CODE2

Cogeneration Observatory

and Dissemination Europe

D2.3 First draft of final CHP roadmap
IRELAND

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Introduction to CODE2

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

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

Roadmap methodology

This document is the draft roadmap for Ireland.

It is based on the range of studies available coupled with many discussions with stakeholders:

- 28th September 2012: Conference call
- 9th January: Meeting in Dublin
- 15th May: Webinar

Besides these exchanges there were over 20 one-on one expert discussion. The proposed actions are being developed through a 10 month process of discussion and exchange with experts and form the best assessment by the sector currently available.

It will be the base for discussion and feedback during the workshop of 6th June in Ireland.

This will result in a final roadmap.

1 Where are we now? Background and situation

1.1 Current status: Summary of currently installed cogeneration

The operational capacity of cogeneration 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 is low.

	Installed capacity electricity (MW)	Total cogenerated electricity generated (MWh)	Total heat supplied (MWh)	Total electricity generated (MWh)	Total share on electricity
2008	280	1.840.000	3.750.000		6,2

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

The **installed capacity** of cogeneration in Ireland at the end of **2010** was **307 MW_e (227 units)** up from 299 MW_e (206 units) in 2009, an increase of 2.6%. However the 2010 installed capacity figures include a number of units that were not operational, therefore, the operating capacity of cogeneration in Ireland at the end of 2010 was 284 MW_e (158 units). Comparing operational capacity, there was a 0.6% decrease from 2009 to 2010, a decrease of 1.7 MW_e of operating capacity.

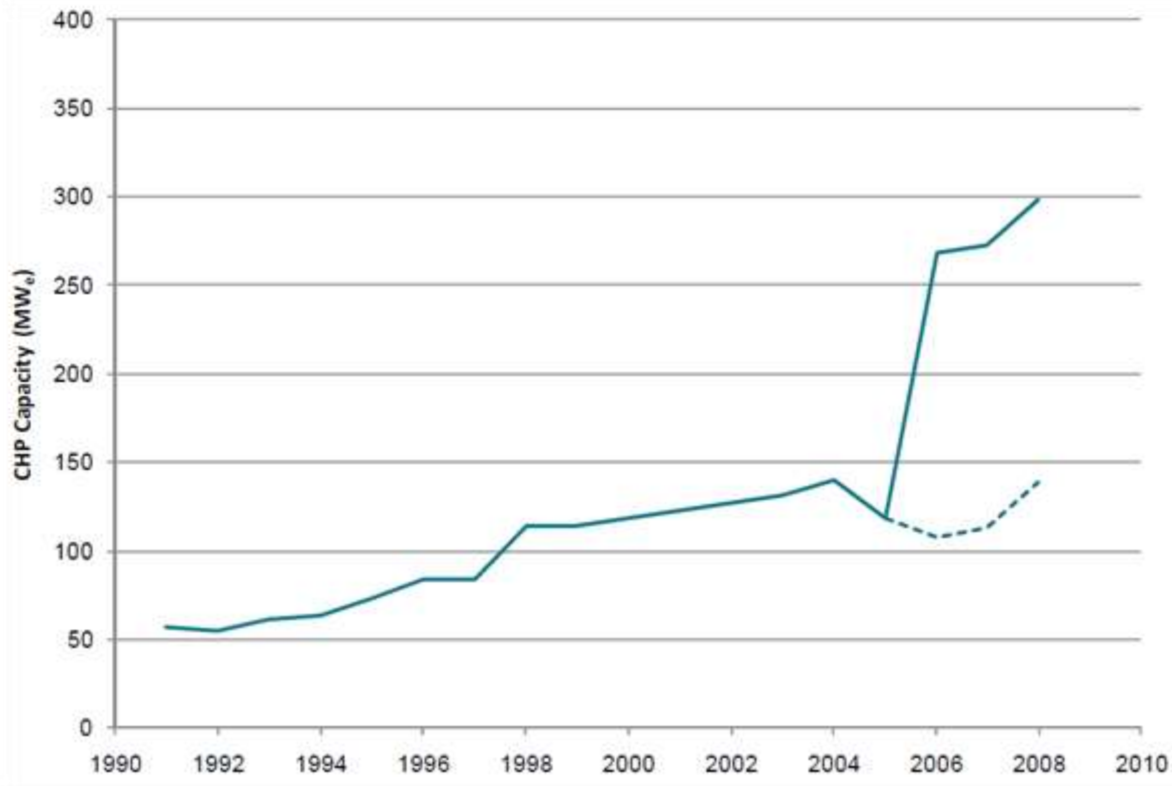
	Installed capacity electricity (MW)	Total cogenerated electricity generated (MWh)	Total heat supplied (MWh)	Total electricity generated (MWh)	Total share on electricity
2008	280	1.840.000	3.750.000		6,2

Table 1.1 Eurostat data for CHP in Ireland

The **Aughinish Alumina plant** which accounts for 160 MW_e is operational since 2006 and is the single largest cogeneration installation

Figure 1 shows the trend in installed cogeneration capacity since 1991. As can be seen from this figure, there has been an increase in active installed capacity between 2006 and 2008, although the underlying **growth rate**, excluding the contribution from Aughinish Alumina, remains **low** (Cléirigh, 2009).

The dashed line shows the trend without the contribution from the Aughinish Alumina cogeneration plant, which indicates that the installed capacity in 2008 would have declined to the level of the late 1990s and, due to plant closures, would only have returned to the 2004 level of 140 MW_e by 2008.



In 2010, 6,8% of electricity was from cogeneration installations and cogeneration installations met 5,4% of Ireland's total thermal energy demand.

Figure 1.1 - Installed (active) CHP capacity: 1991-2008

It is useful to examine the fuel type associated with cogeneration plants from the perspectives of both security of supply and environmental impact. Cogeneration is promoted due to the improved efficiencies and reduced emissions that may be achieved relative to the alternatives. In this context, the choice of fuel has a direct impact on the levels of emissions reductions that may be achieved. Table illustrates the operational capacity and number of units by fuel in 2010. Oil fuels used are liquefied petroleum gas (LPG), heavy fuel oil and refinery gas. **Natural gas** was the fuel of choice for 266,2 MW_e (147 units) in 2010. It is worth noting that there is one single 160 MW_e gas plant which dominates. Oil fuels made up the next most significant share with 7,3 MW_e (7 units) while solid fuels accounted for 5,2 MW_e (2 units). The remainder was biomass at 5,4 MW_e (2 units) (Dennehy, 2012).

	No of units	Operational capacity MW_e	No of units %	Operational capacity %
Natural gas	147	266,2	93,0	93,7
Solid fuels	2	5,2	1,3	1,8
Biomass	2	5,4	1,3	1,8
Oil fuels	7	7,3	4,4	2,7
Total	158	284,0	100	100

Table 1.2 - Number of units and operational capacity by fuel in 2010 (Dennehy, 2012)

Traditionally, cogeneration was more suited to large industrial concerns but the availability of ready-made, small scale, reliable gas units in the 1990s (and more recently micro-turbines) meant that the services sector could avail itself of the technology whereas previously they would not have had the heat and electricity demands to justify the capital investment.

Table 1.2 presents the number of units and installed capacity for cogeneration in Ireland in 2010. The majority of units are in the **services** sector while the bulk of capacity is in **industry**, indicating that there are a large number of relatively small units in the services sector. The services sector accounted for 126 (80%) of the 158 units and 32 MW_e of the 284 MW_e operational capacity (11%) in 2010 (Dennehy, 2012).

	No of units	Operational capacity MW_e	No of units %	Operational capacity %
Services	126	32	80	11,2
Industry	32	252	20	88,8
Total	158	284	100	100

Table 1.2 - CHP number of units and operational capacity by sector in 2010 (Dennehy, 2012)

Examining the breakdown of services further in Table1.3 it can be seen that **hotels and hospitals** account for the majority (57%, 73 units) of units in the services sector while the leisure sub-sector (which includes swimming pools, leisure centres, gyms, etc.) accounts for another 20% (25 units). These sub-sectors, in particular, benefit from having close to constant demand for heat and electricity but the technology may also be suited to any site that has a simultaneous demand for both heat and electricity. It is interesting to note that certain sub-sectors have a small number of cogeneration units but represent a considerable proportion of the installed capacity, notably airports and education. This is illustrated in Table1.3 where the combined Airport/Education sub-sectors have 8% of the number of cogeneration units and 27% of the operational capacity (Dennehy, 2012).

	No of units	Operational capacity MW_e	Services No. of Units %	Operational capacity %	Total CHP No. of Units %	Total CHP Installed Capacity %
Hospital	22	5,6	17	18	13,9	2,0
Hotel	51	7,5	40	24	32,3	2,6
Airport	2	3,7	2	12	1,3	1,3
Education	7	4,9	6	15	4,4	1,7
Office	8	3,9	6	12	5,1	1,4
Leisure	25	3,4	20	11	15,8	1,2
Retail	7	1,3	6	4	4,4	0,5
Services other	4	1,5	3	5	2,5	0,5
Total	126	31,8	100	100	79,7	11,2

Table1.3 - Number of units and operational capacity by services sub-sectors in 2010

Table1.4 presents the sub-sectoral breakdown of operational capacity and number of units in industry. The 160 MW_e installation at Aughinish Alumina dominates the capacity with that single unit accounting for over 63% of the total operational capacity in the industrial sector. It can be seen that the **food and beverages** has the largest number of units with 37,5% (12 units), accounting for 23,3% (58,8 MW_e) of industrial installed capacity in 2010. The sector named 'Other' refers to enterprises in the energy sector and the textiles and **sawmills** sub-sectors.

