

# CODE2

**Cogeneration Observatory  
and Dissemination Europe**



## *Final CHP roadmap* **IRELAND**

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## Table of contents

Introduction to CODE2 .....	3
Draft roadmap methodology .....	3
Executive summary .....	4
1 Where are we now?: Background and situation.....	3
1.1 CURRENT STATUS: SUMMARY OF CURRENTLY INSTALLED COGENERATION.....	3
1.2 THE IRISH ENERGY AND CLIMATE STRATEGY .....	6
1.3 POLICY DEVELOPMENT .....	7
1.3.1. CHP legislation .....	7
1.3.2. Financial support for CHP .....	8
1.4 AWARENESS .....	11
1.4.1. Key role of awareness and know-how on CHP .....	11
1.4.2. Cogeneration Awareness assessment in pilot Member States: Method .....	11
1.4.3. Role of key actors.....	12
1.5 THE ECONOMICS OF CHP .....	14
1.5.1. General remarks.....	14
1.5.2. Energy industry .....	15
1.5.3. Industry, commercial, housing .....	15
1.5.4. Renewable energy sources .....	19
1.5.5. CHP economics matrix .....	19
1.6 BARRIERS TO CHP .....	20
1.6.1. Current policy structure is not providing realistic barrier removal or support for CHP. ....	20
1.6.2. The economics of CHP are unattractive and the spark spread is negative leading to high pay back times and low IRR's.....	21
1.6.3. Awareness is lacking within several socio-economic groups. ....	21
1.6.4. District heating is unknown in Ireland which therefore lacks the structures needed to properly explore this option.....	21
1.6.5. The current policy structure and support for micro CHP is not effective to increase deployment in Ireland Not enough support for micro CHP. ....	22
2 What is possible? Cogeneration potential and market opportunities.....	23
2.1 POTENTIALS AND MARKET OPPORTUNITIES .....	23
2.1.1. CHP - Potential in Ireland – 2009 .....	23
2.1.2. Potential analysis reported to the commission .....	24
2.1.3. Market opportunities in the main usage areas .....	25
3 How do we arrive there? The Roadmap .....	30
3.1 PRELIMINARY REMARKS .....	30
3.2 OVERCOMING EXISTING BARRIERS AND CREATING A FRAMEWORK FOR ACTION .....	30

3.2.1.	Building a policy vision for CHP.....	30
3.2.2.	Removing policy barriers .....	30
3.2.3.	Improving economic viability of CHP projects.....	31
3.2.4.	Obtaining financial support .....	32
3.2.5.	Increasing awareness.....	35
3.2.6.	Setting up a CHP coalition.....	36
3.2.7.	Developing a framework for district heating.....	36
3.2.8.	Simplifying export of electricity to the grid .....	37
3.2.9.	Identifying specific potential market for CHP .....	37
3.2.10.	Overview of the roadmap steps.....	38
3.3	THE ROADMAP PATH IN NUMBERS .....	40
3.4	SAVING OF PRIMARY ENERGY AND CO <sub>2</sub> EMISSIONS BY THE CHP ROADMAP .....	43
	Bibliography .....	57

## Introduction to CODE2

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 is part of an important market consultation for developing 28 National Cogeneration Roadmaps across Europe. These roadmaps are built on the experience of the previous CODE project ([www.code-project.eu](http://www.code-project.eu)) and in close interaction with the policy-makers, industry and civil society in each member state through research and workshops.

The project aims to provide a better understanding of key markets and policy interactions around cogeneration and particularly to identify the possibilities for acceleration of cogeneration penetration into industry and SMEs.

## Draft roadmap methodology

This draft roadmap for CHP in Ireland is written by COGEN Vlaanderen and has been based on a range of studies. It has been developed through a process of discussion and exchanges with experts.

The first draft of the roadmap was discussed and reviewed on an interactive expert workshop with stakeholders on 6th June 2013 in Dublin.

The input from the workshop and any additional input from experts has been used to produce the current version.

For more details and other outcomes of the CODE2 project see: <http://www.code2-project.eu/>

## Executive summary

For the second commitment period of the Kyoto Protocol Ireland has to achieve a 20% reduction in non-ETS emissions by 2020 relative to 2005. In order to reach this specific objective, targets were set in the National Energy Plans, among which 20 % savings in energy use through energy efficiency. Cogeneration has been covered in Irish energy policy since 2006, and a cogeneration capacity of 800 MW<sub>e</sub> for 2020 is repeatedly targeted in the legislation. However these targets are not being met. The CODE2 CHP roadmap of Ireland shows a route to reach this target of 800 MW<sub>e</sub> by 2020, and with a medium growth rate, to extend the installed capacity to ca. 1100 MW<sub>e</sub> by 2030.

However a number of barriers need to be overcome if Ireland wants to obtain these goals. Currently the policy structure in Ireland does not support cogeneration and in fact it may act against it. The level of financial support for cogeneration is very low. At the moment the focus of policy makers on the potential positive role of cogeneration seems limited and cogeneration may not be well understood since no comparative analysis has been made of the environmental impact, value for grid support, or the real energy efficiency potential of a more integrated approach to supply including cogeneration. The elements of the current policy which seem to work against cogeneration should be assessed for this impact. Financial systems in the energy sector such as the Carbon Tax relief the Large Energy Users rebate led to controversy among stakeholders without resulting in a solution for the CHP sector.

Although the power-to-gas ratio is higher than the European average, which could be an opportunity for cogeneration in Ireland, simple pay back times are still above 5 years which is at the limit of what investors will accept. There is an interest in cogeneration in the market and among customers, but mainly for the larger scale industrial installations. Awareness for micro- cogeneration in households and SMEs is still limited. As a result the interest in and support for micro-CHP and district heating is very low. An extra problem for cogeneration on gas is the fact that large areas of the country remain without access to the natural gas grid however this does not inhibit cogeneration on other fuels.

To overcome these barriers and reach the potential for cogeneration a number of action points is put forward which have to be implemented by the different stakeholders (policy makers, grid operators, ...) in the near term and ideally in the implementation of the EED. These steps are (a) building a policy vision for cogeneration, (b) removing policy barriers, (c) improving the economic viability of cogeneration projects, (d) obtaining financial support, (e) increasing awareness, (f) setting up a cogeneration coalition, (g) developing a framework for district heating, (h) simplifying export of electricity to the grid and (i) identifying a specific potential market for cogeneration.

In this roadmap CODE 2 made a first attempt at identifying the economic application and market segments where this potential exists. The technical potential could be reached through economic opportunities in the industrial sector (mainly dairy industry and timber processing) and through growth in the services and commercial sectors. For 2020 housing and district heating can be equally important and for 2030 it is expected that a significant increase will be contributed by the SMEs and housing sectors.

The roadmap steps can be driven by two important factors: first the building a community of interest in cogeneration called here a coalition in Ireland to work with policy makers to develop a successful and appropriate policy approach to achieve the national objectives. Second, full implementation of the EED which holds several articles, such as necessity to set energy efficiency targets, the requirement for heating and cooling plans and the obligations towards awareness building, which collectively could

stimulate Irish policy towards a more integrated vision for cogeneration.

# 1 Where are we now? Background and situation

## 1.1 Current status: Summary of currently installed cogeneration

*The operational capacity of CHP in 2010 was 284 MWe (158 units), which is slightly lower than in 2009. The majority of units are in the services sector while the bulk of installed capacity is in industry. The growth rate since 2006 is low*

Table 1 shows the Eurostat data for combined heat and power in Ireland (Eurostat, 2010).

	Installed capacity electricity (MW)	Total cogenerated electricity generated (MWh)	Total heat supplied (MWh)	Total electricity generated (MWh)	Total share on electricity
2008	208	1.840.000	3.750.000		6,2

Table 1: Eurostat data for CHP in Ireland

The **installed capacity** of CHP in Ireland at the end of **2012** was **330 MWe (325 units)** up from 326 MWe (262 units) in 2011, an increase of 1,4%. However the 2010 installed capacity figures include a number of units that were not operational (14,2 MWe, 72 units) and a number whose status is currently unknown (9,9 MWe, 10 units). It is assumed that the units where the status is unknown are non-operational. Therefore, the operating capacity of CHP in Ireland at the end of 2012 was 306 MWe (243 units). This is an increase of 4,1 MWe (1,3%) in operating capacity since 2011.<sup>1</sup> The **Aughinish Alumina plant** which accounts for 160 MW<sub>e</sub> is operational since 2006 and is the single largest cogeneration installation.

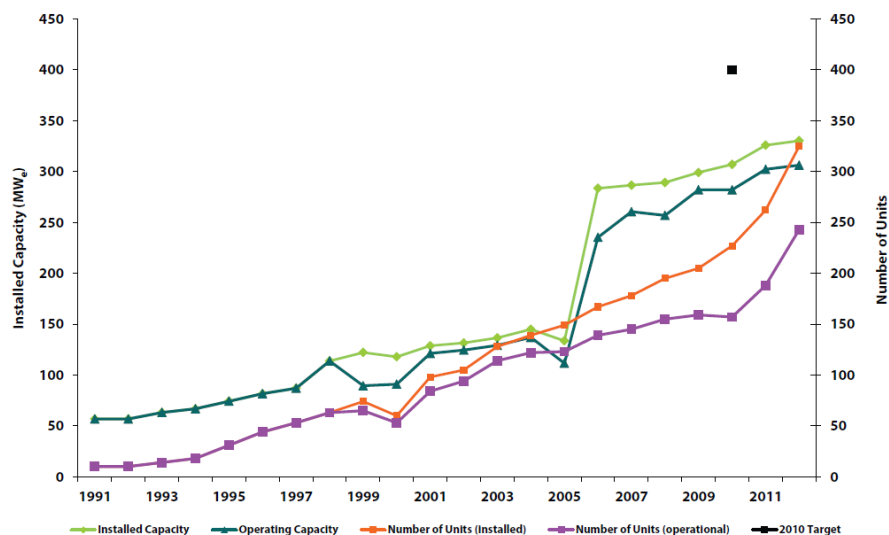


Figure 1: Number of units and installed capacity (1991 to 2012)<sup>2</sup>

<sup>1</sup> Combined Heat and Power in Ireland. 2013. SEAI.

<sup>2</sup> Combined Heat and Power in Ireland. 2013. SEAI.

Figure 1 shows the trend in installed cogeneration capacity since 1991. Without the contribution from the Aughinish Alumina cogeneration plant, the installed capacity in 2008 would even have declined to the level of the late 1990s and, due to plant closures, would only have returned to the 2004 level of 140 MWe by 2008.

In 2012, 7,6% of electricity was from cogeneration installations and cogeneration installations met 6,6 % of Ireland's total thermal energy demand.

CHP is promoted in EU legislation due to the improved efficiencies and reduced emissions that may be achieved relative to the alternatives on the same fuel. In this context, the choice of fuel has a direct impact on the levels of emissions reductions that may be achieved. Table 2 illustrates the operational capacity and number of units by fuel in 2012.

Oil fuels used are liquefied petroleum gas (LPG), heavy fuel oil, refinery gas and biodiesel. **Natural gas** was the dominant fuel for 282,2 MW<sub>e</sub> (206 units) and 92 % of the capacity in 2010. There is one 160 MW<sub>e</sub> gas plant which dominates the installed capacity. Solid fuels, biomass, oil fuels and biogas comprise the remaining 8% of the total.

	No of units	Operational capacity MW <sub>e</sub>	No of units %	Operational capacity %
Natural gas	206	282,2	84,8	92,1
Solid fuels	2	5,2	0,8	1,7
Biomass	2	5,4	0,8	1,7
Oil fuels	20	7,7	8,2	2,5
Biogas	13	5,8	5,3	1,9
Total	243	306,3	100	100

Table 2: Number of units and operational capacity by fuel in 2010<sup>3</sup>

CHP is more suited to some applications and sectors of the economy than others, depending on how the energy is used, the amount of energy consumption and the split between electrical and heat requirements. CHP has been used in large industrial concerns for over 30 years but the availability of ready made, small scale, reliable gas units in the 1990s (and more recently micro-turbines) has meant that the services sector could now avail itself of the technology.

Table 3 presents the number of units and installed capacity for cogeneration in Ireland in 2012. The majority of installations are in the **services** sector while the bulk of capacity installed is in **industry**, indicating that there are a large number of relatively small units in the services sector. The services sector accounted for 202 (83%) of the 243 units and 42 MW<sub>e</sub> of the 306 MW<sub>e</sub> operational capacity (14%) in 2012.

	No of units	Operational capacity MW <sub>e</sub>	No of units %	Operational capacity %
Services	202	42	83,1	13,7
Industry	41	264	16,9	86,3
Total	243	306	100	100

Table 3: CHP number of units and operational capacity by sector in 2012<sup>2</sup>

Examining the breakdown of services further in Table 4 **hotels and leisure** sub-sector (which includes

<sup>3</sup> Combined Heat and Power in Ireland. 2013. SEAI.



swimming pools, leisure centres, gyms, etc.) account for the majority of units (95) in the services sector while the **hospitals** accounts for another 22 units. These sub-sectors have close to constant demand for heat and electricity. Table 4 shows a detailed breakdown by application.

	No of units	Operational capacity MW <sub>e</sub>	Services No. of Units %	Operational capacity %	Total CHP No. of Units %	Total CHP Installed Capacity %
Airport	3	6,7	1	16	1,2	2,2
District heating	3	1,2	1	3	1,2	0,4
Education	17	7,0	8	17	7,0	2,3
Hospital	22	4,3	11	10	9,1	1,4
Hotel	64	8,8	32	21	26,3	2,9
Leisure	31	3,2	15	8	12,8	1,0
Nursing home	13	0,2	6	1	5,3	0,1
Office	11	2,9	5	7	4,5	1,0
Public sector	12	5,1	6	12	4,9	1,7
Retail	12	2,4	6	6	4,9	0,8
Services other	14	0,3	7	1	5,8	0,1
Total	202	42,1	100	100	83,1	13,7

Table 4: Number of units and operational capacity by services sub-sectors in 2012

Table 5 presents the sub-sectoral breakdown of operational capacity and number of units in industry. The 160 MW<sub>e</sub> installation at Aughinish Alumina dominates the capacity with that single unit accounting for over 60% of the total operational capacity in the industrial sector. The **food and beverages** sector has the largest number of individual sites (18 units), accounting for 24,9% of industrial installed capacity in 2012. The sector 'Other' contains enterprises in the energy sector and **sawmills** sub-sectors.

	No of units	Operational capacity MW <sub>e</sub>	No of units %	Operational capacity %	Total CHP No. of Units %	Total CHP Operational Capacity %
Food	18	65,9	43,9	24,9	7,4	21,5
Manufacturing	5	7,3	12,2	2,8	2,1	2,4
Pharmaceutical	10	16,4	24,4	6,2	4,1	5,4
Non-ferrous Metals	1	160	2,4	60,6	0,4	52,2
Other	7	14,6	17,1	5,5	2,9	4,8
Total	41	264,2	100	100	16,9	86,3

Table 5: Number of units and operational capacity by industry sub-sectors in 2012

Electrical capacity size range	No. of Units	No. of Units %	Operational Capacity MW <sub>e</sub>	Operational Capacity %
Micro < 50 kW <sub>e</sub>	46	19,3	0,3	0,1
50 kW <sub>e</sub> ≤ Small < 1MW <sub>e</sub>	150	61,7	27,0	8,8
Large ≥ 1 MW <sub>e</sub>	46	18,9	279,0	91,1
Total	243	100	306,3	100

Table 6: Number of Units and Installed Capacity by capacity size range<sup>4</sup>

Table 6 categorises Ireland's installed capacity in 2012 into capacity classes according to the European Energy Efficiency Directive (EED).<sup>5</sup>

<sup>4</sup> Combined Heat and Power in Ireland. 2013. SEAI.

