

# CODE 2

**Cogeneration Observatory  
and Dissemination Europe**



## *European Cogeneration Roadmap*

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## Executive Summary

The CODE 2 project worked with national experts across 27 European Union Member States to identify a growth path for combined heat and power (CHP) in each country and to project the likely results on Europe's energy and climate goals of a suitable policy structure around CHP.

The project roadmaps estimate that in 2030 CHP could generate 20% of the EU's electricity highly efficiently on a range of increasingly renewable fuels. 15% of the EU's heat today comes from CHP<sup>1</sup> (850 TWh). The CODE 2 project estimates that this heat volume will increase by around half to 1,264 TWh in 2030. The CHP Roadmap projections estimate that new and upgraded CHP capacity beyond 2012 would further reduce total inland energy consumption by 870 TWh and additionally reduce CO<sub>2</sub> emissions by 350 Mt in 2030<sup>2</sup>.

The roadmaps include separate bio-energy based roadmaps showing that the fuel mix for CHP is shifting to renewable fuels, making innovation and the reliability of these supply chains an important factor for the sector. A micro-CHP analysis for each sector shows the potential to increase micro-CHP in Europe before 2030 in response to industry reducing the product cost to a competitive level.

CHP is embedded across Europe's economy: hospitals, universities, industries, and district heating schemes are providing heat and generating electricity. This guarantees energy savings at the energy network level but does not guarantee a return on investment for the CHP operator. The roadmaps reinforce that the main challenge for CHP remains to achieve a good business proposition for CHP operators.

The roadmaps highlight four major barriers to extending CHP in Europe:

- The electricity and heat markets do not consistently reward CHP for its energy savings at the energy system level. There is a market failure for the CHP operator.
- Regulatory uncertainty arising from the significant changes in recent years in both the electricity market and the energy market make CHP investment high-risk.
- Issues relating to grid connection, network charges, permitting and bureaucracy continue for CHP despite legislation to the contrary since 2004.
- The absence of appropriate consideration of heat in general energy and climate policy hampers CHP, as does the weakening focus on primary energy compared to energy end use in EU energy efficiency policy.

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<sup>1</sup> Source: [EEA based on Eurostat](#)

<sup>2</sup> The entire CHP fleet could deliver in 2030 total primary energy savings and CO<sub>2</sub> reductions of around 1,700 TWh and 685 Mt of CO<sub>2</sub>. For a detailed account of the "substitution methodology" used to estimate these figures, please see Annex I.

All the CODE 2 roadmaps recognise the new policy developments of the European Energy Efficiency Directive (EED). All say that the EED must be rigorously and thoughtfully implemented if the energy savings and CO2 reductions projected for 2030 are to be achieved.

The industry itself is adapting to the demands of a high intermittent renewables electricity grid, and new designs will consider electricity services market participation or sizing for on-site demand. SMEs are encouraged to consider CHP where their heat demand is appropriate and where the electricity market conditions are favourable for a good economic return. For industry and district heating, more needs to be done regarding the policy framework and access to capital in order to deliver the high energy savings these sectors could provide.

Europe is a centre of excellence for CHP, designing, selling and innovating in CHP and its applications. Member states which choose to encourage the development of CHP will benefit from economic stimulus through this knowledge-based industry which currently employs 100,000 people across Europe.



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## The CODE 2 Project: An Introduction

The CODE 2 project is jointly funded by the European Commission under the Intelligent Energy Europe (IEE) programme and by the project partners. Between 2012 and 2014, the project carried out a major market consultation with cogeneration experts in all of the 27 European Union Member States to generate proposals to promote CHP in Europe. The project has prepared 27 National CHP roadmaps and this European Roadmap, and the partner Policy Paper summarises the findings of the individual roadmaps.

The CODE 2 project builds on the experience of the previous CODE project (<http://www.code-project.eu/>).

CODE 2 aims to provide a better understanding of key markets and policy interactions around cogeneration and to accelerate cogeneration's penetration into industry. It specifically considers the opportunity through the implementation of the EU's Energy Efficiency Directive (EED) to promote CHP in member states.

Throughout the period of the project a range of national experts and policymakers in each member state (MS) were consulted. Workshops on CHP and the implementation of the EED were held in Ireland, Poland, Belgium, Slovenia, Germany, Italy and Greece.

The outcome of the expert discussions, workshops and communications in the individual MS may have offered valuable impulses, new ideas and additional considerations to the policy discussions. For example, it is encouraging to see that the policy proposals in the new German CHP study<sup>3</sup> include three of the CODE 2 roadmap's proposals. The project consortium is grateful for such active engagement and exchange with German policymakers in the CODE 2 process.

The roadmap structure used in CODE 2 was developed under the original CODE project and highlights the three key interacting elements of market maturity, awareness of key actors, and policy action. All three of these must work together for the CHP sector to grow.

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<sup>3</sup> Fraunhofer IFAM, IREES, BHKW Infozentrum & Prognos, 2015. [Potenzial- und Kosten-Nutzen-Analyse zu den Einsatzmöglichkeiten von Kraft-Wärme-Kopplung \(Umsetzung der EU-Energieeffizienzrichtlinie\) sowie Evaluierung des KWKG im Jahr 2014.](#)

## Cogeneration: Roadmap for Europe



**Figure 1: The CODE 2 roadmap approach**

CODE highlighted that despite the maturity of CHP technology it is under-represented in many likely channels and enabler groups (such as architects, universities or financial products). CHP manufacturers continue to develop the market and yet investors remain wary of policy change risk. There is a significant amount of national CHP policy in the EU, but this contrasts sharply with the performance of the CHP sector. This suggests that current policy often misses its target to stimulate growth. Both economic and non-economic barriers to CHP growth persist despite being well-known in the sector.

Producing real growth in CHP requires action on three fronts: the market, policy structure, and awareness.

## Chapter 1: Overview of EU Energy and Climate strategy and what CHP brings to these objectives

CHP is a core competence of the European economy. The EU is the market leader and is currently exporting its skills and products globally. Over 100,000 employees work in the CHP sector in Europe and the sector provides knowledge-based, engineering and skills-based job opportunities with a supply chain spreading to SMEs in the engineering, project development, construction and design sectors. Users of CHP help the European Union to achieve its energy and climate change objectives, taking their chance in a turbulent electricity market while managing their core businesses of medicine, food processing, education, space heating or refining, for example. CHP is embedded in the EU's economy today, providing 15% of its heat needs and 11% of its electricity needs.

European legislation has included specific measures to encourage the wider use of high-efficiency CHP in the EU since 2004, when the CHP Directive 2004/08/EC was introduced as a measure for improving security of supply and energy efficiency. The Directive standardised the methodology for calculating the efficiency of CHP plants, allowing high-efficiency plants to be supported by member states only if they could demonstrate real energy savings compared to the separate production of heat and power. In 2012 the Directive 2004 was superseded by the Energy Efficiency Directive 2012/27/EC with specific measures – particularly Articles 14 and 15 – mostly concentrating on the CHP policy environment. CHP is also specifically encouraged within the Energy Performance of Buildings Directive as one of the “high efficiency alternative systems”<sup>4</sup> and is covered by Eco-Design and Energy Labelling legislation as part of space heaters’ delegated regulations (Lot1).<sup>5</sup>

### CHP and primary energy savings

The EU's total thermal energy demand consumes 60% of the primary energy resources in the EU and accounts for around 46% of its final energy use. Out of the total heat demand 42% is in industry, 35% in households and 20% in services<sup>6</sup>. Combining the production of this heat with local electricity generation to meet the on-site need for both heat and power saves around 25% of the primary energy needed. Cogeneration stops the wastage of energy in the electricity process by diverting that waste heat to a useful purpose. A suitably high demand for heat is therefore the first essential element for adopting CHP from an energy efficiency policy perspective. Being able to sell or use the electricity generated at an acceptable price is the second essential element, and

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<sup>4</sup> DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings

<sup>5</sup> Lot1 regulations include Commission Regulation (EU) No 814/2013 and Commission Regulation (EU) No 813/2013 of 2 August 2013.

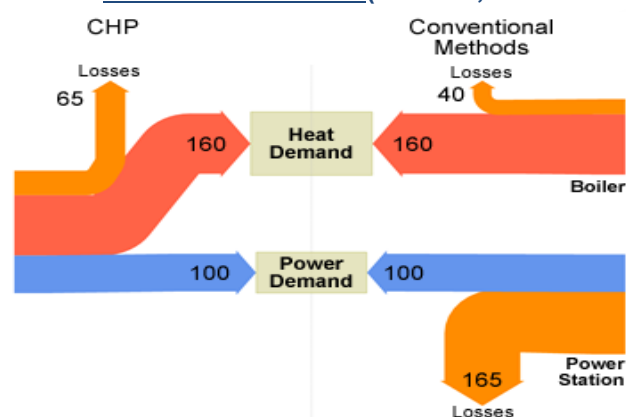
<sup>6</sup> European Commission, 22.06.2011. [European Commission Impact Assessment on the Energy Efficiency Directive SEC\(2011\) 779](#)

this is an economic imperative for the operator.