	No of units	Operational capacity MW_e	No of units %	Operational capacity %	Total CHP No. of Units %	Total CHP Operational Capacity %
Food	12	58,8	37,5	23,3	7,6	20,7
Manufacturing	4	6,4	12,5	2,5	2,5	2,2
Pharmaceutical	7	12,1	21,9	4,8	4,4	4,3
Non-ferrous Metals	1	160	3,1	63,4	0,6	56,3
Other	8	15,0	25,0	5,9	5,1	5,3
Total	32	252,3	100	100	20,3	88,8

Table1.4 - Number of units and operational capacity by industry sub-sectors in 2010

Electrical capacity size range	No. of Units	No. of Units %	Operational Capacity MW_e	Operational Capacity %
Micro < 50 kWe	1	0,6	0,005	0,002
50 kWe≤ Small < 1MWe	121	76,6	20,8	7,33
Large ≥ 1 MWe	36	22,8	263,2	92,67
Total	158	100	284	100

Table1.5 - Number of Units and Installed Capacity by capacity size range (Dennehy, 2012)

The European Directives contain definitions for micro, small and large scale cogeneration.

Table1.5 categorises Ireland's installed capacity in 2010 into those classifications. It can be seen that units in the over 1 MWe category account for most of the installed capacity (93%) while most units are between 50 kWe and 1 MWe (77%). However especially in the micro-CHP category these numbers are outdated, since already more than 40 5,5 kW micro-CHP units are operational in different commercial sectors.

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 **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 has committed to limit average greenhouse gas emissions over the five-year period to 13% above 1990 levels. The increase in emissions for this period is around 8 per cent above the 1990 level, so in aggregate the target will be achieved. Ireland's emissions showed a large increase, of 27 per cent, between 1990 and 2001. This was followed by a modest decline of 4 per cent in the period to 2008. With the economic downturn, emissions then fell sharply, by 9 per cent between 2008 and 2010. Without the sharp economic recession, the Kyoto target would not have been achieved, although domestic policy contributed to the moderation of emissions growth.

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 limit was set in 2012 following a review of Ireland's national greenhouse gas inventory at 37.5 Mtonnes of CO_2eq. Based on current projections, Ireland will not meet this target either based on existing policy (**With Measures, WM**) or with the achievement of ambitious energy efficiency and renewable energy targets (**With Additional Measures, WAM**). In the WAM projection it is assumed that all the targets set in the National Energy Efficiency Action Plan (NEEAP) and National Renewable Energy Action Plan (NREAP) are fully achieved.

In the WM scenario, 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 WAM scenario, emissions are projected to decrease to 10 per cent below 2005 levels by 2020.

There are major challenges involved in achieving these targets and the cost implications. Some measures have been put in place to achieve the targets but many of the measures are still to be developed. Reflecting the NEEAP and the NREAP, the key additional assumptions in the WAM 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).

(NESC, 2012) (EPA, 2013)

The non-ETS area in which there is the greatest technical potential for reduced emissions is undoubtedly energy efficiency in **buildings** (NESC, 2012).

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 and recommendations of previous reports to address this shortfall have not been implemented. 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 Union Cogeneration Directive, approved in February 2004, sought to create a favourable environment for cogeneration installations. The **Energy** (Miscellaneous Provisions) **Act of 2006** is the transposition of the EU CHP Directive into Irish law (Dennehy, 2012).

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.

Thus, while the White Paper acknowledges the potential benefits of cogeneration, it also recognises that there are substantial barriers, although specific targets for installed cogeneration capacity were set as follows:

Targets for CHP:
400 MW_e by 2010
800 MW_e 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 CER of potential administrative and regulatory barriers and decisions on appropriate price support mechanisms for electricity generated from new high-efficiency, large-scale cogeneration.*

(Energy White Paper, 2007)

The 2010 target is repeated in the **National Climate Change Strategy** (NCCS) 2007 to 2012, also published in 2007, which states that 0.162 Mt CO_2 equivalent will be saved by 2010, as a result of cogeneration (Dennehy, 2012).

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 (NEAP, 2009).

In 2009 **three statutory instruments SI 298, SI 299 and SI 499** which related to cogeneration were published. SI 298 brought into law section 6 of the 2006 act which relates to cogeneration. SI 299 gives the Commission for Energy Regulation (CER) the responsibility of calculating Power to Heat Ratios for cogeneration units in Ireland. Under SI 499 the CER is required to certify high efficiency (HE) cogeneration and the electricity system operator is required to give such generation priority when dispatching the system (Dennehy, 2012).

A **Second National Energy Efficiency Action Plan** (NEAP2) was published on 28^{th} 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_e of cogeneration by 2020 (NEAP2, 2013).

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 (Brennan, 2013).

Although cogeneration is clearly covered in the Irish legislation, **targets are not being met** and recommendations of previous reports are not implemented.

The total operational capacity at the end of 2010 was approximately 284 MW_e. The government is due to consider a second cogeneration target for 2020 in light of further feasibility studies by SEAI into cogeneration applications, a review by CER of potential administrative and regulatory barriers, and decisions on appropriate price support mechanisms for electricity generated from new high efficiency large scale cogeneration. It is also intended that the public sector will act as an exemplar in relation to cogeneration.

The installed capacity at the end of 2010 was 71% of the government's 2010 target. Therefore 2.8 times growth in the existing cogeneration capacity is required (516 MW_e) in order to meet the government 2020 target of 800 MW_e or an average annual growth rate of 11%. This compares to a the actual situation of reduction of 1.3% in operating capacity in 2010 and the average annual growth rate between 2006 and 2010 was 5% (Dennehy, 2012).

One of the apparent problems is that the policy commitments made on cogeneration in the major policies are **not binding**, while those for renewable energy are binding. This will be further discussed in the roadmap.

1.3.2. Financial support for CHP

A government support programme for cogeneration was announced in December 2005 as part of the 2006 budget. The **Cogeneration Deployment Programme**, due to run over the period 2006 to 2010, provided grant support to assist the deployment of small-scale (<1 MW_e) fossil fired cogeneration and biomass (anaerobic digestion and wood residue) cogeneration systems. The programme provided funding for cogeneration systems and also included funding for a program of micro-CHP generation trials. The objective of the trial was to assess existing technology and identify possible barriers, risks and benefits associated with its deployment to inform future policy consideration of micro-CHP generation and the opportunities for further efficiency gains through distributed small-scale generation. Additionally, the programme aimed at increasing market penetration of cogeneration schemes in the target sectors and to increase customer awareness and confidence in cogeneration. The SEAI Cogeneration Deployment Programme was closed at the end of December 2010. Under the programme 68 fossil fuelled small scale cogeneration projects with a total installed capacity of 15.7 MW_e were supported, in addition to 3 MW_e of biomass cogeneration and 250 kW_e of anaerobic digestion cogeneration (Dennehy, 2012).This capital grant programme was therefore successful, but when it stopped the projects also stopped, therefore it had no long term impact.

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_e 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 (REFIT, 2013). The support levels for biomass and anaerobic 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 (DCENR, 2013):

- Anaerobic digestion CHP (≤500 kWe) 15,7c per kWh
- Anaerobic digestion CHP (>500 kWe) 13,6c per kWh
- Biomass CHP (≤ 1500 kWe) 14,6c per kWe
- Biomass CHP (>1500 kWe) 12,5c per kWe

However the structure of the REFIT support scheme grid connection might form a barrier for the development of biomass/biogas cogeneration. The requirement to provide a second grid connection at sites where grid connections already exist for the purpose of exporting electricity unnecessarily adds significant costs to projects.

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 2013 (Electric Ireland, 2013).In addition to the 9c/KWh, ESB Networks offered a “Support Payment” of 10c/KWh FIT for a 5 year period but only for the first 3.000 KWh, so the maximum benefit is €300 per annum. However this support has been stopped since 29/2/2012. This was a commercial decision taken by ESB Networks.Any cogeneration that has undergone the vetting process by SEAI 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 a valuable approach to support in that public sector organisations must use Triple E registered equipment when considering purchasing energy products. By stakeholders it is believed to be a good model in supporting cogeneration, because it is not a grant from a gradually diminishing source of government funds, but rather an on-going sustainable support that will still be in place for years to come. However, in terms of making the investment more attractive, it has the effect of reducing the payback time by no more than 6 months for a commercial scale micro-CHP. This will be further discussed in chapter 1.6: *The economics of CHP*.

1.4 Financial constraints for CHP

1.4.1. Carbon tax Rebate

A Carbon Tax was introduced in Ireland in the Budget 2010 at a rate of €15 per tonne and was increased to €20 per tonne in the 2012 Budget.

A partial relief (83%) 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 (Revenue, 2012)!

For a reference installation of 5 MW_e the impact of the carbon tax places an additional cost of €30.000 compared to a site with gas fired heat only. This is a burden of approximately €0,72/MWh.

1.4.2. LEU rebate & network charges

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 the ESB would provide:

- ESB Customer credit: a rebate of €300m applicable to all electricity customers via the Transmission Use of Systems (TUoS) charges mechanism.
- LEU Credit: a Public Service Obligation (PSO) rebate for Large Energy Users (LEU)).

These rebates did not extend to on site 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.

This rebate ended in September 2012. However this move was combined with a **network charge reprofiling** in favour of Large Energy Users from 1 October 2010. The savings for large energy users were to be funded by a rebalancing of domestic network tariffs and the amount of the savings was to be €50m per annum. The implementation of the above resulted in a 13 to 15% increase in domestic network tariffs (14% on average) and a 45% decrease on DUoS and TUoS (Distribution and Transmission Use of System) charges, tariffs for LEUs, relative to those which would otherwise be in place (CER, 2010). This reprofiling is placing an **additional loading of approximately € 0,2/MWh on cogeneration** (calculation of Fingleton White & Co, 2013).