## 1.2 The Irish Energy and Climate Strategy

**For the second commitment period of the Kyoto Protocol Ireland has to achieve a 20% reduction in non-ETS emissions by 2020 relative to 2005. In order to achieve this, specific targets were set in the National Energy Plans, among which 20 % savings in energy use through energy efficiency.**

The National Climate policy has been laid out in the Irish **National Climate Change Strategies (NCCS)** published in 2000 and 2007. Greenhouse gas mitigation is central to climate protection policy and there are currently two 'commitment periods' in range for Ireland.

The first was the **2008-2012** period governed by the Kyoto Protocol, for the purposes of which Ireland had committed to limit average greenhouse gas emissions over the five-year period to 13% above 1990 levels. The increase in emissions for this period was around 8 per cent above the 1990 level, so in aggregate the target was achieved. Without the sharp economic recession, the Kyoto target would not have been achieved, although domestic policy contributed to the moderation of emissions growth.<sup>6</sup>

The second commitment period in range covers the eight years **2013-2020**. It is the responsibility of member states to achieve the reduction in emissions in the non-ETS sector. For these emissions, the total EU target is a reduction of 10 per cent by 2020, compared to 2005. This 10 per cent EU target was allocated across member states through the Effort Sharing Decision. This gave Ireland a target to achieve a 20 per cent reduction in non-ETS emissions by 2020 relative to 2005.

This 20% limit was set in 2012, following a review of Ireland's emissions, at 37,5 Tons of CO<sub>2</sub>eq. Based on current scenario projections, Ireland will not meet this target.

In the scenario based on existing policy, emissions are projected to increase by 10 per cent from 2010 to 2020, which would leave overall emissions 2 per cent below the 2005 baseline. Under the scenario with additional measures, emissions are projected to decrease to 10 per cent below 2005 levels by 2020.

There are major challenges involved in achieving these targets. Many of the additional measures needed are still to be developed. Reflecting the NEEAP (National Energy Efficiency Action Plan) and the NREAP (National Renewable Energy Action Plan), the key additional assumptions in the additional measures scenario are that by 2020 Ireland will have achieved the following:

- **20 per cent savings** in energy use through **energy efficiency**; this includes **33 per cent energy savings in the public sector**;
- 40 per cent of electricity from renewable energy;
- 12 per cent of heating from renewable sources; and
- 10 per cent of transport fuels will come from renewables, including a 10 per cent share for Electrical Vehicles (EVs).

The non-ETS area in which there is the greatest technical potential for reduced emissions is undoubtedly energy efficiency in **buildings**<sup>7</sup>.

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<sup>5</sup> Commission Directive 2012/27/EU on energy efficiency

<sup>6</sup> Ireland's Greenhouse Gas Emission Projections – 2013. Environmental Protection Agency (EPA)

<sup>7</sup> Towards a New National Climate Policy: Interim Report of the NESC Secretariat - 2012. – National Economic and Social Council (NESC)

## 1.3 Policy development

**Cogeneration is covered in Irish energy policy since 2006, and a cogeneration capacity of 800 MWe for 2020 is repeatedly targeted in the legislation. However, targets are not being met. Most financial support for cogeneration has been withdrawn. At the moment the focus of the policy makers is towards 100% renewables where the role of CHP is not well understood.**

### 1.3.1. CHP legislation

The European Cogeneration Directive 2004/08/EC promotes the use of cogeneration in Europe for reasons of security of supply and energy efficiency. The Directive is transposed into Irish law in the **Energy (Miscellaneous Provisions) Act of 2006**.

The government's **Energy White Paper** (Delivering a Sustainable Energy Future for Ireland - the Energy Policy Framework for 2007-2020) was published in March 2007 and was designed to steer Ireland to a new and sustainable energy future.

This paper identified the areas of growth to be targeted in the period to 2020, including growth in the uptake of cogeneration. The White Paper states:

*Growth in Combined Heat and Power deployment is an important objective to 2020. The national economic benefit from cogeneration grows with scale of deployment. It is also the case that cogeneration investment yields a relatively low return at high risk. So barriers need to be addressed and supports maintained in order to realise the deployment potential, not just in community and buildings, but also in large scale plants.*

In 2007? Ireland set the following targets for cogeneration capacity:

<b>Targets for CHP:</b>
400 MW <sub>e</sub> by 2010
800 MW <sub>e</sub> by 2020

The White Paper also set out three specific actions in relation to cogeneration:

1. *Continued support under the Cogeneration Deployment Programme and R&D supports with particular emphasis on biomass fuelled cogeneration.*
2. *Within two years (from 2007) a further target for cogeneration will be considered for 2020 in light of further feasibility studies into cogeneration applications.*
3. *A review by the Commission for Energy Regulation (CER) of potential administrative and regulatory barriers and decisions on appropriate price support mechanisms for electricity generated from new high-efficiency, large-scale cogeneration<sup>8</sup>.*

The **National Energy Efficiency Action Plan** published in May 2009 sets out government plans and actions to achieve its target of 20% energy efficiency savings across the economy in 2020. It also reflects the targets set out in the government white paper<sup>9</sup>.

<sup>8</sup> Energy White Paper, Delivering a Sustainable Energy Future for Ireland - the Energy Policy Framework for 2007-2020; 2007 ; Department of Communications, Marine and Natural Resources

<sup>9</sup> Maximising Ireland's Energy Efficiency; The National Energy Efficiency Action Plan 2009 – 2020; 2009; Department of Communications, Energy and Natural Resources

In 2009 **three statutory instruments (SI 298, SI 299 and SI 499) were published** related to cogeneration. These established the legal responsibility to calculate power to heat ratios for cogeneration units in Ireland to the Commission for Energy Regulation (CER) and also to certify high efficiency (HE) cogeneration. The electricity system operator is required to give to give certified high efficiency cogeneration priority when dispatching the system.

A **Second National Energy Efficiency Action Plan (NEEAP2)** was published on 28<sup>th</sup> February 2013. It provides a progress report on delivery of the national energy savings targets implemented under current EU requirements as well as energy efficiency policy priorities between 2013 and 2020. The second Action Plan reaffirms Ireland's commitment to a 20% energy savings target in 2020 and a 33% reduction in public sector energy use. It also repeats the commitment of achieving at least 800 MW<sub>e</sub> of cogeneration by 2020<sup>10</sup>.

It is expected that this will continue to improve with **EED** implementation and that the EED will be driving greater focus on energy efficiency benefits of cogeneration. At the moment no changes in legislation are expected.

The total operational capacity of CHP in Ireland at the end of 2012 was 83% of the 2010 target and 41% of the 2020 target. Therefore 2,4 times growth in the existing CHP capacity is required (494 MWe) after 2012 in order to meet the 2020 target of 800 MWe or an average annual growth rate of 12%. This compares to the actual growth rate of 1,4% in installed capacity in 2012.

The government is due to consider a second cogeneration target for 2020 in light of further feasibility studies by SEAI into cogeneration and review of barriers and appropriate support mechanisms by the Commission for Energy Regulation (CER). This could provide policy makers with useful insight into the barriers preventing growth in the sector which were recognised to exist in the white paper of 2007. It has also been suggested that the public sector might be used to encourage the wider use of cogeneration.

### 1.3.2. Financial support for CHP

There have been several attempts by the Irish government to support the growth of CHP through incentive programmes. However these have so far had limited success .

The **Cogeneration Deployment Programme**, 2006 to 2010, provided grant support to assist the deployment of small-scale (<1 MW<sub>e</sub>) fossil fired cogeneration and biomass (anaerobic digestion and wood residue) cogeneration systems. Funding was made available for cogeneration systems and also potential trial programmes. The units which were finally installed were all installed on a trial basis. In total 15.7 MWe (68 units) of small scale fossil cogeneration projects were installed with , an additional 3 MW<sub>e</sub> of biomass cogeneration and 250 kW<sub>e</sub> of anaerobic digestion cogeneration<sup>11</sup>. The programme was closed at the end of 2010.

Further support for biomass cogeneration and anaerobic digestion cogeneration is provided through a government **Renewable energy feed-in-tariff (REFIT)** scheme. REFIT is a support mechanism to help meet the national renewable electricity target of 40% by 2020. REFIT 3 is a scheme to cover 310 MW<sub>e</sub> of certain biomass related REFIT categories. The scheme opened in February 2012 and is open for projects built and operational between 1/1/10 and 31/12/15. The support levels for biomass and anaerobic

<sup>10</sup> Ireland's second National Energy Efficiency Action Plan to 2020; 2013; Department of Communications, Energy and Natural Resources

<sup>11</sup> 'Combined Heat and Power in Ireland: 2012 by Emer Dennehy, Eanna Fanning and Martin Howley

cogeneration are linked to the consumer price index, with support for any particular project not exceeding 15 years or extending beyond 2030. The tariffs for cogeneration are<sup>12</sup>:

- |   |               |
|---|---------------|
| • Anaerobic digestion CHP ( $\leq 500$ kWe) | 15,7c per kWh |
| • Anaerobic digestion CHP ( $> 500$ kWe)    | 13,6c per kWh |
| • Biomass CHP ( $\leq 1500$ kWe)            | 14,6c per kWh |
| • Biomass CHP ( $> 1500$ kWe)               | 12,5c per kWh |

However the additional requirements of the REFIT support scheme in terms of grid connection form a deterrent in reality for the wider development of biomass/biogas cogeneration. The requirement to provide a second grid connection for the purpose of exporting electricity at sites where grid connections already exists adds significant cost to projects making the proposal financially unattractive for most investors. Only 2,5 MW of installations have applied for the REFIT scheme in its first year towards the final 310 MWe over 10 years.

Electric Ireland (ESB Electricity Supply company) offer a **9c/kWh feed in tariff for micro generating sites** who are a) their customer and b) are on a domestic type tariff (i.e. no commercial customers). It is decided yearly if the support is to be extended. Currently the scheme extends to the end of 2014<sup>13</sup>.

The SEAI maintains a triple E register which sets requirements for cogeneration. Any cogeneration that has undergone the vetting process for inclusion on the Triple E register qualifies for **Accelerated Capital Allowances (ACA)**, introduced under the Finance Act in 2008. The ACA is a tax incentive for companies paying corporation tax and aims to encourage investment in energy efficient equipment. The investor in the technology can write off the investment made against tax in the year of purchase as opposed to the normal capital write off over eight years.

This is an interesting approach to support for cogeneration project developers as the public sector organisations must use Triple E registered equipment when considering purchasing energy products. Purchasers of cogeneration equipment also like the approach as the tax incentive is seen as an on-going sustainable support that will still be in place over a specific number of years to come. However the level at which the relief has been set is currently too low to trigger on its own, a substantial increase in uptake of cogeneration. The incentive effectively reduces the payback period on a plant by around 6 months for a commercial scale micro-CHP which is not sufficient incentive to invest. This will be further discussed in chapter 1.5: The economics of CHP.

Other supporting systems in the energy sector were introduced at different times, with varying success and sometimes leading to some controversy or discussions.

A **Carbon Tax** was introduced in Ireland in 2010. A partial **relief** from the tax was granted for natural gas supplied for use for environmentally friendly heat and power cogeneration, other than micro-cogeneration. However a full relief from the tax is granted for natural gas supplied solely for the generation of electricity<sup>14</sup>. This resulted in an advantage for sites with gas fired heat only and a relative disadvantage for CHP.

In response to high fuel costs, the Commission for Energy Regulation (CER) introduced in 2009 an increase in ESB Public Electricity Supply (PES) tariffs. In order to mitigate the price impact for customers there was a **rebate** for electricity customers via the Transmission Use of Systems (TUoS) charges mechanism and another rebate for **Large Energy Users (LEU)**. These rebates did not extend to on site

<sup>12</sup> 2013 - <http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/REFIT.htm>.

<sup>13</sup> 2014 - <https://www.electricireland.ie/ei/residential/price-plans/micro-generation-scheme.jsp>

<sup>14</sup> Guide to Natural Gas Carbon Tax; 2012; Revenue

consumption of cogeneration generated electricity, even though sites with cogeneration were experiencing the same energy price increases. The rebate payment due on many sites was more than the savings that were made by having a cogeneration on site.

It can be learned from the past that solid support systems are needed for CHP and that controversial measures don't have a positive effect on the sector but instead lead to wide ranging discussions without final solution.

## 1.4 Awareness

**There is an interest in cogeneration in the Irish market and among several customer groups , but mainly for the larger scale industrial installations.**

### 1.4.1. Key role of awareness and know-how on CHP

Sales of cogeneration to customers rely on a commercial proposition and a **functioning market** for the application of cogeneration. The policy intervention of the European Union to support cogeneration and assist the removal of market barriers is an important element of creating a good commercial proposition however in itself it will not be sufficient to grow sales of cogeneration if the customers are unaware or misinformed and lacking support within influencing groups or, and if the supply chain of skills and suppliers does not exist.

A final buying decision by a customer is the result of a set of complex interactions, involving the supplier, the supply chain and the customer. External conditions influence the process as do the market structure and the policy structure. A mature market for a product is characterized by a high degree of awareness among all the relevant players in the market and ongoing buying and selling activity.

### 1.4.2. Cogeneration Awareness assessment in pilot Member States: Method

An assessment of awareness of cogeneration among key market actors has been developed. Using qualitative interview techniques with experts and market participants four groups of the socio-economic actors for cogeneration were assessed. The four groups and their subsectors are below. The list is not exhaustive but contains all the most relevant players.

- Customers: utilities (& DH), industry, potential users;
- Market and supply chain: installation companies, planners, energy consultants, architects, technology and equipment providers, banks/leasing, energy agencies;
- Policy structure: energy and climate legislators and all levels of government;
- Influencers: media, general public, academics, environment NGOs, associations.

Figure 2 lists the possible actors under each of the groups in the socio-economic model. The level of awareness was assessed for each of the and rated 1-5 , (1 poor and 5 Active market) , as below. The detailed comments on each group are described in Annex 1 (p.45).



