits during the period in which they make the investment. Good Quality CHP is one of the technologies eligible for support under the ECA scheme, as it qualifies as "energy-saving plant and machinery". The CHP plant and machinery covered by the ECA scheme is detailed on the Energy Technology Criteria List.

- CHP and district heating are eligible for ECA's however there are a couple of limitations. ECA's are available to industrial companies that invest in CHP. ECA for District heating pipes are only available on the volume of insulation within a pipe and does not include the cost of the entire pipe network.

*Community Energy Saving Programme*

- *On the* On the 30 June the Government confirmed that District Heating would be boosted by the Community Energy Saving Programme (CESP)[25]. The Government has also announced £25 million in funding for community heating schemes.

*Preferential Treatment of Business Rates for CHP Plant*

- The Government has introduced preferential treatment under the business rates regime for Good Quality CHP plant.

*VAT Reduction for Micro CHP*

- Micro-CHP schemes benefit from a reduced rate for their installation, from the standard level of VAT payable from the normal level of 17.5% to 5%.This was announced by the Chancellor in his Budget 2005.

**Sweden.** The summary note only provides a brief overview of the incentive framework, there is tax reduction for CHP schemes covered by ETS; peat-fired CHP qualifies for Green Energy Certificates and grants are available for converting electric heating to district heating. Due to the lack of information contained within the summary report, it is unclear whether these incentives are based on the high efficiency criteria laid out in Annex III.

**Denmark.** The Electricity Supply Act and Heat Supply Law were introduced in 1979. The Electricity Supply Act effectively prevented the building of power plants (Cogeneration plants with an electrical capacity of over 25 MW) without heat recovery. The Heat Supply Law required local authorities to undertake an analysis of current and future heat supply within their own building stock and buildings and industry within their jurisdiction. Once these heating needs were determined the Council then prepared a regional heat plan. Once this plan was completed through a mixture of fiscal and regulatory tools (further details below), heat users were driven to connect to district heating schemes and/or source their energy requirements form a CHP station.

As discussed above, the Heat Supply Law was underpinned by a deterministic fossil fuel taxation policy. Put simply, heat only generators are taxed more for fuels then generators who also produce electricity. This because the proportion of fuel allocated to electricity production is exempt from the tax and can be deducted from the total levyable fuel consumption. In 2000 this exemption was extended to natural gas CHP.

The Heat Supply Law has underpinned much of the development of Cogeneration within Denmark however it is also supported by a number of additional measures.

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[25] On September 11 2008 the UK Prime Minister announced a package of initiatives designed to help people to reduce their fuel bills whilst also ensuring that the most vulnerable receive help this winter. One element of this package was the Community Energy Saving Programme. It aims to deliver around £350m of energy efficiency packages. Reducing energy use also helps tackle climate change, and CESP will contribute to our ambition of an 80 per cent CO2 reduction by 2050. Click here for further details.

- A Feed in Tariff regime was extended to cover Gas CHP in 1992. This gave the generator a payment for electricity exported to the grid.
- Obligation to buy locally produced CHP electricity when exported onto the public distribution network. Phased out in 2005.
- An obligation for new and existing buildings connect to DH or mains gas was introduced in 1982.
- These measures were supported by a ban on electric heating within all new buildings or existing buildings that were serviced by water based central heating system.

It is unclear whether these incentives are based on the high efficiency criteria laid out in Annex III.

**Netherlands.** The draft potential report the CODE received does provide some information pertaining to the incentive framework in the Netherlands. Electricity producing installations do not have to pay energy tax on their fuel consumption, provided that the electrical efficiency is higher than 30%. As mentioned within the barriers section of this report, a feed in tariff style mechanism existed until recently provided operational support per kWh produced. This form of support is referred to as MEP. A successor for the MEP is under development, the SDE. This is also based on a support tariff per blue kilowatt-hour. The support level will probably be yearly tuned to actual market conditions in a predefined way. This offers additional certainty to investors, while preventing over stimulation.

Tax exemptions also stimulate the uptake of cogeneration. The Energie-investeringsaftrek is an exemption of taxes on company profits for investments on energy savings measures. 44% of the invested amount may be subtracted from the profits. With current tax rates (25%), it is roughly equivalent to a subsidy percentage of 11%.