1.5 Awareness

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

1.5.1. 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.

1.5.2. 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 1.2 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.43).

1.5.3. Role of key actors

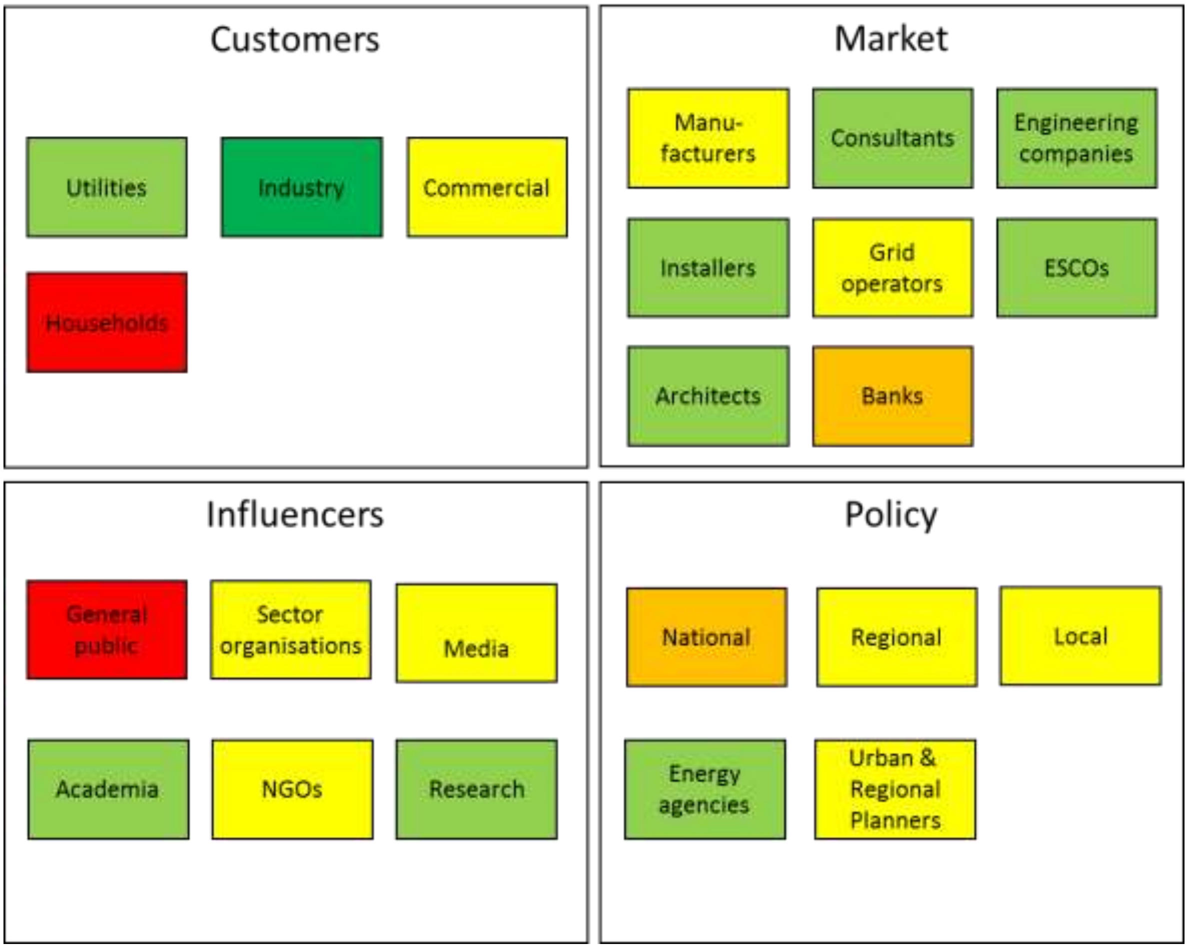


Figure 1.2 - Level of awareness among key actors under the 4 socio-economic groups

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

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. However 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.

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_e 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.

1.6 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.

1.6.1. 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. (Annex 4: Assumptions used in market extrapolation). 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.

Other 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_2 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 1.6).

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_e (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_e ≤ 10 MW_e
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_e

Table 1.6: Main CHP markets

1.6.2. Energy industry

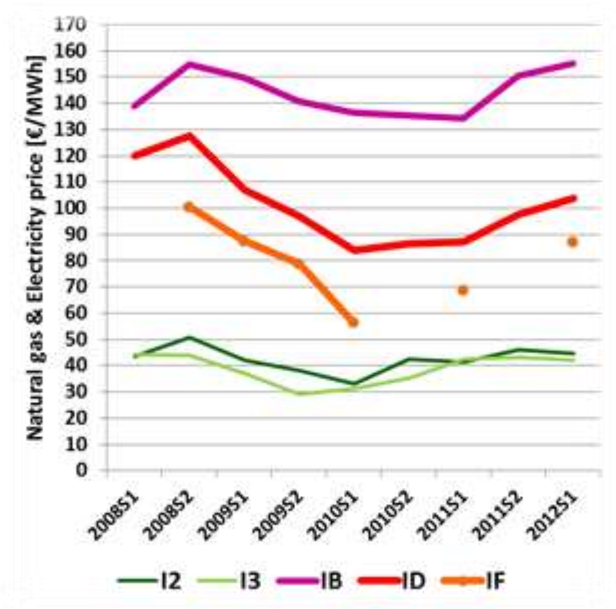
In the energy industry the cogeneration plant will run in the periods when its operating cost is lower than the power price. As the gas purchase prices are mainly determined by the commodity price, the commodity gas and electricity prices and their relation are a suitable indicator for the economics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

1.6.3. 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 1.3 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 (SEAI, 2012).



With:
Gas prices (without VAT) for:
1.000 GJ < I2 < 10.000
10.000 GJ < I3 < 100.000 GJ
Electricity prices (without VAT) for:
20 MWh < IB < 500 MWh
2.000 MWh < ID < 20.000 MWh
70.000 MWh < IF < 150.000 MWh

Figure 1.3 - 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 15th and the 19th highest price (SEAI, 2012).

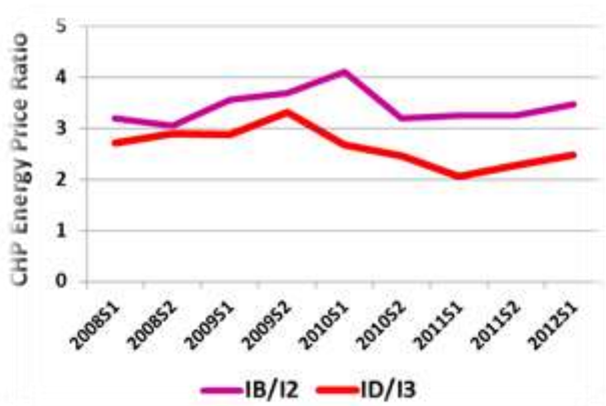


Figure 1.4 - CHP energy price ratio for business (without VAT) in Ireland

Figure 1.4 shows the power-to-gas ratio. For the larger installations it has declined recently and the ratio is higher than the European average (Figure 1.5). This is an opportunity for cogeneration based on natural gas firing.

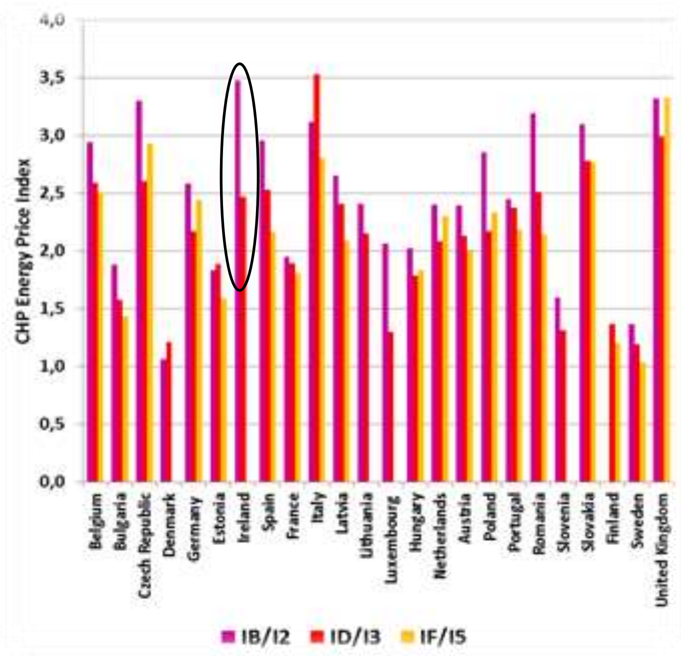


Figure 1.5 - CHP energy price ratio in Europe (2012 S1)

These electricity and gas prices were used with other input parameters in a simple calculation model for a number of reference installations (see Annex 4 p. 50). The resulting IRR and payback times are shown in Figure 1.6.