## Modern CHP saves upwards of 25% primary energy compared to separate production of heat and power

### Schematic representation

Starting with the needs of end-users (citizens, industries, etc..)



• Fuel inputs:  
**325**

vs

**465**

For the same 260 units of energy services



cogeneurope.eu

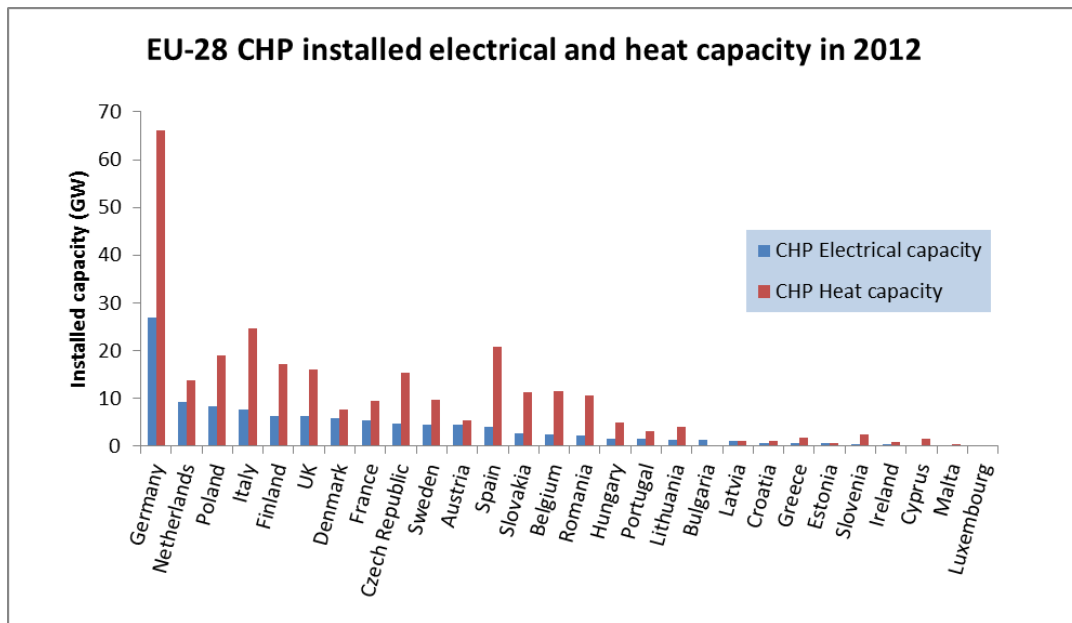
6

**Figure 2: Schematic representation of the difference in fuel inputs (325 to 465 units) in providing the same level of heat and power services to a customer using respectively CHP and separate production of heat and power**

Currently the fuels used in CHP in Europe are: natural gas 48%, solid fossil fuel 21%, renewable fuels 16%, and others 15%. The cogeneration fuel savings occur at the overall energy system level i.e. at the remote site of the separate electricity production which is effectively no longer needed (Figure 2).

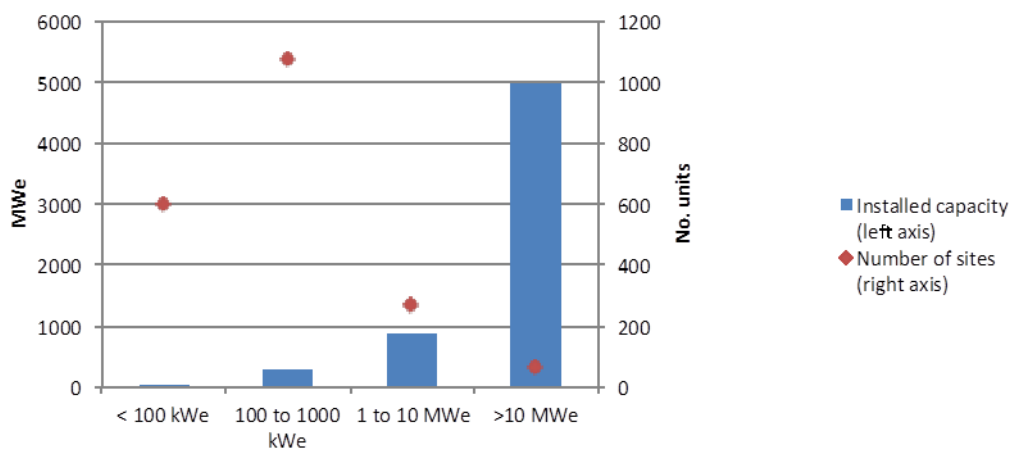
There is currently 109 GWe (2012) of installed CHP electricity capacity in the EU. The penetration of CHP into different member states' electricity and heat supply varies considerably from country to country (Figure 3).





**Figure 3: The installed electrical capacity of CHP in different member states (2012)<sup>7</sup>**

CHP is widespread in Europe’s economy. Sites of several hundred megawatt capacity can be found in industry (refining, chemicals) or in large district heating schemes: these are relatively few in number. The majority of CHP installations by number (Figure 4) are under ten megawatts, serving industrial heat needs in the food or paper sectors or embedded in still smaller heat demands such as hospitals, university campuses or greenhouses. Within the last ten years, manufacturers have brought kilowatt capacity micro-CHP units for individual homes to the market.



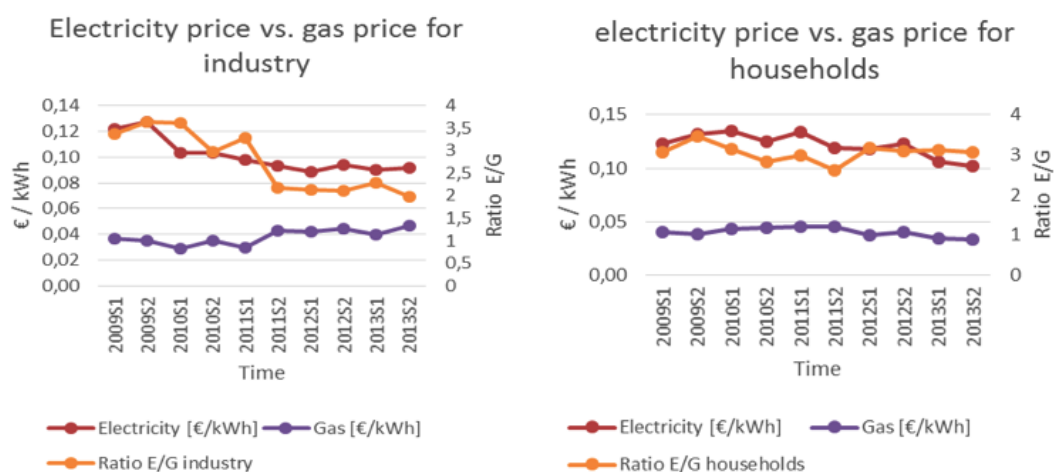
**Figure 4: An example of the range of capacities of CHP in the UK (2013)<sup>8</sup>**

<sup>7</sup> European Commission, 2014. [Eurostat CHP data for 2012](#)

<sup>8</sup> UK Department of Energy and Climate, 2014. [Combined heat and power: chapter 7, Digest of United Kingdom energy statistics \(DUKES\)](#)

## The economics of CHP

The economics of any particular CHP plant depend heavily on the difference between the fuel price the operator pays for the primary fuel and the electricity price which the operator can get (or avoid) for the electricity the plant generates: the so-called 'spark spread'. As a rough guide, if the ratio (electricity price/fuel price) is around 3, then the plant will be economic. If the ratio is less than 2, it will not be. The economics of CHPs are therefore sensitive to changes in both the electricity price and the primary fuel price. The graphs in Figure 5 give an example of the spark spread in Hungary between 2009 and 2013 on both the wholesale and the retail markets.



**Figure 5: Examples of the differences between gas and electricity prices affecting CHP operators in Hungary.**

At the time of writing, the EU is experiencing a period of particularly difficult spark spread challenges for CHP operators using gas. Low wholesale electricity prices have coincided with relatively high gas prices. As a result, large CHPs in many member states are either running at part-capacity or have been switched off altogether. As many of these plants were built in the late 1990s, they are close to reinvestment decisions.

The joint impact of changes in global energy prices on the one hand and shifts in the wholesale electricity market on the other precisely pinpoints the difficulties of CHP operators working across two separate markets and products with considerable exposure to both. The choice of reinvesting in CHP will be looked at very closely against a background of uncertain electricity market prices and market structures combined with regulatory risk.