In the households and services sector the Energy Performance Standard defines the maximum energy use for newly constructed buildings. This enforces the application energy saving measures. For micro CHP, the benefits of this regulation are reinforced by a grant to installer micro units as well as the operational support offered, as seen above.

**Belgium.** Each of the three Belgian Regions has a different scheme, but essentially they are similar and provide similar benefits. They are based around a certification process for CHP electricity, based on efficiencies, carbon and energy savings. An obligation is placed on electricity suppliers to supply a part of their electricity from CHP sources. The certificates are backed up by a fine and a minimum price, which allows CHP schemes to be bankable. The fine in Flanders is €45/MWh, with the floor being half of this. The certificate is paid on top of any revenue earned from power or heat sales. The current certificate price is €38/MWh. These regional support schemes are supported by federal investment support (like UK ECAs but all market actors are eligible).

# 6. National potential studies

Within the following section, support mechanisms are listed county-by-country. In some instances, not all the requirements for national potentials for high-efficiency cogeneration referred to in Article 6 are provided. This is explored below. This information gap has created challenges in terms of extrapolating a Europe wide potential for Cogeneration. This is summarised in the table below and a description of the analysis process employed is given in Annex 1.

| | Reported Installed | Reported Technical Additional | Reported Economic Additional | Estimated Installed | Estimated Technical Additional | Estimated Economic Additional |
|---|---|---|---|---|---|---|
| **Member State** | **GWe** | **GWe** | **GWe** | **GWe** | **GWe** | **GWe** |
| **Austria** | 4.25 | 11.83 | | 4.3 | 7.6 | 3.0 |
| **Belgium** | 2.09 | | 3.24 | 2.1 | 1.2 | 1.2 |
| **Denmark** | 9.68 | 13.90 | 10.10 | 9.7 | 4.2 | 0.4 |
| **Finland** | 5.90 | | | 5.9 | 1.2 | 1.2 |
| **Germany** | 20.83 | | | 20.8 | 66.3* | 66.3* |
| **Ireland** | | 1.91 | 0.73 | 0.3 | 1.9 | 0.7 |
| **Netherlands** | 9.54 | | | 9.5 | 0.0 | 0.0 |
| **Sweden** | 3.99 | | | 4.0 | 3.8 | 3.8 |
| **United Kingdom** | 5.40 | | 10.60 | 5.4 | 10.6 | 10.6 |
| **Total** | | | | **62** | **97** | **87** |

***Table 2 Additional potential for cogeneration in the CODE Northern Region***

**Austria.** The Potential study was carried out by E-Bridge Consulting GmbH. Whilst the English translation of the executive summary of the potential and barriers report contains only a limited assessment of the techniques and approach used, the study researched the applicability of cogeneration for following useful heat types; heating, cooling, warm water, steam, industrial furnace and mechanical energy. All investigations and calculations were done for the base year 2002, because for this year there were adequate data available.

No assessment was made beyond the potential based on the 2002 data and does not appear to adhere to Annex 4 (C), whereby the analysis of the potential should specify the potentials in relation to the timeframes 2010, 2015 and 2020 and include, where feasible, appropriate cost estimates for each of the timeframes.

The analysis to comply with Article 6 is based on "Technical Cogeneration Potential for Cogeneration plant (of all variations covered in Annex 1), Micro CHP and DH. This technical potential is a theoretical potential and no attempt has been made to look at how suitable the identified heat loads are to the physical requirement needed to develop a CHP project (gas infrastructure and the presence of existing heat networks etc).

The analysis for primary energy saving (PES) was done on the basis of realised projects and shows that all available technologies can be categorised as 'high efficient' according to the EU Directive, if they were optimally constructed and operated under good conditions.

**Germany.** The German analysis on the potential for CHP under the requirements of Article 6(1) and (2) is exemplary in terms of detail. As well as incorporating both macro and microeconomic analysis, an attempt has been made to identify all potential for useful heating and cooling demands, suitable for application of high-efficiency cogeneration. This analysis considers the availability of fuels and other energy resources to be utilised in cogeneration. As well as incorporating a logical methodology, the assessment of technical and economic potential the analysis includes an assessment of the cost effectiveness — in terms of primary energy savings — of increasing the share of high-efficiency cogeneration. In addition, the analysis specifies the potentials in relation to the timeframes 2010, 2015 and 2020.

