CODE

Growing Cogeneration in Europe

D6.1 Proposal for a European Cogeneration Roadmap

www.code-project.eu

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1. Introduction

The Cogeneration Directive

The Cogeneration 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 and encourages the use of cogeneration in the production of heat and power as a successful and well developed technique delivering primary energy savings. The background policy objectives in 2004 were security of supply and energy savings. The climate agenda which has grown in importance since 2004 has added further impetus to the wider use of cogeneration. Cogeneration is a highly energy efficient, technologically mature approach to generating electricity and providing useful heat. It is a key enabler for improving the efficiency of electricity production from fossil fuels.

One of the main achievements of the Cogeneration 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 based on the same fuel. Using the framework of the Cogeneration Directive, promoting cogeneration to meet additional electricity needs gives a Member State a quantifiable primary energy saving per unit of electricity generated.

The CODE project

The CODE project was established in October 2008 by COGEN Europe under the EU's Intelligent Energy Europe (IEE) programme. The objectives of CODE are to have stakeholders in the sector independently monitor the implementation of the Cogeneration Directive and to use stakeholder input to assess the progress being achieved through Member State initiatives. The project runs until 2011 and will report in sequence on 1) the identified European potential for cogeneration; 2) the barriers and support mechanisms for cogeneration existing across the Member States; 3) best practise and progress in Member States; and 4) a draft CHP roadmap for Europe.

2. Identifying needs for a European Cogeneration Roadmap to 2020

Introduction

The CODE project has allowed a detailed snapshot of the 27 EU Member States' CHP markets around the end of 2009. This was a point in time where the European Commission itself highlighted that the sector was showing a growth of 0.5% per annum with widely varying performance across the 27 countries. The monitoring under the CODE project from 2008-2011 has given valuable insight into what was then driving success in a limited number of Member States and possible future indicators of success. Any one Member State is unique in energy history and infrastructure and each must therefore take it own path forward in achieving its energy objectives. However, it is possible to propose, based on these 27 snapshots, a list of indicators for the likely success or failure of any policy action to drive growth in CHP. The indicators are proposed as elements to be considered by any Member State seeking to increase its energy efficiency, security of supply and sustainability of renewables by promoting the wider use of cogeneration across its economy. Given that cogeneration can be very widely applied in applications ranging from home and buildings through industry and in a range of capacities, this report also highlights the most likely markets for early success in each of the four CODE regions and Member States.

Proposal for a European Cogeneration Roadmap

Through the analysis of Member State reports and the work of regional cogeneration experts, the CODE project is in an ideal position to understand both the potential for cogeneration in Member States (as reported by Member States themselves; see figure1) and the sectors which are the most attractive for development, given the policy and energy challenges in each Member State.

STEP 1: The simple and fundamental question was asked: Is CHP economically attractive in each CODE region and Member State? If so, at what capacities and on what fuels? The insights of WP3 concerning the necessary uplift of Member State support mechanisms before a project is attractive, is a useful background indicator for Member States considering a new support mechanism. The financial return on a project is still the primary indicator of the probability of a successful growth in the CHP sector. However, it is not of itself sufficient as several non-economic additional barriers stand in the way of a project developer. The creation of a successful business case for CHP in a Member State emerges as the fundamental indicator of the likely success of policy for growth.

STEP 2: The Member States' National Potential Reports were analysed to identify the sectors considered by the Member States the most attractive for CHP growth. The Roadmap reflects these identified opportunities and gives commentary on the opportunities and barriers which still remain in both market and policy before the potential can be developed. Barriers and enablers from the Member State reports are included as indicators in the list.