## Chapter 2: Summary of the CODE 2 European Roadmap findings

### Regional Summary for the CODE 2 Project North-Western Europe Region

Belgium (pilot), Ireland (pilot), Luxembourg, Netherlands and United Kingdom

#### 1) Overview of current situation in member states in North-Western Europe CODE 2 Region

The Netherlands has the largest share of electricity produced by CHP, with 33%. Belgium and Luxembourg each have a share of 12% and the United Kingdom and Ireland only 6%. In all member states, the share of CHP is flat or decreasing despite the shortage of electrical capacity in the United Kingdom and Belgium.

Belgium, the Netherlands and the United Kingdom have a large share of industry where steam is an important energy carrier, such as oil refineries, chemicals, pulp and paper, and food and beverages. Within those sectors, where steam is dominant, there is a large potential for CHP. This is less the case for Ireland. Luxembourg has a relatively large iron and steel industry, with electric arc furnaces, which decrease the potential of CHP. District heating is not widespread.

Three of the five member states (Belgium, the Netherlands and Luxembourg) are located within the CWE electricity market, where the electricity price is mainly determined by the marginal cost of coal power plants. This results in a low spark spread for CHP. This is also true for the United Kingdom. On the other hand, in Ireland, more than half of the electricity is produced by gas, which results in a more interesting spark spread.

## 2) Summary of national roadmaps grouped by CODE 2 regions:

Member state	Belgium	Netherlands	United Kingdom	Ireland	Luxembourg
Where we are	Flat	Declining	Flat	Flat	Flat
MS (electrical) potential	21 TWh	68 TWh	81 TWh	3,6 TWh	2,3 TWh
What could be achieved in 2030 (CODE 2 Roadmaps) <sup>9</sup>	Electricity: 23 TWh/a 98% growth PES: 18,7 to 22,9 TWh/a CO2 reduction: 2,3 to 8,1 Mton/a	Electricity: 71 TWh/a 26% growth PES: 42 TWh/a CO2 reduction: 12-15 Mton/a	Electricity: 81 TWh/a 145% growth PES: 86 TWh/a CO2 reduction: 10-14 Mton/a	Electricity: 7 TWh 233% growth PES: 18,7 to 22,9 TWh/a CO2 reduction: 2,3 to 8,1 Mton/a	Electricity: 2,6 TWh 575% growth PES: 4,5 TWh/a CO2 reduction: 1,8 Mton/a
Barrier 1* (economic and non-economic)	The current low spark spread.	The current low spark spread.	The current low spark spread.	Current policy structure is not providing realistic barrier removal or support for CHP.	Since a large share of electricity is currently imported, an increase in electricity generated in small Luxembourg CHP plants would increase the national emissions with the risk of missing several climate and energy targets.
Barrier 2	No targets are set for CHP	Lack of appropriate financial support for CHP	Lack of appropriate financial support for CHP	The current low spark spread	The current low spark spread

<sup>9</sup> PES and CO2 emission reductions refer to further savings from the new CHP plants compared to the existing installed fleet in 2012.

<b>Barrier 3</b>	Policies and support are changing and complex, resulting in insecurity.	The policy focus on final energy consumption instead of primary energy consumption, leaving out efficiency gains in the transformation sector.	The investor uncertainty issues related to renewable heat and electricity support.	Awareness is lacking within several socio-economic groups.	The abolition of operational support for new CHP installations.
<b>How do we get there**</b>	A large CHP potential exists for SMEs with interesting heat profiles e.g. car washes, nurseries, hotels.	There is still a large potential for CHP in industry but with the current low spark spread, it will not be easy to activate this. Besides this, there is still potential for small-scale CHP in SMEs and in the healthcare sector.	There is a large market opportunity for CHP in the services sector with high and constant heat demand.  Furthermore, a further increasing share of renewable sources used in CHP is expected. Heat networks fuelled by CHP have a large potential in cities.	A significant CHP potential still exists in the industrial sector, the services sector and commercial sector.	A significant potential in district heating could be activated if the necessary barriers are removed.
<b>Barrier removal 1*</b>	Stimulating a continuous dialogue between the policy level and the CHP sector to keep the role of CHP in a continuously evolving energy scene up to date.	Improve the EU emission trading system (ETS) at the European level or introduce a CO2 tax on energy.	Strengthening the EU emission trading system (ETS).	Building a policy vision for CHP.	Eliminating the disadvantage for CHP as result of the shift of emissions from foreign power plants to local CHP plants.

<b>Barrier removal 2</b>	Setting (binding) CHP targets	Reinstating financial support for high-efficiency CHP.	Developing a coordinated government approach to total energy delivery.	Removing policy barriers	Integrating the Luxembourg gas market with other national gas markets
<b>Barrier removal 3</b>		Focusing on a reduction of primary energy consumption instead of final energy consumption would stimulate energy efficiency gains by electricity production.	Performing an assessment of the high-efficiency CHP and efficient district heating potential.	Improving economic viability of CHP projects	Rewarding the benefits of cogeneration with operational support

\*(include market sector comments with barriers)

### 3) How to move to growth for CHP:

The major barrier in all member states within this region is the weak business case for CHP. This is due to a combination of reasons:

- High gas prices and low electricity prices (low spark spread)
- Low economic value of primary energy savings and/or carbon emissions savings
- Investors demand high returns for investments such as CHP which are non-core activities:
  - Uncertainty in investment climate due to low economic growth.
  - Uncertainty in the energy markets (as a result of energy market liberalisation).
- Most member states (except Belgium) are reducing financial support for fossil CHP due to the negative impact of CHP on emission targets.
- Overcapacity in case of the Netherlands.

Opportunities are located in:

- Smaller CHP installations (50 kWe – 1 MWe) in applications with a high amount of hot water and electricity like hospitals, homes, leisure centres, etc. These kinds of application typically have higher electricity prices than the energy intensive industry.
- Bio-CHP: most member states still provide financial support for renewable energy, including bio-CHP.



## Regional Summary for the CODE 2 Project Northern Europe Region

Germany (pilot), Austria, Denmark, Finland, Sweden

### 1) Overview of current situation in member states in Northern CODE 2 Region

All the countries in the group differ in their approaches to CHP and their energy history.

Germany's energy history is mainly determined by huge own hard coal and lignite reserves which have dominated electricity production for a long time and are partly still doing so. Nuclear power has also been developed, but will be terminated up to 2023. On the other hand electricity from RES has strongly developed in the last decade. District heating has been developed mainly in major cities and has a medium share in total heat supply, whilst industrial CHP is relatively well developed.

Austria and Sweden have huge hydropower resources. Sweden has also developed nuclear power but has recently decided to get out. Finland still relies on nuclear power, but huge wood energy resources have also been developed. Austria and Denmark have renounced nuclear power. All Scandinavian countries have extensive district heating networks but only Denmark and Finland's have high CHP shares, whilst Sweden's CHP share is relatively low.

Austria has a medium CHP share in electricity production. With the exemption of Germany, which aims to develop its CHP share in total electricity production from 16% currently to 25% up to 2020, none of the countries in the Northern Region have CHP development plans or even targets.



## 2) Summary of national roadmaps grouped by CODE 2 region:

Member state	Germany (pilot)	Austria	Denmark	Finland	Sweden
Where we are	Growing	Flat	Flat	Flat	Growing
MS potential (TW/h of electricity)	351	59 (technical potential)	21	36.8 (2020)	36 (2020)
What could be achieved (CODE 2 Roadmaps) <sup>10</sup>	2030: 185 TWh/a CHP % GROWTH: 98% CO <sub>2</sub> red.: 104 to 123 Mt/a PES: 202/ 203 TWh/a	2030: 29 TWh/a CHP % GROWTH: 32% CO <sub>2</sub> red.: 8 to 9 Mt/a PES: 16 to 17 TWh/a	2030: 21 TWh/a CHP % GROWTH: 10% CO <sub>2</sub> red.: 3 to 4 Mt/a PES: 5 to 6 TWh/a	2030: 39 TWh/a CHP % GROWTH: 50% CO <sub>2</sub> red.: 17 to 21 Mt/a PES: 29 to 30 TWh/a	2030: 40 TWh/a CHP % GROWTH: 142% CO <sub>2</sub> red.: 2 to 3 Mt/a PES: 52 to 53 TWh/a
Barrier 1* (economic and non-economic)	Low wholesale electricity market prices impede investments in new large gas CHP plants and even threaten the continued operation of existing CHP plants	Low wholesale electricity market prices impede investments in new large CHP plants and even threaten the continued operation of existing CHP plants	Low wholesale electricity market prices impede investments in new larger natural gas-fired CHP plants and even threaten the continued operation of existing gas CHP plants	Low wholesale electricity market prices impede investments in new large CHP plants and even threaten the continued operation of existing CHP plants	General lack of awareness of the important role of CHP for an efficient sustainable use of energy resources
Barrier 2	Deficits in information and knowledge of CHP	Deficits in information and knowledge of CHP	Uncertainty of economics of CHP investments due to capacity payments expiry in 2017 is creating reluctance to invest	Growing competition of electric heat pumps in areas suitable for DH worsens the economics of DH	Low electricity market prices impede investments in new CHP plants

<sup>10</sup> PES and CO<sub>2</sub> emission reductions refer to further savings from the new CHP plants compared to the existing installed fleet in 2012.