The German compliance documentation provides one of the few accurate estimations of the potential for Micro-cogeneration (101-308MWe).

Cooling potential has escaped a systematic analysis of its potential for Germany. It is simply assumed that the cooling potential which exists in this country is relatively small compared to the heat requirement coverage from cogeneration plants.

**Ireland.** Pervious potential studies have been produced by the Irish Energy Centre, funded by the Irish Government under the National Development Plan and part financed by the European Union[26]. On the basis of this work and further consultation, Ireland's National CHP targets were set out in the Government's Energy White Paper[27]. This paper set a target of 400 MWe by 2010 and 800 MWe by 2020 of installed CHP capacity.

The potential report published in August 2008 does provide some quite progressive bottom up analysis of the potential for CHP within different market sectors. This analysis is carried out within three scenarios; low, medium and high uptake. In all scenarios it is assumed their will be loss of CHP capacity out to 2020. The effect of this loss will be different in each of the three uptake scenarios. In the Low Uptake, there is expected to be little replacement of lost capacity. Under the Medium Uptake scenario, the loss of CHP capacity is expected to be offset by an approximately equal uptake, while the High Uptake scenario is based upon a growth in CHP capacity substantially exceeding CHP plant closures.

The low uptake scenario is based on the current rate of CHP growth and takes a more conservative assessment of the economic recovery and industries appetite to invest in CHP projects at various scales. The outlook also takes into consideration the Government's current support for CHP and therefore highlights a modest breakthrough in residential mini/microCHP, aided by the Feed-in-Tariff support.

Under the medium uptake scenario the majority of growth in energy intensive sectors is expected to occur in the latter half of the 2010 to 2020 period, and beyond. Technological advances in micro-CHP allow for the retrofitting of such units into existing houses from 2015/2016 onwards.

Under the High uptake scenario advancements existing commercial buildings look favourably on the retrofitting CHP and invest in the technology, with growth between 2016 and 2020.

Overall the industrial sector is where any substantial future growth in CHP capacity is likely to come from, whilst the waste management sector is one where CHP prospects are improving. This is reinforced in the report by a detailed examination of Waste-to-Energy Plant in Dublin Port.

**Finland.** Estimates for the potential for cogeneration are obtained on the basis of the background scenario for the review years 2010, 2015 and 2020 defined in the CHP Directive. In some cases, estimates are also presented for the more distant future right up to 2050. The estimates of the future picture for cogeneration and district heating are supplemented by a questionnaire addressed to the management of the district heating companies. The report also presents the results of previous reports on the potential for cogeneration.

**United Kingdom.** On 19 October 2007, DEFRA published a study 'Analysis of the UK Potential for Combined Heat and Power', demonstrating the economic potential for an additional 8.2 GWe of

[26] An Examination of the Future Potential of CHP in Ireland, A Report for Public Consultation Prepared by Irish Energy Centre, December 2001.
[27] Delivering a Sustainable Energy Future for Ireland published in 2007.

capacity by 2010 and 10.6 GWe by 2015. The potential report for the UK was prepared by AEA Energy & Environment, and used existing information from consultants' reports[28]. The report that was presented to the Commission provides an update of this pervious assessment, in the context of Article 6 of the Cogeneration Directive, and reportedly draws together analysis in three areas: industrial sectors, individual buildings and community heating. The report states "All three areas have been assessed using a bottom-up methodology, based on defined heat and power demands and costs and performance for CHP units"[29].

Since the UK Government provided this report to the Commission, the Department for Energy and Climate Change (DECC) have released an Energy White Paper entitled "The Low Carbon Transition Plan[30]". This document draws upon the latest set of the Government's Updated Emissions Projections, which predict a 'significant increase in the generation of electricity from new CHP plants'[31]. Under these predictions, installed CHP capacity is expected to rise from the current level of 5.5 GW to 15.5 GW by 2020. This increase in capacity is estimated to contribute a total of 13 million tonnes of CO2 towards the UK's 3rd Carbon Budget which applies to the period 2018 -2022. Although the Government recognises that there will be uncertainty around these estimates, their significance cannot be understated: with CHP now earmarked to make a significant and defined contribution towards our statutory carbon budgets it begins to assume the status of a de facto target, and increasingly the Government will need to adopt the policies and mechanisms that will secure its delivery.