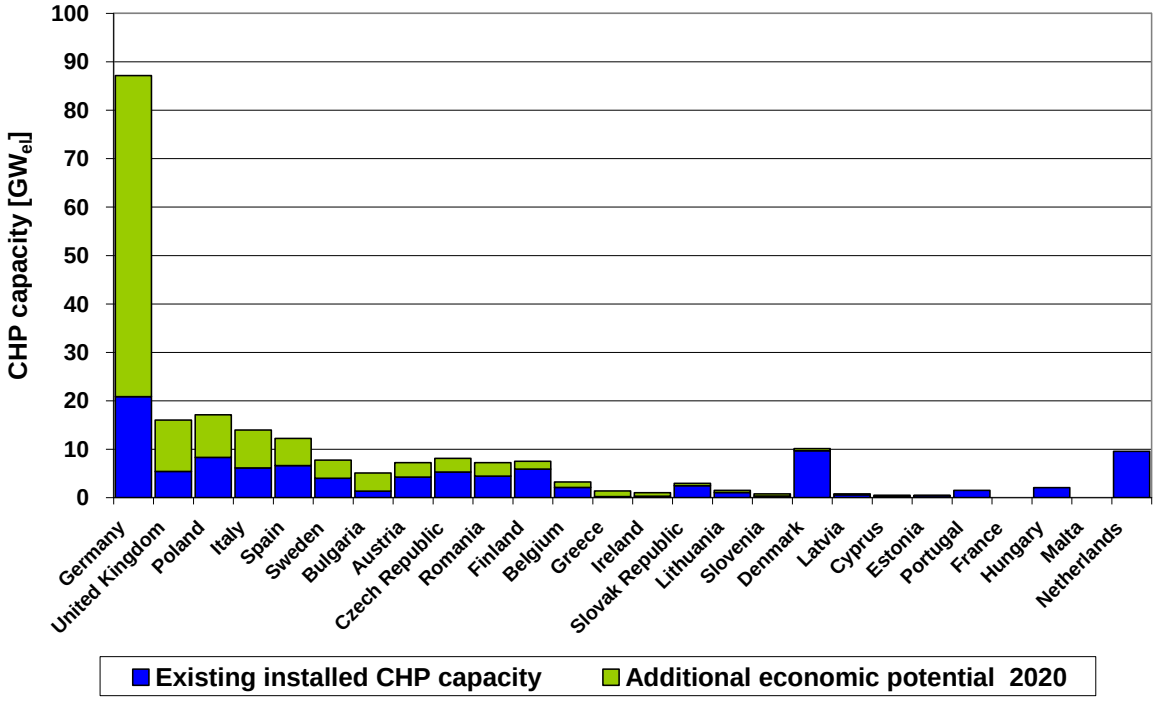

Figure 1: Existing installed cogeneration capacity and reported additional economic potential in the year 2020

STEP 3: The current best practise cases were analysed for enabling factors which the projects themselves recognised as either keys to success or major barriers to their progress. These were sometimes specifically local but for the most part were issues which were found repeatedly across Member States.

STEP 4: Consideration was given to the highest penetration CHP economies (>30%) in Europe looking for the source of major cogeneration expansion. These have to hold some lessons for the a Member State wishing to lift CHP above the 11% average penetration of Europe in 2011

Discussion

CHP has grown in Europe in the period 2004 to 2008 by 0.5% per annum. This indicates a market in the doldrums and is well short of the European Commission's own Primes model projection for the presumed growth of cogeneration in response to existing European policy measures. Primes recast in 2009 to take into account the effects of the financial crisis of 2008/2009 suggests that CHP will add an additional 50% to its penetration by 2020 under the impact of the Cogeneration Directive 2004/08/EC. This indicates a growth year on year reaching three or four times the existing rate. There is no sign of this at the time of writing. Indeed if instead of looking at average figures performance in individual Member States is considered, the "growth" in CHP is very patchy with some states like the Netherlands France and Hungary suffering serious setbacks in the market while only Germany and the region of Flanders are showing clear, real growth at the time of writing. In Spain, Portugal and Italy,

where potentially effective financial support exists for cogeneration, there is no sign of confidence and growth in the market. Secondary legislation in these three Member States is slow to materialise and non-financial barriers discourage investors from engaging with the market. Additional Member States (Greece and Cyprus) completed the legislative process of the Directive 2004 only in 2010. This raises the question of why it has taken so long and how can this be avoided in future.