Member state	Germany (pilot)	Austria	Denmark	Finland	Sweden
<b>Barrier 3</b>	Current regulatory environment (tenancy law, property law, rules for connection to the electricity network, network fees, income and sales taxation) hinders the deployment of CHP	Inhibiting regulatory environment impedes CHP development in on-site installations	The energy taxation system discriminates against natural gas CHP.	The new energy taxation from 2011 weakened the competitiveness of district heating.	
<b>How do we get there** (Name economic sectors with best prospect , innovation needed , fuel changes needed industry changes)</b>	CHP deployment in DH, small & medium-sized industry, room heating market outside DH; modernisation of old coal-fired CHP in DH and industry, further development of bio-CHP	CHP development in DH, small & medium-sized industry, room heating market outside DH; development of more efficient conversion technologies for bioenergy particularly in paper industry	Modernisation or replacement of old CHP by new CHP with higher efficiency; promotion of small-scale CHP; realise potentials in industry and the commercial sector.	Modernisation or replacement of old CHP with new CHP with higher efficiency; realise potentials in industry and the commercial sector; development of more efficient conversion technologies for bioenergy, particularly in paper industry	
<b>Barrier removal 1*</b>	Support CHP investments with payments for security and flexibility of electricity supply; support bio-CHP via additional payments for decarbonisation	Creation of a working group on CHP under the guidance of the federal government, with a view to tabling precise proposals based on their suggestions.	Consider suitable instruments to encourage investments in new CHP and modernisation or replacement of old CHP and to make the CHP share in DH production independent from	Consider suitable instruments to make investments in new CHP and modernisation or replacement of old CHP and the CHP share in DH production independent from	Consider suitable instruments to increase the CHP share in district heat production.

Member state	Germany (pilot)	Austria	Denmark	Finland	Sweden
			power exchange prices.	power exchange prices.	
<b>Barrier removal2</b>	Launch a long-term information campaign, encourage and support formation, certification and accreditation schemes	Improvement of economic conditions of CHP by state support payments.	Revision of the energy taxation system with the aim to encourage natural gas CHP	Examine possibilities of better interaction between CHP and heat pumps.	Consider suitable instruments to make investments in new CHP and modernisation or replacement of old CHP independent from power exchange prices.
<b>Barrier removal 3</b>	Municipalities should be obliged to carry out local heat concepts	Launch of a long-term information campaign on CHP; training programmes for professionals.	A subsequent regulation of capacity payments after 2017 should be decided as soon as possible	Support for CHP implementation by ESCOs	Support the development and market introduction of biomass gasification for use in CHP
	Third party implementation of CHP by ESCOs should be supported	Obligation for municipalities for local heat and cold concepts.	For use of bio energy enduring and reliable sustainability criteria should be decided.	Support for development of efficient biomass gasification technologies, particularly black liquor and solid biomass gasification	Strengthen the implementation and operation of CHP by energy service companies (ESCOs)
	CHP regulatory environment of CHP	Support for CHP implementation by	Support for CHP implementation by	DH supply companies to review their tariff	



Member state	Germany (pilot)	Austria	Denmark	Finland	Sweden
	should be systematically adapted	ESCOs	ESCOs	system aiming to amend attractiveness of connection.	
		Support for development of efficient biomass gasification technologies.	Support for development of efficient biomass gasification technologies.		
		Systematic adjustment of the regulatory environment for CHP.	Promotion of electric heat pumps in combination with district heating and small-scale CHP.		



### **3) How to move to growth for CHP:**

Keeping CHP's benefits visible in the energy policy agenda at both the EU and MS level is important if policy action is to result; MS implementation of the CHP measures in the EED is an immediate opportunity therefore to encourage investments in highly efficient and flexible CHP plants. The EED provides a policy framework for member states to support CHP systems; strengthen information on CHP and its opportunities; support know-how building for professionals (planners, consultants, installers); and encourage CHP implementation by ESCOs.

To achieve the EU's Third Energy Package and long-term energy and climate policy objectives, the current lack of price signals for long-term investment in high-efficiency, low-carbon dispatchable power must be addressed at the EU level through improved electricity market design/operation. The European Commission consistently supports CHP; however, it has failed with the 2004 Directive to achieve the targeted efficiency gains through CHP. Should there be similarly poor progress with the EED, the EU should consider a special communication on CHP to reinforce and improve the EED provisions. Try and strengthen the ETS, e.g. via minimum CO<sub>2</sub> prices, or alternatively CO<sub>2</sub> taxation.

## Regional Summary for the CODE 2 Project Eastern Region

Slovenia (pilot), Poland (pilot), Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovakia.


### Key regional challenges:

- **How to finance support schemes** in the current unfavourable energy market: CHP needs a rather high level of support and as a consequence there is huge pressure on final electricity sales prices from the plants, bringing resistance especially from industrial consumers.
- **State aid compliance** – several ongoing notification procedures within DG Competition are currently increasing uncertainty for CHP support in the future.
- **Security of natural gas supply** – huge dependence on imported natural gas from Russia linked to high prices and uncertain supply require solutions to reduce energy dependence, including completion of plans for electricity and gas network connections.
- **Future competitiveness and economic operation of district heating systems** is a key precondition for the future of the majority of current CHP capacity in the region.
- **Small-scale CHP is not yet in the policy focus** of several Member States in the region.
- **Lack of investment capital resources** especially in industry and SMEs.

### 1) Overview of current situation in member states in Eastern CODE 2 Region

Cogeneration is a traditional approach among Eastern Region EU member states, resulting in an above EU-28 average share of CHP in electricity generation (except Estonia and Slovenia with lower shares). Except Hungary, all MS have a positive or stable cogeneration development trend as a result of operational government incentive support schemes. Almost all support schemes are in a transitional period, modified in accordance with state aid regulation or due to a lack of financial resources.

District heating is the major cogeneration sector in all Eastern Region member states. Coal is the dominant fuel in Poland, Czech Republic, Slovenia and Estonia (oil shale) whereas in other MS natural gas is used. Presence and future plans on nuclear energy play an important role in the energy strategies in the Czech Republic, Hungary, Lithuania, Slovakia, and Slovenia. High import dependency



(Lithuania and Latvia) of natural gas from Russia tends towards a future strategic reduction of natural gas consumption and the development of renewables-based cogeneration. The goals to increase energy independence and security of energy supply required by national security do not include further development of natural gas-fuelled CHP in the Baltic region. Small-scale CHP is well-developed in the Czech Republic, Slovakia and Slovenia, whereas in other MS development is very limited as support schemes are mainly focused or restricted to district heating CHP plants.

## 2) Summary of national roadmaps grouped by CODE 2 region:

Summary of position of CHP in Eastern Region member states

Member State	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia	Slovenia
Where we are	Flat	Growing	Declining	Growing	Growing	Growing	Flat	Growing
MS potential (TW/h of electricity)	18 TWh	1.5 TWh	8 TWh	4.3 TWh	5.1 TWh	48 TWh	6.4 TWh	3.9 TWh
What could be achieved (CODE 2 Roadmaps) <sup>11</sup>	16 TWh 26% CHP el. in final el. demand 6 MtCO <sub>2</sub> 12 TWh PES	1.8 TWh 16% CHP el. in final el. demand 1 MtCO <sub>2</sub> 1.4 TWh PES	16 TWh CHP 100% GROWTH 2 MtCO <sub>2</sub> 16 TWh PES	3.9 TWh 40% CHP el. in final el. demand 0,5 MtCO <sub>2</sub> 1 TWh PES	4.2 TWh 32% CHP el. in final el. demand 1.2 MtCO <sub>2</sub> 2.4 TWh PES	48 TWh 22% CHP el. in final el. demand 30 MtCO <sub>2</sub> 47 TWh PES	6.1 TWh 16% CHP el. in final el. demand 2.3 MtCO <sub>2</sub> 5.3 TWh PES	3.7 TWh 23% CHP el. in final el. demand 2.7 MtCO <sub>2</sub> 5.6 TWh PES
Barrier 1* (economic and non-economic)	Unreliable long-term support framework	Unfavourable energy market conditions	Lack of a proper CHP policy and support leaves market imperfections unaddressed	End of existing CHP support scheme in 2017	High investment costs of RES CHP and lack of financial resources.	Unstable legal framework for CHP	Weak competitiveness of district heating systems	Uncertain CHP support scheme
Barrier 2	Weak competitiveness of district heating	Lack of own financial resources in industry	High gas prices combined with low	Unfavourable energy market conditions	Unfavourable energy market conditions	CO <sub>2</sub> and other environmental costs	Unfavourable energy market conditions	Non consistent measures and local energy

<sup>11</sup> PES and CO<sub>2</sub> emission reductions refer to further savings from the new CHP plants compared to the existing installed fleet in 2012.