**Sweden.** Only a very brief summary of the CHP potential analysis was supplied in English, this has hindered the CODE team's ability to look in depth at the assumptions used, analyse and identify the most likely areas for growth.

The report does note that the report's author, Bengt Owe Birgersson, commissioned Öhrlings PricewaterhouseCoopers (ÖPwC) to conduct a study of the economic potential for cogeneration in Sweden. Within the fuller document (only provided in Swedish) he presents a comparison of the results of the OPwC work with other studies and reports on Sweden's cogeneration potential[32]. The results of the ÖPwC report showed a cogeneration potential is lower than has been calculated in other relevant studies[33]. The scale of divergence of potential is very large; it ranges from 11 to 41 TWh e per year.

**Denmark.** The Danish approach to identifying the potential for cogeneration follows is a similar methodology to the UK and Austria. In order to map out the potential for cogeneration, the member state first considered the energy requirements that can technically/economically be covered by

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[28] An assessment of the economic potential for CHP in the UK was made during the development of the UK Government's CHP strategy to 2010. Click here for further details.
[29] Ibid
[30] Energy White Paper entitled "The Low Carbon Transition Plan.
[31] Click here
[32] Svensk Fjärrvärme's forecast, Swedish Energy Agency practical potential and Nordleden, calculation of technical potential.
[33] Svensk Fjärrvärme's forecast for 2010 (poll), Swedish Energy Agency practical potential 2010–2025

cogeneration and the technical and economic possibilities, assumptions are then made on load factors and electrical and thermal efficiencies based on which scale and application they serve. However, there is no reference to individual sites nor is there any analysis to determine other potential heating techniques/technologies. It is therefore hard to consider that this approach is a truly micro -economic or bottom up analysis. However, Denmark does benefit from a wealth of cumulative data as a result of the aforementioned Danish Heat Act.

**Netherlands.** The analysis of the potential for cogeneration in this member state was based on running different scenarios which use various sets of energy prices and CO2-prices. This is based on the assumption of a linear relation between CO2-prices and electricity prices. Put simply, the increase in carbon prices drives the electricity price upwards relative to fuel and therefore the economic and technical potential for CHP can be evaluated. This analysis also looks at other options include savings on heat demand, alternative heat supply technologies and technologies that compete with CHP for the available energy resources.

The calculations assume all existing support policies directed at cogeneration or other energy saving technologies to remain in place. The fact that the Minister of Economic Affairs does not intend to continue some of these subsidies will have an effect on the

Because was microCHP is commerciality unavailable at the time of the report, a quantitative analysis of the potential for microCHP is not included within the draft report however it does look at the factors which might effect its uptake such as future heat demand, competing technologies within the domestic sector, access to financial incentives and the effect on the payback of the microCHP plant. The most important element to ensure high levels of take up is technical reliability at the moment of market introduction, and the amount of financial support/ financial conditions during market introduction.

Despite mentioning the growing demand for cooling within businesses, the potential report does not endeavour to investigate the potential for trigeneration.

**Belgium.** The analysis for the potential for cogeneration was carried out separately for each of the main regions. The VEA (Flemish Energy Agency) analysed the potential in 2006 and looked at two main scenarios; the adoption under a business usual case compared to a pro scenario to 2020.

For the Walloon region, an initial potential was calculated in June 2005 at the request of the regulator, CWaPE. This potential was looked at again in July 2007 by the Cogeneration Facilitator for the Walloon Region, the ICEDD (Institut de Conseil et d'Etudes en Développement Durable – Institute for Advice and Research on Sustainable Development). In short a technical and economic potential is reached and a high level 'pragmatic' potentials supplied, this is mainly based on varying Green Certificate price levels. This analysis was used as the basis for compliance in the region but does not incorporate all of the requirements of Article 6.

