CODE2

Cogeneration Observatory and Dissemination Europe

D5.1 - Draft Cogeneration Roadmap

Member State: **Austria**

October 2014

Leading CODE 2 Partner: KWK kommt U.G.

Austria is part of the non-pilot Member States of the Northern Europe CODE2 Region.

The CODE2 Region 'Northern Europe' comprises the following Member States: Austria, Denmark, Finland, Germany, Sweden

Co-funded by the Intelligent Energy Europe Programme of the European Union

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Introduction and Summary

The CODE2 project[1]

This roadmap has been developed in the frame of the CODE2 project, which is co-funded by the European Commission (Intelligent Energy Europe – IEE) and will launch and structure an important market consultation for developing 27 National Cogeneration Roadmaps and one European Cogeneration Roadmap. These roadmaps are built on the experience of the previous CODE project (www.code-project.eu) and in close interaction with the policy-makers, industry and civil society through research and workshops.

The project aims to provide a better understanding of key markets, policy interactions around cogeneration and acceleration of cogeneration penetration into industry. By adding a bio-energy CHP and micro-CHP analysis to the Member State projections for cogeneration to 2020, the project consortium is proposing a concrete route to realise Europe's cogeneration potential.

Draft roadmap methodology

This roadmap for CHP in Austria is written by CODE2 partner KWK kommt U.G. based on a range of studies and consultations (see list of sources in the Annex). It has been developed through a process of discussion and exchanges with experts.[2] The first draft roadmap has been discussed on a webex workshop on 12 May 2014 with 9 experts from Austria (see minutes on the website). The input from the workshop has been used to draft a final roadmap. The roadmap was developed over the period from end 2012 to mid-2014. The national policy framework around CHP continues to evolve in Austria and at the time of publication of this roadmap (December 2014) some items are under discussion. This should be taken into account when using the material in the roadmap.

Acknowledgement

KWK kommt U.G. and the CODE2 team would like to thank all experts involved for their contributions to develop this roadmap, which has been valuable regardless of whether critical or affirmative. It has to be stressed that the statements and proposals in this paper do not necessarily reflect those of the consulted experts.

Summary

Despite huge potentials, CHP development in Austria is currently stagnating, mainly due to unfavourable economic conditions which are not compensated by political support. With a bundle of measures it is estimated that CHP power production in Austria could increase by 7 TWh/a up to 2030 compared to 2010. CHP power capacity could rise from 5.7 GW to 9 GW. It is viewed crucial for achieving these results, that a systematic collaboration of CHP stakeholders from all areas will be organised. Following the experience with the creation of the roadmap, an initiative from a federal political authority aiming to create a sector overlapping CHP working group could be helpful.

[1] For more details and other outcomes of the CODE2 project see: http://www.code2-project.eu/

[2] First discussions with policy authorities and experts (Ministries of Economics and Environment, Austrian Energy Agency, E-Control, OE Austrian Energy, FGW Association on Gas and Heat, Wien Energie) took place in November 2012 in Vienna. With support of the Austrian Institute of Technology (AIT) on 10 July 2013 at the AIT a Kick-off Workshop on an Austrian CHP Alliance was organised, where 30 experts attended – see report on the project website http://www.code2-project.eu (in German). At this workshop first elements of an Austrian CHP roadmap have been developed.

1 Where are we now? Background and situation of cogeneration in Austria

1.1 Current status: Summary of currently installed cogeneration

Against the background of a 53 % share of hydropower in electricity production the CHP share of at least 17 % is relative high compared to other EU countries with much less hydropower. Natural gas and bio energy are the most important CHP fuels. Small and micro-CHP have only a limited presence in the Austrian heating market.

The CHP statistics in Austria is unclear. The 2nd Progress Report of the Austrian Government to the EU-Commission on CHP, Excel spreadsheet attached to the report, is containing two different values on produced CHP power in 2010: 10 TWh in the overview table (which seems to be nearly in accordance with the official energy balance of the Austrian Statistics Office – 11 TWh); 22 TWh in the tables on "sectors" and "technologies" (which seems to be rather in accordance with the 18 TWh without specifying a year of reference published 2014 by the Austrian Energy Association. Referred to the 68 TWh of total Austrian power production in 2010 the CHP share was 17 % (11 TWh) or 32 % (22 TWh). Regarding a 53 % share of hydropower even the lower value would be relative high compared to other EU countries with less hydropower. Based on the Austrian energy balance, the share of condensing power production was 24 % in 2010.

Pursuant to the second progress report 2011 of the Federal Government in accordance with the EU Cogeneration Directive in Austria the construction of thermal power plants with 1,700 MW electric power was being planned up to 2018. All these planned power plant projects were CHP plants. However, following the Austrian CHP experts involved in the consulting for the roadmap, meanwhile a lot of these projects have been withdrawn with regards to the worsened economic situation for CHP plants.

Small and micro-CHP have only a limited presence in the Austrian heating market, internal combustion engines representing only 0,2 GWel of total 5,6 GWel CHP capacity as published in the 2nd progress report.

1.2 Energy and Climate Strategy of Austria

Austrias climate strategy objective is to stabilise the final energy consumption to the level of 2005 and to increase the share of renewables to 34 %. An explicit target for CHP development does not exist. But new inquiries show, that more significant and fundamental structural changes are necessary.

The Climate Protection Act (KSG) from 2011 sets emission ceilings for a total of six sectors and regulates the development and implementation of effective mitigation measures outside the EU emissions trading scheme. It thus forms an essential pillar of the Austrian climate policy until 2020.

To achieve the objectives of the climate and energy package in a cost efficient way, also the Austrian Energy Strategy was developed. Its goal is to stabilize the final energy consumption to the level of 2005 and to increase the share of renewables to 34 %. An explicit target for CHP development does not exist.

The results from scenarios compiled by the Federal Environment Office in 2013 show that, without additional measures, the Austrian greenhouse gas emissions will stabilise after 2020. For a trajectory which is compatible with achieving the global 2° C objective, therefore significant and fundamental structural changes are considered necessary by the Office.

1.3 Policy development

A first CHP act providing support for the maintenance of operation of CHP plants and Investment support for new CHP plants as well expired in 2012. Currently there is political support for investments in CHP fuelled with natural gas or LPG, if the power produced is used on-site, and for bio fuel CHP. A new certificate system for DH CHP has been proposed by the Government in 2014.

The CHP Act expiring 2012 provided - operation support for existing CHP plants, which received funds for a) the maintenance of operation in the years from 2003 to 2010 and b) investment support for new CHP plants in the years 2007 to 2012.

Furthermore, under the Green Electricity Act there was an investment aid for cogeneration plants based on black liquor (pulp and paper production) for the years 2009 to 2012.

According to the Environmental Support Act (UFG) highly efficient combined heat and power plants based on natural gas or LPG are funded with a grant up to 30% of investment costs. Target groups for this support instrument are business and other entrepreneurial organizations. At least 80% of the electricity generated must be used within the company. Eligible are CHP plants only in areas where there is no opportunity to connect to a district heating system. Electricity from bio energy incl. biomethan is supported by the "Ecopower law" with a feed in tariff system.