	systems		wholesale electricity prices result in low profitability for the electricity produced by CHP.					planning destroying the potential for cogeneration
<b>Barrier 3</b>	A complex legal framework for CHP	Frequent changes in CHP support framework	Nuclear power is being promoted by Hungary as a means of reducing CO2 intensity.	Lack of own financial resources of local governments	Uncertain new energy goals due to on-going review of the National Energy Strategy of Lithuania	Lack of competitiveness of district heating systems	Complex administrative procedures	Lack of private investment funds in industry and SMEs
<b>How do we get there**</b>	District heating, Industry and Services. Partial switch from coal to use of RES and natural gas.	District heating, Industry, Services. Dominant use of RES, especially wood biomass,	Key proposal is to take the obligations resulting from the EU Energy Efficiency Directive and to renew CHP policy, removing existing indirect	District heating, Services, limited Industry. Dominant use of RES, especially wood biomass.	District heating CHP plants on RES and waste. Gradual development of small-scale CHP in industry services.	District heating, Industry, Services. Dominant share of wood biomass and biogas.	District heating, Services and Industry	Industry, district heating, services and households. Prevailing use of natural gas, up to 20% biomass.

			barriers and compensating as far as possible for market failures. Growth expected for local bio-CHP.					
<b>Barrier removal 1*</b>	Establishing long term stable, incentive and predictable legal framework for CHP	Preserving long term stable, incentive and predictable legal framework for CHP	Adopt policies which encourage cogeneration	Introduction of proper market oriented instruments to preserve the existing new CHP plants after the stop of the support in 2017.	Providing adequate EU funds and preserving long term stable, incentive and predictable legal framework for CHP	Establishing long term stable, incentive and predictable legal framework for CHP	Establishing long term stable, incentive and predictable legal framework for CHP	Fast approval of the new support scheme and providing stable CHP support
<b>Barrier removal 2</b>	Intensify the support for increasing competitiveness of the district heating systems	New incentives to empower CHP position on the energy market	introduce a CO2 - tax on energy	Establishing the long term stable and predictable CHP support for new renewable and small scale units.	New incentives to empower CHP position on the energy market	Providing support for increasing competitiveness of the district heating systems	Intensify the support for increasing competitiveness of the district heating systems	Establishing sustainable heating and cooling planning
<b>Barrier removal 3</b>	Fast and	Fast and	Put overall	Continuation	Setting of	Enforcing the	Fast and	Simplification

	quality implementation of EED.	quality implementation of EED.	efficiency and/or emission requirements on power and heat generation.	of investment subsidies for increasing efficiency of district heating systems and investments in RES CHP.	clear quantitative goals for cogeneration in the reviewed National Energy Strategy	local energy planning.	quality implementation of EED.	and unification of network connection rules.
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### 3) How to move to growth for CHP:

Current unfavourable energy market conditions are a key barrier for future CHP development without there being additional policy support in place. Preserving or establishing stable, predictable incentive support in accordance with state aid guidelines and member-state energy and climate objectives is the key challenge in almost all MS in the region.

The lack of member-state financial resources for support schemes is a key barrier and most often the reason for the reduction even of successful support instruments. A gradual introduction of additional market incentives for CHP to provide ancillary services to the electricity network and demand response could improve the current disadvantageous market position of CHP plants, especially of medium and small-scale CHP units, which are not yet supported in several MS. There is a clear positive turn toward renewable cogeneration, although at least limited support should be maintained for efficient recent fossil-fuelled CHP plants, where the integral implementation of new EU transmission infrastructure for diversification of the natural gas supply is crucial to reducing the current huge dependency and risks for the supply of natural gas from Russia.

Investment subsidies from EU structural funds for the energy retrofit of existing district heating systems are potentially a very important instrument used in several MS in the region to increase the efficiency and competitiveness of district heating compared to other heating alternatives. Similarly, investment subsidies for switching from fossil fuels (mainly coal; in Baltic states natural gas too) to renewables enable faster environmental retrofit of existing old CHP units and sustainable growth of cogeneration. The future economic operation of district heating systems is crucial for the majority of the existing CHP capacity in the region.

Lack of investment resources and difficulty accessing affordable funds are serious barriers for industry and SMEs in the current unstable economic situation. Faster development of ESCO service offerings and specific financial products for cogeneration could significantly ease this problem in those MS where the ESCO market is still at an early stage and suitable finance is lacking.

Fast and rigorous implementation of the EED could significantly contribute to:

- more consistent local heating planning and the setting of accurate priorities in heat supply based on a comprehensive assessment and cost benefit analysis;
- standardisation and simplification of network connection procedures and standards, especially for small-scale and micro-CHP units, where simplification and reduction of costs is an important factor to increase their competitiveness, and;
- faster access for CHP plants to the ancillary services market and demand response and the design of these markets to allow the full participation of non-utility (electricity-only generators) such as CHP.

## Regional Summary for CODE 2 Project South-West Europe Region

Italy (pilot), France, Malta, Portugal, Spain

### 1) Overview of current situation in member states in South- Western CODE 2 Region

These member states share broadly similar climate and space heat demands. However, the MS are diverse in terms of industrial development, energy history, resources and CHP adoption. Italy and Spain – and to a lesser extent Portugal – have historically strong development of cogeneration in industrial applications. Italy has maintained the position of CHP in several sectors and the future of cogeneration is tied to good implementation of the Energy Efficiency Directive and to ongoing economic demand. CHP in Spain and Portugal has suffered a critical decline since 2008 due to a combination of economic recession and major adjustments to support measures in the electricity sector.

France in the last 30 years has chosen to follow nuclear energy. Currently biomass CHP is the single CHP growth sector.

As an island with a mild climate and specific energy challenges Malta has not yet developed cogeneration stock for either space heating or industry. However, applications in tourist/ tertiary segments may exist.

## 2) Summary of national roadmaps grouped by CODE 2 Region:

Member state	Italy	France	Malta	Portugal	Spain
Where we are	Flat	Decline	Flat	Decline	Decline
Electricity Potential (TWh) 2030	56.736	22.752	0	7.041	30.118
What could be achieved (CODE 2 Roadmaps) <sup>12</sup>	2030: +35% capacity /2010 58,1 TWh/a elet prod PES -140 TWh/a CO2 -36 Mton/a	2030: +40,4% capacity/2010 22,7 TWh elet prod PES -83 TWh/a CO2 -34 Mton/a	2030: +7% capacity/2010 0,49 TWh elet prod PES -4,3 TWh/a CO2 -1,4 Mton/a	2030: +17,3% capacity/2010 7,0 TWh elet prod PES -30 TWh/a CO2 -10 Mton/a	2030: +78% capacity/2010 30,1TWh elet prod PES -3 TWh/a CO2 -2 Mton/a
Barrier 1* (economic and non-economic)	Regulation inertia and complexity and lack of strategic focus	Electrical energy overcapacity, determined by nuclear and hydro generation	Lack of consistent heat demand for space heating and hot water	Regulated electricity tariffs do not take into account avoided network and fuel costs	High tax system on gas and power generation together with subsidy reduction
Barrier 2	Network costs charged on self-produced energy	Low grid power price and low CO2 credit price	Strong competition with other RES technologies	Connection costs to gas grid	Present overcapacity due to decreasing heat demand and electricity generation from RES
Barrier 3	WhC, even if valid support scheme, is too articulated and complex esp. for SMEs	Energy efficiency of CHP is not sufficiently recognised in energy markets	Absence of gas distribution grid	High gas and oil fuel prices	Energy saving and environmental benefits are not recognised
How do we get there**	Propose concrete and focused measures to	Support CHP in new legal framework	Support CHP policies and incentives	A global vision of CHP within energy	Rapid inversion in the energy policy strongly

<sup>12</sup> PES and CO2 emission reductions refer to further savings from the new CHP plants compared to the existing installed fleet in 2012.

	overcome inertia and cumbersome legislation, getting a feasible level of acceptance.	defining clear and stable national energy investment scenario	schemes within a general energy plan	challenge is required, supported by adoption of EED	required, reconsidering tariffs and taxation
<b>Barrier removal 1*</b>	Stabilise permitting procedures and shorten times	Define investment scenario (connectivity, incentives, taxation)	support incentive scheme prizing energy saving performance	Provide immediate stability through incentives and taxation	Differentiation between CHP and other RES regulation
<b>Barrier removal2</b>	Redefine parameters in WhC to reduce investment return payback and simplify calculation	Renovation and revamping of present CHP installation	Support completion of NG distribution network	Moving resources focusing on CHP technology applied to sectors with potential growth	Review remuneration scheme to allow economically viable operations
<b>Barrier removal 3</b>	Modification of SEU configuration to allow one-to-other connections favouring m-CHP	Support growth of biomass CHP	Optimise procedure for grid connection, especially for small installations	Differentiate CHP plants from others in Special Regime	Incentive schemes based on primary energy saving and CO2 reduction

### **3) How to move to growth for CHP:**

The common theme through practically all the member states is that the economic crisis has increased uncertainty of investments, due to a fall in industrial heat demand. Inadequate policy responses regarding tariffs, taxation and incentives have rapidly produced a non-profitable position for operating CHPs on gas. At the same time there is a general overcapacity in the electrical system (in Italy it exceeds 50%) caused by a reduction in energy demand and by the powerful entry of some renewable energy sources.