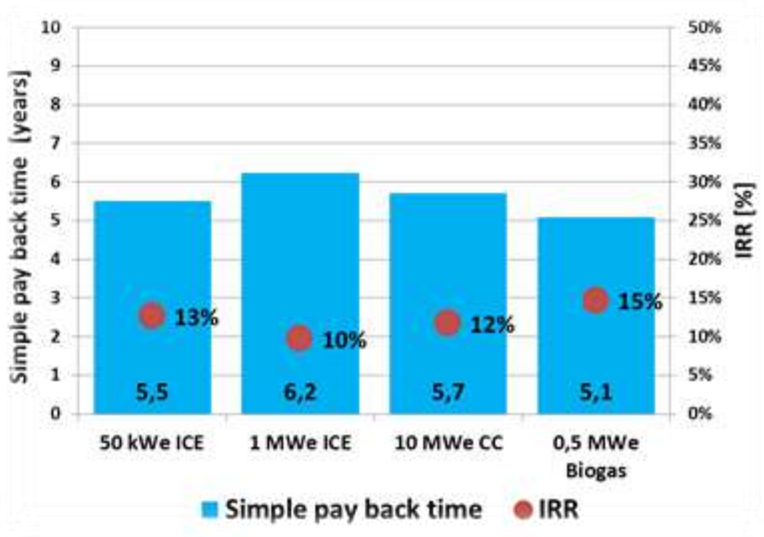


Figure 1.6 - Pay back times and IRR for 4 reference installations in Ireland

As can be seen in the calculations, the typical payback periods are between 5 and 6 years. Discussions with stakeholders confirm 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 ESCOs, 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_e unit, and 1,4 c per kWh for the 1 and 10 MW_e 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 (SEAI, 2012), 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 (Ó Cléirigh, 2009). The actual economic viability of a cogeneration installation is also dependent on how opportunities are maximised.

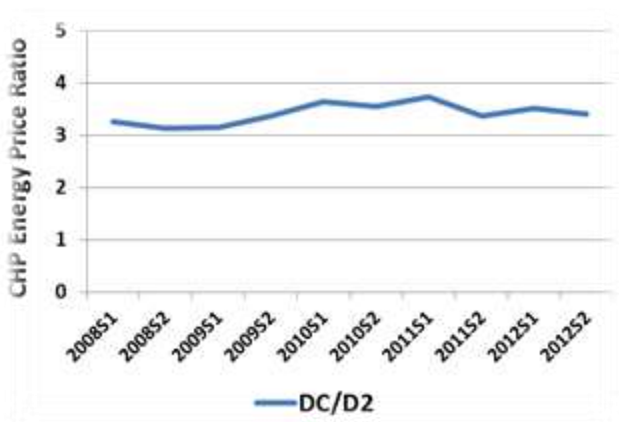


Figure 1.7 - CHP energy price ratio for households in Ireland (including taxes)

1.6.4. 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). However economics are still not interesting.

1.6.5. 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 1.7: CHP economics matrix

Legend:

"normal" Cogeneration Investment has **good economic benefits**, return on investment acceptable (X?) 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(Y?), **limited interest for new investments**.

"poor" Cogeneration Investment has **poor or negative return on investment (Z?) 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.)

1.7 Barriers to CHP

In previous studies different barriers have been identified at all levels. In 2009 the cogeneration Potential in Ireland study (Ó Cléirigh, 2009) 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.
2. **Current Political choices are to the detriment of CHP**
3. **The economics of CHP are unattractive and the spark spread is negative leading to high pay back times and low IRR's.**
4. **Awareness is lacking within several socio-economic groups.**
5. **No experience in district heating.**
6. **Not enough support for micro CHP.**

1.7.1. Current Political choices are to the detriment of CHP.

Although policy makers are aware of cogeneration (see chapter 1.5 on awareness) and cogeneration is covered and targeted in several action plans (see 1.3 - *Policy development*), targets are not being met and recommendations of previous reports are not implemented.

At the moment Irish policy is mainly focusing on the concept of **100% renewable energy**, with cogeneration apparently classed as a transition technology. This is proven by the fact that:

- There is no government support for cogeneration despite the stated targets and the identified role for the sector. The capital grant for units below 1 MW_e and for bioenergy cogeneration was successful but withdrawn in 2011, due to lack of budget (SEAI, 2013). When it stopped there were no new installations.

- There is a REFIT support for renewables, but not for fossil fired cogeneration.

- The recommendations of 2006 and 2009 reports were not implemented. E.g. the recommendations for units above 1 MW_e were not implemented and there was no growth in this sector.

- SEI supports a range of other technologies in addition to cogeneration, some of which directly compete for the same market. In the residential and services sector the other programmes include grants for high efficiency boilers, for ground source heat pumps, geothermal energy and biomass boilers.
- While competition in the market place is advantageous in reducing the costs associated with the technologies in the longer term, it has the potential to result in inefficient prioritisation of supports for these technologies in the absence of a detailed comparison of the benefits and drawbacks associated with each (Ó Cléirigh, 2009). [1]
- It also appears that previously implemented Energy legislation/Policy has sometimes failed to take cogeneration into account and unintentionally works against cogeneration, such as the carbon tax, LEU rebate and network charges reprofiling (see chapter 1.4).
- 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.

One of the problems is that commitments for energy efficiency which impact cogeneration are not binding compared to the renewable energy commitment which impacts geothermal, biomass and heat pumps.

However the contribution of the Irish energy efficiency objective could 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. The EED could be used to convince the government of rethinking its policy; especially if the Commission decides to make it a binding target.

The result is that the today's policy structure in Ireland works detrimentally for the wider use of cogeneration, despite the explicit policy goals to grow the sector.

1.7.2. 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 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
- other political decisions work to the detriment of cogeneration, such as carbon tax, LEU rebate and network charges.

This results in low IRR's and high payback times.

Especially in this period of crisis these 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.

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[1] An example for Belgium will be given during the workshop. Also for Ireland a first analysis of this kind will be presented during the workshop.

1.7.3. 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 role within a policy orientated towards renewables. There is a good level of awareness of cogeneration among industry users and their market but limited awareness among commercial users and households. 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 these groups is also lacking, and there is no strong cogeneration coalition.

1.7.4. No experience in district heating.

At the moment there is no district heating in Ireland. Barriers that have been identified in the past (SEI, 2002) include:

- 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,
- 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 have made that it is not considered at 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.

1.7.5. Not enough support for micro CHP.

It has been recognised that a considerable potential for micro-CHP in housing on one hand, and in commercial sites on the other hand, can be realised. However micro-CHP was 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.
- The new feed-in tariff is only beneficial to household micro-CHP and not to larger commercial micro-CHP.
- Micro-CHP (< 50 kWe) is also excluded from the partial carbon tax relief for cogeneration.

However, the investment cost for end-users is significant, and, in the absence of financial supports, this presents a barrier to the deployment and uptake of micro-CHP.

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 have defined 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 (*Ó Cléirig*h, 2009). In assessing the potential for growth in cogeneration, three growth scenarios were considered: Low, Medium and High. Under each of these scenarios, 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.

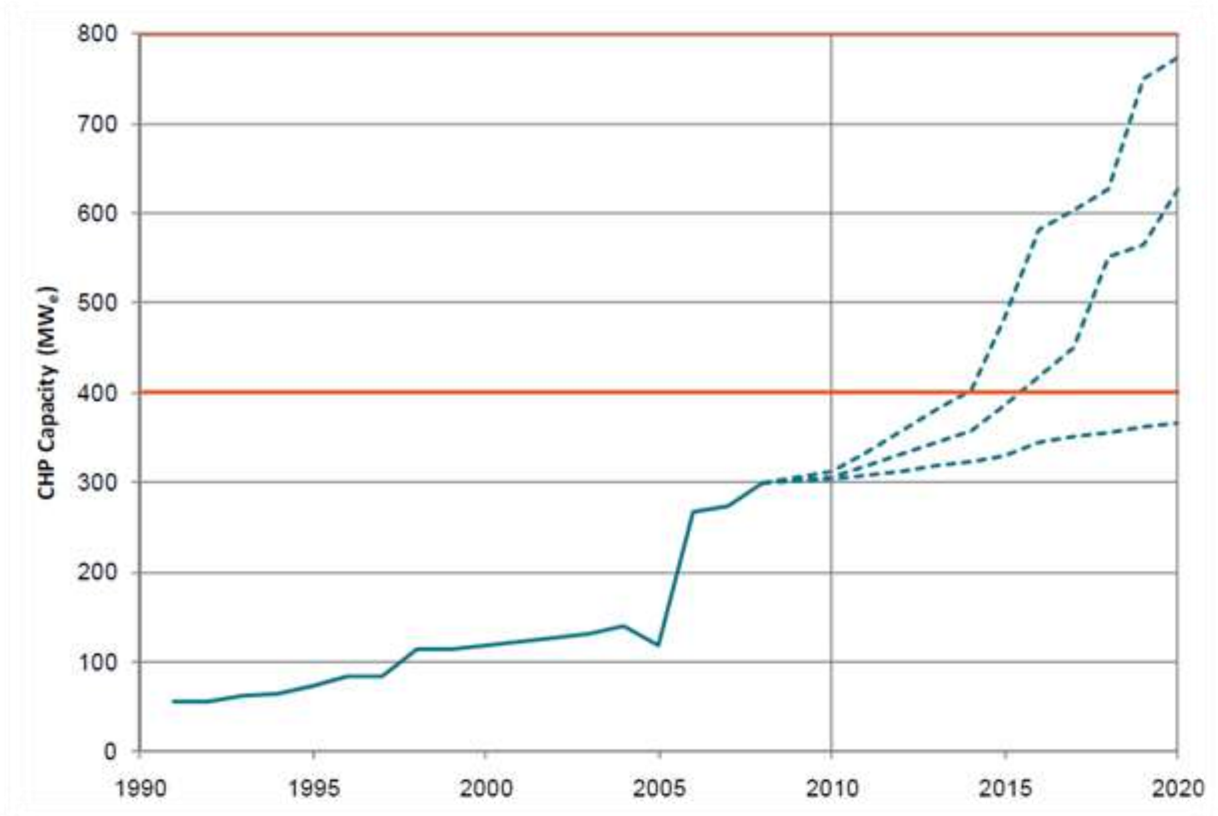


Figure 2.1: Potential installed CHP capacity under three uptake scenarios (high, medium, low)

The low uptake scenario is based on the current rate of cogeneration growth and takes a more conservative assessment of the economic recovery and industries appetite to invest in cogeneration projects at various scales. Under the medium uptake scenario the majority of growth in energy intensive sectors is expected to occur in the latter half of the 2010 to 2020 period, and beyond. Under the High uptake scenario advancements existing commercial buildings look favourably on the retrofitting cogeneration and invest in the technology, with growth between 2016 and 2020.