### 1.4.3. Role of key actors

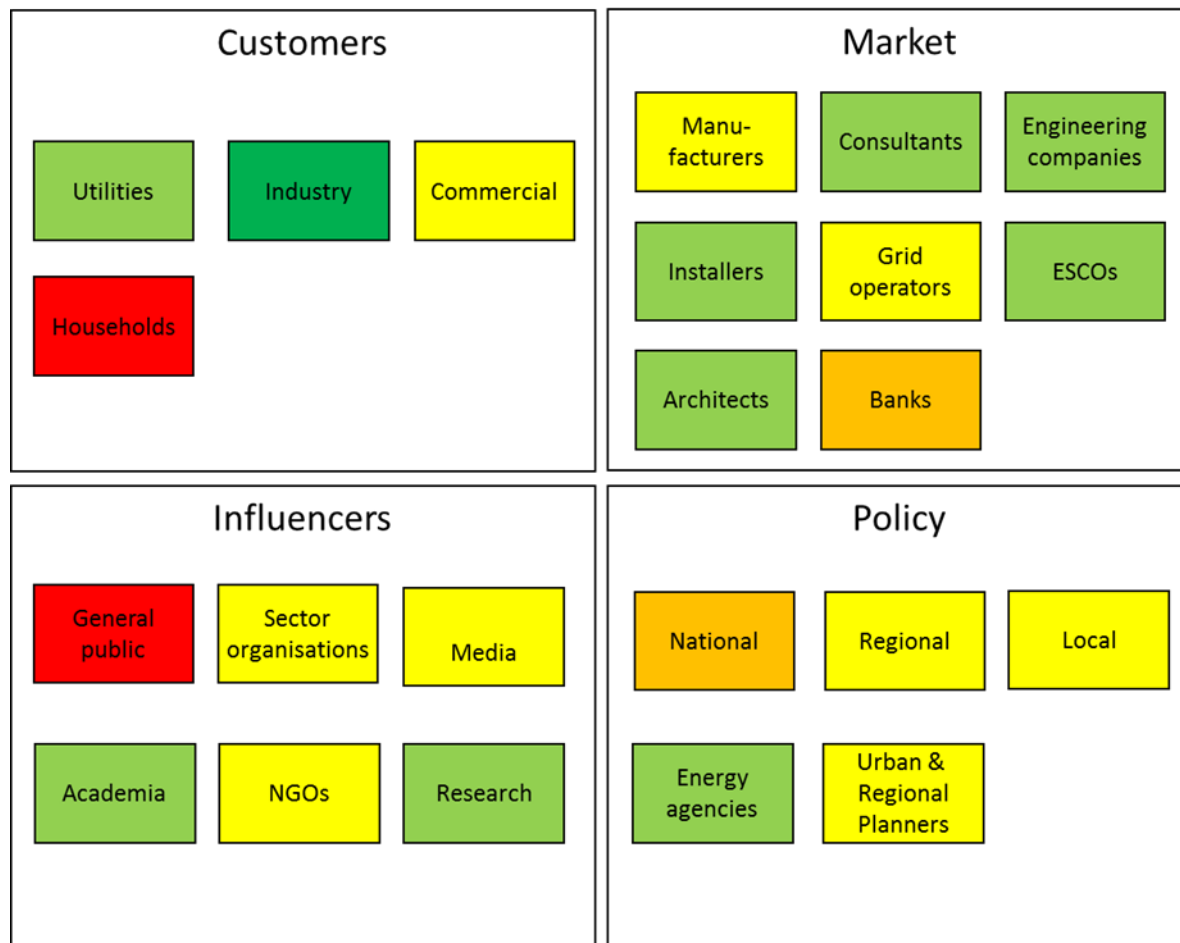


Figure 2: Level of awareness among key actors under the 4 socio-economic groups

#### Legend:

1	Poor	<span style="display:inline-block; width:15px; height:15px; background-color:red;"></span>
2	Low	<span style="display:inline-block; width:15px; height:15px; background-color:orange;"></span>
3	Early awareness	<span style="display:inline-block; width:15px; height:15px; background-color:yellow;"></span>
4	Interest	<span style="display:inline-block; width:15px; height:15px; background-color:lightgreen;"></span>
5	Active market	<span style="display:inline-block; width:15px; height:15px; background-color:green;"></span>

In the Customer group there is a good level of awareness of cogeneration among industry users with high heat loads, who have been implementing cogeneration for a long time. Some negative awareness is the result of a number of units being not operational. Among the smaller commercial sites and households awareness of cogeneration is still limited. Among potential users of small scale cogeneration and among householders people are not aware of the potential for cogeneration application and there are no information tools or guidelines available to make them aware.



Among the enduser group CHP copes with the problem of ‘Conspicuous conservation’<sup>15</sup>, or in other words, ‘To be seen to be Green’ doesn’t help CHP. Stakeholders have mentioned that in certain (public) cases where CHP was the best option, preference was given to PV installations which enhanced the green image of the building

Awareness among **market** players: installers, manufacturers and financial institutions are developed for the large scale installations. Consultants and engineering companies are aware but have a limited experience with conducting full technical and financial feasibility studies. In general there is a lack of experience since there is no continuous growth and customer references through case studies of good examples are missing which can be a guidance for new players in the market. Moreover there is a lack of information on the potential market for cogeneration.

Among **policy** makers, the concept of cogeneration is generally known, and energy agencies such as SEAI have published valuable reports on a regular basis. However the current policy has made a clear choice not to give support to cogeneration and rather to focus on achieving a 100% renewable energy system, where cogeneration plays no role, or a minor role as a transition technology. However no comparative analysis has been made of the environmental impact or the value for grid support to justify this choice and for the purpose of prioritising financial supports. Even when cogeneration has been recognised and a target has been set, such as the 800 MW<sub>e</sub> target still valid in the NEAP, no (financial) support is given to actually reach this target. Therefore the actual awareness among policy makers is considered rather low.

At this moment **influencers** of the cogeneration market have a low impact on the general awareness level. cogeneration is a topic not covered in articles, media, on websites or in guidelines and it is under represented in academic courses and the sector organisations are active but with limited resources.

Moreover, not only the actors only but also the **interaction** between these groups are important on the level of awareness.

Even in 2006 at the moment that the government introduced a cogeneration policy including financial support, the dissemination of this information towards end users was not optimal. There was no central source of information regarding grants, other supports, licensing, and relevant agencies.

Potential users are not aware of the opportunity of a cogeneration application. Several sectors were funded by different supporting programmes, e.g. the healthcare sector, hospitality sector, educational sector. However the information was not disseminated, there were no visible good examples and no case studies that could be disseminated in these sectors to other potential users, for example with the help of sector organisations.

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<sup>15</sup> ‘Conspicuous conservation’ refers to the relatively recent phenomenon of engaging in activities that are environmentally friendly in order to obtain or signal a higher social status.

## 1.5 The economics of CHP

**Although the power-to-gas ratio is higher than the European average, which could be an opportunity for cogeneration in Ireland, simple pay back times are above 5 years which is the maximum for investors. Other financial barriers for cogeneration in Ireland such as the carbon tax and the reprofiling of network charges decrease the attractiveness of cogeneration even more.**

### 1.5.1. General remarks

To estimate the economic attraction of cogeneration in each member state CODE II has established a standard set of cases to be evaluated in each member states. Clearly the capital cost of the cogeneration unit and its maintenance compared to a standard boiler is an important factor. The second significant parameter is the difference between the cost of fuel and the price of electricity over the lifetime of the unit and the uncertainty of these prices are the second main element.

Important financial parameters are:

- a. Investment or capital cost
- b. criteria for internal rate of return (IRR) or return on Investment (ROI)
- c. fuel cost
- d. other operating cost (e.g. maintenance cost)
- e. other fix cost (e.g. staff cost)
- f. electricity prices
- g. value of the heat produced
- h. support by CHP law or RES law
- i. tax exemptions
- j. investment grants or feed-in-tariffs
- k. in case of large CHP participating in the emission trading system (ETS), the CO<sub>2</sub> prices.

Among these, the policy support elements h, i and j are described in chapter 1.3, constituting important revenues for cogeneration projects.

In all market segments the value of the produced heat is linked to the heat market price level, determined mainly by the prices of natural gas and – with decreasing importance - heating oil.

For fossil energy fuelled cogeneration there exist three market segments regarding electricity with fundamentally different decision criteria or parameters (see Table 7).

Main CHP markets		
user	Criterion	CHP size
1. Energy industry	CHP electricity produced competes immediately with the market price of the considered period.	mostly big CHP plants > 10 MW <sub>e</sub> (but partly also smaller CHP devices)
2. Industry and commercial,	CHP electricity produced competes against the power taken from the grid whose price contains additionally to the commodity price the grid cost and taxes & levies, particularly the cost allocation fee from the renewable energy law.	small and medium scale CHP > 50 kW <sub>e</sub> ≤ 10 MW <sub>e</sub>
3. Housing and small scale commercial	CHP competes against other heating systems, mainly heat boilers. The relevant economic criterion is mostly the heating cost.	micro-CHP ≤ 50 kW <sub>e</sub>

Table 7: Main CHP markets

### 1.5.2. Energy industry

In the energy industry the cogeneration plant will run in the periods when its operating cost is lower than the power price. As the gas purchase prices are mainly determined by the commodity price, the commodity gas and electricity prices and their relation are a suitable indicator for the economics of cogeneration in this segment.

### 1.5.3. Industry, commercial, housing

The economic viability and the spark spread can be considerably different for similar cogeneration technologies (e.g. natural gas fired cogeneration) depending on the installed capacity and even in different sectors, as the market prices for both electricity and thermal input fuels vary.

**Business** can generally recover value-added-tax (VAT) but no other taxes including energy taxes, carbon taxes and climate-change levies, so the level of ex-VAT taxes is important. Figure 3 shows the prices of electricity and gas (without taxes) in Ireland.

The electricity prices to Irish business fell throughout 2009 and 2010 and have been increasing since 2011. For IB the price is **above the European average**, for ID it dropped below the European average since 2009, due to the LEU rebate<sup>16</sup>.

<sup>16</sup> Electricity and gas prices in Ireland; 2012; Sustainable Energy Authority Ireland (SEAI)

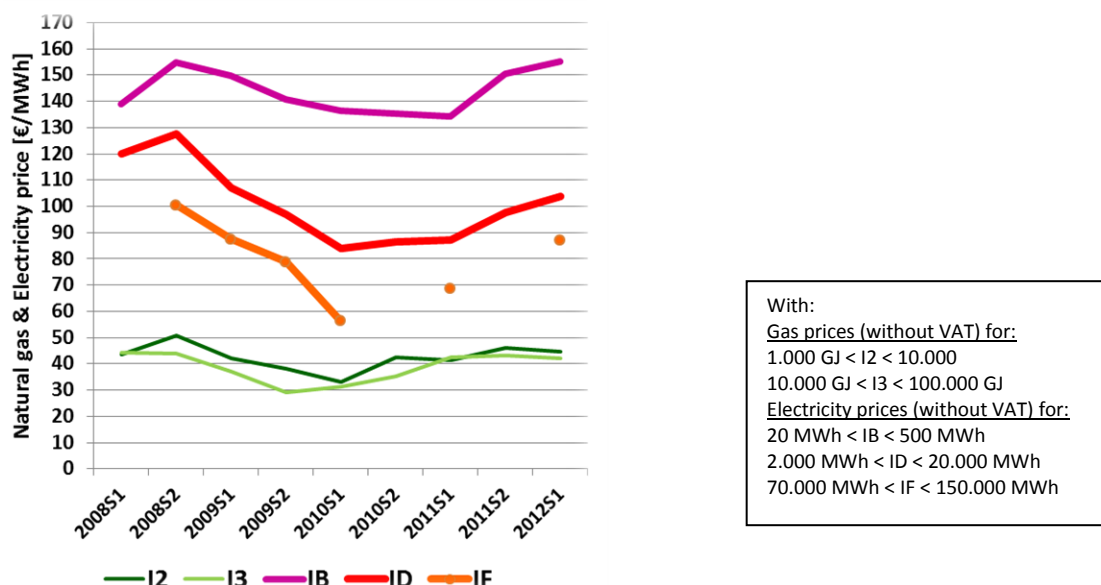


Figure 3: Electricity and gas prices for business in Ireland (source: Eurostat)

Gas prices to business fell from 2008 to the end of 2009-beginning of 2010 and increased since then, till the first semester of 2012. At this moment prices are at 14% below EU average for I2 and 4,8% **below EU average** for I3. Of the EU countries, Ireland has a competitive ranking, at between the 15<sup>th</sup> and the 19<sup>th</sup> highest price<sup>17</sup> (SEAI, 2012).

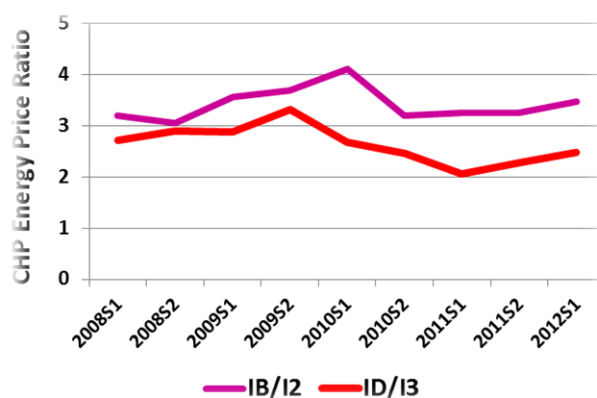


Figure 4: CHP energy price ratio for business (without VAT) in Ireland

Figure 4 shows the power-to-gas ratio. For the larger installations it has declined recently and the ratio is higher than the European average (Figure 5). This is an opportunity for cogeneration based on natural gas firing.

<sup>17</sup> Electricity and gas prices in Ireland; 2012; Sustainable Energy Authority Ireland (SEAI)

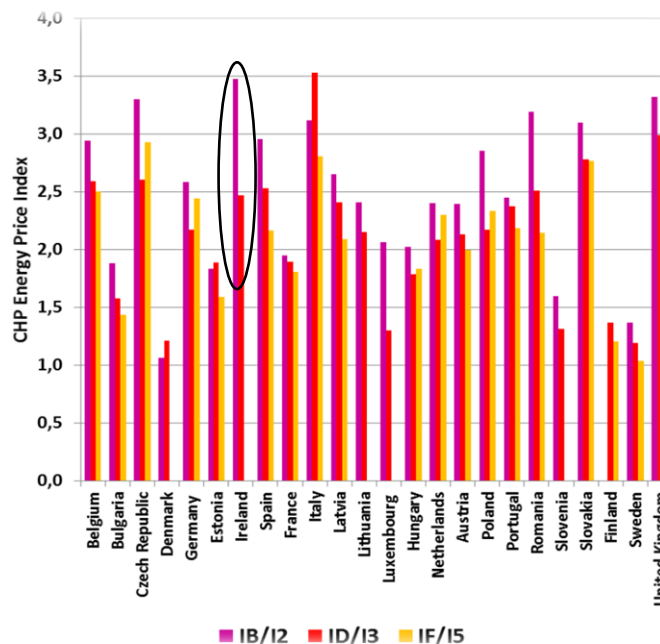


Figure 5: CHP energy price ratio in Europe (2012 S1)

These electricity and gas prices were used with other input parameters in a simple calculation model for a number of reference installations. The resulting IRR and payback times are shown in Figure 6.

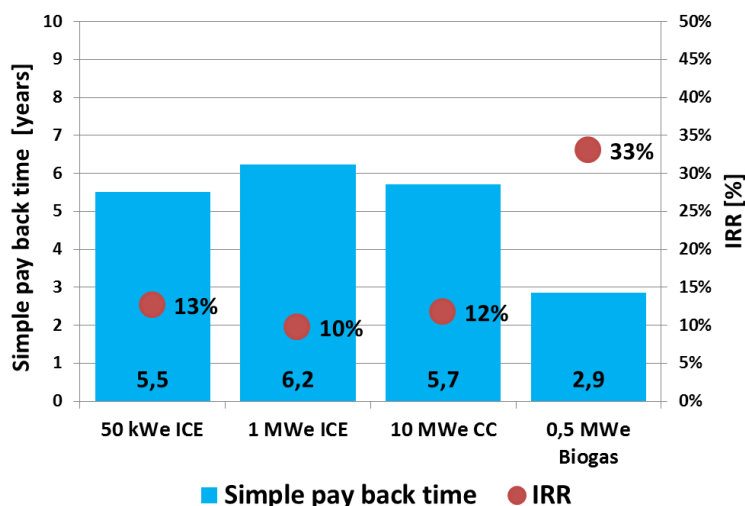


Figure 6: Pay back times and IRR for 4 reference installations in Ireland

As can be seen in the calculations, the typical payback periods are between 5 and 6 years. Discussions with stakeholders confirm these payback times. Payback times for smaller systems are even longer: about 6 to 8 years for micro CHP between 2 and 50 kW and about 12 years for residential micro-CHP (1-2 kW).