While new regulation of the legal framework, led by the implementation of the EED, is generally felt by the CHP sector to be a premise to pump new life into the industrial cogeneration sector, other sectors like micro-/small-scale cogeneration, domestic and tertiary, district heating, and gas or biomass-fuelled CHP may be able to offer quicker paths to create a shift under the current financial and electricity market conditions compared to traditional cogeneration applications.



## Regional Summary for the CODE 2 Project South-East Europe Region

Greece (pilot), Bulgaria, Cyprus, and Romania.

### 1) Overview of current situation in members states in South- Eastern CODE 2 Region

In Bulgaria and Romania – two member states with a history of planned economies until 1990 – CHP developed in connection with district heating systems and for heavy industrial purposes. These fell into decline for a period but the CHP sector has been gradually growing, especially in industry. In Greece, CHP is still in slight decline and the most notable applications can be found in the agricultural and industrial sectors. In Cyprus, the development of CHP projects started after the transposition of the CHP Directive (2004/8/EC) with biogas as fuel.

The only partial liberalisation of gas and electricity markets creates further obstacles to further integration in these countries.

Regarding their respective energy mix, consumption patterns, level of liberalisation and resource potentials, the region faces three major common energy challenges:

- Over-dependence on using oil and coal for electricity generation;
- almost total dependence on hydrocarbon fuel imports that are necessary to meet domestic demand, except for Romania, which has a relatively low dependence, and;
- sharp increase in RES penetration, especially PV, in the energy and electricity mix of the region, over the past five years, particularly in Greece and Bulgaria, with legal and financial implications for investors.

## 2) Summary of national roadmaps grouped by CODE 2 regions:

Member state	Bulgaria	Cyprus	Greece	Romania
Where we are	Slightly declining	Slightly growing	Decreasing	Increasing
MS potential (TW/h of electricity)	9.7	0.07	2.47	11.93
What could be achieved by 2030	13.3	0.12	4.95	18.4
CHP %	42.90%	61.20%	54.40%	53.50%
GROWTH PES	20.82 to 10.4	0.3 to 0.027	5.32 to 2.15	25.6 to 12.8
CO2 reduction Mtoe <sup>13</sup>	7.91 to 4	0.15 to 0.02	2.31 to 0.93	9.73 to 4.9
Barrier 1* (economic and non-economic)	Unfavourable energy prices for high capital investment	All fuels are imported – Absence of natural gas	Low electricity pricing for all sectors and one of the highest gas prices in EU	Characterisation of all CHP units as high-efficient ones, under current situation
Barrier 2	The role of existing political environment and of bureaucracy in the promotion of CHP; Relatively limited funds for energy efficiency measures	Difficulties occurring as the country moves from an island-mode energy market to a liberalised one and the implementation of Electricity and Heat Policies	The role of existing political environment and of bureaucracy in the promotion of CHP – No stable policy towards CHP as no long-term energy policy	Lack of specific national targets regarding development of CHP- Complicated support schemes - No support mechanisms to encourage small-scale and micro-CHP

<sup>13</sup> PES and CO2 emission reductions refer to further savings from the new CHP plants compared to the existing installed fleet in 2012.

<b>Barrier 3</b>	Heat trading in the district-heating sector	Electricity market prices and F-i-Ts impede investments in new HECHP plants	No consideration for micro & small-scale CHP	Aged district heat networks, many of them connected with CHP units
<b>How do we get there**</b>	Industry / DHS Biofuels	Tertiary/DCHS NG required	Tertiary/DCHS Biofuels	Industry/DHS Biofuels
<b>Barrier removal 1*</b>	<i>"The obligations resulting from the EU EED should be taken as an impulse for reviewing the CHP policy" is a common barrier removal for all MS in the SEE region</i>			
<b>Barrier removal2</b>	Making authorisation procedures simpler and faster could increase interest in CHP – developing a secure investment environment with no changes of Energy Laws for at least five years	The government should consider revising the existing licence policy, in order to make new investments in new CHP more appealing – boost development of a new support mechanism for cogenerators, using different types of fuel	Making authorisation procedures simpler and faster could increase interest in CHP – the Government should consider revising the existing licence policy especially for micro-scale	The government should revise the existing policy of all CHP units to be considered as “high-efficient” – to revise the existing permit policy, to eliminate bureaucracy – to introduce a new support mechanism for CHP of up to 1 MW <sub>e</sub> , (micro- & small-scale)

**Barrier removal  
3**

New updated Heat law, which will include the improvement of existing heat tariffs in a more applicable way for customers – grants for improving ageing DHS, and the introduction of biomass as fuel.

Government and local Energy Agencies should boost a new awareness campaign for further penetration of cogeneration and trigeneration in Cyprus

New tariff system for HECHP – Overpass of old and outdated policies by the state regarding the promotion of CHP – targeted awareness campaign at state officials for the benefits of CHP

Implementation of a targeted action plan for improving the operation of existing ageing DHS, strengthened the possibilities for new CHP units

### 3) How to move to growth for CHP:

The transposition of the 2004/8/EC Directive for HE CHP gave a boost to the promotion of CHP in all MS, especially in Cyprus, where it gave an impulse for the first CHP units with biofuel/biogas in the agricultural sector.

The Energy Efficiency Directive represents an opportunity for MS in the CODE 2 SEE region to review CHP policies. MS in the SEE region should pay particular attention to thoroughly implementing the EED requirements of Article 15, and of Article 14 where a “comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling” and a territory level cost-benefit analysis based on socio-economic and ecologic criteria are required.

The further development of industrial CHP in Romania and to some extent Bulgaria requires more pronounced economic activity in general plus active policy action to remove key barriers to CHP growth. Investment in the renovation and upgrade of District Heating is a significant concern. In Greece and Cyprus, industrial cogeneration can be an asset, but the promotion of CHP should primarily target the tertiary and agricultural sector, as tourism is a major economic sector. The promotion of CHP in these sectors should thus aim to increase penetration of tri-generation, allowing CHP units to operate for more than 7,000 hours annually.

## Chapter 3: A CHP roadmap for Europe

DG Energy's expectation for CHP growth is reflected in its PRIMES modelling of EU Energy, Transport and GHG emission trends to 2050 (Reference scenario 2013)<sup>14</sup>. The scenario includes the expected impacts of the EED and estimates that 15.8% of Europe's electricity will be generated in CHP mode by 2020 and 16.1% by 2030. DG ENER proposes that the EED can stimulate this moderate CHP growth, overcoming the very flat overall installation performance for additional CHP in Europe since 2004.

DG Energy projects growth for CHP to 2030 and suggests that it will reach 15.8% of Europe's delivered electricity in 2020 and 16.1% in 2030. The projections of the CODE 2 roadmap (Table 1) suggest that CHP will have grown to 20% of delivered electricity.

<b>EU totals from CODE 2 roadmaps<sup>15</sup></b>	<b>2030</b>
EU Total CHP Heat Delivered (TWh) <sup>16</sup>	1260
EU Total CHP Electricity Delivered (TWh)	750
EU Total Electricity Delivered (TWh)	3650
PES (TWh)	870
CO <sub>2</sub> savings (Mt)	350

*Table 1: Summary of EU-level findings of the CODE 2 CHP roadmaps*

The collective impact of the CODE 2 roadmaps would be to deliver up to 750 TWh of high-efficiency CHP electricity in 2030. The CODE 2 project estimates that heat delivered by CHP will increase by around a half, to 1,264, between 2012 and 2030<sup>17</sup> TWh. The lack of a strong distributed generation-oriented market model for electricity and the absence of supporting public policy make reaching DG Energy's 15.8% CHP in electricity generation by 2020 very unlikely. The CODE 2 roadmaps recognise that to reach the projected 2030 level, the EED and its revisions must radically improve the policy environment around CHP in order to kick-start growth.

CODE 2 recognises the potential of the measures included in the Energy Efficiency Directive to increase the deployment of CHP, thus providing the EU with tangible primary energy savings, fuel import reductions and CO<sub>2</sub> reductions. But achieving the CHP potentials described in the CODE 2 roadmaps

<sup>14</sup> European Commission, 2013. [EU Energy, Transport and GHG emission trends to 2050 \(Reference scenario 2013\)](#)

<sup>15</sup> PES and CO<sub>2</sub> emission reductions refer to further savings from the new CHP plants compared to the existing installed fleet in 2012.

<sup>16</sup> Average 0.6 power to heat factor was used, higher than 0.44 average factor in 2012 due to expected CHP technology improvements.