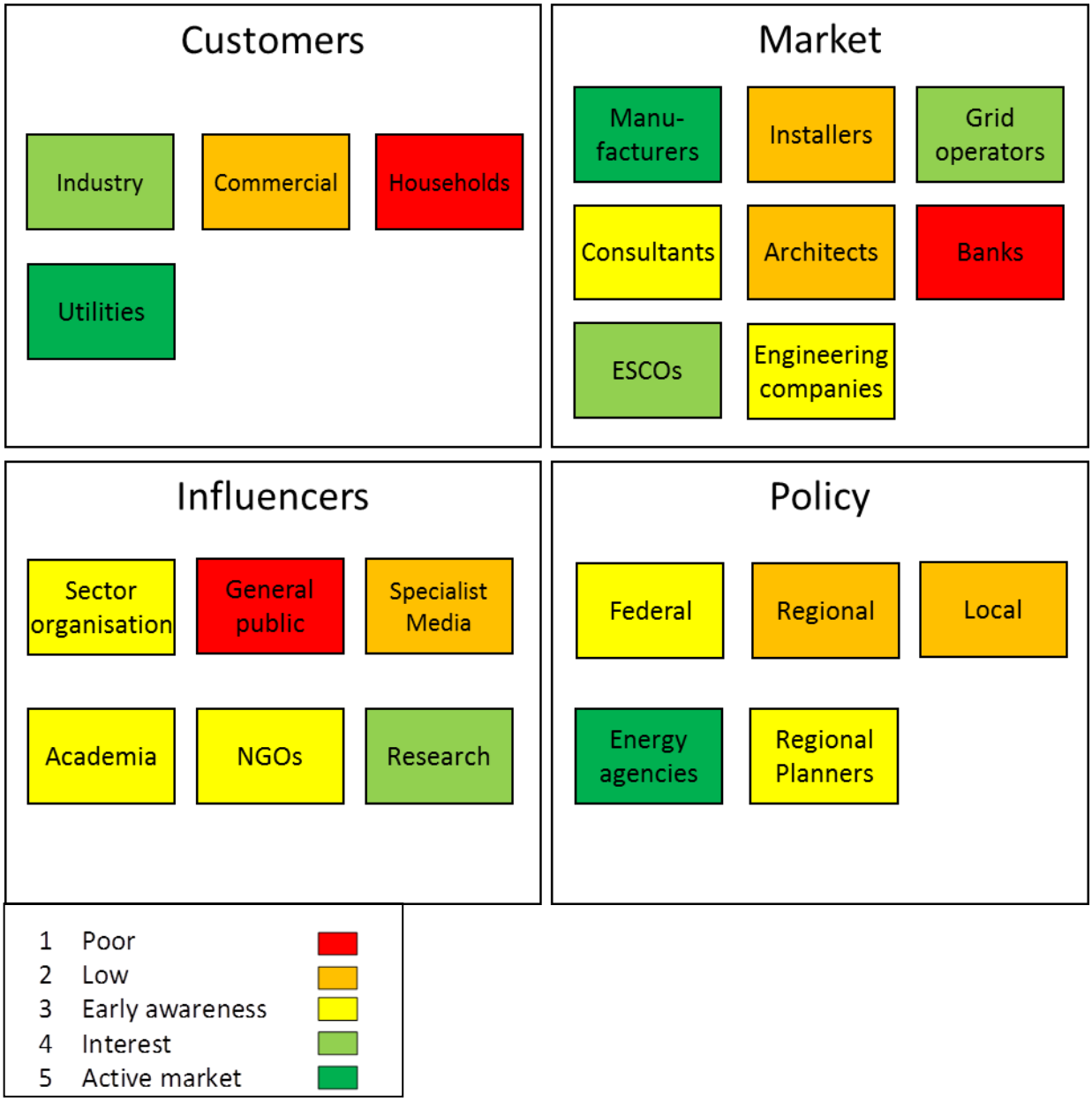
In May 2014 a promotional "CHP points act" was proposed by the Government together with a new energy efficiency package. The law is aiming to support the operation of already existing district heating CHP by allocating CHP points to operators of CHP plants and the obligation for business and private electricity consumers to sell certain shares of CHP power (points) if they are not themselves operating a high efficient CHP device.

1.4 Exchange of information and awareness

In Austria the general awareness on CHP and its importance and possibilities are considered relatively low. Active market players are utilities, manufacturers and energy agencies.

In the workshop on a CHP Alliance mentioned in the introduction chapter, a questionnaire was distributed to the participants. It asked for the subjective assessment of the degree of awareness on CHP and its importance and possibilities. The results of the inquiry are shown in more detail in Annex 1. Table 1 provides an overview by use of a standardized graph developed in the CODE2 project.

Table 1 Ratings of the awareness of CHP in the different groups



Following the assessment of the CHP experts, in the general public CHP is still little known. This corresponds with the low levels of awareness in some customer groups (households, commercial). Remarkably appear relatively low ratings of supply companies in the relevant markets, with the exception of manufacturers, energy service providers and grid operators. Significant weaknesses are also seen in the media and local and regional authorities. In the academia area as well as at regional planners an "early awareness" is assessed after all.

Of high importance for the political role of cogeneration in Austria seems to be a general lack of awareness about the value of fuel efficiency independent whether fossil or biogenic.

1.5 The economics of CHP

In Austria attractive economic conditions for CHP currently do not exist in any application area. There is also no political support which would change the economic case, which is characterised by low and decreasing electricity prices and an unfavourable power-to-gas price relation.

Table 2 Economic situation of CHP in major user groups

	Mikro *)		Smal & Medium		Big		
	up to 50 kWel		up to 10 MWel		more than 10 MWel		
	NG	RES	NG	RES	NG	Coal	RES
Industry							
District heating							
Services							
Households							

Legend:

"normal" CHP Investment has **good economic benefits**, return on investment acceptable (8-10%) for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.

"modest" CHP Investment has **modest/limited economic benefits** and return on investment (5-7%), **limited interest for new investments**.

"poor" CHP Investment has poor or negative return on investment or is not possible due to other limitations, no interest/possibilities for new investments.

Not applicable for the sector

NG **Natural Gas** or appropriate fossil fuel

RES **Renewable energy sources** (wood biomass, biogas, etc.)

The estimation of the economic situation of CHP with different fuels and in the different user groups has been made based on the price conditions in April 2014. These are dominated by low and decreasing electricity prices at the power exchange. EEX Attractive economic conditions for CHP currently do not exist in any area of application, either with natural gas or bio-energy. In single-family homes specifically suitable micro-CHP plants ("power-generating heating") are in the early market introduction phase, or - in the case of fuel cells - in the field test phase.

1.6 Barriers to CHP

CHP development in Austria is affected by a row of barriers, which partly have been reported already in the potential study made in fulfilling the EU CHP directive 2004. The barriers exist in the areas of economics, general awareness and knowhow, awareness on DH CHP advantages, regulatory environment.