Discussions with stakeholders confirm that many corporate investors will only consider capital projects

with payback periods in the order of three to four years, with some organisations requiring even shorter payback periods. While the difference may seem relatively small, this is a significant barrier to the future uptake of cogeneration and these projects will not progress in the absence of some form of stimulus to bridge the gap between projected payback times and what corporations are demanding of their investments.

With the help of ESCo's, projects with payback times of up to 5 years could be feasible, according to discussions with stakeholders. This could significantly influence the uptake of cogeneration for all these 4 typical examples!

However the role of ESCos in removing, or partially removing this barrier, appears to have been limited.

Stakeholders consider a targeted support of about 1c per kWh to be beneficial for cogeneration. Indeed, with this amount of additional support the payback times for all these examples would go below 5 years! If payback times of 4 years have to be considered, this support would have to be 3,5 c per kWh for the 50 kW<sub>e</sub> unit, and 1,4 c per kWh for the 1 and 10 MW<sub>e</sub> units.

**Households** cannot generally recover any taxes so the level of total tax levied is important.

Prices of electricity and gas to households significantly increased in 2011. At this moments electricity prices for households are above EU counterparts, while natural gas prices are below<sup>18</sup>, resulting in a high price ratio. However it has been declining in the last year.

Of course the ratio is much higher during the daytime electricity tariff than in periods when the night rate electricity tariff applies<sup>19</sup>. The actual economic viability of a cogeneration installation is also dependent on how opportunities are maximised.

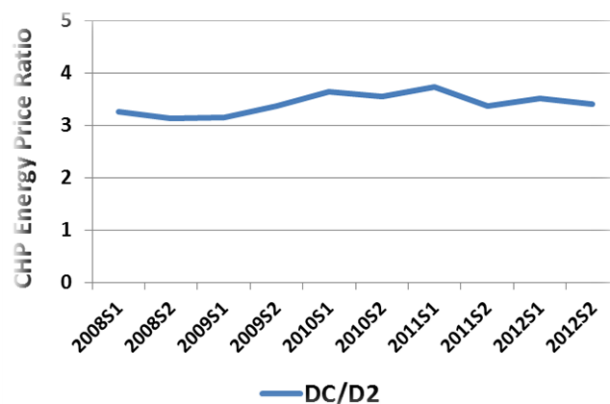


Figure 7: CHP energy price ratio for households in Ireland (including taxes)

<sup>18</sup> Electricity and gas prices in Ireland; 2012; Sustainable Energy Authority Ireland (SEAI)

<sup>19</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

#### 1.5.4. Renewable energy sources

Biomass cogeneration and anaerobic digestion cogeneration receive financial support through a government Renewable energy feed-in-tariff (REFIT) scheme (see paragraph 1.3.2). This makes the economics interesting for bio-CHP. However these installations have other (political) barriers.

#### 1.5.5. CHP economics matrix

The following matrix gives an overview on the economic situation of cogeneration in the main market segments.

Ireland	Micro		Small & Medium (Industry)		Large (District heating)		
	up to 50kWe		up to 10 MWe		more than 10 MWe		
	NG	RES	NG	RES	NG	Coal	RES
Industry							
Services							
District heating							

Table 8: CHP economics matrix

#### Legend:



“normal”

Cogeneration Investment has **good economic benefits**, return on investment acceptable for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.



“modest”

Cogeneration Investment has **modest/limited economic benefits** and return on investment, **limited interest for new investments**.



“poor”

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

NG

**Natural Gas** or appropriate fossil fuel

RES

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

## 1.6 Barriers to CHP

**The most important barriers for CHP in Ireland are: (1) current policy structure is not providing realistic barrier removal or support for CHP; (2) the economics of CHP are unattractive and the spark spread is negative leading to high pay back times and low IRR's; (3) awareness is lacking within several socio-economic groups, (4) district heating is unknown in Ireland which therefore lacks the structures needed to properly explore this option, and (5) the current policy structure and support for micro CHP is not effective to increase deployment in Ireland Not enough support for micro CHP.**

In previous studies different barriers have been identified at all levels. In 2009 the cogeneration Potential in Ireland study<sup>20</sup> made a list of 34 barriers in following sectors:

- Socio-economic structure of Ireland
- Economic
- Fuel prices
- Availability of heat loads
- Technological
- Availability of fuel
- Electricity market
- Competition with other technologies
- Competition with energy saving programmes
- Other

Some of these barriers have been removed and some are still remaining. This study aims at identifying the five main barriers at this moment, that need to be overcome in order to reach the technical potential for cogeneration in Ireland.

After discussions with stakeholders, the 5 important barriers are:

### 1.6.1. Current policy structure is not providing realistic barrier removal or support for CHP.

Although policy makers are aware of cogeneration (see chapter 1.4 on awareness) and cogeneration is covered and targeted in several action plans (see 1.3 - Policy development), the Irish CHP target was not met in 2010 and the current rate of installation is too low to achieve the 2020 target.

At the moment Irish energy and climate policy has a strong focus on growth in renewables. The cogeneration support for bio-energy is consistent with the renewables strategy, and while it is relatively new the response has been short of what will be necessary to achieve the overall CHP target.

There is no support for fossil based CHP despite the ambition set by the CHP target for 2020. Micro CHP is also unsupported in a market where government is supporting high efficiency boilers and several renewables heat sources are supported.

Other supporting systems in the energy sector such as the Carbon Tax relief the Large Energy Users rebate led to controversy among stakeholders without resulting in a solution for the CHP sector.

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<sup>20</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh



Finally grid connection is in some cases a barrier for HE CHP, especially for bio-CHP due to the structure of the REFIT support system, where the requirement to provide a second grid connection for the purpose of exporting electricity at sites where grid connections already exists adds significant cost to projects making the proposal financially unattractive for most investors.

Up to this point the energy efficiency requirements on member states have not been binding. However the contribution of the Irish energy efficiency objective will now contribute to European energy efficiency targets as set in the Energy Efficiency Directive (EED). Article 3 of the EED states that each member state has to set indicative energy efficiency targets with a contribution to this target coming from a range of measures one of them CHP. Full implementation of the EED including explicitly linking the Article 3 energy efficiency target to the existing CHP target could be used as a framework for renewed policy action on CHP.

#### **1.6.2. The economics of CHP are unattractive and the spark spread is negative leading to high pay back times and low IRR's.**

The power-to-gas ratio in Ireland is higher than the European average, which in theory could be an opportunity for cogeneration. However other factors have a negative impact on the economic opportunity: there is no grant support, a feed-in tariff exists only for bio-CHP and the existing policy structure around CHP and its interaction with energy and climate legislation as a whole are not structured to move the sector forward. This results in low IRR's and high payback times.

Especially in this period of Irelands emergence from economic crisis the achievable payback times are too long for investors. While the difference may be relatively economically overcome compared to the support for other parts of the energy sector it is currently a significant barrier to the future uptake of cogeneration and these projects will not progress in the absence of some form of stimulus to bridge the gap between market based projected payback times and what companies require for an acceptable return on investments.

#### **1.6.3. Awareness is lacking within several socio-economic groups.**

As has been discussed in the awareness chapter, policy makers know cogeneration but are not fully aware of its significant supportive role within a policy orientated towards high renewables. There is a good level of awareness of cogeneration among industry users and their market but limited awareness among commercial users and households.

Among the enduser group CHP copes with the problem of 'Conspicuous conservation', or in other words, 'To be seen to be Green' doesn't help CHP.

Moreover there is a lack of information on the potential market for cogeneration, especially for specific markets such as micro cogeneration or district heating. There are no guidelines or case studies of good examples. An exchange of information between the various interest groups is also lacking, and there is no strong cogeneration coalition.

#### **1.6.4. District heating is unknown in Ireland which therefore lacks the structures needed to properly explore this option.**

At the moment there is no district heating in Ireland. Barriers that have been identified in the past include:<sup>21</sup>

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<sup>21</sup> SEI, 2002. Assessment of the barriers and opportunities facing the deployment of district heating in Ireland.

- the mild Irish climate and improved insulation standards in modern buildings which limit the heat usage and hence the potential revenue from heat sales,
- spark spread between gas and electricity prices,
- high capital cost of network construction,
- uncertain consumer uptake because private residents prefer to choose their own method of home heating,
- awareness and knowledge of DH and the lack of one or more committed enthusiasts acting as technology champions.

Low density of housing has also been considered an important barrier to the uptake of district heating. Although increasing population densities in cities offer more and more opportunities, this lack of experience and culture in district heating mean that it is not considered at a political level and that there is a very low general awareness. Therefore there is no funding available, and a strategy for implementation of district heating is lacking.

#### **1.6.5. The current policy structure and support for micro CHP is not effective to increase deployment in Ireland Not enough support for micro CHP.**

Ireland has a large installed base of gas fired boilers in individual homes and buildings. There is therefore a considerable potential for energy efficiency improvements by encouraging the uptake of micro-CHP in housing on one hand, and in commercial sites on the other hand. However micro-CHP has been excluded from grants in the past.

- Support was given to a number of micro-CHP trials, while the stakeholders were already aware of the advantages of the technology and would have been benefitting more from an investment grant that lasted longer.
- Micro-CHP (< 50 kWe) is also excluded from the partial carbon tax relief for cogeneration.

At this relatively early stage in its deployment, the investment cost of micro CHP for end-users is significant. Most member states have some level of support for micro in recognition of its relatively early product stage and its important role in tackling overall energy efficiency in the existing building stock. The absence of support either through the market or from government for micro CHP, presents a barrier to the deployment and uptake of micro-CHP in Ireland.

## 2 What is possible? Cogeneration potential and market opportunities

### 2.1 Potentials and market opportunities

#### 2.1.1. CHP - Potential in Ireland – 2009

Three levels of uptake scenarios in the study 'Cogeneration potential in Ireland' have proposed a technical CHP potential for 2020 between 366 and 773 MWe installed capacity. All three scenarios fall short of the 2020 target of 800 MWe.

The Sustainable Energy Authority of Ireland published a 'Cogeneration potential in Ireland' study in 2009. Low, Medium and High growth in deployment were considered in assessing the potential for growth in cogeneration. . In each scenario, the potential installed cogeneration capacity in 2020 was estimated based upon historic uptake patterns and an assessment of the impact of removing the identified barriers was made.

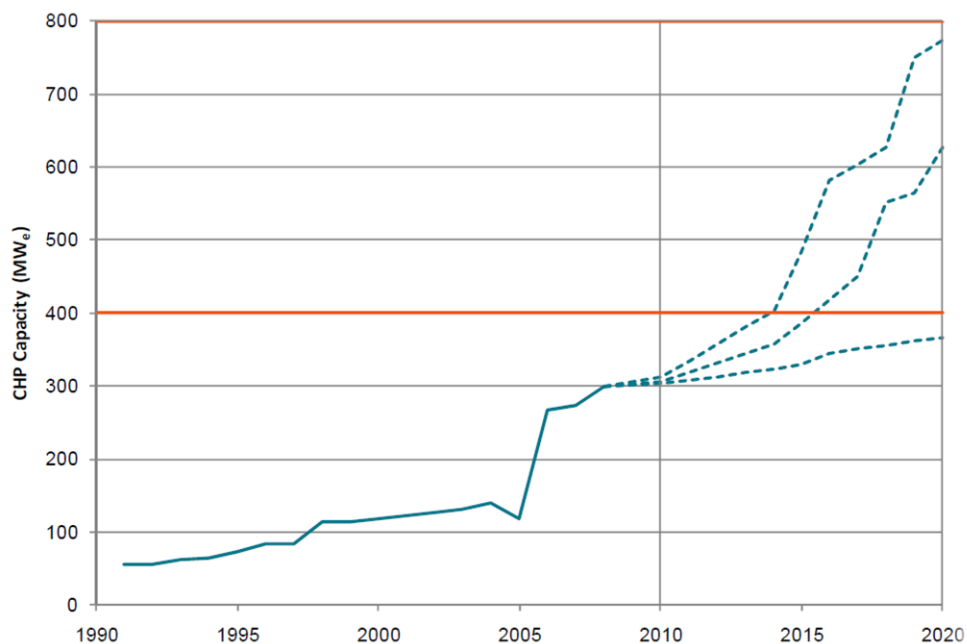


Figure 8: Potential installed CHP capacity under three uptake scenarios (high, medium, low)

- Low uptake scenario uses current rate of cogeneration growth with a conservative assessment of the Irish economic recovery and investment climate.
- Medium uptake scenario assumes the majority of growth in energy intensive sectors is occurs in the latter half of the 2010 to 2020 period, and beyond.
- High uptake scenario assumes existing commercial buildings choose to retrofit cogeneration and invest in the technology is made, with growth between 2016 and 2020.

Although the high uptake scenario comes close the models project in all scenarios that Ireland will fall short of the 2020 target of 800 MW<sub>e</sub>. The low scenario achieves only a 434 MW position in 2020. The high uptake scenario projection requires a high level of policy engagement provided by a wide variety of stakeholders, from the Department of Communications, Energy and Natural Resources, the Commission for Energy Regulation, SEI and a full mobilisation of stakeholders. The experts consulted by CODE 2 considered that this technical potential is realistic and can be reached, if the appropriate measures are taken and the economic proposition of CHP can be brought to a reasonable level.

### 2.1.2. Potential analysis reported to the commission

The 'Cogeneration potential in Ireland' study from 2009 was used in Irish reporting of the CHP potential to the European Commission (under the CHP Directive 2004.) The same numbers are copied for the 3 scenarios.

In this study it was also identified that regarding **fuel type**, it would be likely that the majority of future cogeneration plants would be fuelled on natural gas, although the promotion of biomass fuelled cogeneration would be likely to increase the capacity. However it was found that the majority of large scale energy users investigating the feasibility of cogeneration at their sites were only considering the use of natural gas as fuel source, while only two sites in the wood sector were considering biomass.

Table 9 summarises the use of cogeneration **technologies** and the prospects for future uptake of

Technology description	Potential for use in 2020
Gas fired CCGT with heat recovery (> 100 MW <sub>e</sub> )	Possible in very large scale plants
Steam back pressure turbines (c. 3 MW <sub>e</sub> )	Wood processing Peat briquetting
Steam condensing extraction turbines (c. 3 MW <sub>e</sub> )	Wood processing Peat briquetting
Combined pass out and condensing steam turbine (c. 3 MW <sub>e</sub> )	Wood processing Waste incineration
Gas turbines with heat recovery (up to 75 MW <sub>e</sub> )	Alumina Dairy ICT Pharmaceutical
Internal combustion engines (0,25 to 17 MW <sub>e</sub> )	Multiple sectors in industrial and services sectors
Microturbines (100 kW <sub>e</sub> )	Residential Commercial (small scale)
Fuel cells (1 kW <sub>e</sub> )	Potential dependent on wider development of the technology
Sterling engines (domestic scale)	Potential in residential sector
Micro-CHP gas engines	Yes
Organic rankine cycles (100-500 kW <sub>e</sub> )	Possible in conjunction with geothermal pilot plants
Steam engines	None identified
Biomass gasification with internal combustion	Potential in large scale plants

cogeneration.