Scenario	Basic assumptions
Low Uptake Scenario Capacity potential for 2020: 366 MW_e Distance to target (form end 2010): 59 MW_e	Based upon the current rate of cogeneration capacity growth (excluding the contribution of the 160 MW_e plant) and the current supports in place from Ireland's national energy agency (Sustainable energy Ireland) and industry bodies. It acknowledges that some existing sites may close down within both the 2010 and 2020 horizons and assumes that there is little or no replacement of lost cogeneration on a like-for-like basis. This scenario also takes a more pessimistic view in terms of a short-term economic recovery, the confidence of industry to invest in large capital projects with uncertain economic prospects and the uncertainties surrounding fuel prices, in particular the recent volatile oil markets. However, it is recognised that even in the current climate, advances are being made in small and micro cogeneration units and that the uptake of cogeneration in recent years has been dominated (in the number of units rather than in installed capacity) by the commercial and leisure sectors. Therefore, the Low Uptake Scenario includes an allowance for a modest breakthrough in residential micro-generation, aided by the recently announced Feed-in-Tariff support, albeit in a much reduced new-build housing market compared to the recent building boom years. There may be opportunities for some retrofitting of such micro cogeneration units but this is unlikely to contribute significantly to the uptake in this scenario. Similarly, there may be some retrofit projects in commercial and public sector sites (hotels and hospitals). It is assumed that no expansion takes place at the 160 MW_e cogeneration plant. In the longer term (post 2016) this scenario assumes that the proposed waste-to-energy and district heating plans for Dublin are rolled out, with an initial uptake of up to 20 MW_e as cogeneration, although its qualification as high efficiency cogeneration would need to be demonstrated.
Medium Uptake Scenario Capacity potential for 2020: 627 MW_e Distance to target (form end 2010): 320 MW_e	The medium Uptake scenario is based upon more favourable market conditions for cogeneration. However, while the rate of uptake is greater than in the Low Uptake scenario, the majority of growth is expected to occur in the latter half of the 2010 to 2020 period, and beyond. Sites that have completed or are in the process of completing feasibility studies are expected to install the plants, where practicable and economic, between 2015 and 2020. Other, as yet unidentified, sites will carry out feasibility studies from 2012 onwards and, where feasible, the plants may be constructed before 2020. It is assumed that the 160 MW_e cogeneration plant, which has already investigated the potential of constructing a further 75 MW_e of capacity, invests in the project towards the end of the 2010 to 2020 period. The Medium Uptake scenario also assumes that the construction industry recovers towards the middle of the 2010 to 2020 period but at a rate significantly lower than the peak of the previous years. New developments are more favourable to cogeneration, although the growth is from a relatively low (capacity) level of new build activity. There is also a recovery in the residential building sector, although new build housing is not expected to be greater than 30.000 houses per annum. Technological advances in micro-CHP allow for the retrofitting of

	such units into existing houses from 2015/2016 onwards. The proposed waste-to-energy and district heating plans for Dublin are rolled out by 2016 and the waste-to-energy plant in Cork is partially subscribed to (as with the Dublin development, this station would need to demonstrate that it qualifies as high efficiency cogeneration).
High Uptake Scenario Capacity potential for 2020: 773 MW_e Distance to target (form end 2010): 466 MW_e	The High Uptake scenario is the most optimistic in terms of economic recovery, improvements in the market for cogeneration (both in terms of existing and new sites) and the support structures (both informative and financial) from the government and financial institutions. This scenario is based upon economic recovery within three or four years, with economic growth returning to the pre 2008/2009 levels, although it does not reach the peak rates experienced during the early part of the 21st century. The majority of sites identified as having the technical and economic potential for cogeneration install it, ore commence installing it, by 2016. New sites begin feasibility studies and invest progressively over the 2010 to 2020 period. The 160 MW_e plant expands by 75 MW_e sometime after 2015. The advancements in micro-cogeneration allow for a higher rate of installation in a more buoyant housing market (approximately 60.000 houses per annum) and the retrofitting of these units in the existing housing stock.

Table 2.1 - Three uptake scenarios for the potential of CHP in Ireland (2009)

It is expected that Ireland will fall short of the 2020 target of 800 MW_e, although there is a considerably greater spread between the three scenarios, ranging from a shortfall of 434 MW_e under the low scenario to just under 27 MW_e in the high scenario. The achievement of the 2020 target (or the high uptake scenario projection) will be dependent upon the level of support provided by a wide variety of stakeholders, from the Department of Communications, Energy and Natural Resources, the Commission for Energy Regulation and SEI, to industry and business groups and individual end users (Cléirigh, 2009). At this moment it is still considered that this technical potential is realistic and can be reached, if the appropriate measures are taken. However according to different stakeholders this will be in the first place dependant on the amount of support.

2.1.2. Potential analysis reported to the commission

The previous study was used for the potential reporting towards the commission in 2009. 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 in an assessment 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 summarises the use of cogeneration **technologies** and the prospects for future uptake of cogeneration.

Technology description	Potential for use in 2020
Gas fired CCGT with heat recovery (> 100 MW_e)	Possible in very large scale plants
Steam back pressure turbines (c. 3 MW_e)	Wood processing Peat briquetting
Steam condensing extraction turbines (c. 3 MW_e)	Wood processing Peat briquetting
Combined pass out and condensing steam turbine (c. 3 MW_e)	Wood processing Waste incineration
Gas turbines with heat recovery (up to 75 MW_e)	Alumina Dairy ICT Pharmaceutical
Internal combustion engines (0,25 to 17 MW_e)	Multiple sectors in industrial and services sectors
Microturbines (100 kW_e)	Residential Commercial (small scale)
Fuel cells (1 kW_e)	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_e)	Possible in conjunction with geothermal pilot plants
Steam engines	None identified
Biomass gasification with internal combustion	Potential in large scale plants

Table 2.2 - 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.

According to the study 'Combined Heat and Power (CHP) - Potential in Ireland', the greatest prospect for achieving the National target is through the installation of large scale plants. However, in recent years the commercial sector has seen the strongest growth and it is likely that the residential sector will see similar growth once domestic scale micro-CHP technology becomes more widely available to the market. It is important, therefore, to consider all scales of cogeneration in achieving the target (Cléirigh, 2009).

2.1.3.1. Industry

Examination of the current cogeneration capacity breakdown (**Error! Reference source not found.**) ighlights the **dominance of the industrial sector** in meeting Ireland's cogeneration targets. It is positive to note that Irish industry is showing a strong interest in cogeneration despite the current unfavourable economic climate and it appears that it is technically viable at large scale across a number of sites in different sectors. However the economic return on investment of new cogeneration projects is the key to achieving the national targets.

The Provisional 2008 National Energy Balance (**Error! Reference source not found.**) provides a useful ndicator of the potential for the uptake of cogeneration, with the total (final) electrical and thermal demands for the main sectors identified.

Sub-Sector	Final Electricity Demand (GWh)	Total Fossil Fuel Demand (GWh)	Renewables Fuel Demand (GWh)	Portion of Fuel Demand Suitable for CHP (Note 2) (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
Total *(Note 1*	***8,037***	***19,738***	***1,768***	***9,537***

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 2.3 - Breakdown of Final Energy Consumption in Industrial Sector (2008) (Ó Cléirigh, 2009)

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

Dairy industry

There is currently a large 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, it would suggest that cogeneration may be viable at other dairies. Stakeholders have estimated a growth of 50% in the dairy sector, 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_e 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_e). 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_e to the potential by 2020

2.1.3.2. *Commercial/Services Sector*

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 account for 80% of the number of cogeneration units, and as seen in Table1.3, hotels and hospitals account for the majority (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 therefore has shown a large 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 (Ó Cléirigh, 2009) that 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. E.g. more than 30 5,5 kW_e units are operating in this market segment and growth is expected.

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

<u>Hospitality</u>

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, financial support would be needed as a stimulus.

<u>SME's/commercial micro-CHP</u>

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 systems in commercial sites that are well designed and installed deliver reasonable levels of efficiency and CO_2 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[2] suggests that there are sufficient applications in Ireland to accommodate at least 1000 5 KW units of in total 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)

[2] Study by Kinviro Limited

Within this project a micro-CHP potential study was conducted in which the potential for commercial systems (SME and district heating) (± **40 kW_e**) 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 stock is estimated at:

- 240 units in 2020 (9,6 MW_e) and
- 3300 units in 2030 (132 MW_e).

These numbers include all commercial systems (also hotels) and district heating. A very large potential in these sectors is envisaged 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. Therefore in this sector additional growth can be expected. On 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.

2.1.3.4. Residential

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.

The High Uptake Scenario projects that the residential sector could l 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 can be expected because of the feed-in-tariff support, technical advances and a growing number of installations in the existing housing market.

Within this project a micro-CHP potential study was conducted in which the potential for household micro-CHP (± 1 kW_e) 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 stock is estimated at:

- 1000 units in 2020 (1 MW_e) and
- 157.000 units in 2030 (157 MW_e).

Compared to the high uptake scenario, this is much lower in 2020 but the market is expected to grow by 2030.

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_e was 'technically' feasible and 50 MW_e 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.