Barrier 1: Decreasing electricity market prices impede investments in new large CHP plants and even threaten the continued operation of existing CHP plants

Due to the fast rising share of fluctuating RES in the power market in combination with the extremely low ETS carbon prices in the last years, the economic situation of existing and new CHP plants and the uncertainty for investments in cogeneration plants has become worse. Investments in big cogeneration plants are considered more and more to be no good business against the background of expectation on further decreasing EEX average power prices and persistently low ETS carbon prices. It must be added that in Austria, the gas price level is relatively high. Even the temporary operation shut-down of the 830 MWel CHP plant in Mellach, one of the most modern CHP plants at all, has been decided in May 2014.

Barrier 2: General absence of awareness of the existence and the advantages of CHP solutions compared to conventional fuel based space heating impedes integrated consideration of heat and electricity supply and technology innovation

As already pointed out in the chapter on barriers against CHP in the Austrian potential analysis reported to the EU commission in 2005 (E-Bridge study), that basically there is a lack of information about the benefits of cogeneration. The authors stated that "especially in the small scale application area the knowledge gaps about the functionality, performance and efficiency of existing and new innovative cogeneration technologies can be improved and thus contribute to a more widespread application of these systems through appropriate targeted information campaigns." As described in chapter 1.4. the lack of information on CHP and its benefits and chances has been confirmed in a recent inquiry at Austrian CHP experts. This concerns all areas of usage: district heat, industry and small & on-site CHP installations.

Actually one of the most important issues affecting the broader use of cogeneration is its relative complexity in terms of technology, planning, approval and funding opportunities, as well as the resulting specific high standards of planning and information. The advantages of cogeneration with regards to energy saving are not easy to understand for most people. The advantages with regards to decarbonisation are not as visible on the first evidence as they are for solar and wind energy, and they need an explanation, more or less abstract, mostly presented as a graph comparing the energy input and output flows to those of separated production of heat and power.

With regards to a transformation of the energy supply system, public and political awareness is limited mainly to RES electricity, disregarding the enormous day-to-day energy waste in the traditional heating market.

Barrier 3: Lack of knowhow of planners, installers and architects means that the potential channels for getting CHP information and projects offered to customers are not active.

The knowhow and capabilities of many planners, installers and architects concerning cogeneration are still low. In addition, any planner and consultant, who cannot adequately inform clients about cogeneration and work with cogeneration because of a low level of information may inadvertently advise against cogeneration installations simply by recommending conventional solutions, even if the user is interested in cogeneration. On the other hand, any expert for heat installations, who has become familiar with cogeneration, can be expected to be a multiplier.

Regarding Micro-CHP certain technologies are only at the beginning or shortly before the launch phase (eg Stirling engines, micro-turbines, fuel cells) . The basis of low numbers in the production still high cost and the still small practice experiences are a barrier to widespread use of these technologies.

Barrier 4: Inhibiting regulatory environment impedes CHP development in on-site installations of the heating market

Cogeneration in single objects in housing, commerce and services sector is affected by a variety of laws and other regulations, which are designed for conventional heat generation in central or individual heating and conventional electricity supply from the public grid only, but being inhibitory for the realization of on-site CHP solutions. This concerns in particular the right of residential trade and industry (tenancy law, property law, ...), but also the connection to the electricity network , network charges, and income and sales tax issues.

2 What is possible? Cogeneration potential and market opportunities

The official Austrian CHP potential analysis from 2005 indicates an additional CHP electric capacity of 2.4 GW from 2004 up to 2020. The development of gasification technologies for black liquor and solid biomass could increase the CHP power potential by several TWh per year. The share of micro CHP in heating systems in the domestic sector is estimated to increase to 42 % up to 2030.

E-Bridge study 2005

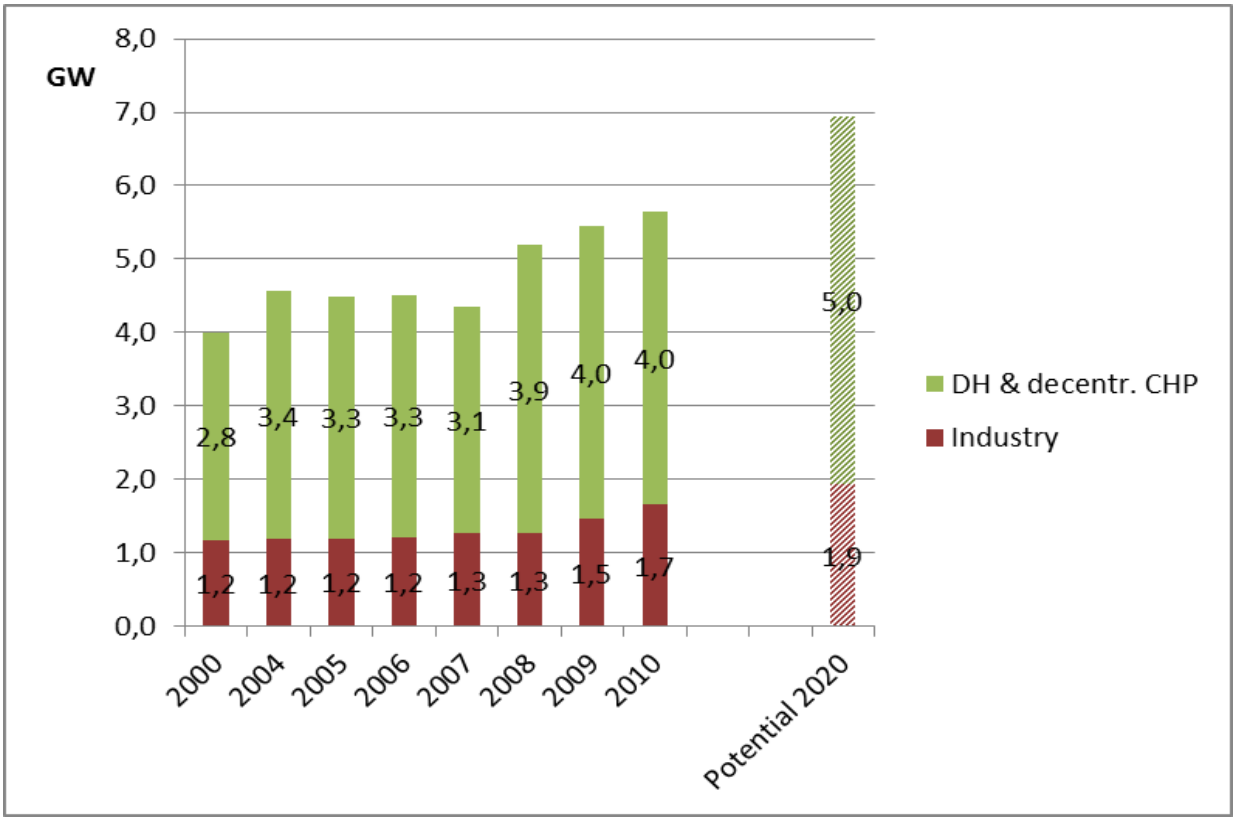
In order to implement the EU Cogeneration Directive, the Institute E-Bridge was charged by the federal government in 2005 with an analysis of the Austrian cogeneration potential.