3. Barriers and enablers to cogeneration

Currently cogeneration faces several challenges. Market liberalisation has so far not helped cogeneration operators. Liberalisation encourages competition in individual supply sectors and for electricity which is a transportable tradable commodity liberalisation works at the European level. For heat, which is the second market of interest for cogeneration, liberalisation is moving more slowly and its scope, because heat remains a local market, is different. Liberalisation has changed the model for cogenerators. Electricity is the by-product of heat in cogeneration and electricity market structure changes have not favoured cogeneration operators. The electricity market does not value energy efficiency and hence CHP is not rewarded for its overall efficiency in a reliable way through the electricity price. Unsurprisingly the single indicator of whether CHP will be successful is the business case. If a new entrant can gain a reasonable return on investment from cogeneration, compared to other investment opportunities, they will invest. The single task of any successful government policy to grow CHP is to achieve this result through legislation at the lowest cost or an acceptable cost to society. The internal rate of return, access to affordable capital and costs of grid connection and support remain the best indicators as to whether CHP will succeed or not.

Cogeneration for the traditional utility is a disruptive and not very attractive proposal although recent work carried out by Eurelectric show that there is an emerging active interest in the wider use of cogeneration among some of its members. The traditional 20th century electricity generation model produced electricity to push on to the market. The interest was in producing and selling electricity not in the efficiency of the overall supply of electricity and heat to the final customer. The traditional market conflict for a new small cogenerator is to have to overcome the high barriers to enter the electricity market. Poor information flow, lack of transparency in both heat and electricity markets and high risk in energy markets are all significant barriers even in 2011.

Hence a successful cogeneration policy requires a design which takes a suitably holistic approach to removing the barriers for cogeneration while finding ways to reward the efficiency of the approach. Such policy will consider a range of necessary indicators. A single action such as putting in place a Member State support scheme is liable to be limited in success or unsuccessful in impact on its own. The other elements of maturity, remaining

structural barriers and interaction with other elements of energy and climate policy also need to be taken into account.

Example of Spain

The CHP support put in force in Spain became fully operative since the approval on 26 March 2007 with the Royal Decree 661/2007 of the Spanish Government. This Decree includes also the schemes for renewal energy plants. Some of the main advantages for CHP in the new Decree are:

- 10 years guaranteed support for new plants.
- All CHP plants – from micro to 50 MWe in all sectors – are eligible.
- There is a guaranteed purchase electricity price (quarterly adjustments).
- Plants between 50 and 100 MWe will have a reduction linear factor applied to the Premium value; plants up to 100 MWe will have no support schemes.

Despite this being a supportive policy system, it has not led to an increase in cogeneration in Spain over the recent years. So a supportive system in itself is not enough to ensure an increase of cogeneration.

From the analysis a list of indicators was developed which are listed below. These are divided into "fundamental", "strong indicators", and "enablers". When evaluated using the two strongest growth markets for CHP in Europe (Flanders and Germany) the indicators were all firmly positive.

Category	Indicator
Fundamental	Is the business case for cogeneration workable in key sectors?
Strong indicator	Grid connections standardised and possible?
	Is there any policy on heat? Is there a national target for CHP or energy efficiency?
	Is there a structured energy planning process at regional level?
	is there a reasonable balance between energy efficiency and CHP policy and other energy and climate policy?
Enabler	Is there a well informed CHP champion in government central or regional?
	Is there a good awareness of CHP as a low carbon option for DH, industry and own supply?
	Is there access to affordable capital finance?
	Are there solution providers active in the market?

Table 1: List of indicators

Fundamental enabler: the business case

The fundamental indicator of growth in the CHP sector is the effectiveness of the economic case in the different sectors. The modelling of the impact of Member State support

mechanisms (WP3) showed that if the effect of support mechanisms is to improve the IRR for new investors to a point where the cogeneration investment is more attractive than other possible investments in their core business. In other words: CHP competes for investment in the real world in a fiercely competitive space, profitability or even survival of the business. Hence for a private citizen the cogeneration must not only show more than "reasonable" payback, it has to be sufficiently attractive to capture a substantial proportion of the disposable household income.

Achieving a successful business case for a cogeneration sector is the fundamental indicator of success for a Member State policy. Therefore the following two actions are necessary:

1) Remove all bureaucratic and market barriers which currently translate into additional cost.