Many houses 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 or ESCOs as we understand that the maintenance required on the units is more extensive than for gas fired units. Consequently, the potential for the conversion from an oil based boiler heating system to an oil based cogeneration system in the residential sector is likely to be limited (Ó Cléirigh, 2009).

2.1.3.6. Bio-CHP

Bio-CHP is of very small importance in Ireland at this moment. In Table it can be seen that in 2010 only 2 biomass units with a capacity of 5 MW 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). The future potential is also limited as a result of different constraints, such as an only limited support and low awareness. Therefore the future penetration rate of bio-CHP in the cogeneration market is estimated as follows:

- 2009: 1,1% (EEA, Eurostat)
- Projection for 2020: 8,0%
- Projection for 2030: 6,0%

The methodology and assumptions are explained in Annex 3.

3 How do we arrive there? The Roadmap

3.1 Preliminary remarks

The roadmap is the result of 3 meetings/webinars and over 20 one-on one expert discussions (see introduction). It will be the base for discussion and feedback during the workshop of 6th June in Ireland.

The chapter is based on the assumption that the 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_e by 2020), and the view of stakeholders that this 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 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 landscape. Actions have to be undertaken in order to reach the targets that have been set. Cogeneration is an important actor in obtaining energy efficiency objectives, and as an energy *conversion* technology it stands beside renewable energy *production* in its low carbon and sustainability potential. It offers energy efficiency bonuses through its integrated approach as it lowers network investment costs and transmission losses. Cogeneration should not be viewed as a transition technology. It 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 in obtaining 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 have to be used in such studies.

As cogeneration will be an important part 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 used to establish a consistent framework to achieve these targets.

3.2.2. Removing policy barriers

Once a policy vision has been created, it will become more obvious which policy measures detrimental to cogeneration need to be adjusted, such as carbon tax, LEU rebate and network charges reprofiling.

- Electricity generated by a cogeneration needs to be included in the LEU rebate.
- Gas consumed by a cogeneration site should be exempted from carbon tax as for other electricity generators.

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 in Ireland! 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.

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.

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. Moreover in other European countries bad outcomes were experienced on the level of financial agreements with the third parties.

In the non-residential sector, a key factor in overcoming the barriers to investment is supporting the emergence of energy service companies (ESCOs) and performance contracting models. Increased ESCO activity should be promoted in both the public and private sectors.

3.2.4. Obtaining financial support

Financial support is essential for reaching the High Uptake Scenario potential. However the support should be well targeted and well calculated.

- Compare advantages of technologies:
  As already discussed above, a comparative carbon foot printing of competing programmes should be conducted for the purpose of prioritising financial supports.
- 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. Grant schemes are effective in promoting the uptake of cogeneration, although poorly designed grant schemes, and grant schemes without accompanying quality measures can lead to unintended outcomes in the past feed-in-tariffs have been successful in Ireland for wind energy. However in other countries this kind of support has led to over-support and has therefore been withdrawn. An export tariff is not an effective support mechanism, since a well-designed cogeneration system does not export significant quantities of electricity. A generation

tariff might be better. Policy makers should make a comparative analysis on the type of support.

- Amount of support:
  It has been shown in this roadmap that in many occasions a small amount of financial support would be sufficient to kick start the technology in different market sectors. 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 from them.

- Target the support:
  A comparative analysis should be made to which sectors the support should be given and thought should be given if every technology needs the same amount of support. Especially the household as well as commercial micro-CHP sectors are in high need of support.

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 on 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. Following steps should be taken towards these market sectors:

- Develop comprehensive flow charts/road maps setting out the process for installing cogeneration from inception to commissioning.
- Prepare 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.
- Develop targeted programmes for the promising sectors such as the hospitality sector. This 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 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.

For the micro-CHP market in the households, it is still early to develop awareness. First the market should be more developed, technologies should be ready and financial support should be available. 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 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.

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. A coalition of platform should be created which channels all the information from and to stakeholders. This group could be an information exchange group, a neutral discussion forum or an influential lobbying body.

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. Stakeholders should make the government aware of the necessity to develop an integrated network approach for district heating. Also, some of the barriers preventing the uptake of DH in Ireland could possibly be overcome by the introduction of institutional incentives. 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.

The EED obligation for making heating and cooling plans should be taken seriously and should be seen as a basis for further planning.

Only when policy makers are aware, other stakeholders should also be involved, and private residents should be motivated towards participating in district heating projects.

3.2.8. Simplifying export of electricity to the grid

Grid connection remains a significant barrier, especially to the development of biomass/biogas cogeneration due to the structure of the REFIT support scheme. The requirement to provide a second grid connection at sites where grid connections already exist for the purpose of exporting electricity unnecessarily adds significant costs to projects. A smart grid solution using smart meter configurations is far more sensible, cost effective solution. E.g. using sub metering to provide metered data identical to that of a second grid connection. The Network operator should be more engaged with industry to identify a workable solution. In Article 15 Demand Side Management provisions and balancing potential of HE CHP are clearly mentioned (with penalties for those hampering the development of those markets). This shall provide incentives to transmission and distribution system operators to improve the network infrastructure and to simplify and shorten authorization procedures.

3.2.9. Identifying specific potential market for CHP

The total operational capacity at the end of 2010 was approximately 284 MW_e. The government is due to consider a second cogeneration target for 2020 in light of further feasibility studies by SEAI into cogeneration applications, a review by CER of potential administrative and regulatory barriers, and decisions on appropriate price support mechanisms for electricity generated from new high efficiency large scale cogeneration. It is also intended that the public sector will act as an exemplar in relation to cogeneration, with 33% energy efficiency to be reached.

There is no vision on how to develop the current target of 800 MW_e. 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.

- Within this target, sub-targets should be established for the three high level sectors (industrial, services and other) in order to focus support programmes, 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.

These 3 suggestions were already made in the Irish potential study (Ó Cléirigh, 2009) but haven't been implemented so far.

Chapter 3.3 (*The roadmap path in numbers*) will be a first identification of possible growth sectors.

3.2.10. Overview of the roadmap steps

Action	Reason	Steps	Target group	Outcome	Time planning
1 **Building a policy vision for CHP**	- Current targets are not met - No of view of CHP within renewable policy - No understanding of role of CHP in energy efficiency targets	- Comparative analysis of advantages of CHP - Continuous communication by a CHP coalition to follow up objectives - Follow up of EED implementation by CHP coalition	Policy makers CHP coalition	A better policy where the role of CHP within the energy efficiency and renewable energy landscape is better defined.	2015
2 **Removing policy barriers**	Policy measures are detrimental to CHP (carbon tax, LEU rebate).	- Include CHP electricity in LEU rebate - exempt CHP gas from carbon tax	Policy makers	CHP treated equally with other electricity generators	2020
3 **Improving economic viability of CHP projects**	Payback times are too long for investors in the current economic climate.	- Decide on the introduction of PAYS schemes - Promote ESCO activities	Policy makers	With the help of these systems the small economic barrier towards feasible payback times can be overcome.	2020
4 **Obtaining financial support**	- to make projects economically viable - to reach the potential for CHP	- compare different technologies - open discussion for type and amount of support - obtain support from policy or private sector	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

5 Increasing awareness	- lack of awareness among actors in all socio-economic groups - lack of exchange of information between groups	- develop flow charts - prepare case studies - develop targeted programmes - use how-to-guides - choose champions	Policy makers CHP coalition	A high degree of awareness among all relevant players will support the market for CHP.	2015
6 Setting up a CHP coalition	- no exchange of information between stakeholder groups - no platform for discussion - no lobbying mechanism towards government	- discuss on the type of coalition, based on experience from other European countries - set up the coalition	All stakeholders	An active and operational CHP coalition in Ireland.	2013
7 Developing a framework for district heating	- no view of district heating - integrated and long term approach necessary	- integrate DH in the existing policy - integrate DH in energy efficiency plans	Policy makers	District heating understood among policy makers and included in plans.	2030
8 Simplifying export of electricity to the grid	- existing regulations of REFIT scheme are adding costs to projects	Develop simpler and cheaper solutions	Grid operators	Easier and cheaper use of grid for export of electricity.	2020
9 Identifying specific potential market for CHP	- no vision on how to reach the existing general target	- use identified potentials identified in this roadmap to develop sector specific targets	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, we propose a way forward for cogeneration in Ireland.

First we assume that the government remains committed to the cogeneration targets that were already set in the White Paper (800 MW_e by 2020), and the view of stakeholders that this is an achievable goal. However this can only be realised if the barriers 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.

One of the aims of this project is also to expand member state's visions 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 unrealistic to be achieved between 2020 and 2030. Therefore the growth speed that will be necessary between 2010 (when 284 MW_e 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 .