Based on the useful heat demand in 2002 of 133 TWh, a technical cogeneration potential of 70 TWh/a heat and 59 TWh /a electricity was estimated.

Within this total potential district heating could provide 41 TWh/a of thermal energy and 37 TWh / a of electricity; decentralized CHP could produce 53 TWh/a of heat and 43 TWh/a, whereby these part potentials are overlapping.

Based on the technical CHP potential an economically feasible increase of the electric CHP capacity by 2.4 to 6.9 GWel was estimated from 2005 to 2020. The diagram shows the actual development of the installed CHP capacity compared to the estimated potential.

Figure 1: Development of installed CHP capacity compared to the reported economic potential



Additional CHP electricity bio energy gasification

The primary energy consumption of biofuels in Austria in 2010 was 74 TWh. 26% of which were each used in industry and households, 15% in CHP plants and 10% for power plants and heating plants.

According to the Austrian energy balance the share of bioenergy in CHP electricity generation in 2011 was 27% (however note the reservation mentioned in chapter 1.1).

In the E-Bridge-study, a total potential of 81 TWh / a fuel for bioenergy has been stated. Recalling that concerning CHP no adequate studies or statistical analyses were available, no further evaluation was given.

A survey conducted in the frame of the CODE2 project provides indications that the use of the considerable 8.4 TWh (2012) of black liquor which is a by-product in the paper and pulp industry, probably could be done much more efficiently. In 2012 only 32% of this volume has been used in the energy transformation sector, therein 26%-points in CHP plants. After successful development of bioenergy gasification technologies the currently predominant use of black liquor in boilers and steam turbines could be substituted by more efficient cogeneration technologies such as engines and gas turbines. As a result the electrical efficiency could be increased considerably and lead in combination with an increased share of black liquor use in CHP to an increase of CHP electricity by several TWh/a. Additionally the CHP power production from solid biomass could rise considerably. A more precise estimate cannot be made within the CODE2 project.

A bio CHP potential analysis carried out in the CODE2 project, shows that under current conditions the share of bio fuels in CHP is estimated not to grow up to 2030.[3]

Micro CHP potential

In the E-Bridge study in 2005 due to lack of profitability no economic potential for micro-CHP up to 5 kWel has been identified in Austria.

With a dynamic approach, the micro CHP study conducted in the framework of the CODE2-project, which is based on a learning curve factor of 15% (= cost degression with each doubling of production) is expecting for Austria in 2030 a market share in new heating systems of 42% in the domestic sector and 19% for small and medium-sized enterprises. The expected sales numbers are 500 units in 2020 and considerable ca. 28,000 in 2030 (see annex 2).

However, such a dynamic volume and price development requires a strong government support in the EU Member States.

3 How do we arrive there? : The Roadmap

3.1 Overcoming existing barriers and creating a framework for action

Key proposal is the creation of a working group on CHP under the guidance of the federal government. It should precise proposals to policy and industry based on the following suggestions: improvement of economic conditions of CHP; launch of a long-term information campaign on CHP; training programs for professionals; obligation for municipalities for local heat and cold concepts; encouraging CHP implementation by ESCOs; support for development of more efficient conversion technologies for bioenergy; systematic adjustment of the regulatory environment for CHP.

The following strategic imperatives emerge from the barriers analysis. Policy and/or industry must:

(1) improve the economic conditions of CHP operation

(2) strengthen information and formation measures

(3) activate municipalities

(4) encourage and boost CHP implementation by Energy Service Companies

Additionally some other energy policy objectives are to be considered:

a) Implementation of the EU Energy Efficiency Directive (EED)

For many requirements considerable margins exist for concrete design in member states. With views of a successful CHP roadmap it is a fundamental requirement that CHP relevant

[3] The national bio-CHP potential analysis is based on figures from the PRIMES database, Eurostat, the National Renewable Energy Action Plan (NREAP), and the project Biomass Futures. The analysis has been discussed and, where necessary, refined in consultations with national energy experts (see Annex 3 for the Austrian bio-CHP potential analysis or http://www.code2-project.eu/wp-content/uploads/130712_Bio_CHP_EU-27.pdf for the complete EU-27 analysis).

obligations in the EED are implemented ambitiously and are used as an inducement to ambitious action. Some CHP promoting actions referring to the EED will be presented below.

Art. 14: In the frame of the "comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling" according to a cost-benefit analysis shall be carried out based on socio-economic and ecologic criteria.

Regarding the high capital intensity of CHP it is important that the discount rate used in the economic analysis for the calculation of net present values shall be chosen at a low value according to Annex IX of the EED and be nearby the discount rate as defined by the European Central Bank. Generally the cost-benefit analysis should be based on a socio-economic consideration and not on common business level criteria (e.g. discount rate 2 to 3 % instead of > 10 %).

b) Development of renewable energies

   Consequence for CHP: increasing share of bio energy.

c) Reduction of greenhouse gas emissions

   Consequence: decarbonisation, switch from coal to natural gas and bio energy

d) Long-term security of heat and electricity supply in interaction with wind and solar power

   Consequence: change of CHP design to higher operating flexibility

Regarding social and political acceptance, a simultaneous development of different cogeneration solutions on a broad line is regarded to be useful, that means cogeneration expansion both, in heat grids and on-site-installations. In this way there will be no losers in the transformation towards a broader cogeneration use, e.g. installers of heatings, but ideally only winners.

Taking into account the strategic imperatives derived from the barriers analysis and the other energy policy objectives to be considered, the following measures are proposed, so that cogeneration can contribute fully to Austria´s energy and climate objectives:

3.1.1. The economic conditions of CHP should be improved

a) Encouraging the production of CHP electricity in newly constructed and modernised or replaced CHP plants by financial support
   - in all areas of the heat market,
   - for bioenergy, natural gas and LPG.
   - Incentives for shifting of CHP electricity generation into hours with high electricity prices (scarcity indicator) aiming to guarantee long-term security of supply in connection with growing fluctuating wind and solar power supply, e.g. payments for capacity provisions or bonus payments for electricity generation in high-load hours; investment incentives for heat storage.

b) Promotion of small and micro-cogeneration in areas not suitable for district heating

Policy should give a clear and reliable signal to the markets that CHP shall be developed.

3.1.2. A long-term Information campaign on CHP should be launched

In order to overcome the general lack of awareness of the low energy efficiency of conventional heating systems and condensing power production and the opportunities to overcome it by cogeneration, a nationwide long-term information campaign on cogeneration and its advantages for consumers, the

environment and the national economy should be launched. With a relatively small financial sum spent in these measures the effectiveness of the financial support provided according to 3.1.1. can be expected to be strongly amplified. The campaign could refer to Article 17 of the EED (Information and training).

It is proposed that the Federal Government initiates the project by commissioning a subsidiary body or an agency to develop a concept with appropriately detailed measures including the coordination of sector specific activities of the affected associations in a special steering committee. The project financing could be generated through a joint fund with a distribution between the involved associations and the Federal Government (e.g. 50%/50%) is proposed. The objective of the campaign would be to create a better general awareness of the important role of transforming heat generation towards CHP independent whether fossil or biogenic fueled.