Table 9: Cogeneration technology potential in Ireland

### 2.1.3. Market opportunities in the main usage areas

The technical potential could be reached through economic opportunities in the industrial sector (mainly dairy industry and timber processing) and through growth in the services and commercial sectors. For 2020 housing and district heating can be equally important according to the high uptake scenario. For 2030 it is expected that a significant increase will be contributed by the SMEs, housing sector and public sectors.

#### 2.1.3.1. Industry

The industry installed capacity of CHP in Ireland is the dominant capacity today. Irish industry is still showing an interest in cogeneration in traditional CHP sectors despite the current unfavourable economic climate and, according to the 'Cogeneration potential in Ireland' study of 2009 it is technically viable at large scale across a number of sites in different sectors.

The Provisional 2008 National Energy Balance provides a useful indicator of the potential for the uptake of cogeneration, with the total (final) electrical and thermal demands for the main sectors identified.

In examining the types of industries, a number of specific sectors were identified that showed the potential for cogeneration.

Sub-Sector	Final Electricity Demand (GWh)	Total Fossil Fuel Demand (GWh)	Renewables Fuel Demand (GWh)	Portion of Fuel Demand Suitable for CHP <sup>(Note 2)</sup> (GWh)
Non-industry mining	663	861	0	372
Food, beverages & tobacco	1,989	3,385	686	2,501
Textiles & textile products	93	198	0	35
Wood and wood products	349	174	1,082	1,117
Pulp, paper, publishing & printing	372	326	0	244
Chemicals & manmade fibres	1,186	1,907	0	1,268
Rubber & plastic products	372	174	0	116
Other non-metallic mineral products	640	5,234	0	593
Basic metals & fabricated metal products	872	5,850	0	2,094
Machinery & equipment n.e.c.	198	233	0	163
Electrical & optical equipment	1,326	1,151	0	919
Transport equipment manufacture	105	116	0	81
Other manufacturing	302	233	0	35
<b>Total <sup>(Note 1)</sup></b>	<b>8,037</b>	<b>19,738</b>	<b>1,768</b>	<b>9,537</b>

Note 1: There are statistical differences associated with the National Energy Balance which account for the differences in the total summations.

Note 2: The fuels with CHP potential in industry are natural gas, biogas, LPG, refinery gas, biomass and peat.

Table 10: Breakdown of Final Energy Consumption in Industrial Sector (2008)<sup>22</sup>

<sup>22</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

### Food industry (mainly dairy industry)

There is currently 58.8MWe of cogeneration capacity installed across the food and drink sector, including mainly dairies and drinks manufacturers. Due to the nature of the processes involved across the dairy industry, requiring significant heat and electrical loads during the milk intake season, cogeneration may be viable at other dairies. The industry has estimated a growth of 50% in the dairy sector over the target period, all of which could be carried out by cogeneration units. As such it would be possible to install 10 to 15 more sites, with an installed capacity of 50-60 MW<sub>e</sub> by 2020.

### Timber processing

Several wood processing sites in Ireland use biomass to fire large scale cogeneration units (in the range of 1,8 to 3,3 MW<sub>e</sub>). A number of other sites have been identified with similar or greater technical cogeneration potential. Stakeholders have identified these sites as also having commercial potential, when they get a small amount of support. This would contribute about 50 MW<sub>e</sub> to the potential by 2020.

### Pharmaceuticals

There is already 12.1 MWe installed CHP capacity within the pharmaceutical sector, with the nature of the manufacturing operations generating both substantial electrical and heat demands. In the view of national experts and the Dublin workshop discussion it was agreed that growth in production can still be expected in this sector which may drive plant renewal and upgrade.

### *2.1.3.2. Commercial/Services Sector*

Installations of CHP in the commercial sector has shown the highest growth rate in recent years and the projections indicate that this sector will continue to contribute an increasing proportion of cogeneration capacity out to 2020. At the moment the services sector accounts for 80% of the number of cogeneration units, and as seen in Table 4, hotels and hospitals are the majority of sites within that group at 73 units. These sub-sectors, in particular, benefit from having close to constant demand for heat and electricity. The sector has already made use of the grant support schemes in the past, and responded with growth, and it is expected that a considerable amount of the technical potential can be reached if they can be convinced again of the commercial possibilities. Moreover it has been identified that within this group<sup>23</sup> not all of the end users are reliant on strong economic growth for uptake.

At this moment this sector also benefits from the experience and steady uptake of micro-CHP units. More than 30 units of 5,5 kW<sub>e</sub> are operating in this market segment and product manufacturers expect further growth..

Therefore following subsectors are potentially important for the future uptake of cogeneration:

#### Hospitality

The hospitality sector formed a very buoyant and receptive market for cogeneration in the past, partly due to growth in the Irish tourism market and partly on the basis of the stimulus provided by the SEI Cogeneration Deployment Programme. There are still opportunities for retrofitting cogeneration in the current hotel stock. However since growth in uptake of cogeneration in this sector is suffering from the economic crisis, a route to supplying a sound commercial case would be needed as a stimulus.

#### SME's/commercial micro-CHP

In 2008, the Sustainable Energy Authority of Ireland commissioned a field trial to assess the operation, performance and benefits of micro-CHP in commercial situations. The trial demonstrated that micro-CHP

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<sup>23</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

systems that are well designed and installed in commercial sites deliver reasonable levels of efficiency and CO<sub>2</sub> savings, and are at least as cost-effective as competing alternative energy technologies, such as solar thermal, small-scale wind, and solar photo-voltaic (SEAI, 2011). At this moment the market for **5 kW micro-CHP** in the commercial sector is rapidly growing in Ireland. This technology has proven to be working and is very suitable for SME's. Therefore a high potential is expected. A market analysis<sup>24</sup> suggests that at this moment there are sufficient applications in Ireland to accommodate at least 1000 units of 5 KW reaching a total installed capacity of 5 MW, split approximately as follows:

- nursing homes/small hospitals: 300 (1,5 MW)
- hotels (up to 50 bedrooms): 300 (1,5 MWe)
- leisure centres/ swimming pools: 150 (0,75 MWe)
- district heating (apartments): 100 (0,5 MWe)
- service stations: 50 (0,25 MWe)
- fire stations/ local authorities/ schools: 50 (0,25 MWe)
- other commercial: 50 (0,25 MWe).

Within the CODE 2 project a separate micro-CHP potential study was conducted in which the potential for commercial systems ( $\pm$  **40 kW<sub>e</sub>**) was determined for 2020 and 2030. More information on the methodology and the results can be found in Annex 2: Micro CHP potential assessment. The potential penetration is estimated at:

- 240 units in 2020 (9,6 MW<sub>e</sub>) and
- 3300 units in 2030 (132 MW<sub>e</sub>).

Although both studies were made independently, they both suggest that in the short term (2020) there is a moderate potential for micro CHP in the SME sector. The CODE2 study also expects an even larger potential between 2020 and 2030.

#### **2.1.3.3. Public sector**

Within the targets of 20 % savings in energy efficiency, 33% of energy savings in the public sector were also included (see NEEAP: National Energy Efficiency Action Plan). Therefore in this sector additional growth can be expected. One important subsector is the healthcare sector.

##### Healthcare

The healthcare sector was considered as a strong candidate for new cogeneration capacity given its 24-hour occupancy and seven day per week operation, particularly in hospitals and nursing homes. Therefore, despite the economic downturn, it is expected that the healthcare sector can continue to increase their share of the cogeneration market, either through new builds or retrofitting, particularly in older, less energy efficient buildings.

##### Schools, sport & leisure

#### **2.1.3.4. Residential**

Many houses in Ireland are not connected to the gas grid but are fuelled on oil (kerosene or gas oil). However, while it is technically feasible to operate small cogeneration units, including micro-CHP units, on kerosene (or gas oil), it is not particularly attractive to end users.. Consequently, the potential for the conversion from an oil based boiler heating system to an oil based cogeneration system in the residential

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<sup>24</sup> Study by Kinviro Limited



sector is likely to be limited<sup>25</sup>

The Provisional Energy Balance for 2008 indicated that the residential sector yields a high thermal and electrical demand, offering considerable potential for the use of cogeneration. Although the residential sector has not shown the same level of growth as the industrial or the commercial/services sectors, it is expected that strong growth will take place in light of technological advances in household micro-CHP. There are approximately 500.000 homes connected to natural gas in Ireland.

The High Uptake Scenario<sup>26</sup> projection suggests that the residential sector could see very strong growth out to 2020, contributing a similar cogeneration capacity to that from the commercial sector. Breakthroughs in the residential micro-CHP market are expected in this scenario because of assumed feed-in-tariff support, technical advances and a growing number of installations in the existing housing market.

Within CODE2 the separate micro-CHP potential study also considered the potential for household micro-CHP ( $\pm 1 \text{ kW}_e$ ) which was determined for the following decades. More information on the methodology and the results can be found in Annex 2: Micro CHP potential assessment. The potential deployment is estimated at:

- 2700 units in 2020 (27 MW<sub>e</sub>) and
- 128.000 units in 2030 (128 MW<sub>e</sub>).

Compared to the high uptake scenario<sup>27</sup>, this is much lower in 2020 but the market is expected to grow by 2030. Moreover during the Dublin workshop discussions it was considered that 200 to 300.000 units could be feasible.

#### **2.1.3.5. District heating**

While micro-CHP in individual houses is expected to grow once the technology is further developed and introduced in the market, district heating, or perhaps micro grids in the initial phase has potential in more densely populated areas, residential campuses, government building groupings and custom built developments and cities. A report by Sustainable Energy Ireland (SEI, 2002) quantified the potential for district heating in Ireland. 100 MW<sub>e</sub> was 'technically' feasible and 50 MW<sub>e</sub> was feasible against 'economic' criteria. The report identified a potential for between 5-10 'economic' schemes. The economics are such that retrofitting a house for DH can cost in the region of €2,500 per house whereas new houses can be connected to a DH scheme for as little as €150 per unit.

#### **2.1.3.6. Bio-CHP**

Bio-CHP is of very small importance in Ireland at this moment. In 2010 only 2 biomass units with a capacity of 5 MW (Table 2) were operational. Reasons of this low uptake include: the limited availability of a biomass supply, the economics of the plant and the higher maintenance costs (compared to natural gas).

Bio-CHP is sometimes seen as a solution for price dependency of gas fired CHP. However in Ireland users are highly dependent on import and on competition for biomass by other sectors.

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<sup>25</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

<sup>26</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

<sup>27</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh



The future penetration rate of bio-CHP in the cogeneration market is estimated as follows:

- 2009: 1,1% (EEA, Eurostat)
- Projection for 2020: 6,0%
- Projection for 2030: 6,4%

The methodology and assumptions are explained in Annex 3: Bio-CHP potential assessment.

## 3 How do we arrive there? The Roadmap

### 3.1 Preliminary remarks

The roadmap is the result of a preparatory process involving 3 meetings/webinars and over 20 one-on-one expert discussions with experienced stakeholders in Ireland followed by an expert workshop in Dublin on June 6<sup>th</sup> 2013. (see introduction) .

The chapter is based on the assumption that Ireland as part of its commitments to energy efficiency remains interested in growing the level of cogeneration in its economy to reach the target level set f in the White Paper (800 MW<sub>e</sub> by 2020). It also adopts the results of scenario modelling showing that with a meaningful level of policy attention and in the view of stakeholders that 800 MWe by 2020 is an achievable goal. This chapter aims at creating a roadmap and outlining concrete and practical steps to reach this goal.

The First most important step to overcome the existing barriers is discussed and then the implications in terms of action for achieving cogeneration targets for 2020 and 2030 are proposed for different sectors.

### 3.2 Overcoming existing barriers and creating a framework for action

#### 3.2.1. Building a policy vision for CHP

A clear policy vision needs to be established on the role of cogeneration in the energy strategy of Ireland if progress is to occur... Cogeneration is an important measure in obtaining the energy efficiency objectives of member states , and as an energy *conversion* technology it stands beside renewable energy *production* in its low carbon and sustainability potential. Through its integrated approach cogeneration lowers network investment costs and transmission losses. Considering cogeneration as a transition technology risks missing opportunity in energy efficiency. Cogeneration is fuel independent and is as significant in its impact on renewables as on fossil fuel Therefore policy makers have to become aware of the position of cogeneration within the renewable aspirations.

Policy makers need to understand the importance of the role of cogeneration in network balancing and other electricity network services as well as in obtaining CO2 emission reductions. When support is allocated towards a technology, the advantages and impacts of the different technologies need to be compared. Results from test sites which combine wind, PV and cogeneration provide valuable information in such studies.

As cogeneration will be an important part of implementation of the EED, a vision should be made in 2013/2014 on how cogeneration will contribute to energy efficiency targets of Ireland and of Europe and the EED is an opportunity to establish a consistent framework to achieve these targets.

A first important step in creating this policy vision is for industry to request a clearly identified responsibility for CHP within the Department of Energy.

#### 3.2.2. Removing policy barriers

Once a policy vision has been created, it will become more obvious where there may be existing policy gaps and if there are shortcomings or barriers created by existing policy these will become visible.

Article 19 of the EED mentions that Member States shall evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States. Such measures to remove barriers may include providing incentives, repealing or amending legal or regulatory provisions, or adopting guidelines and interpretative communications, or simplifying administrative procedures. The measures may be combined with the provision of education, training and specific information and technical assistance on energy efficiency.

Discussions such as the ones on the Carbon Tax relief and the Large Energy Users rebate should be put to an end and instead clear solution for the CHP sector should be found.

### **3.2.3. Improving economic viability of CHP projects**

The economic analysis has clearly shown that due to favourable electricity and gas prices compared to the rest of Europe, economics are actually offering opportunities for cogeneration based on natural gas firing in Ireland. Although the average payback time for a CHP project is about 5,5 years, the power-to-gas ratio is still higher than in many European countries.

Solutions to improve the economic viability include:

- 1) Obtain financial support (see next point);
- 2) Overcome the credit problem with financial schemes;
- 3) Overcome the financial barrier with other incentives.
- 4) Encourage competition on the market to reduce prices.

While the average payback times across a range of projects may still be above the 3 years that investors require, specific projects may see opportunities and can be carried out.

According to a report on the New National Climate Policy (NESC, 2012), the financial barrier for energy efficiency measures in general can be overcome. Indeed, the search for ways to promote funding of energy efficiency investments, after the removal of grant aid, might contribute to addressing the wider credit problem. What steps can individual companies take to create an opportunity and improve their economics (e.g. flexibility mechanisms). Other possibilities include the proposed Pay as You Save (PAYS) scheme, and some alternatives which might be considered and piloted to target different market segments, several of which are aimed at attracting greater levels of private savings into retrofit. A PAYS scheme may have the potential to overcome several of the barriers:

- it might help facilitate investments with longer paybacks (tackle the split-incentive issue associated with higher investment) because the debt is linked to the property not the initial homeowner in person;
- it might help overcome the obstacles suggested by customers with high discount rates by providing upfront funding at no cost to the householder; and
- it might also help overcome aspects of the financing barrier.