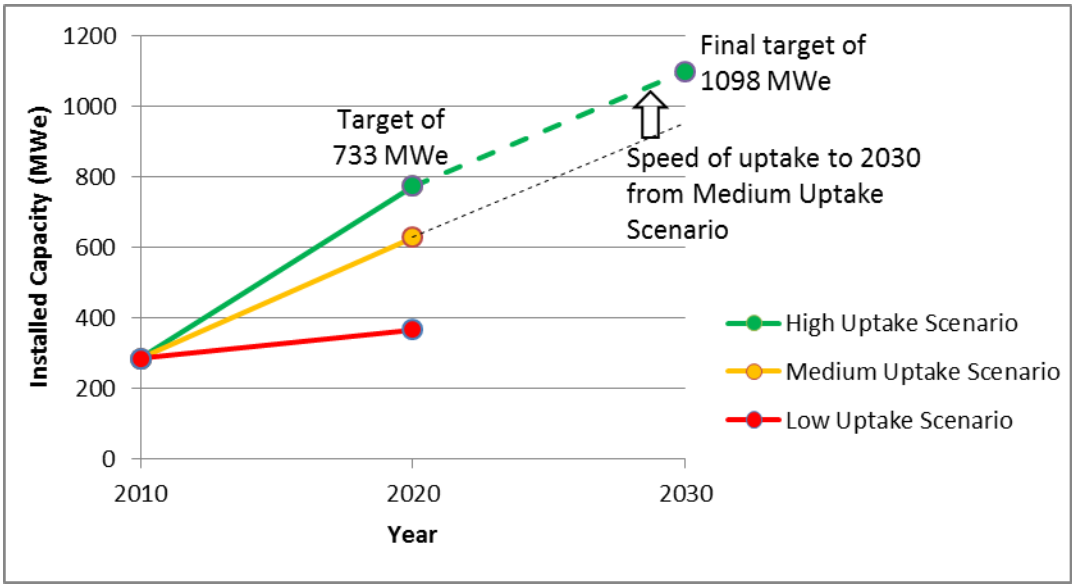


Figure 3.1 - Assumptions made for reaching a final target in 2030

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

Targets for CHP: 733 MW_e by 2020 1098 MW_e by 2030

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.

At the moment 6,8 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. At this moment the average for Europe is 11% but up to 22% could be reasonable with 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 the industry, growth is expected by the stakeholders in the dairy industry (50 MW_e) and timber processing (50 MW_e). An uptake of 75 MW is expected in the Aughinish Alumina Plant (Ó Cléirigh, 2009). 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 study the total technical potential for micro-CHP of about 40 kW_e (including all commercial and district heating) is estimated at about 10 MW_e in 2020 and 132 MW_e in 2030.
- In the micro-CHP study the technical potential for micro-CHP of about 1 kW_e 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_e, 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. Therefore we assume a higher growth by 2020 than the high uptake scenario, and by 3030 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 .

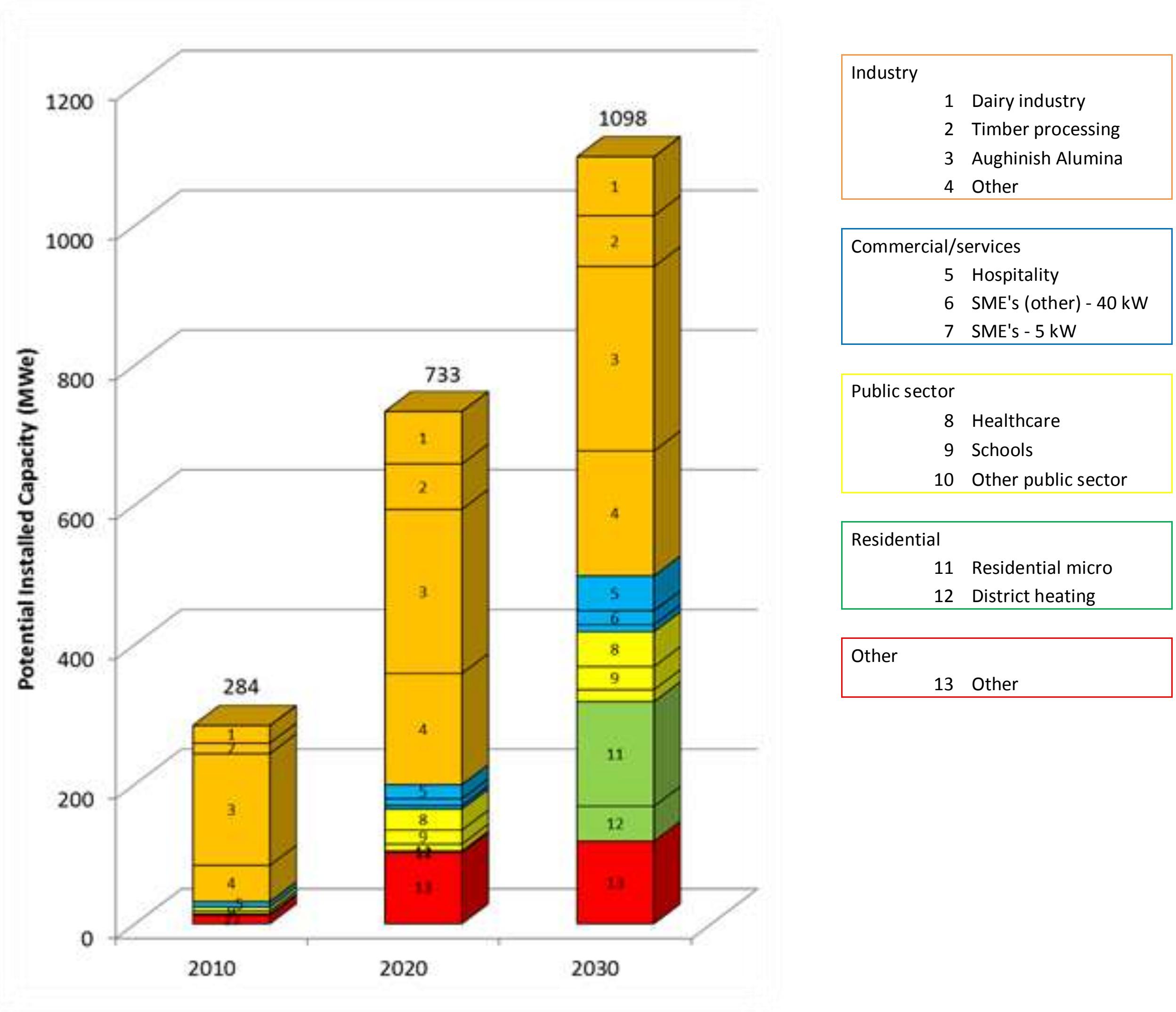


Figure 3.2 - Identification of the market potential for 2020 and 2030

4 Conclusions

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 is also covered in the Irish policy since 2006, and a cogeneration capacity of 800 MW_e for 2020 is repeatedly targeted in the legislation. However targets are not being met and recommendations of previous reports are not implemented.

This report shows that it can be possible to reach this target of 800 MW_e by 2020, and with a medium growth rate, to extend the installed capacity to ca. 1100 MW_e 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 in fact it acts against it. Most financial support for cogeneration has been withdrawn. At the moment the focus of policy makers is towards 100% renewables where the potential positive role of cogeneration has not been assessed and is not 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. The elements of the current policy which work against cogeneration should be assessed for this impact. Carbon tax and network charges re-profiling, and exporting surplus electrical power to the grid is complex. 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 the maximum for investors. 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 is the fact that large areas of the country remain without access to the natural gas grid.

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, …) between now and 2030. 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 we already tried to identify this potential market for cogeneration. 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 of a cogeneration coalition in Ireland, which will be started during the workshop on 6th June 2013 in Dublin. Second, several articles from the EED, such as necessity to set energy efficiency targets, the requirement for heating and cooling plans and the obligations towards awareness building, could stimulate the Irish policy towards a more integrated vision for cogeneration.

Sources

Brennan Darran COGEN Europe Policy Update [Report]. - 2013.
CER Proposed decision on 2011 to 2015 distribution revenue for ESB Networks Ltd [Report]. - 2010.
Cléirigh Byrne Ó Combined Heat and Power (CHP) - Potential in Ireland [Report]. - Dublin : Sustainable Energy Ireland (SEI), 2009.
DCENR [Online]. - 2013. - http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/REFIT.htm.
Dennehy [Journal]. - 2012.
Electric Ireland [Online]. - 2013. - https://www.electricireland.ie/ei/residential/price-plans/micro-generation-scheme.jsp.
Energy White Paper [Online]. - Department of Communications, Marine and Natural Resources Ireland, 2007. - http://www.dcenr.gov.ie/NR/rdonlyres/54C78A1E-4E96-4E28-A77A-3226220DF2FC/30374/EnergyWhitePaper12March2007.pdf.
EPA Ireland's Greenhouse Gas Emission Projections 2012-2030 [Journal]. - 2013.
Eurostat Combined Heat and Power (CHP) in the EU, Turkey, and Norway - 2008 Data. [Report]. - Euorpean Union : Environment and Energy, 2010.
NEAP [Online]. - Department of Communications, Energy and Natural Resources Ireland, 2009. - http://www.dcenr.gov.ie/NR/rdonlyres/FC3D76AF-7FF1-483F-81CD-52DCB0C73097/0/NEEAP_full_launch_report.pdf.
NEAP2 [Online]. - Department of Communications, Energy and Natural Resources Ireland, 2013. - http://www.dcenr.gov.ie/NR/rdonlyres/B18E125F-66B1-4715-9B72-70F0284AEE42/0/2013_0206_NEEAP_PublishedversionforWeb.pdf.
NESC Towards a New National Climate Policy: Interim Report of the NESC Secretariat [Journal]. - 2012.
Ó Cléirigh Byrne Combined Heat and Power (CHP) - Potential in Ireland [Report]. - Dublin : Sustainable Energy Ireland (SEI), 2009.
REFIT [Online]. - 2013. - http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/REFIT.htm.
Revenue Guide to Natural Gas Carbon Tax [Report]. - 2012.
SEAI [Online]. - 2013. - http://www.seai.ie/Grants/CHP/.
SEAI Commercial micro-CHP Field Trial Report [Report]. - 2011.
SEAI Electricity and gas prices in Ireland [Report]. - 2012.
SEI Assessment of the barriers and opportunities facing the deployment of district heating in Ireland [Report]. - 2002.