Additionally CHP statistics as an important information and policy management tool should be reviewed and adapted.

3.1.3. Training programs combined with certification schemes for providers of energy services, energy audits, energy managers and installers should be launched, thereby explicitly including CHP

Requested and financially supported by the Federal Government, the relevant professional chambers and associations shall develop training and certification programs for planning and installation of CHP plants and devices. CHP should also be explicitly included in the formation regulations of relevant professions. Also in the repertoire of energy consultants cogeneration shall be included.

The measure would be in line called for in Article 17 (4) of the EED.

3.1.4. The municipalities should be obliged to carry out local heat and cold concepts

The momentum of the EED, Art. 14, should be used for implementation of local heat plans including industrial waste heat. The degree of interpretation allowed in implementing the EED should be used by the government to increase “target oriented” action and to support additional commitment to develop sound plans and cogeneration.

An obligation should be considered for municipalities to develop simplified standardized heat and cold concepts. This obligation should identify the economically feasible cogeneration potentials based on DH, small scale heat grids and gas grids. The economic support proposed in 3.1.1. must be taken into account. A standardised planning tool should be developed to be used by the municipalities for this purpose and commissioned by the Federal Government. In these heat concepts also waste heat potentials from industry should be taken into consideration.

Complementary to this obligation, financial support for carrying out the heat concepts should be provided.

With regards to social acceptance and political feasibility, efforts must be made on the local level to convince the citizens of the advantages of politically coordinated efforts to create an efficient and sustainable energy supply system, with cost advantages for each individual household.

3.1.5. Third party implementation and operation of CHP by energy service companies (ESCOs) should be strengthened

The implementation of Article 18 EED, requiring that “Member States shall promote the energy services market …” could be a core element for bringing the cogeneration potentials of the industry into the reality. The same is true for many other energy users e.g. in the commercial or housing sector who aren´t able or do not wish to invest in cogeneration devices and operate them. It is important to make sure that cogeneration implementation by external ESCOs is explicitly supported.

3.1.6. The development of energy efficiency technologies in the field of bio energy should be promoted

Regarding the significant wasted bio energy resources mentioned in chapter 2, the industry, possibly with government financial support, should strengthen the development of more efficient conversion technologies for bioenergy, particularly for the gasification of solid biomass and black liquor in the paper and pulp industry. This should be done by international cooperation (The same proposal have been made in the CHP roadmaps for Finland and Sweden regarding their huge solid biomass and black liquor potential).

3.1.7. The regulatory environment should be systematically reviewed and adjusted

A specially implemented working group "regulatory environment" with participation of the touched ministries and associations should identify the CHP retardant regulations in detail and recommend appropriate solutions.

3.1.8. Under the guidance of the federal government, a working group on CHP should be created to specify and accompany the Roadmap realisation

The proposed measures are far-reaching and require further discussion, if necessary modification and specification. It is proposed to create a working group on CHP under the guidance of the federal government (or an appropriate federal institution) and under participation of touched organisations and scientists. It would be charged with drawing up concrete proposals to be addressed to the political level. Also the special working group "regulatory environment" mentioned under 3.1.7. would be to link here.

The CHP Roadmap should be linked to the district heating and cooling roadmap currently developed by AIT Austrian Institute of Technology.

3.2 Possible paths to growth

In the business-as-usual case CHP power and capacity will not further grow. With the proposed roadmap it is estimated, that up to 2030 CHP electricity production could increase by 7 TWh/a and CHP electric capacity by 3.3 to 9 GW.

The following projections do not represent forecasts in a scientific sense; they are aiming to indicate the results of the implementation of the proposed CHP roadmap compared to an estimated business-as-usual development. For assumptions see Annex 4.

Business as usual path

Without an active improvement of the profitability of CHP plants as proposed in chapter 3.1. it is likely that, due to the declining propensity to invest in new equipment and upgrades, both CHP electricity and capacity as well will stagnate. The share of bioenergy will stay at the current level, as indicated in the CODE2 bio CHP study, which is based on a "score card" analysis reflecting the current situation (see Annex 3).

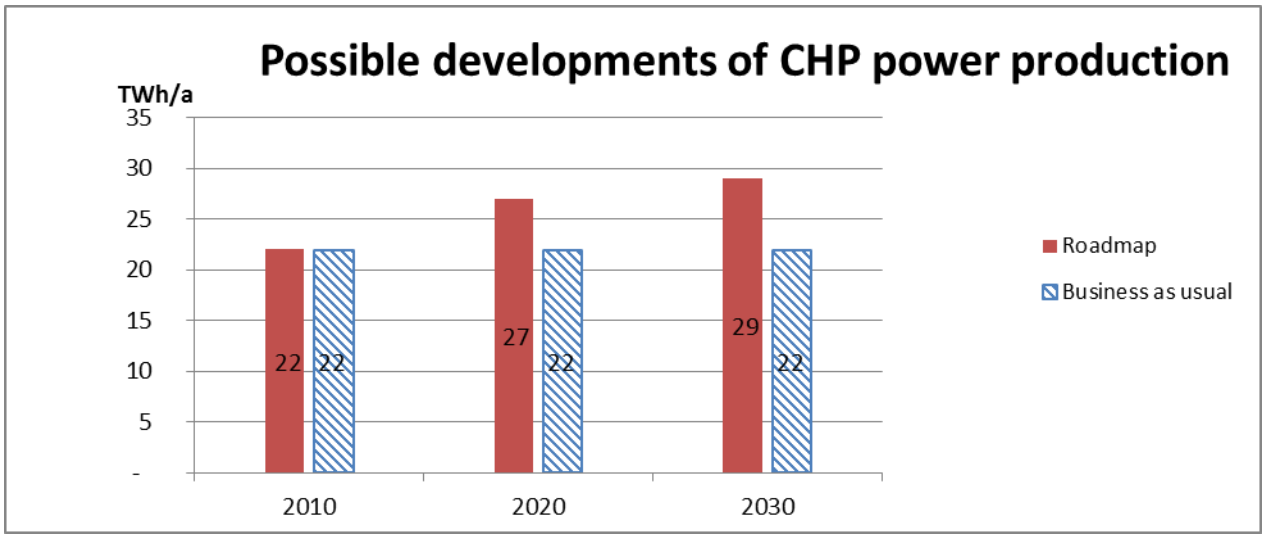
Roadmap path

It is assumed that in 2020 with the measures proposed in chapter 3.1. the economic potential of 6.9 GWe estimated by E-Bridge could be achieved. For the period 2020-2030 a detailed assessment for the CODE2 project is not possible. It is estimated that from 2020 to 2030 an annual average increase across all areas of 0.2 GWel is possible.

For CHP electricity it is calculated an increase by 5 TWh/a from 2010 to 2020. Based on the higher of the two different statistic numbers for 2010 as reported in chapter 1.1., which is 22 TWh/a, the CHP power production would increase to 27 TWh/a.

For 2030 a further increase in CHP electricity capacity up to 9 GW and of CHP electricity production to 29 TWh /a is calculated.