2) Provide a level of Member State support either in feed-in tariff or through a certificate with target mechanism which is equivalent to uplift in electricity price starting at 1.5c/kWh for plants over 10 MW and proportionally higher for smaller capacities depending on maturity of the existing market. Capital support is currently less common in Member States but its impact is significant in triggering investment in mini and micro-CHP. These parts of the market are immature and would benefit from the cost reduction of volume production. This can be achieved earlier with capital support for these sectors.

Strong indicators

A strong enabler where it exists in the market or in policy has a major impact on the development of new CHP.

1) Grid connection

The single most often cited issue for new projects in the best practise cases is the complexity and lack of transparency in grid connection for new projects. This is not a new point and it covers almost every aspect of access to the electricity grid for new cogenerators. The problems cover all of:

- Procedures dictated by the DSO or TSO for new distributed generation projects gaining access
- Tariffs charged for the connection, and ongoing support
- Timescales which apply to process completion
- Overall procedural and permitting requirements

These problems add cost to all projects, heightening the risk, extending timescales and influencing contract negotiations. Using the European legislation available around market liberalisation, renewables and cogeneration Member States should frame policy to streamline and make fully transparent these processes for CHP.

Best practise in this area already exists for large CHPs in all of the Member States with a significant penetration of cogeneration (Netherlands, Finland and Denmark). Standardised processes, centralised information, transparent tariffing, fixed timescales with the right to appeal, are all normal practise in these Member States.

2) Strong policy indicators

- Is there any policy on heat ? Is there a national target for CHP or energy efficiency?
- Is there a structured energy planning process at regional level
- is there a reasonable balance between energy efficiency and CHP policy and other energy and climate policy?

The CODE project is not offering these as a definitive list of key indicators for CHP growth but these are the most commonly identified factors among success projects influencing their success and, although the list may not be complete, it is certainly a sensible starting point for an assessment of what remains to be done to promote cogeneration.

4. Sectoral potential

Cogeneration is a principle which can be applied to a very wide range of applications. Its success both as an energy efficiency principle and as an economic concept depends on being able to provide the heat and electricity at competitive market prices. Historically the most challenging part of this business proposition has been to provide a good market model for the electricity when the process is essentially heat led. The economics of the position is effected by the size of the cogenerator, their flexibility in generation and their storage capacity.

The major identifiable sectors are:

1. Energy intensive industry – CHP systems used in industries with continuous demand for electrical and thermal energy (e.g. food processing, paper manufacturing, chemicals)
2. Tertiary sector – CHP applications within the service industry (e.g. hospitals, schools, hotels)
3. District heating and cooling – CHP plants connected to a district heating network to provide power and heating or cooling to built environments
4. Small-scale CHP – Small-scale applications of CHP used primarily in small or medium sized residences or businesses[1]
5. Micro-CHP replacing inefficient boilers in traditional building stock

[1] Includes both Micro-CHP and Mini-CHP

6. Bio-energy CHP – CHP applications that use biomass (e.g. wood, peat, waste) or biogas as primary fuel

5. A sectoral and regional approach to increasing cogeneration deployment across Europe

Based on the identified key indicators (see table 1) and the identified sectors (see Chapter 4), the European Cogeneration Roadmap illustrates actions that each EU Member State can undertake in order to improve the penetration of cogeneration based on country-specific characteristics. To outline country-specific recommendations, the knowledge that has been accumulated through individual country reporting, as stipulated by the Cogeneration Directive, is utilised[2]. The European Cogeneration Roadmap addresses CHP recommendations for all 27 EU-Member States.

5.1 CODE Northern Region (Austria, Belgium, Denmark, Finland, Germany, Ireland, Netherlands, Sweden, United Kingdom)

The most CHP intensive economies in Europe are situated in this region. Denmark, Netherlands and Finland already produce over 30% of their electricity in CHP mode. The two strongest performing areas are also in this region: Germany and Flanders. Not surprisingly the challenge in much of this region is to this to maintain and support the existing cogenerators to maintain and develop their existing energy efficiency contributions and also to encourage the less performing Member States in the region to take best practises from their neighbours. This region also shows the strongest countries in making early transition to bio-energy with Finland and Sweden being advanced in this approach.

Is the fundamental business model right?