However this system has not been implemented before in Ireland.

In the non-residential sector, where investment barriers and uncertainty remain there may be a role for Energy Service Companies. ESCO's either by managing energy facilities or through special financial contracts such as performance contracting limit the financial risk and the support challenge for the site

where the CHP resides. Increased ESCO activity can be led through requirements/enabling in public sector procurement.

Article 17 of the EED states that Member States shall encourage the provision of information to banks and other financial institutions on possibilities of participating, including through the creation of public/private partnerships, in the financing of energy efficiency improvement measures. Member States shall establish appropriate conditions for market operators to provide adequate and targeted information and advice to energy consumers on energy efficiency. ESCO development is encouraged through Article 18.

Smart metering is also seen as an element of a successful future financial solution, especially as mechanisms to valorise electricity exported to the grid emerge. The new ancillary services market and the demand response market which will be enabled through implementation of Article 15 of the EED, can reward CHP for services offered to network support.

The European Cohesion fund has set aside 4% of the funds for energy savings projects. This is matched funding with the public sector. Interest in public building renovation and improvement could be funded through cohesion and used to develop knowledge and capacity in the sector and supporting supply chain as well as developing appropriate on site CHP and heat networks via the public sector.

It should be realised by potential users that a CHP plant lasts for 15 years, therefore after a payback period of 5 years you still have 10 years of energy savings benefit.

Stakeholders also realise that, especially for the household or even commercial micro CHP, payback times are maybe not the most important issue. Decisions of possible buyers depend on a range of benefits as well as price incentives. Therefore it is also important for the industry to work on marketing, making the product visible, and on convincing end users with other benefits such as independence of electricity supply, low carbon foot print, modern energy approach.

#### **3.2.4. Obtaining financial support**

An acceptable financial return as well as access to capital is necessary to reach the High Uptake Scenario potential.

Under Article 14 of the EED Member States are required to adopt policies which encourage reaching the cogeneration potential. To meet the requirements of the Directive all member states have to carry out a comprehensive assessment of the potential for high-efficiency cogeneration based on a cost-benefit analysis which identifies the most resource- and cost-efficient solutions for heating and cooling needs. When the cost-benefit analysis is positive, Ireland will have to take adequate measures to accommodate the development of high-efficiency cogeneration.

However the support should be well targeted and well calculated. It is generally agreed that industry and market actors should be more scrupulous in assessing the financial support needed to successfully implement CHP and that they should convey this clearly to policy makers. Different types of support can be given.

- Compare advantages of technologies:  
As already discussed above, a comparative carbon foot printing or primary energy savings calculation of competing programmes should be conducted for the purpose of prioritising financial support.

- **Type of support:**  
An analysis should be made, based on experiences in the past and experiences from other European countries, which type of financial support would be optimal for the specific situation of Ireland. Policy makers should make a comparative analysis on the type of support. A first simple analysis is made on the next page.
- **Amount of support:**  
Stakeholders consider a targeted support of about 1c per kWh to be beneficial for cogeneration. This would already be enough to lower the payback times below 5 years.
- **Where to obtain support:**  
Discussions should be started with the private sector if financial support could be obtained through suitably designed financial products.
- **Target the support:**  
A comparative cost benefit analysis should be made to which sectors the support should be given. Not every technology requires the same amount of support. Households as well as commercial micro-CHP sectors in Ireland are limited in access to capital as disposable income is under many demands hence these sectors are in very clearly in need of support if they are the target for CHP growth..

During the Dublin workshop , held in June 2013 on the framework of the CODE project, different types of support were already proposed. There was a consensus among the stakeholders present that a combination of feed-in-tariffs and generation tariffs were the most likely support mechanisms to succeed in the current economic climate.. It is important that electricity exported to the grid will be validated.

Most important, discussions around financial support systems should be overcome and CHP operators should participate fully in the new electricity network markets which are emerging to provide stability to the network with a greater content of intermittent renewables.

Article 14 of the EED also states that Member States shall ensure that any available support for cogeneration is subject to the electricity produced originating from high-efficiency cogeneration and the waste heat being effectively used to achieve primary energy savings. Public support to cogeneration and district heating generation and networks shall be subject to State aid rules, where applicable.

Specific for micro-CHP, several articles in the EED support the growth in this sector. The EED recommends financing for research, demonstration and accelerated introduction of the technology and optimization of the grid connection.

### How to judge a fair level of support compared to the primary energy savings

In Figure 9 the primary energy saving of CHP is compared with an installation with separate production of heat and power. 100 units of primary energy generate in a CHP installation with a total efficiency of 90% 54 units of heat and 36 electricity. When the same amount of primary energy is used in a reference installation to generate the same amount of heat (with an efficiency of 90%), the reference electricity generation is only 20 units. Therefore, 16 units of **additional electricity** are generated in a CHP installation.

If the subsidy for the electricity production via CHP is a feed-in-tariff of A €/MWh, the total cost for the government for the production of the 'additional electricity' (without adding additional fuel) would be  $A \times \frac{36}{16}$  €/MWh.

We compare this with the feed-in-tariff for renewable energy, for example a **hydro energy** plant with a maximum export capacity of or less than 5 MW which is connected directly to the electricity network, and which receives a REFIT tariff of 87,455 €/MWh (in 2013) and a balancing payment of 9,9 €/MWh (DCENR, 2013). The market value of electricity is about 65 €/MWh (Commission, 2013), therefore the additional cost of the support system is 32,355 €/MWh. If the government would give the same amount of support for the 'additional' electricity from CHP, as for hydro-energy, the amount of support (A) would be 14,38 €/MWh (= **1,4 c/kWh**).

Similar this can be compared to a small scale **wind** project with a maximum export capacity of or less than 5 MW, which receives a REFIT tariff of 71,664 €/MWh (in 2013) and a balancing payment of 9,9 €/MWh (DCENR, 2013). The market value of electricity is estimated at 52 €/MWh\*, therefore the additional cost of the support system is 19,664€/MWh. If the government would give the same amount of support for the 'additional' electricity from CHP, as for small scale wind energy, the amount of support (A) would be 8,74 €/MWh (= **0,9 c/kWh**).

Therefore it can be concluded that a support of **1c/kWh** which is often demanded by the CHP sector would be in the same magnitude as the support for wind. This amount of support would be much cheaper per amount of primary energy savings than the support for hydro energy.

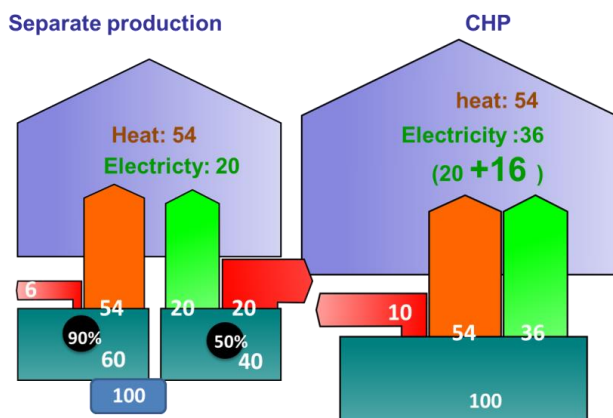


Figure 9: Primary energy savings of CHP.

\* For wind energy the market value will be realistically about 20% lower than average due to the effect on the market from simultaneous production of all wind energy and the imbalance between the predicted and actual production.

### 3.2.5. Increasing awareness

Awareness should be raised at several levels, not only at policy level as discussed above.

In larger energy intensive industrial applications awareness of the advantages of cogeneration appears to be sufficient. Stakeholders have mentioned that all potential cogeneration sites in large industry have already studied the possibilities for implementing cogeneration. The challenge at this moment appears to be at the level of commercial premises and the services sectors who are aware of the benefits of CHP to their operations..

Article 8 of the EED requires auditing and empowerment of customers. Implementation of this article could stimulate capacity building among SME's, services and commercial premises and households increasing speed of uptake and hence progression towards the CHP target.. In article 8 there is a special reference to SME's being encouraged to use energy audits.

Following steps should be taken towards these market sectors by industry and appropriately with publicly funded communication plans to create awareness among citizens and hence informed participation in the growth of CHP:

- Develop general awareness on the role of CHP in energy independence, security of supply, energy efficiency and emphasize the environmental and social benefits.
- Help commercial premises realise that pay back times are not the only or most important sales argument. Work on publicity and marketing campaigns and emphasise corporate responsibility, social and environmental benefits and energy independence. Make conservation suspicious.
- At the appropriate planning level encourage the development of comprehensive flow charts/road maps setting out the process for installing cogeneration from inception to commissioning.
- Preparation by industry, sectorial industry associations and publicly funded energy services and agencies of case studies for different sectors. Potential users are not well aware of the market. Several sectors were funded by different supporting programmes, e.g. the healthcare sector, hospitality sector, educational sector. This information should be disseminated and case studies should be made from good examples for other potential users, for example with the help of sector organisations. Article 17 of the EED encourages the exchange and wide dissemination of information on best energy efficiency practices in Member States.
- Develop targeted programs for the promising sectors such as the hospitality sector. Hospitality formed a very buoyant and receptive market for cogeneration in the past, partly due to growth in the Irish tourism market and partly on the basis of the stimulus provided by the SEI CHP Deployment Programme. There are still opportunities for introducing cogeneration in the current hotels. A targeted programme for the sector together with case studies and awareness programmes involving the cogeneration vendors, ESCOs and the Industry Representative bodies would therefore be beneficial.
- Use the how-to-guides, developed within the CODE2 project, to target specific sectors. Use proper cost benefit analyses to ensure proper design.

For the micro-CHP market in the households, it is still early to develop awareness. At this moment micro-CHP units for houses (1kW) are becoming available on the market, so it could be possible to start a



demonstration programme to prove the technology for the Irish market.

Awareness can also be created with the help of ‘champions’: public figures who raise awareness on cogeneration. It has been noted already<sup>28</sup> that one or more committed enthusiasts acting as technology champions would be beneficial for driving forward socio-technical change to disseminate knowledge of district heating. This strategy could be used in general for cogeneration.

Raising technical knowledge of CHP among stakeholders will be part of Article 16 of the EED, in which Ireland can ensure that, by 31 December 2014, certification or accreditation schemes, or equivalent qualification schemes, including suitable training programs, become available for providers of energy services, energy audits, energy managers and installers of energy-related building elements.

Article 17 also states that information on available energy efficiency mechanisms and financial and legal frameworks should be transparent and widely disseminated to all relevant market actors, such as consumers, builders, architects, engineers, environmental and energy auditors, and installers of building elements. Member States shall, with the participation of stakeholders, including local and regional authorities, promote suitable information, awareness-raising and training initiatives to inform citizens of the benefits and practicalities of taking energy efficiency improvement measures.

### **3.2.6. Setting up a CHP coalition**

Not only awareness among different stakeholder groups is important, but also the continuous exchange of information between these groups which creates understanding of the issues and opportunities and creates a dialogue partner for policy makers. A stakeholder “coalition” or “platform” could be created which would play a constructive central role as a dialogue partner for policy makers as they implement the EED and further energy and climate policy. This group should serve various aims: an information exchange group for stakeholders, a neutral discussion forum for the different aspects of the cogeneration sector and an advocacy body relaying information and thinking to the policy makers concerning cogeneration in key policy debates.<sup>29</sup>

### **3.2.7. Developing a framework for district heating**

Under the EED Ireland has an opportunity to develop and test concepts of district heating under the heating and cooling plan of Article 14. The obligation for identifying the potential for efficient district should be a driver to overcome the barrier of lack of interest in and awareness of district heating among non-industrial players in Ireland. Ireland also has the obligation to analyse the cost benefit of the opportunities and to make adequate provisions to ensure the cost effective potential is developed.

Also, some of the barriers preventing the uptake of DH in Ireland could possibly be overcome by the introduction of institutional drivers. This could be the insistence that the planning process for development projects includes the study of possible CHP/DH schemes (SEI, 2002). The government should continue its existing initiatives to realise the economic potential, i.e. to identify suitable potential projects and attempt to remove the numerous barriers preventing the uptake of CHP/DH schemes. Only when policy makers are aware, other stakeholders should also be involved, and private residents should be motivated towards participating in district heating projects.

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<sup>28</sup> SEI, 2002. Assessment of the barriers and opportunities facing the deployment of district heating in Ireland.

<sup>29</sup> For example the CHP coalition in Flanders, see ‘CHP Roadmap Belgium’ of the CODE2 project.



### 3.2.8. Simplifying export of electricity to the grid

A smart grid solution using smart meter configurations is an alternative to the double connection in which sub-metering is used to provide metered data identical to that which can be collected from a second grid connection.

Incentives to transmission and distribution system operators to improve the network infrastructure and to simplify and shorten authorization procedures shall be provided by Article 15 of the EED. The aim of Article 15 is to maximize grid and infrastructure energy efficiency and to promote demand response. Tariff regulations which are detrimental to overall energy efficiency and participation in demand response and balancing are removed in Article 15. Also, the Irish authorities have, according to Article 15, to provide incentives for grid operators to improve efficiency: the regulator should strongly recommend energy management services, innovative pricing formulas, intelligent metering or smart grids. An assessment of the improvement in energy efficiency in the design and operation of the gas and electricity infrastructure has to be undertaken.

### 3.2.9. Identifying specific potential market for CHP

At the time of writing the target of 800 MW<sub>e</sub> of cogeneration in Ireland in 2020 is not apparently supported by a tangible strategy or action plan. The next important step for cogeneration in Ireland will be the assessment of the potential for high efficiency cogeneration in Ireland an obligation under Article 14 of the EED. Which must be completed by the end of 2015 Ireland also has to analyze the costs and benefits of the opportunities and to make adequate provisions to ensure the potential is developed, as required in Article 14.

In this study the potential has been determined for micro and bio CHP. These results should be used for further development of plans for the market for cogeneration in Ireland. These 3 suggestions were first made in the Irish potential study<sup>30</sup> but haven't been implemented so far. In the view of the author these recommendations are still valid.

- Within this target, sub-targets should be established for the three high level sectors (industrial, services and other) in order to focus support programs, resources and marketing campaigns. The sub-targets should be established being informed by the three Uptake Scenarios.
- Specific targets should be developed for fossil fuel fired cogeneration, biomass fired cogeneration and anaerobic digestion fired cogeneration.
- Investigate the merits of establishing further sub-targets for specific industrial and commercial sectors (e.g. pharmaceutical, wood processing, hospitality and healthcare). The use of the targets at a national level is not beneficial to sector specific barriers and improving the uptake of cogeneration.