Figure 2: The CHP roadmap path compared to the business-as-usual path



3.3 Saving of primary energy and CO2 emissions by the CHP roadmap

Primary energy saving (PES) and CO_2 emissions saving projections resulting from increased use of CHP require assumptions about not just what types of fuel and technology are displaced, but also their operation on the market. Within CODE2 two approaches are developed. These represent two different analytic considerations which are summarised here and more fully explored in Annexe 5.

1) **Methodology according to Annexes I and II of the EED**. This method is used at a member state level today for national reporting to the European Commission and at project level for determining if a specific CHP plant is highly efficient. In the methodology, the efficiency of each cogeneration unit is derived by comparing its actual operating performance data with the best available technology for separate production of heat and electricity on the same fuel in the market in the year of construction of the cogeneration unit using harmonized reference values which are determined by fuel type and year of construction.

2) **Substitution method**. This method has been developed within the project. It estimates the amounts of electricity, heat and fuel which are actually replaced by additional new CHP based on a projection of the supply base changes in the member state supply over the period are calculated. The situation in 2030 is compared to the current status.

With this method PES for Austria through implementing the roadmap for CHP is estimated at 16 to 17 TWh per year and CO_2 savings are estimated to be between 8 and 9 Million tons per year in 2030. The actual saving is particularly dependent on the efficiency increase through upgrading both current power plant and CHP technology efficiencies.

The final share of bio energy in additional CHP has a major impact on the CO_2 savings which can be anticipated. The CO_2 reduction achieved is due to both higher energy efficiency and fuel switching towards low carbon (natural gas) or non-carbon (bio energy) fuel, but CHP development and fuel switching are anticipated to be an integrated process driven by policy objectives.

Table 3 Saving of primary energy and CO_2 by the Austrian CHP roadmap

	Substitution method				EED method			
	low case		high case		low case		high case	
PE saving	17	TWh/a	16	TWh/a	19	TWh/a	21	TWh/a
CO_2 saving	8	Mio t/a	9	Mio t/a				
- per kWh el*	1.16	kg/kWh el	1.31	kg/kWh el				

* This value represents the CO_2 reduction of the power generation. It includes the avoided CO_2 emissions from fuel savings for separate heat generation in boilers; it must not be confused with the considerably lower CO_2 emissions of the substituted condensation electricity or with even lower emissions of compared power production according to the BAT approach in accordance with the EU CHP directive reference values.

The naming of the “low” and high” cases is related to CO_2-emission saving. In the Austrian case with the substitution method the PES is higher in the “low case” than in the “high case”. This is due to a higher share of new bio energy CHP in the “high case”, which leads to a lower PES, because bio CHP has lower electric efficiency compared to natural gas CHP, but also lower CO_2 emissions. The EED method results in higher PES than the substitution method as, regardless the real primary energy use development; the additional CHP is always compared to separated heat production with the same fuel, as described in Annex 5.

The CO2 reduction estimates are based on the following assumptions:

- The additional CHP electricity essentially replaces electricity from old coal power plants and coal cogeneration plants with low efficiency.

- The fuel for the additional CHP electricity quantities fed in large part from a redirection of natural gas, fuel oil and LPG from inefficient old boilers in highly efficient cogeneration plants .
- Through efficient use of bio energy potential substantial additional amounts of CHP electricity can be generated without additional CO_2 emissions.

Annex 1: Stakeholder group awareness assessment

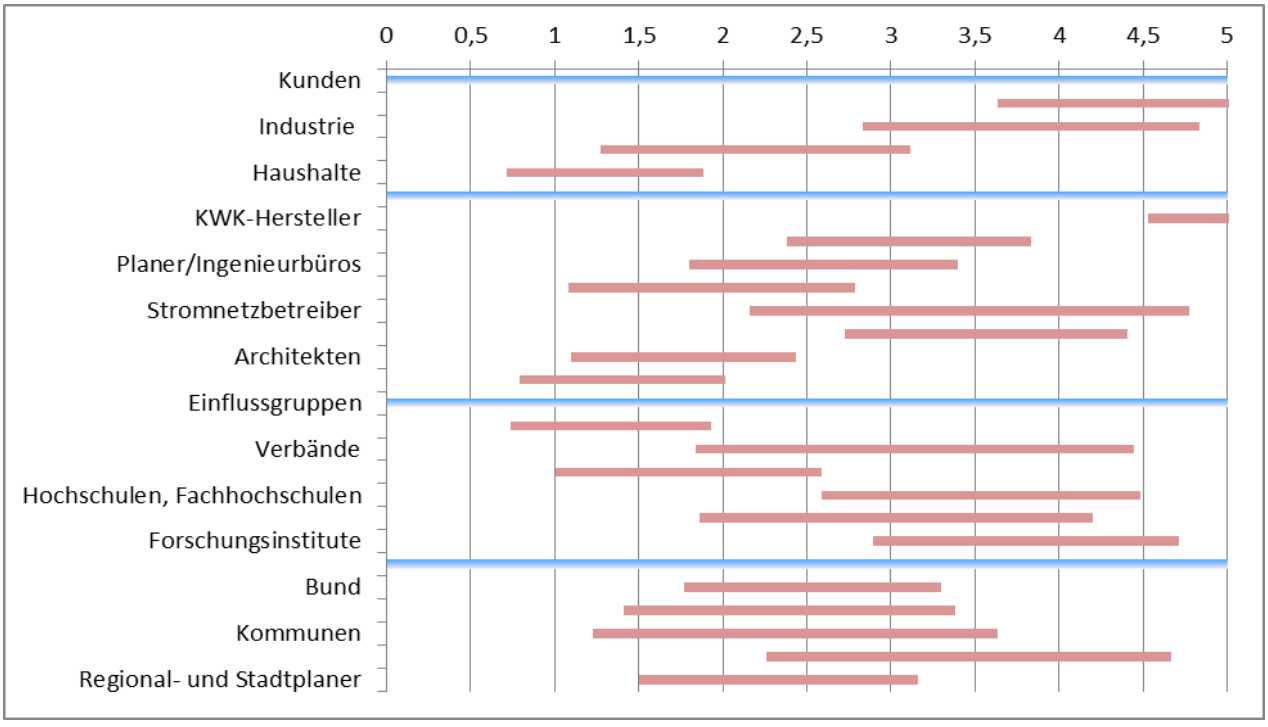
In the kick-off workshop on a CHP Alliance in July 2013 a questionnaire on the reputation of cogeneration was distributed to the participants. It was filled by 15 experts. The questionnaire asked for the subjective assessment of the degree of awareness on CHP and its importance and possibilities. Here are the questions and results (in German).

Fragen zur Bekanntheit der KWK in Österreich

Gefragt ist Ihre subjektive Einschätzung des Grades der Bekanntheit der KWK und ihrer Bedeutung und Möglichkeiten. Teilweise geht es auch darum, wie intensiv Wissen und Knowhow über KWK sind.

1. sehr gering; 2. gering: 3. beginnendes Interesse; 4. deutliches Interesse; 5. aktiv.