The business model for CHP is clearly successful in Flanders and Germany driven by support mechanisms in those areas, and in Finland stimulated by a carbon tax on fossil fuel and a climate of long winter seasons which makes district heating a particularly good business proposition. Installations are increasing as a result. The growth is not uniform across all capacity segments in each area.

The CODE Northern Region as a whole is characterised by complicated support mechanisms possibly underpinned by desire to avoid rents in elements of the supply chain. This seems to relate also to complex liberalised markets adding to the cost and complexity of entry. In the areas which have been most successful with cogeneration direct support on feed-in tariffs or similar have been removed and incentives target changing fuel behaviour by promoting renewables.

[2] http://ec.europa.eu/energy/efficiency/cogeneration/member_states_reports_en.htm

Strong indicators: grid connection/policy driver at central or regional level

The Northern Region Member States represent electricity markets which are advanced in their liberalisation and many have a strong cogeneration history. Access to the electricity network is either good or improving and in two areas there is policy which is directly driving cogeneration.

Sectoral growth opportunities

The areas identified by the Member States as most attractive for growth are noted below.

Northern Region	Most attractive segments
Austria	District cogeneration; private service and public section; producing industry; private households.
Belgium	Commercial/tertiary sector.
Denmark	Industrial cogeneration; micro-CHP.
Finland	Residential buildings and commercial premises; district heating; district cooling; pulp and paper industry.
Germany	Food industry; upgrade of district heating.
Ireland	Micro-CHP for residential sector; industrial and commercial sector.
Netherlands	Industry; agriculture; office buildings.
Sweden	Biomass; micro-CHP; district heating above all in industry sector.
United Kingdom	Micro-CHP; hospitals; food industry; universities.

5.2 CODE Eastern Region (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia)

Is the fundamental business model right?

The Eastern Region comprises new EU Member States. Market liberalisation is not well advanced in many cases and the price of heat in district heating networks is controlled in several cases as are the operating hours of the schemes. There is a more managed electricity market resulting in lower transparency in costs and business models. The low electricity supply price results in a lower 'spark spread' or profit for cogenerators. There also tends to be a higher installation (capital expenditure) cost in several market segments.

The business model for cogeneration is poor. High capital costs and price control make profitability a challenge. The Member State support schemes are therefore fundamental to the success of cogeneration and in the cases of Slovenia, Latvia and Lithuania there is real confidence that the support system will generate growth in cogeneration. Poland, Hungary and Slovakia stand out as running contrary to the main view in the region indicating a poor position for cogeneration profitability.

Strong indicators: grid connection/policy driver at central or regional level

The Eastern Region represents electricity markets which are at the early stage of liberalisation. Many have a history of district heating and the introduction of cogeneration to these networks is a significant energy saving opportunity. Hungary stands out as having a strong industrial cogeneration base and a high penetration of cogeneration in delivered electricity. Access to the electricity network is either good or improving and several Members States indicate some focus within policy which is favourable to CHP.

Poland, Slovakia and Hungary however seem to have a relatively poor general governmental position for cogeneration with an absence of political champions, market capacity and attractive business proposition.

Enablers

Access to affordable capital is an issue in some Member States and there appears to be a general lack of awareness of the positive role which cogeneration can play in CO2 reduction. Poland and Slovakia indicate along with a poor business model both difficulty in accessing capital and an absence of providers in the market which - taken together - suggest the cogeneration market in these Member States is experiencing difficulty.

Sectoral growth opportunities

Eastern Region	Most attractive segments
Czech Republic	Small power plants using gaseous and liquid fuels; medium-size power plants using natural gas; large power plants burning coal and biomass.
Estonia	Hospitals, building complexes, swimming pools, spa centres; new energy-intensive companies; upgrade of district heating.
Hungary	Newly built housing estates; shopping centres; newly built office blocks; warehouses, logistics centres; universities, colleges, hospitals.
Latvia	Local and individual heating; biomass.
Lithuania	District heating sector; industry sector (steam/heating water/mechanical energy).
Poland	Industrial thermal power stations; combined heat and power stations at new industrial plants; new closed estates; large cubic capacity buildings.
Slovakia	Combustion engines in medium-sized and small units.
Slovenia	Small scale applications (up to 1 MWe in all sectors); district heating; industry.