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<sup>30</sup> Combined Heat and Power (CHP) – Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

### 3.2.10. Overview of the roadmap steps

Action	Reason	Steps	Target group	Outcome	Time planning
<b>1 Building a policy vision for CHP</b>	<ul style="list-style-type: none"> <li>- Current targets are not met</li> <li>- No view of CHP within renewable policy</li> <li>- No understanding of role of CHP in energy efficiency targets</li> </ul>	<ul style="list-style-type: none"> <li>- Comparative analysis of advantages of CHP</li> <li>- Continuous communication by a CHP coalition to follow up objectives</li> <li>- Follow up of EED implementation by CHP coalition</li> <li>- have a CHP champion within the Department of Energy</li> </ul>	Policy makers CHP coalition	A better policy where the role of CHP within the energy efficiency and renewable energy landscape is better defined.	2015
<b>2 Removing policy barriers</b>	Ongoing discussions on policy measures are a barrier for the development of the CHP sector.	<ul style="list-style-type: none"> <li>- Put discussions to an end</li> <li>- implement article 19 of the EED</li> </ul>	Policy makers	CHP treated equally with other electricity generators	2020
<b>3 Improving economic viability of CHP projects</b>	Payback times are too long for investors in the current economic climate.	<ul style="list-style-type: none"> <li>- Decide on the introduction of PAYS schemes</li> <li>- Promote ESCO activities</li> <li>- Support flexible mechanism and/or smart metering</li> </ul>	Policy makers	With the help of these systems the small economic barrier towards feasible payback times can be overcome.	2020
<b>4 Obtaining financial support</b>	<ul style="list-style-type: none"> <li>- to make projects economically viable</li> <li>- to reach the potential for CHP</li> </ul>	<ul style="list-style-type: none"> <li>- compare different technologies</li> <li>- open discussion for type and amount of support</li> <li>- obtain support from policy or private sector</li> </ul>	CHP coalition, stakeholders and policy makers	A small amount of targeted support would result in energy efficiency savings, reaching CHP targets and kicking off the technology in certain sectors.	2015
<b>5 Increasing awareness</b>	<ul style="list-style-type: none"> <li>- lack of awareness among actors in all socio-economic groups</li> <li>- lack of exchange of information between groups</li> </ul>	<ul style="list-style-type: none"> <li>- develop general awareness campaign</li> <li>- develop flow charts</li> <li>- prepare case studies</li> <li>- develop targeted programs</li> <li>- use how-to-guides</li> </ul>	Policy makers CHP coalition	A high degree of awareness among all relevant players will support the market for CHP.	2015

		<ul style="list-style-type: none"> <li>- choose champions</li> <li>- implementation of article 16 of the EED</li> <li>- Implementation of Article 17 of the EED</li> </ul>			
<b>6 Setting up a CHP coalition</b>	<ul style="list-style-type: none"> <li>- no exchange of information between stakeholder groups</li> <li>- no platform for discussion</li> <li>- no lobbying mechanism towards government</li> </ul>	<ul style="list-style-type: none"> <li>- discuss on the type of coalition, based on experience from other European countries</li> <li>- set up the coalition</li> </ul>	All stakeholders	An active and operational CHP coalition in Ireland.	2013
<b>7 Developing a framework for district heating</b>	<ul style="list-style-type: none"> <li>- no view of district heating</li> <li>- integrated and long term approach necessary</li> </ul>	<ul style="list-style-type: none"> <li>- integrate DH in the existing policy</li> <li>- integrate DH in energy efficiency plans</li> </ul>	Policy makers	District heating understood among policy makers and included in plans.	2030
<b>8 Simplifying export of electricity to the grid</b>	<ul style="list-style-type: none"> <li>- existing regulations cause barriers for projects</li> </ul>	<ul style="list-style-type: none"> <li>Develop simpler and cheaper solutions</li> <li>Adapt regulations to Article 15 of the EED.</li> </ul>	Grid operators	Easier and cheaper use of grid for export of electricity.	2020
<b>9 Identifying specific potential market for CHP</b>	<ul style="list-style-type: none"> <li>- no vision on how to reach the existing general target</li> </ul>	<ul style="list-style-type: none"> <li>- use identified potentials identified in this roadmap to develop sector specific targets</li> <li>- implementation of article 14 of the EED.</li> </ul>	Policy makers	Specific sectors will be more motivated to reach their targets and specific measures will be more effective, resulting in the reaching of the general targets as well.	2015

### 3.3 The roadmap path in numbers

Based on a number of assumptions and discussions with stakeholders and keeping in mind the roadmap steps that have been proposed in the previous paragraphs. Under the CODE 2 project the regional stakeholders propose an actionable way forward for cogeneration in Ireland. It is not the only route but by making concrete a set of next steps, and making visible an achievable outcome, it can focus thinking and sharpen debate around options.

First it is assumed that the cogeneration target that was set in the White Paper <sup>31</sup> of 800 MW<sub>e</sub> by 2020 remains the aim. As demonstrated by the actual historical progress to this target, sectorial modelling, and the work carried out under the CODE 2 project this target can only be realised if the barriers to cogeneration growth are removed and if the steps proposed in the previous chapter are being implemented. By overcoming these barriers and following the roadmap steps it will be possible to go further with the uptake of cogeneration and reach higher goals in 2030.

CODE 2 aims to expand member state's vision and targets towards 2030. No additional targets after 2020 have been set in Ireland. The same growth that is now expected in the High Uptake Scenario is unlikely to be achieved between 2020 and 2030. Therefore the growth speed that will be necessary between 2010 (when 284 MW<sub>e</sub> was actually installed) and the projection of the Medium Uptake Scenario for 2020 will be used as the growth speed of cogeneration uptake after 2030, as shown in Figure 10.

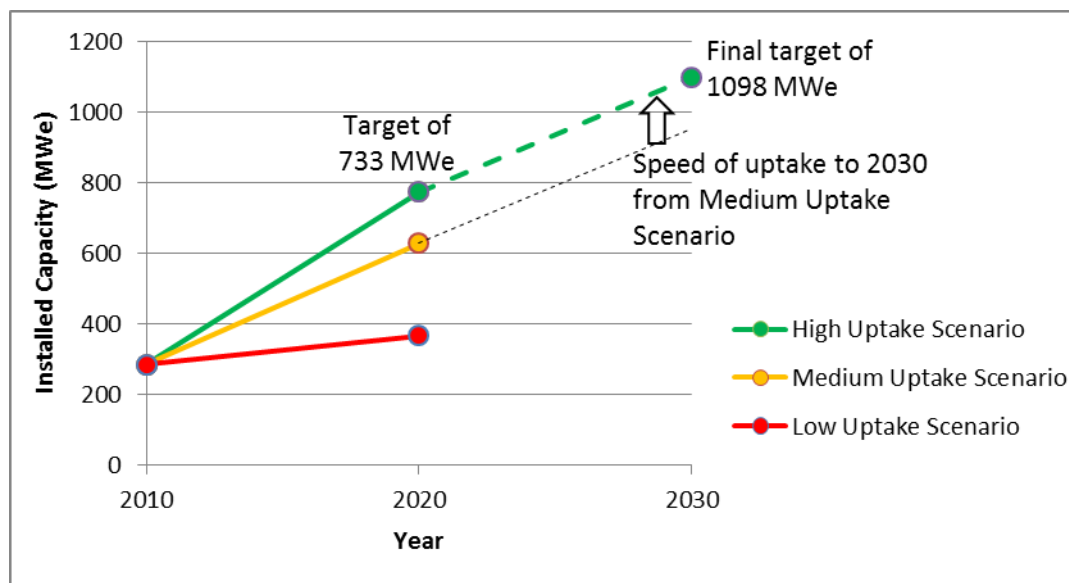


Figure 10: Assumptions made for reaching a final target in 2030

With these assumptions the new targets as laid out in this roadmap are:

**Targets for CHP:**  
 733 MW<sub>e</sub> by 2020  
 1098 MW<sub>e</sub> by 2030

<sup>31</sup> Energy White Paper, Delivering a Sustainable Energy Future for Ireland - the Energy Policy Framework for 2007-2020; 2007 ; Department of Communications, Marine and Natural Resources

Within the possibilities of the market of Ireland, taking into account the current electricity and gas prices and in prospect of implementation of the European Energy Efficiency Directive we have to be ambitious and optimistic in Ireland and it is thought that these targets can be achieved. Several sectors that have not or not enough been included in the 2020 target can be addressed to drive this increase.

In 2012, 7,6% of electricity comes from cogeneration installations in Ireland. When reaching the above targets, this would grow to respectively 16% in 2020 and 23% in 2030. In 2014 the European Member State average percentage of delivered electricity in cogeneration mode is 11% but a number of member states today have delivered electricity at over the 22% level through a mix of industry and domestic applications. Therefore these targets are realistic.

Following assumptions are being made for the sectors contributing to the overall target:

- In industry, growth is expected by the stakeholders in the dairy industry (50 MW<sub>e</sub>) and timber processing (50 MW<sub>e</sub>). An uptake of 75 MW is expected in the Aughinish Alumina Plant<sup>32</sup>. The rest of the industry is expected to follow the High Uptake Scenario until 2020. After 2020 growth in the industrial cogeneration will be limited.
- In the commercial/services sectors, healthcare and hospitality are expected to grow significantly till 2020, according to the numbers from the High Uptake Scenario. 5 kW micro-CHP for small SMEs is also regarded as having high potential: 5 MW by 2020 but a much larger increase is expected by 2030.
- In the micro-CHP sector following the CODE 2 study findings the total technical potential for micro-CHP of about 40 kW<sub>e</sub> (including all commercial and district heating) is estimated at about 10 MW<sub>e</sub> in 2020 and 132 MW<sub>e</sub> in 2030.
- In the CODE 2 micro-CHP study the technical potential for micro-CHP of about 1 kW<sub>e</sub> in households is for 2020 only 1MW, however the potential for 2030 is about 150 MW.
- The potential for district heating which was set in a previous feasibility study at 50 MW<sub>e</sub>, is used for 2030. It is expected that most growth will happen between 2020 and 2030.
- The public sector is bound to play an exemplar role and has to achieve 33% savings in energy efficiency<sup>33</sup>. Therefore we assume a higher growth by 2020 than the high uptake scenario, and by 2030 a total of 100 MW is assumed because of the important role this sector has to play.

A break up of the potential for 2020 and 2030 is presented in Figure 11.

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<sup>32</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

<sup>33</sup> Commission Directive 2012/27/EU on energy efficiency

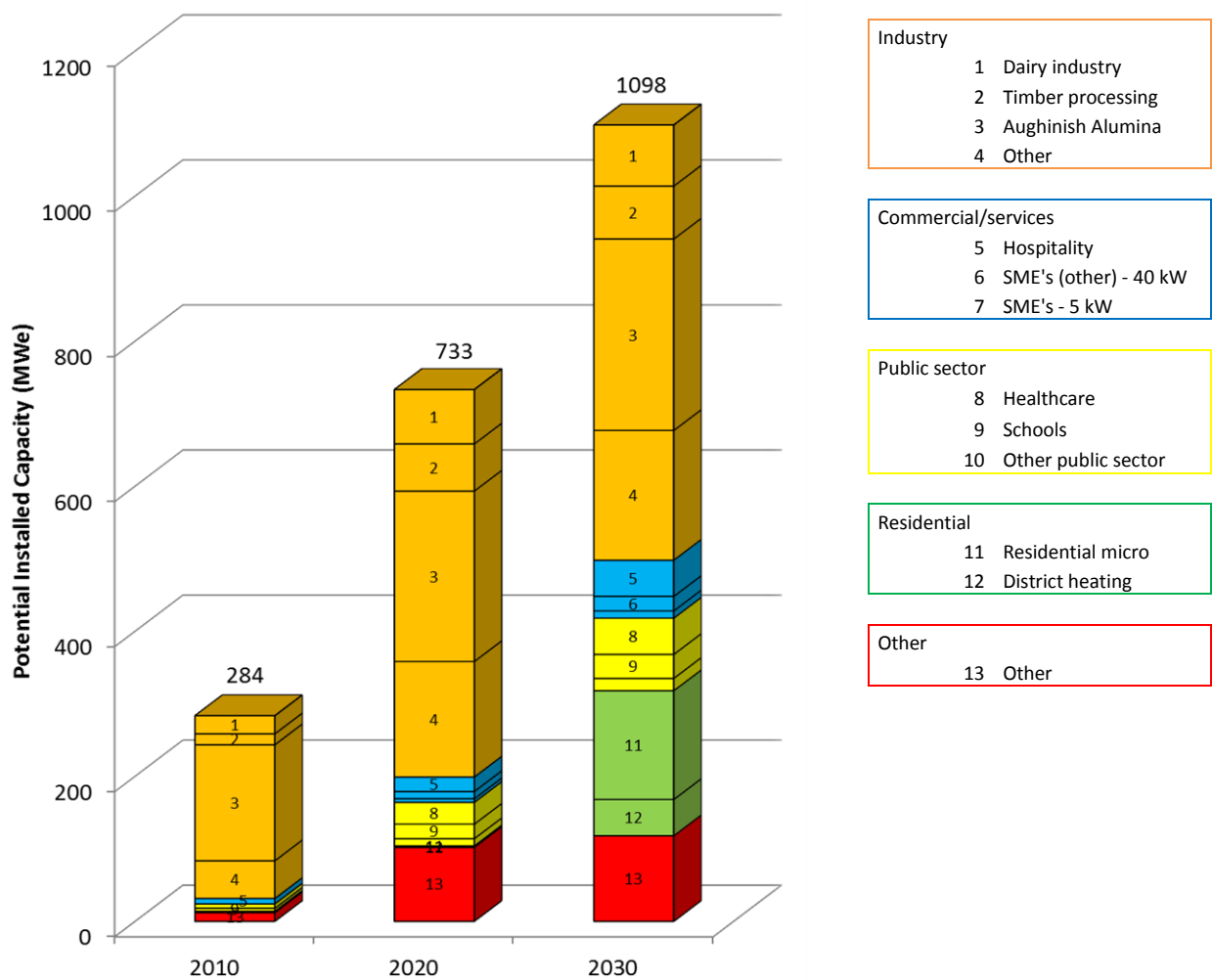


Figure 11: Identification of the market potential for 2020 and 2030

### 3.4 Saving of primary energy and CO<sub>2</sub> emissions by the CHP roadmap

Primary energy saving (PES) and CO<sub>2</sub> 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 4.

#### 3.4.1. 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.

#### 3.4.2. Substitution method.

This method has been developed within the project and 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.

Two scenarios were calculated based on the fuel input for new CHP: a low case scenario, where the share of renewable CHP in 2030 remains constant compared to 2010, and a high case scenario where the fuel share of renewable CHP increases from 1,8% in 2010 to 6,4% in 2030. This higher renewable fuel share was calculated in the bio CHP potential study (see annex 3), but since this is relatively low for Ireland, the impact is rather small.

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<sub>2</sub> savings which can be anticipated in the high case scenario. The CO<sub>2</sub> 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.

With this method PES for Ireland through implementing the roadmap for CHP is estimated to be between 5,9 and 10,3 TWh per year and CO<sub>2</sub> savings are estimated to be between 1,08 and 3,71 Million tons per year in 2030.

**Table 11 Saving of primary energy and CO<sub>2</sub> by the Irish CHP roadmap**

	Substitution method				EED method			
	low case		high case		low case		high case	
PE saving	10,27	TWh/a	10,30	TWh/a	5,90	TWh/a	6,23	TWh/a
CO <sub>2</sub> saving	3,50	Mio t/a	3,71	Mio t/a	1,13	Mio t/a	1,08	Mio t/a
- per kWh el <sup>34</sup>	0,72	kg/kWh el	0,76	kg/kWh el	0,23	kg/kWh el	0,22	kg/kWh el

<sup>34</sup> This value represents the CO<sub>2</sub> reduction of the power generation. It includes the avoided CO<sub>2</sub> emissions from fuel savings for separate heat generation in boilers; it must not be confused with the considerably lower CO<sub>2</sub> emissions of the substituted

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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.