Die Balken zeigen jeweils die doppelte Standardabweichung,(d.h. den Bereich mit 68% der Antworten) von 15 Teilnehmern eines Expertenworkshops im Juli 2013. Mittelwerte jeweils zentral.



Annex 2: Micro CHP potential assessment

micro-CHP potential summary Austria

Country statistics

Population: 8 400 000 (2010)
Number of households: 3 650 000 (2010)
GDP per capita: € 32 400 (2010)
Primary energy use: 27 900 ktoe/year (2010)
GHG-emissions: 85 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kWe)

Boiler replacement technology

Present market (2013)
Boiler stock: 930 000 units
Boiler sales: 69 000 units/year

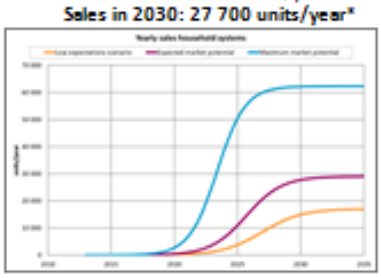
Potential estimation

Indicator	Score
Market alternatives	1
Global CBA	3
Legislation/support	2
Awareness	0
Purchasing power	3
Total	8 out of 12

Expected final market share: 42% of boiler sales in Household sector

Yearly sales

Sales in 2020: 500 units/year*
Sales in 2030: 27 700 units/year*



Stock

Stock in 2020: 1 000 units*
Stock in 2030: 140 000 units*
Stock in 2040: 290 000 units*

Potential savings in 2030

Primary energy savings:
3 PJ/year*
69 ktoe/year*
GHG-emissions reduction:
0 Mton $CO_{2,eq}$/year*

SME & Collective systems (±40 kWe)

Boiler add-on technology

Present market (2013)
Boiler stock: 92 600 units
Boiler sales: 6 900 units/year

Potential estimation

Indicator	Score
Market alternatives	1
Global CBA	3
Legislation/support	2
Awareness	0
Total	5 out of 9

Expected final market share: 19% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 30 units/year*
Sales in 2030: 850 units/year*

Stock

Stock in 2020: 200 units*
Stock in 2030: 3 500 units*
Stock in 2040: 12 000 units*

Potential savings in 2030

Primary energy savings:
90 PJ/year*
70 ktoe/year*
GHG-emissions reduction:
0 Mton $CO_{2,eq}$/year*

*Corresponding to the expected potential scenario.

Micro-CHP Score card Argumentation

The score card is used to assess the relative position of an EU country based on current regulations, markets and economics. The score itself functions as input to the implementation model to 2030.

±1 kWe systems (Households)

Boiler replacement technology

Scorecard

Indicator	Score
Market alternatives	1
Global CBA	3
Legislation/support	2
Awareness	0
Purchasing power	3
Total	8 out of 12

Market alternatives

*Development (local) gas grid: **in cities well developed***

Global CBA

*SPOT: **5.5 years***

Legislation/support

*Current incentives on micro-chp **Yes 25% investment funding***
*Current incentives on other technologies as heatpumps and district heat: **Yes***
*Current regulation in favour of microCHP **No***
*Current legislation in favour of other technology: **No***

Awareness

Are stakeholders aware of the microCHP technologies
*Homeowners? **low***
*Consultants ? **low***
*Installers? **low***
*Planners? **low***
*Government? **Yes***
*Are manufacturers active in the market? **beginning***

Purchasing power

*GDP: **€ 32 400 per year***

±40 kWe systems (SME & Collective systems)

Boiler add-on technology

Scorecard

Indicator	Score
Market alternatives	1
Global CBA	2
Legislation/support	2
Awareness	0
Total	5 out of 9

Market alternatives

*Current national roadmaps on micro-CHP: **No***
*Current national roadmaps on other technologies: **No***

Global CBA

*SPOT: **7 years***

Legislation/support

*Current incentives on micro-chp: **Yes 25% investment funding***

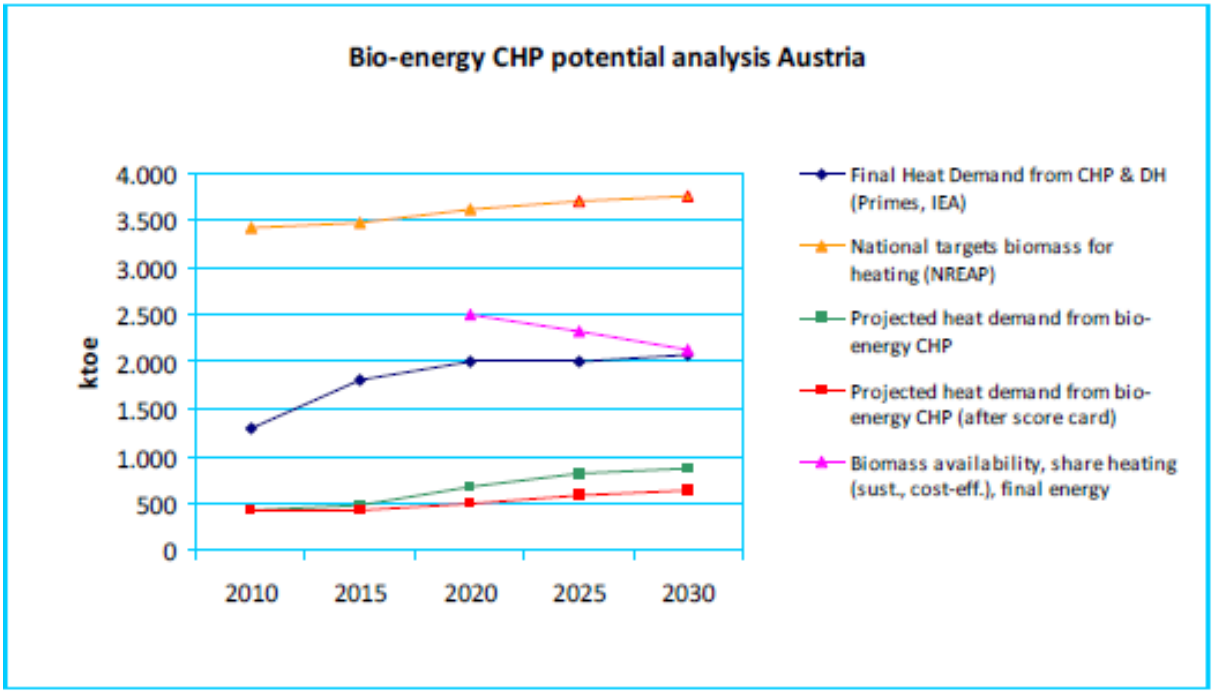
Awareness

Are stakeholders aware of the technology
*Homeowners? **Low***
*Consultants? **low***
*Installers? **low***
*Planners? **low***

Annex 3: Bio CHP potential assessment

Bio-energy CHP potential analysis Austria

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	1.291	1.993	2.062
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	416	496	639
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	32,2% (2009)	24,9%	31,0%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		2.488	2.132



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	+ 2 (of 3)	Limited support by eco-power law
Suitability of heat market for switch to bio-energy CHP	++ 3 (of 3)	High interest in bio-fuels by consumers in all market segments
Share of Citizens served by DH	o 1 (of 3)	21% of households supplied with DH
National supply chain for biomass for energy	+ 2 (of 3)	Large parts available only at high costs
Awareness for DH and CHP	++ 3 (of 3)	

Annex 4: Assumptions used in the market extrapolation

Business as usual path

Without an active improvement of the profitability of CHP induced by policy support measures as proposed in chapter 3.1. it is likely that, due to the declining propensity to invest in new equipment and upgrades, both CHP electricity and capacity as well will stagnate. The share of bioenergy will stay at the current level.