5.3 CODE South Eastern Region (Bulgaria, Cyprus, Greece, Romania)

Is the fundamental business model right?

In the four Member States of this CODE region there is limited deployment of CHP and also limited access to data. In all these countries there is a lack of awareness of the possibilities of cogeneration in industry while for space heating in Greece and Cyprus as in other Mediterranean countries there a need for cogenerated cooling, while in Bulgaria and Romania there is an urgent need to upgrade old district heating schemes from heat only to cogeneration.

There is moderate confidence in both Greece and Cyprus that with the existing Member State support mechanisms there is a reasonably profitable business model for cogeneration. In Bulgaria and Romania this is not the case.

Strong indicators: grid connection/ policy driver at central or regional level

Electricity grid connection for new cogenerators remains a major barrier. Nor is there an overly supportive policy structure or the level of attention to the sector in energy policy which is likely to drive change.

Enablers

Access to affordable capital is highlighted as a significant issue across this CODE Region. Moreover, solution providers are not readily available suggesting that capacity building by industry is a concern. A generally low awareness of the potential for cogeneration to limit CO2 emissions also suggests that the market for cogeneration remains immature and that the cogeneration industry can have a major role to play in developing this region.

Sectoral growth opportunities

South-Eastern Region	Most attractive segments
Bulgaria	Hospitals, schools, hotels; residential buildings; biomass
Cyprus	Hotels, office buildings, hospitals; food/beverages, non-metallic minerals, non-ferrous metals industries; biogas; agriculture.
Greece	Hospitals, hotels and recreation industry and CHP with biomass.
Romania	Industry; biomass.

5.4 CODE South Western Region (France, Italy, Luxembourg, Malta, Portugal, Spain)

Is the fundamental business model right?

In market development the South Western Region is similar to the Northern Region. The region as a whole is characterised by relatively complicated support mechanisms possibly underpinned by desire to avoid rents in elements of the supply chain. Local legislation however also has a considerable bearing on the development of cogeneration in the region. Cogeneration is broadly supported through the mechanisms which Member States have put in place but the secondary legislation seems to be problematic. France with its very high penetration of nuclear electricity generation is in a unique position among Member States.

Strong indicators: grid connection/policy driver at central or regional level

The Member States' electricity grid connection for new cogenerators remains a major barrier. Nor is there an overly supportive policy structure or the level of attention to the sector in energy policy which is likely to drive change.

Enablers

Surprisingly access to affordable capital is highlighted as a challenge to the sector. Despite the fact that solution providers are active in these countries and well established other enablers of an awareness of the potential role of cogeneration in reducing CO2, a general lack of champions of cogeneration at various levels highlights the challenges which the sector faces.

Sectoral growth opportunities

South-Western Region	Most attractive segments
France	Bio-energy based CHP.
Italy	Bio-energy; micro-CHP; food sector.
Luxembourg	Industry (small CHP); biomass.
Malta	Hotels; beverage industry, laundries and the packaging industry; waste sector.
Portugal	Industry (small CHP); tertiary sector (hotels, hospitals, commercial buildings); district heating and cooling
Spain	Large industry, small industrial, hospitals, district heating and cooling.

6. Conclusion

As every EU Member State is unique in its energy history and infrastructure, the CODE team proposes an individual country-by-country approach to increase the national cogeneration share. This report has identified a list of indicators for the likely success or failure of any policy action to drive growth in cogeneration. The creation of a successful business case for cogeneration in a Member State has emerged as the fundamental indicator of the likely success of policy for growth. The main task for the 27 national governments lies therefore in ensuring a supportive policy framework with financial measures.

The internal rate of return, access to affordable capital and costs of grid connection and support remain the best indicators as to whether a cogeneration project will be successful or not. In addition to the identified key indicators (see table 1), the report also identified the major sectors for cogeneration. Based on these indicators (barriers and enablers) and sectors, the European Cogeneration Roadmap illustrated actions that each EU Member State can undertake in order to improve the penetration of cogeneration based on country-specific characteristics.

Under the influence of the Cogeneration Directive, national policies and market changes are in most cases in the right direction. However, things are slowly moving due to the length of time to have original legislation and secondary legislation implemented, which is unacceptable.