For the Brussels-Capital Region, estimates of the cogeneration potential were based on a double approach, bottom-up and top-down. The region used surveys and top-down analysis to arrive at a technical potential and economic potential based on payback periods.

Whilst the Brussels-Capital Region does look at the applicability of microCHP for offices and to a lesser extent the domestic sector, microCHP or trigeneration is not analysed.

# Annex 1: Description of the calculation process and methodology

**Introduction**

The published MS reports were interrogated and where it was available the following information was collected: Existing CHP capacity (in terms of Electrical capacity) Gwe, Technical CHP Capacity (in terms of Electrical capacity) Gwe, Economic CHP Capacity (in terms of Electrical capacity) GWe

Some Member States did not provide all data under all of these three sections and where this is missing estimates have been made in accordance with the procedure noted below.

We have compared the existing capacity with the Economic Capacity to derive an estimate of the Additional Economic Capacity to be exploited throughout Europe.

We have estimated the Primary Energy Savings and corresponding Carbon Dioxide emissions reduction that are available if this additional economic CHP capacity were to be implemented. The methodology for estimating the Energy Savings and Carbon Dioxide emission reduction is noted below.

**Methodology to estimate Economic Capacity where data is not reported**

Most Member States reported their existing CHP capacity but where this is missing the latest Eurostat data has been used.

Some Member States have reported both Existing Capacity and Economic Capacity, these data have been summed and the ratio of Existing to Economic for reporting countries in Europe has been noted.

Where a Member State has not reported Economic Capacity, it has been estimated by applying the European ratio to its Existing Capacity

**Methodology to estimate Energy Saving from the Additional Economic Capacity**

Member States are required to complete reports on the basis of compliant CHP, this implies that CHP included must have achieved Primary Energy Savings of at least 10%. However, Member States have not reported on the actual Energy Savings Achieved. In order to estimate the Energy Savings, three assumptions must be made: Ratio of Capacity to Output., Energy Savings attributable to adoption of CHP, Energy Savings can be assumed as electricity

The ratio of Capacity to Output was derived from the latest Eurostat data (2007) for CHP employed in Europe by dividing the installed capacity by the total electrical generation.

The achievable energy saving was deemed to be 10% as this is the minimum required by the Directive.

The total additional Economic Capacity was found by subtracting the Existing Capacity from the Economic Capacity as derived above.

The Energy Saving was then found by multiplying the Additional Economic Capacity by the ratio of Capacity to Output and multiplying this result by 10%.

**Methodology to estimate Carbon Dioxide emission reductions attributable to the Energy Saving**

The Energy Saving derived above is in the form of electricity. The average Carbon Dioxide concentration of electricity generated in Europe is quoted as 0.45 kg/kWh. To estimate the Carbon Dioxide emission reductions available the total annual Energy saving was multiplied by 0.45kg/kWh. The Value of this potential Carbon Dioxide reduction was found by multiplying by the price of €39 / te CO2 as quoted in the Commission impact assessment.

***Note to calculations.***

*We used a number of sources for the calculations as noted above, however, subsequent to completing this work we became aware of the* ***Commission Decision of 24 December 2009 determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage*** *(notified under document C(2009) 10251)*

*We note that in paragraph 10 on page L. 1/11 of the complete doc. the EU notes the price of CO2 (see extract below)*
*According to the impact assessment of the Commission accompanying the package of implementation measures for objectives of the Union on climate change and renewable energy for 2020 ( 1 ). The resulting carbon price from the most relevant scenario including Joint Implementation and Clean Development Mechanism credits is EUR 30 per tonne of CO 2 equivalent*

*We note that in paragraph 13 on page L. 1/11 of the complete doc. the EU notes the CO2 intensity of electricity (see extract below)*

*The assessment of indirect cost was based on the Union average emission factor for electricity of 0,465 tonnes of CO 2 per MWh according to the Model-based Analysis of the 2008 EU Policy Package on Climate Change and Renewables used for the impact assessment of the Commission accompanying the package of implementation measures for objectives of the Union on climate change and renewable energy for 2020. The use of an average Union value is appropriate as it is consistent with the requirement to perform the assessment at Union level and as it reflects the actual emissions linked to the electricity production in the Union.*

*However, we have not adjusted our figures.*