Roadmap path

It is assumed that with the measures proposed in chapter 3.1. the positive trend from 2007 to 2010 can be continued up to 2020. The economic potential of 7 GWel estimated by E-Bridge thus should be achieved in 2020. For the period 2020-2030 a detailed assessment for the CODE2 project is not possible. In the light of a historical CHP capacity annual growth of 0.24 GW in the period 2005 to 2010 (see chapter 2) it is estimated that from 2020 to 2030 an annual increase across all areas of 0.2 GWel should be possible.

Bases for this are:

- A further expansion of CHP heat generation by substitution of heat generation in boilers (which are however further needed as a back-up and supplement)

- An increase in the average electrical efficiency of new and modernized CHP plants

- Increasing the efficiency of electricity generation from solid biomass and black liquor by gasification (see chapter 2).

- Larger design of new and modernized CHP plants to shift with the aid of large heat buffer storing the operating hours in hours with high power exchange prices. This requires higher capacities at given heat sinks.

It is further assumed that the average annual utilization time (ratio of work and power) of the new and modernised CHP plants by 2020 will be 3,850 h/a, equal to the average of the years 2000 to 2010, followed by an average of 3,000 a/h between 2020 and 2030 because of the mentioned larger plant design.

After all it is calculated by 2020 an increase of CHP electricity by 5 TWh/a from 2010 to 2020. Based on the higher of the two different statistic numbers for 2010 as reported in chapter 1.1., which is 22 TWh/a, the CHP power production would increase to 27 TWh/a.

For 2030 a further increase in CHP electricity capacity up to 9 GW and of CHP electricity production to 29 TWh / a is calculated.

Annex 5: Assumptions used in the economics of CHP

Detailed economic analysis of four standard CHP cases was implemented in all pilot roadmaps and optionally in non-pilot roadmaps.

As requested detailed economic data for economic analysis of four standard CHP cases were not available or are not sufficiently reliable for making objective conclusions about the CHP profitability and comparison of economics with other member states, detailed calculation table is not included in this report.

Annex 6: Methodologies used to calculate the saving of primary energy and CO2 emissions under the roadmap

Substitution method

This method has been developed in the CODE2 project. In doing this, two other approaches have been considered: 1) the "replacement mix method[4]" from the Munich FfE institute, which however cannot be used directly for a long term comparison as needed in CODE2; 2) a method used to calculate the CO_2 saving resulting from a voluntary commitment of the German industry for CO_2 reduction[5], however this method has been considered as too simple. Therefore the following more differentiated approach has been developed:

Based on an estimate of the increase in cogeneration electricity the thereby caused decrease of CO_2 emissions and primary energy consumption is estimated. In this approach, an attempt is made to determine the actual quantities saved compared to the base year (e.g. 2010). Hence it refers to the actual saving of fuels for the production of the amounts substituted by modern CHP plants

a) of electricity and heat in the replaced or retrofitted old CHP plants

b) of electricity in power plants

c) of heat in boilers.

The savings result from a combination of three effects:

- CHP effect
- Technology effect (improved CHP technologies)
- Fuel switching (e.g. lower carbon content of natural gas compared to coal, CO_2 neutrality of bioenergy)

The results show the savings actually induced by the expansion of CHP compared to the situation in the base year.

This approach differs fundamentally from the methods for checking the high-efficiency according to the CHP Directive or in accordance with ANNEX II of the EED (Directive 2012/27/EU on energy efficiency), in which a comparison between CHP and the best available Technology (BAT) of separate production of electricity and heat produced is carried out strictly on a same-fuel basis.

[4] 10. FfE Forschungsstelle für Energiewirtschaft e.V., Energiezukunft 2050; http://www.ffe.de/die-themen/erzeugung-und-markt/257

[5] The calculation has been made by the VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V., 2010, Unpublished.

This procedure is considered to be inappropriate to deliver an estimate of the actual fuel saving quantities by CHP over a longer period, which is considered relevant value, representing meaningful the contribution of CHP to the long-term objectives of the EU to reduce CO_2 emissions and primary energy consumption. The BAT approach of the CHP Directive has been developed to verify the high efficiency of individual plants, but not to determine actual saved CO_2 emissions and primary energy quantities by CHP expansion.

In fact, the CHP expansion is closely associated with a replacement of old by new cogeneration technologies and a change in the structure of fuel away from coal to natural gas and bio-energy. These three developments,

- replacement of separate generation by cogeneration,
- replacement of old by new cogeneration technologies,
- replacement of carbon-rich by low-carbon fuels,

can be usefully seen only as an integrated process.

To account for the uncertainties in particular with regard to fuel shares and technology development, a window of possible developments with an upper value and a lower value of emission reduction and savings has been determined. The different levels of results are due to assumptions about key parameters such as current share of electricity from cogeneration, which is replaced by electricity from new or retrofitted units, fuel shares in the replaced CHP plants, power plants and boilers as well as in the new CHP plants.

The results have been calculated based on the following input values: growth of CHP power production, share of current old CHP to be replaced by new installations and retrofitting, fuel efficiency and electric efficiency of new CHP and replaced CHP for different fuels, electric efficiency of replaced power from conventional power plants for different fuels, heat efficiency of replaced heat from boilers, corresponding fuel shares.

EED method

The Primary Energy Savings methodology of the EED is used at a country level for national reporting to the Commission, and at project level for determining if CHP is highly efficient. In the methodology, each cogeneration unit is compared with the best technology for separate production of heat and electricity on the same fuel on the market in the year of construction of the cogeneration unit and the harmonized reference values are determined by fuel type and year of construction.

The underlying principle is that, knowing that regularly new investments have to be made in new energy production units, it is necessary to compare CHP with the centralized production installation which could be built using the same fuel rather than assuming a displacement of a different fuel or introduction of a new fuel. It is a logical approach when looking at the decision making process of investors or a member state government. By investing in or supporting CHP, a certain electricity generating capacity will be produced by CHP and NOT by centralized production based on the same fuel (= principle of 'avoided production').

For the timeframe of the roadmap (between 2010 and 2030), and especially in countries where there is no overcapacity, it is relevant to compare installing a certain capacity (at national level) of CHP compared to installing new capacity with another technology (power plant + gas boiler). Older installations being replaced with state-of-the-art technology.is a typical reinvestment decision. New CHP-plant (or combination of smaller installations) would not necessarily lead to less production in older production installations, but would rather pre-empt investments in e.g. new CCGT investments.

Annex 7: Sources

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