<sup>17</sup> 15% of the EU's heat today comes from CHP (850 TWh).

requires rigorous and thoughtful implementation of the EED provisions in all member states as a pre-cursor of significant growth. The experience with the 2004 CHP Directive, which was framed in a very similar way to the EED (study >reveal the potential >MS recognise potential >MS act on the potential), is that implementation of EU legislation at member-state level is slow, selective and heavily driven by the country's energy history. The lesson from the original 2004 Directive is that it will take considerable effort from all industry, market and policy actors if the EED is to receive rigorous and thoughtful implementation.

### What sectors of the CHP market could respond rapidly to actions on Market and Awareness?

There are currently clear 'hot spots' where CHP today is an attractive investment due to a combination of policy and market factors. These would be the first point of focus for joint industry and member-state action to raise awareness and improve channels to market. These are listed in Table 2 below.

Application	Member State Support?	Additional Economic Drivers
Applications under 1MW	In some cases	High retail electricity prices
Applications in industry and processing >5MW which is own consumption of electricity	In some cases	Advantage of own generation at low marginal cost
Bio-based CHP	In all cases	
Applications where heat storage is available or the heat and electricity production can be de-coupled for periods and there is excess electricity to sell to the grid.	In some cases	Wholesale electricity markets with high peak generating prices

Table 2: Hot spots for CHP in Europe under the prevailing 2014 policy and market conditions

### Unlocking sector potentials through Market and Awareness actions

Beyond the applications of Table 2 there are several areas where with relatively small changes to member-state policy the market could be relied on to provide attractive additional returns for CHP, yielding the desired energy efficiency and CO2 savings for the member state as a consequence.

SMEs and CHP: A recent DG Enterprise<sup>18</sup> report highlighted that the two priority interests for SMEs regarding sustainability are recycling and saving energy. For an SME with a suitable heat load, adopting CHP should be considered where the SME has access to finance and where the electricity market conditions are sufficiently well understood to accurately assess the return on investment.

There may be added business benefits for an SME having control of its electricity supply if local electricity reliability is poor, if using CHP may help the SME to achieve its social responsibility goals, or in contributing to GHG goals and initiatives.

CODE 2 has produced a 'How-To Guide' and online tool to help SMEs make an initial assessment of the attractiveness of CHP for their business.

Investing in CHP is a significant financial investment. It represents an ambitious undertaking for many SMEs and one which moreover may be viewed as a diversion from their main activity. Project developers and manufacturers should seek to provide turnkey solutions for SMEs including access to finance.

More detailed recommendations for SMEs are made in the CODE 2 policy report where appropriate EED implementation, metering, and improved awareness through SME clusters are all important.

#### Stand-alone CHP

There is steady interest in the use of CHP in university campuses, hospitals, hotels and leisure centres. All have substantial space/water heating and cooling demands over the course of the year and hence are good candidates for considering CHP. Enterprises such as these may find it more economical to generate their own electricity in CHP mode, if their electricity price is high.

Stand-alone CHP, some with small local heat exchanges, is also a useful first step in developing understanding of the potential of both CHP and heat networks for space and water heating.

The CHP sector is already targeting these applications. Joint activity with member states to address energy managers in the public and private sector would be a simple and effective way to raise awareness and multiply the effectiveness of this market interest.

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<sup>18</sup> European Commission, 2013. [Flash Eurobarometer 381. SMEs, Resource Efficiency and Green Markets.](#)



## What sectors of the CHP market are failed by current policy implementation

*(A separate CHP Policy report has been prepared by CODE 2, featuring a fuller discussion of the EU policy questions raised here)*

The hot spots and easy wins of market effort and awareness-raising cannot alone deliver the substantial potential of CHP across the European economy. The roadmaps make clear that in those member states where there is real CHP growth (Germany, Italy and Belgium) it is delivered through a well thought-out government policy structure, with a market or government-based support scheme operating within an overall energy efficiency or energy and climate plan. This prompts the market into action and awareness increases through experience and customer references. The big primary energy savings and economic and efficiency gains rely on including all of the CHP applications – particularly the large applications of district heating and industry – in an effective CHP legislative framework.

There are four main barriers to address to mobilise CHP potential in Europe. The barriers are visible across Europe to varying degrees but require an EU-level response if the market for cogeneration is to develop across the whole of Europe.

***Barrier 1: The heat and electricity markets do not consistently reward CHP's efficiency gains at the energy system level, hence there is an economic barrier facing new customers taking on CHP and an ongoing one for those already running CHP.***

The most important factor in encouraging economic actors to adopt CHP is that the CHP must be an economic proposition in the first place. This means giving an adequate return on the investment over its lifetime and a sufficiently low investment risk.

Hence policy must address the economic issue by creating a suitable legislative structure. Article 14 of the EED recognises this market failure and calls on member states to develop appropriate measures to support CHP where there are energy efficiency advantages at the macroeconomic level to do so.

***Barrier 2: A range of non-economic and economic hurdles for distributed generators in connecting to and operating on the electricity network remain. These barriers persist in many member states despite EU legislation dating back to 2004.***

Non-Economic Barriers to CHP usually relate to the inherently distributed nature of cogeneration. Cogeneration is embedded with the heat demand it serves as part of society. Capacities are often under 10MW or even 2MW. Much of the

capacity is connected at the Distribution System Network level which in many senses is not 'ready' for its presence.

Despite the requirement to streamline the processes associated with distributed generators dating back to the 2004 Directive, the industry sees very little improvement. Policymakers, through NEEAP reporting and surveillance of the implementation of legislation, must insist that the legislation (currently the EED) is implemented.

***Barrier 3: There is a high regulatory risk in the energy market at the moment which is impacting CHP at a time of cyclic reinvestment in plants.***

Uncertainty in the direction of EU energy efficiency policy (particularly in the transformation sector), ongoing instability in the electricity sector, and sudden changes of policy at member-state level have made high regulatory risk a significant barrier to investment in CHP.

Hence policymakers must act to reinforce and implement existing energy policy consistently and transparently including by giving economic actors clear information regarding timescales and scopes for review or other significant changes. The recent electricity market changes have produced far-reaching effects beyond those anticipated. Lessons should be learned from this experience and applied to EU policy action.

***Barrier 4: Heat Demand and Primary Energy Demand are poorly covered – if at all – by energy planning, which results in the opportunities for energy saving through CHP remaining hidden.***

Around half (55%) of the EU's primary gross inland energy consumption is used for space and water heating in the residential and tertiary sectors and for process heat in industry, compared to 17% for electricity. All of Europe's 2050 energy planning is around electricity. The study and understanding of how we use heat as a society is at an early stage in Europe.

Europe's energy efficiency efforts are focused around end use, although primary energy use is a key factor in monitoring waste in the electricity sector: the sector which absorbs one third of Europe's total inland energy consumption.

Policymakers should use the Security of Supply discussion and the 2030 energy and climate structure to fully include primary energy use and heat in energy efficiency and energy and climate strategy.

## The Benefits of addressing the Barriers

Major sectors requiring additional policy action:

### District Heating

Europe is a global centre of excellence for district heating, and district heating is a good heat base for high-efficiency CHP. The District Heating sector has continued to evolve its heat network technologies in the past 10 years and modern heat networks are now an invaluable interface between heat, electricity and gas networks. Currently the sector supplies 840TWh of heat/year, including heat sold to buildings and industry, some of which is supplied by CHP<sup>19</sup>, in Europe. However, much of the capacity in the new member states is outdated and becoming less efficient. In the new member states, DH – like all electricity generators – is changing to cope with the new high RES electricity market. All electricity generators need to invest and adapt to meet the coming fuel and electricity changes.

Barriers 1, 2 and 4 have a major impact on District Heating. DH faces the additional challenge of funding both network development and the renovation of Central and Eastern European member states' networks. Policymakers should create investment vehicles using the financial tools at their disposal to finance the investments needed to renovate existing networks in CEE member states.

### Large industry potential in Europe

Several industries with a large heat demand (chemicals, refining, ceramics, starch and paper) today use CHP as a cutting-edge technology. Exporting electricity to the grid, these industries give the EU network a big energy efficiency advantage. Some are already offering network support services. As large industries have a clear focus on shareholder return, industrial operators are alert to changes in profitability. At the time of writing, industries have experienced 18 months of low electricity sale prices and high fuel prices, and this means that large industrial CHPs designed to export electricity are switched off for long periods.

Industrial CHP is affected by all four of the major barriers to CHP growth. Policymakers should use the growing need to close down old, end-of-life, central electricity generation capacity as an opportunity to use industrial CHP to achieve their energy and climate policy goals. High-efficiency CHP in industry can replace central generating capacity with controllable high-efficiency power and services from industrial CHP.