## Annex 1: Stakeholder group awareness assessment

1	Poor	
2	Low	
3	Early awareness	
4	Interest	
5	Active market	

Group	Ireland
<b>Customers</b>	
Industry	<p>Cogeneration started in industrial sites where the steam demand was high and where requirements for electricity were large in relation to local grid capacity. Examples include brewing, sugar extraction, milk drying and briquette manufacture. Cogeneration is most common in the industrial sector, especially because it includes some large sites such as the Aughinish Alumina plant. Today food and beverages are sectors where cogeneration is well known. The industrial sector is well aware of the potential and possibilities for cogeneration. There is good awareness of cogeneration among industry users with high heat load. However since Ireland has no large numbers of heavy industry with continuous steady heat loads, the potential as well as the number of examples is limited.. In the services cogeneration is commonly known among hotels and hospitals.</p> <p>Some negative awareness is possibly the result of the fact that a number of installations are at the moment not operational.</p>
Utilities	Cogeneration is commonly known in the utilities sector, but there is no active market.
Commercial	<p>There is a low level of penetration of cogeneration in SMEs. Awareness is low, which can be shown by the fact that cogeneration in offices declined even when cogeneration grants were awarded<sup>35</sup>. Sustainable Energy Ireland identified lack of information on the potential market for cogeneration as a barrier. There is no 'road map' to guide prospective cogeneration installations in the process of installation cogeneration. SMEs are very slowly becoming more aware of the presence of suitably sized cogeneration solutions, but paybacks are long in the absence of any supports. There could appear to be a greater acceptance and confidence in alternative technologies such as solar, heat pumps etc.</p>
Households	<p>There is limited or no awareness among households and growth in the residential sector has been very limited, despite strong expectations in the high uptake scenario. The public awareness of renewables would far outweigh the awareness of cogeneration. This could change dramatically if domestic scale cogeneration takes hold.</p> <p>Problem of "Conspicuous Conservation", or "To be seen to be Green" doesn't help CHP .</p>

<sup>35</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

Market and supply chain	
Manufacturers	<p>Marketing for large scale is commensurate with industry size. There is good awareness among potential large scale users.</p> <p>For micro-CHP, Ireland is not seen as a big market. At the moment, there are only two to three suppliers in the commercial micro-CHP space.</p>
Installers	For large cogenerations, Installation companies have full suite of required competencies and awareness. For commercial scale micro-CHP, many installers only become aware of the technology when they are asked to price it as part of a tender.
Grid operators	Application process for export capacity is adequate. Grid operators are slowly beginning to see the benefit of cogeneration in terms of network support etc. There is a growing interest in micro-CHP in the role it can play in the smart grid. However for REFIT applications sites are currently required to install a second export connection rather than using a smart arrangement of tariff metering.
Consultants	There are a number of consultants that are actively looking at cogeneration of all sizes. There is growing awareness of the presence of commercial scale micro-CHP. Many independent energy consultants are aware of cogeneration but would have limited experience with conducting full technical and financial feasibility studies.
Engineering companies	Engineering companies have problems selling into sectors that have little or no experience of CHP; however consultant engineers are becoming more aware of the availability of, for example, micro CHP for commercial applications.
Architects	Cogeneration is not something that architects regularly consider or specify. They rely more on the engineering consultants to consider the various technologies available including cogeneration.
Banks	<p>Sustainable Energy Ireland was instrumental in ensuring the success of joint applications for funding a number of units in a variety of applications, as such showing the advantages of contract servicing.</p> <p>However at the moment, due to the economic climate, there is no active role of the banks in the cogeneration market.</p>
ESCOs	<p>The role of ESCOs has been positive in promoting cogeneration, in managing projects on behalf of developers and other sites, in providing support and expertise in the operation of the plants and in maintaining the cogeneration units. They are therefore an important part of the marketing of cogeneration, while the availability of SEI grants for cogeneration has been an important selling tool for ESCOs to promote interest in developing cogeneration schemes in all sectors<sup>36</sup>.</p> <p>However ESCOs are mainly available in the &gt;1MW<sub>e</sub> bracket.</p> <p>In the smaller sizes, it is hard to offer attractive ESCO contracts given the long payback for micro-CHP.</p>
Policy	

<sup>36</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

National	<p>Cogeneration is specifically covered in policy since 2009. A cogeneration deployment programme was supporting cogeneration from 2006 to 2010, however it has now come to an end which halted the investments, so the policy had no long term effect.</p> <p>It has been recognised as a barrier that there is no central source of information regarding grants, other supports, licensing, and relevant agencies<sup>37</sup>.</p> <p>There is high competition with other renewable energy/energy efficiency support schemes. The government has not made a comparative analysis of the carbon footprinting of competing programmes for the purpose of prioritising financial supports.</p> <p>There is now a concept towards 100% renewables, where cogeneration has no place. Therefore there is a certain understanding of cogeneration, but the choices that are made are not in the advantage of cogeneration, it is only seen as a transition technology.</p>
Regional	
Local	
Urban & Regional planners	<p>There is a lack of awareness about the potential for cogeneration for district heating.</p> <p>In general they are not very aware of cogeneration.</p>
Energy agencies	<p>The Irish Energy Centre (IEC) was established in January 1994 to promote the efficient use of energy in all sectors, offering advice, information and expertise. It was replaced by Sustainable Energy Ireland (SEI) – later Sustainable Energy Authority of Ireland (SEAI) in 2002 as Ireland's national energy agency. The agency published cogeneration reports on a regular basis.</p> <p>The interaction with state agencies is considered a barrier when sites intend to export electricity to the grid and therefore require the appropriate licenses and permits from the agencies.</p>
<b>Influencers</b>	

<sup>37</sup> Combined Heat and Power (CHP) - Potential in Ireland; Sustainable Energy Ireland (SEI), 2009, Byrne Ó Cléirigh

Sector organisations	<p>The Irish Cogeneration Association was established in 2005 as a representative body for the Combined Heat and Power sector in Ireland North and South. It was established to promote greater uptake of cogeneration, spread information and lobby for appropriate change to the cogeneration economic and operating environment. The association was broad-based including developers, equipment suppliers, consultants and all other interested organisations and individuals. It provided useful information on its website, guidance on the selection of cogeneration technologies and an overview of the process required to establish a cogeneration plant (licencing/permitting requirements).</p> <p>In 2008 cogeneration Ireland was formed under IBEC (Irish Business and Employers Confederation). Cogeneration Ireland is the IBEC group which represents combined heat and power developers and users. Its role is to promote the uptake of cogeneration in Ireland, with a view to realising the full potential of combined heat and power technology as one of the solutions for the achievement of Ireland's energy policy goals to 2020. The group consists of IBEC, ESCOs, cogeneration technology suppliers and end user representatives. It provides a useful forum for identifying opportunities for the uptake of cogeneration and contributed to the current study in identifying the barriers to growth in cogeneration capacity.</p>
General public	<p>There is no 'road map' to guide prospective cogeneration installations in the process of installation cogeneration . There is minimal or zero awareness.</p> <p>Problem of "Conspicuous Conservation", or "To be seen to be Green" doesn't help CHP .</p>
Media	Industry magazines promote cogeneration of all sizes but it is not covered in popular media.
Academia	Some universities have installed industrial scale cogeneration units, and two Institutes of Technology have installed commercial scale micro cogeneration. Therefore awareness is considered quite good in this sector.
Research	There are a number of projects being conducted. E.g. a project looking at the role of cogeneration (and other technologies) as part of a smart grid.
NGOs	More interest in renewables.

## Annex 2: Micro CHP potential assessment



\*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	0
Global CBA	3
Legislation/support	1
Awareness	0
Purchasing power	3
<b>Total</b>	<b>7 out of 12</b>

### ***±40 kWe systems (SME & Collective systems)***

*Boiler add-on technology*

#### ***Scorecard***

Indicator	Score
Market alternatives	1
Global CBA	4
Legislation/support	1
Awareness	1
<b>Total</b>	<b>3 out of 9</b>

#### ***Market alternatives***

*Estimates of microCHP potential in current national roadmaps on microchip: SEAI CHP report quotes potential market of 657,250 units (20 MW) in low growth scenario to 2020; estimate of 45 MWe in housing in high uptake scenario for 2020; estimate of 112 MW in services in high uptake scenario (but these are not necessary micro chp); the total chp estimate in the high uptake scenario is 800 MW*  
*No DH, but significant competition from HE boilers, heat pumps, biomass boilers/stoves and solar technologies.*  
*Local gas grid has ~35% coverage of the domestic heating market.*

#### ***Market alternatives***

*Current national roadmaps on microCHP. No roadmap being followed.*  
*Current national roadmaps on other technologies*  
*Road maps for other technologies being followed include solar, wind and insulation.*

#### ***Global CBA***

*SPOT: 4.4 years*

#### ***Global CBA***

*SPOT: 3 years*

#### ***Legislation/support***

*Current incentives on microchip*  
*Accelerated Capital Allowances for micro CHP technologies that have succeeded in the SEAI vetting process. Only one micro CHP (5KW) technology is currently on the list.*  
*Current incentives on other technologies*  
*The SEAI have grants to improve insulation, upgrade boiler controls and upgrade boilers.*  
*Current legislation in favour of other technologies*  
*Building regulations require a level of renewable technology to be incorporated into New builds.*

#### ***Legislation/support***

*Current regulation in favour of microCHP*  
*Building regulations recognise the heat from micro CHP as renewable element in group heating schemes as long as a certain level of energy savings is achieved through micro CHP. Collective systems are encouraged by the building regulations technical guidance document Part L paragraph 1.2.5.*  
*Current legislation in favour of other technologies.*  
*Building regulations require a level of renewable technology to be incorporated into New builds.*

#### ***Awareness***

*Are stakeholders aware of the microCHP technologies*  
*Homeowners? No.*

#### ***Awareness***

*Are stakeholders aware of the technology*  
*Homeowners? SOME*

*The sole responsibility of the content of this fact sheet lies with the authors. It does not represent the opinion of the Community. The European Commission is not responsible for any use that may be made of the information contained therein.*

Consultants? <i>Some are aware.</i>	Consultants?
Installers? <i>No.</i>	Increasing awareness with consultants over the last 3 to 5 years.
Planners? <i>No.</i>	Installers? <i>SOME</i>
Government? <i>No.</i>	Planners? <i>FEW</i>
Are manufacturers active in the market? <i>No.</i>	
<b>Purchasing power</b>	
<b>GDP: € 32 500 per year</b>	

The methodology and results of all 27 Member States are presented in the report 'Micro-energy CHP Potential Analysis', July 2013, by CODE2.

## Annex 3: Bio-CHP potential assessment

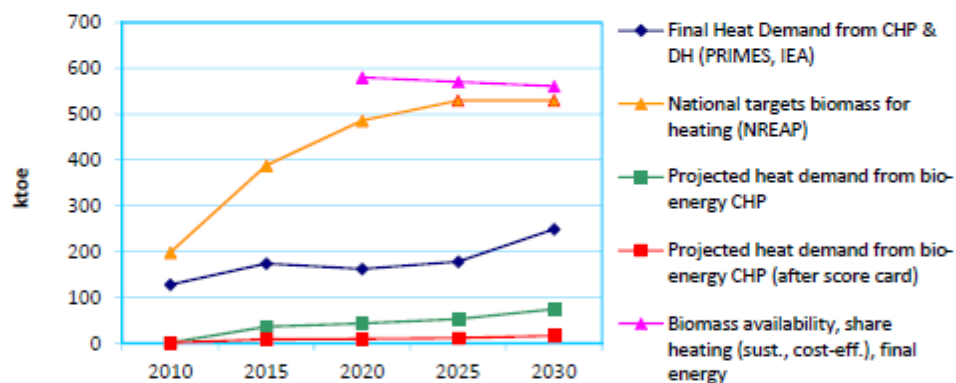


### Bio-energy CHP potential analysis Ireland



Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	128	162	249
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	1	10	16
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	1,1% (2009)	6,0%	6,4%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		580	561

### Bio-energy CHP potential analysis Ireland



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	○ 1 (of 3)	Renewable energy feed-in-tariff (REFIT) scheme, but unfavourable conditions; no new bio-CHP systems through new legislation so far
Suitability of heat market for switch to bio-energy CHP	+ 2 (of 3)	Dairy processors with > 9 months continual load, pharmaceutical sector.
Share of Citizens served by DH	- 0 (of 3)	Minimal



National supply chain for biomass for energy	- 0 (of 3)	Co firing plants and panel board manufacturers will consume 100% of limited indigenous supply.
Awareness for DH and CHP	- 0 (of 3)	Very slight awareness

### Comments on country analysis

#### General comments

- The national framework assessment through the scorecard results in a low score (3 of 15 possible points).
- Thus, it is projected that the growth potential for bio-CHP until 2030 will be exploited to 20%.
- The possible bio-CHP penetration rate in 2030 (2030 dot of green curve) under ideal framework conditions is seen at 30% (the country's RE target according to RED (28/2009) is at 16% in 2020)
- The share of bio-fuels in CHP (bio-energy penetration rate in CHP markets) is expected to increase from 1,1% (2009) to 6,4% (2030)
- The national biomass availability (cost-efficient, sustainable; pink curve) is sufficient to enable the projected growth; however, these biomass resources include types of biomass which are currently not usually used in CHP, but are expected to be utilisable by 2030

#### Specific issues

- The projected development of CHP heat demand (PRIMES, blue curve) foresees growth especially between 2010 and 2015 and again after 2020
- National targets for biomass for heating (yellow curve) see a very strong growth especially between 2010 and 2015
- The growth projections of the bio-energy CHP heat demand (green and red curves) apply the average growth rates of both the blue and the yellow curve (weighting 50:50)

The methodology and results of all 27 Member States are presented in the report 'Bio-energy CHP Potential Analysis', Deliverable D.2.6, July 2013, by CODE2.

## Annex 4: Methodologies used to calculate the saving of primary energy and CO<sub>2</sub> 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<sup>38</sup>” 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<sub>2</sub> saving resulting from a voluntary commitment of the German industry for CO<sub>2</sub> reduction<sup>39</sup>, 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<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 (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<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 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.

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<sub>2</sub> 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<sub>2</sub> 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

<sup>38</sup> 10. FfE Forschungsstelle für Energiewirtschaft e.V., Energiezukunft 2050; <http://www.ffe.de/die-themen/erzeugung-und-markt/257>

<sup>39</sup> The calculation has been made by the VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V., 2010, Unpublished.

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 preempt investments in e.g. new CCGT investments.

## Contacts

### Project partners

The project consortium exists of the following partners that have a solid expertise on cogeneration:

- COGEN Europe, the European Association for the promotion of cogeneration, is the project coordinator (Belgium) – contact: [fiona.riddoch@cogeneurope.eu](mailto:fiona.riddoch@cogeneurope.eu)
- Hellenic Association for the Cogeneration of Heat and Power (HACHP) (Greece) – contact: [hfa@heatflux.eu](mailto:hfa@heatflux.eu)
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- KWK kommt (Germany) – contact: [adi.golbach@kwkkommt.de](mailto:adi.golbach@kwkkommt.de)

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