### **Impact of the EED on the existing Barriers**

All of the CODE 2 roadmaps show a potential positive impact for the EED (Table 3) in addressing and reducing elements of the major barriers. The EED provides a structure to make progress in terms of heat planning, with suitable measures

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<sup>19</sup> Aalborg University, 2013. [Heat Roadmap Europe 2050](#), pp 21

being required of member states to promote CHP where their analysis reveals a socio-economic benefit at the member-state level. However, the EED has been written to allow member states considerable latitude in how they apply Articles 14 and 15, which are the most relevant to CHP. Given the lack of awareness of the benefits of CHP still visible in many member states, there is a considerable role for the industry itself to play in encouraging member-state governments to adopt a progressive and rigorous implementation of the EED for CHP.

The transposition at national level of the EED would probably not fix most of the short-term issues related to the electricity market, and energy discussions in general. However, thanks to the EED policymakers are equipped with tools to address market failures and to plan for a more sustainable energy, power and heat system for the decades to come.

	Barrier	EED article	Potential Impact
1	Market failure to reward energy efficiency improvements	14: Promotion of efficiency in heat supply, supported by adequate measures 15: Electricity Balancing and fostered participation of electricity users 7: Energy efficiency in energy use 18: Energy Services 20: National EE Fund setting up	Good
2	High regulatory risk	14: Adequate national measures should be put into the 2020-2030 time frame Energy transformation, transmission and distribution	Poor (related to general awareness and political support)
3	Economic and non-economic barriers to DG (distributed generation)	8: Energy audits for companies 9: Energy Metering 12: Consumer information and empowering programme 15: EE improvement in managing energy grids	Good
4	Policy focus on Heat/Primary Energy Demand	3: Report on PES by 2020 14: Comprehensive Assessment of CHP potential 24: CHP Statistics	Good heat/Poor on Primary Energy

*Table 3: Opportunities in Energy Efficiency Directive (EED) to begin to tackle major barriers to CHP in Europe*

## The bonuses of Unlocking CHP through joint Market, Policy and Awareness actions

### *Manufacturing and innovation*

CHP is a core competence of the European economy. The EU is a market leader and is currently exporting its skills and products globally. The manufacturers at the heart of the CHP sector are taking EU standards and energy efficiency applications into the global market. This innovation drives competition which in turn drives improvement. These skills and competencies are a valuable economic and knowledge base for Europe contributing to GDP and jobs. It is important to strengthen the home market to retain these skills and encourage innovation.

There is a strong micro-CHP design and manufacturing competence in Europe. The CODE 2 study has shown that the potentials for micro-CHP in areas without heat networks are probably underestimated. Micro-CHP products are now available from most boiler manufacturers in Europe and the sector is investing heavily, including in fuel cells (FC). The sector needs to bring product cost down and MS should consider the advantages in assisting manufacturers through the early stages of production to volume as is currently being done by JU FCH for FC technologies.

### *Fuel diversification*

There is a steady shift in CHP fuels towards increased renewable fuels in Europe. Geothermal, concentrating solar and a range of bio-based fuels are currently used in CHP and in 2012 the penetration of renewables reached 16.3%. The principle of CHP is fuel-independent: whatever the fuel, a combined heat and power approach uses that fuel in the most efficient manner. The development of bio-based gaseous fuels to use in CHP mode, rather than solid fuels, is a more electrically efficient route for these materials and provides a very high-efficiency solution. Using CHP for heat and power makes renewable resources more sustainable.

Certain member states' approaches to assessing biofuels used in CHP mode raise important questions for the overall delivery of heat and power. Both Sweden and Denmark, member states well advanced in the use of bio-energy, have highlighted the additional potential they see for the future.<sup>20</sup>

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<sup>20</sup> CODE 2 CHP roadmap Sweden (page 11); Code 2 CHP Roadmap Denmark (pages 4, 13).

## Annex 1: Methodologies used to calculate saving of primary energy and CO<sub>2</sub> emissions in CHP Roadmap

Two established methodologies were employed to determine the primary energy savings (PES) and CO<sub>2</sub> emission reductions of the CHP fleet in 2030: the EED method and the substitution method presented in this annex.

The CODE 2 2030 Roadmap primary energy savings (PES) and CO<sub>2</sub> emission reductions were calculated using the 'Substitution Method', which project partners assessed as adequate for the purposes of this analysis. Yet for considerations of thoroughness, the project partners performed the analysis using the EED Method as well.

	<b>Substitution Method</b>	<b>EED Method</b>
<b>Total PES (TWh/year)</b>	1714	980
<b>Additional PES (TWh/year)</b>	870	497
<b>Total CO<sub>2</sub> (Mt/year)</b>	686	392
<b>Additional CO<sub>2</sub> (Mt/year)</b>	348	199

*Table 4: Comparison of PES and CO<sub>2</sub> reductions delivered by CHP in 2030 calculated using the Substitution Method and EED Method<sup>21</sup>*

While the EED Method benefits from recognition in the CHP community, the Substitution Method has the advantage of providing a more accurate estimation of real energy savings and CO<sub>2</sub> emission reduction potential. The total primary energy savings potential in 2030 (i.e. that delivered by the entire CHP fleet, taking into account both plants that exist today and new CHP installations) could reach 980 TWh when employing the EED methodology<sup>22</sup> and up to 1,700 TWh under the Substitution Method.

Based on the assessed PES, total CO<sub>2</sub> savings could reach between 390-680 Mt CO<sub>2</sub>, calculated with the specific CO<sub>2</sub> emission factor 0.4 Mt CO<sub>2</sub>/TWh of PES<sup>23</sup>.

### Substitution Method

<sup>21</sup> Additional PES and CO<sub>2</sub> emission reductions refer to the savings delivered by new CHP installations beyond 2012.

<sup>22</sup> An average PES factor of 1.3 was used to calculate the primary energy savings from CHP electricity generation (based on an estimated fuel and technology structure of CHP in 2030).

<sup>23</sup> The factor used is the average CHP roadmap specific CO<sub>2</sub> savings factor following the Substitution Method where realistic PES and CO<sub>2</sub> savings were calculated for each member state (high share of RES in future CHP generation is the reason why specific CO<sub>2</sub> savings per PES exceed the specific CO<sub>2</sub> factor for fossil fuels as the achieved real CO<sub>2</sub> savings with the replacement of fossil fuel used for heat and electricity generation should be calculated from the whole replaced fuel volume and not just from the PES).

This method was developed in the CODE 2 project. Before opting for this, two other approaches were considered: 1) the “replacement mix method”<sup>24</sup> from the Munich FfE Institute, which however cannot be used directly for the long-term comparisons required by CODE 2, and; 2) a method used to calculate the CO<sub>2</sub> saving resulting from a voluntary commitment by German industry for CO<sub>2</sub> reduction<sup>25</sup>. However, this method was considered too simple.

Therefore the following, more differentiated approach was developed:

Based on an estimate of the increase in cogenerated electricity, the thereby-caused reduction of CO<sub>2</sub> 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. 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<sub>2</sub> 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 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 the separate production of electricity and heat produced is carried out strictly on a same-fuel basis. That 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 to be the relevant and meaningful value for representing the contribution of CHP to achieving the EU's long-term objectives of reducing CO<sub>2</sub> emissions and primary energy consumption. The BAT approach of the CHP Directive was developed to verify the high efficiency of individual plants, but not to determine actual saved CO<sub>2</sub> emissions and primary energy quantities from CHP expansion.

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

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<sup>24</sup> 10. FfE Forschungsstelle für Energiewirtschaft e.V., Energiezukunft 2050; <http://www.ffe.de/die-themen/erzeugung-und-markt/257>

<sup>25</sup> The calculation was made by the VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V., 2010, Unpublished.

replacement of old cogeneration technologies with new ones, and the replacement of carbon-rich fuels with low-carbon fuels – can be usefully considered only as an integrated process.

To account for 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 PES was 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, and fuel shares in the replaced CHP plants, power plants and boilers as well as in the new CHP plants.

The results were 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, and corresponding fuel shares.

### **EED Method**

The Primary Energy Savings methodology of the Energy Efficiency Directive (EED) is used at country level for national reporting to the European Commission, and at project level for determining if CHP is highly efficient<sup>26</sup>. In the methodology, each cogeneration unit is compared with the best technology for the separate production of heat and electricity on the same fuel on the market in the year of construction of the cogeneration unit and the harmonised reference values are determined by fuel type and the year of construction.

The underlying principle is that, knowing that regular new investments in new energy production units have to be made, it is necessary to compare CHP with the centralised production installation which could be built using the same fuel rather than assuming the displacement of a different fuel or the 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 centralised production based on the same fuel (= the 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 the national level) of CHP compared to installing new capacity with another technology (power plant + gas boiler). Replacing older installations with state-of-the-art technology is a typical reinvestment decision. New CHP plants (or combination of smaller installations) would not necessarily lead to less production in older production installations, but would rather pre-empt investments in new CCGT, for example.

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<sup>26</sup> This refers to the methodology for determining the efficiency of the cogeneration process in the Energy Efficiency Directive, Annex II.