Annex 1: Stakeholder group awareness assessment

Customers	
Industry	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.
Utilities	Cogeneration is commonly known in the utilities sector, but there is no active market.
Commercial	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 (Ó Cléirigh, 2009). 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.
Households	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.
Market and supply chain	
Manufacturers	Marketing for large scale is commensurate with industry size. There is good awareness among potential large scale users. 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.
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	
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	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. However at the moment, due to the economic climate, there is no active role of the banks in the cogeneration market.
ESCOs	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 (Ó Cléirigh, 2009). However ESCOs are mainly available in the >1MW$_e$ bracket. In the smaller sizes, it is hard to offer attractive ESCO contracts given the long payback for micro-CHP.
Policy	
National	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. It has been recognised as a barrier that there is no central source of information regarding grants, other supports, licensing, and relevant agencies (Ó Cléirigh, 2009). 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. 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.
Regional	
Local	
Urban & Regional planners	There is a lack of awareness about the potential for cogeneration for district heating. In general they are not very aware of cogeneration.

Energy agencies	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. 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.
Influencers	
Sector organisation s	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). 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.
General public	There is no 'road map' to guide prospective cogeneration installations in the process of installation cogeneration. There is minimal or zero awareness.
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.

Table 8 - Ratings of CHP awareness of different influential groupings

Legend:

- Active CHP market
- Interest in CHP
- Early CHP awareness
- Low CHP awareness
- Poor CHP awareness

Annex 2: Micro CHP potential assessment

micro-CHP potential summary Ireland

Country statistics

Population: 4 600 000 (2010)
Number of households: 1 640 000 (2010)
GDP per capita: € 32 500 (2010)
Primary energy use: 11 800 ktoe/year (2010)
GHG-emissions: 61 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kWe)

Boiler replacement technology

Present market (2013)

Boiler stock: 1 160 000 units
Boiler sales: 136 000 units/year

Potential estimation

Indicator	Score
Market alternatives	0
Global CBA	3
Legislation/support	1
Awareness	0
Purchasing power	3
Total	**7 out of 12**

Market share in 2030: 29% of boiler sales in Household sector

Yearly sales

Sales in 2020: 500 units/year*
Sales in 2030: 35 500 units/year*

Stock

Stock in 2020: 1 000 units*
Stock in 2030: 157 000 units*
Stock in 2040: 389 000 units*

Potential savings in 2030

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

SME & Collective systems (±40 kWe)

Boiler add-on technology

Present market (2013)

Boiler stock: 146 000 units
Boiler sales: 17 000 units/year

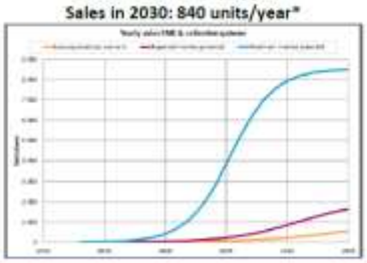
Potential estimation

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

Market share in 2030: 12% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 40 units/year*
Sales in 2030: 840 units/year*



Stock

Stock in 2020: 240 units*
Stock in 2030: 3 300 units*
Stock in 2040: 15 900 units*

Potential savings in 2030

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

*Corresponding to the expected potential scenario.

micro-CHP score card Argumentation

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

±1 kWe systems (Households)

Boiler replacement technology

Scorecard

Indicator	*Score*
Market alternatives	0
Global CBA	3
Legislation/support	1
Awareness	0
Purchasing power	3
Total	7 out of 12

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 and 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.

Global CBA

SPOT: ***4.4 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.

Awareness

Are stakeholders aware of the microCHP technologies

Homeowners? ***No.***

Consultants? ***Some are aware.***

Installers? ***No.***

Planners? ***No.***

Government? ***No.***

Are manufacturers active in the market? ***No.***

Purchasing power

GDP: ***€ 32 500 per year***

±40 kWe systems (SME & Collective systems)

Boiler add-on technology

Scorecard

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

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: ***14 years***

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 technology

Homeowners? **SOME**

Consultants?

Increasing awareness with consultants over the last 3 to 5 years.

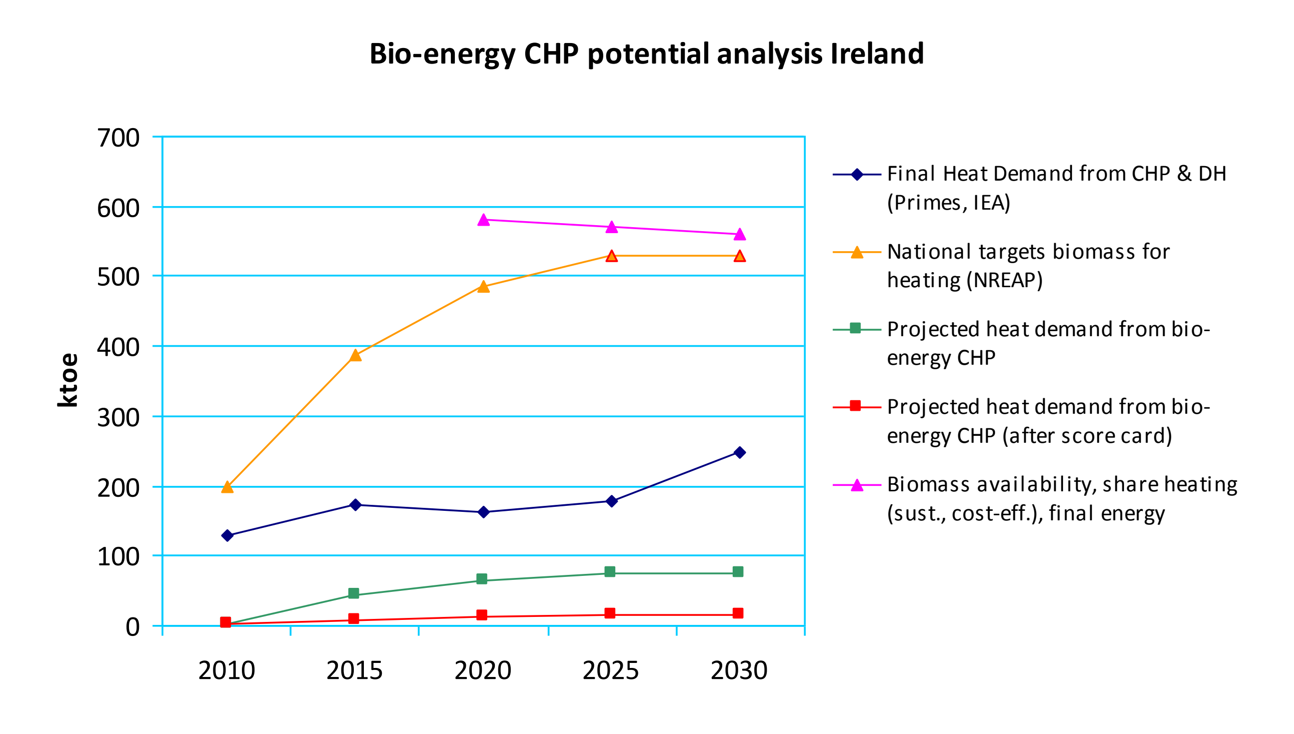
Installers? **SOME**

Planners? **FEW**

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	13	15
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	1,1% (2009)	8,0%	6,0%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		580	561



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	o 1 (of 3)	No known legislation.
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

Annex 4: Assumptions used in market extrapolation

Sector		Heating in services and multifamily houses	Industry and service process heat and heating supply	District heating	Bio gas CHP (agriculture, waste, industrial wastewater or sewage treatment)
		50 kWe ICE	1 MWe ICE	10 MWe CC	0,5 MWe Biogas
Technology		**ICE**	**ICE**	**CC**	**ICE**
Power	**MW_{El}**	**0,05**	**1**	**10**	**0,5**
Efficiency-el.	Eff_{EL}	34%	40%	46%	38%
Efficiency-th.	Eff_{H}	56%	45%	42%	37%
Efficiency-sum.	Eff_{SUM}	90%	85%	88%	75%
Operation	**h/a**	**4.000**	**6.500**	**6.500**	**7.500**
Fuel	MWh	588	16.250	141.304	9.868
Electricty	MWh	200	6.500	65.000	3.750
Heat	MWh	329	7.313	59.348	3.651
Investment	**EUR**	**100.000**	**1.000.000**	**12.300.000**	**2.200.000**
	€/kWel	2.000	1.000	1.230	4.400
O&M costs	% of Inv.	6%	14,0%	7%	6%
	€/MWh	30,0	21,5	13,2	35,2
Price of fuel	€/MWh	35	35	35	20
Value of electrcity	€/MWh	153	90	87	
Other market revenues	€/MWh				
Value of heat	€/MWh	39	39	39	40
Support					
Electricty	$€/MWh_{El}$				157
Other support or benefits	€/a	1250			27500
Investment subsidy	€				
Costs & revenues					
Fuel	€/a	-20.588	-568.750	-4.945.652	-197.368
Electricty	€/a	30.680	585.000	5.648.500	0
Heat	€/a	12.810	284.375	2.307.971	146.053
Support	€/a	1.250	0	0	616.250
Other market revenues	€/a	0	0	0	0
O&M costs	€/a	-6.000	-140.000	-861.000	-132.000
TOTAL	**€/a**	**18.152**	**160.625**	**2.149.819**	**432.934**
SPB	**years**	**5,5**	**6,2**	**5,7**	**5,1**
IRR	**%**	**13%**	**10%**	**12%**	**15%**

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
- Hellenic Association for the Cogeneration of Heat and Power (HACHP) (Greece) – contact: hfa@heatflux.eu
- Jožef Stefan Institute (Slovenia) – contact: stane.merse@ijs.si
- Federazione d' associazioni scientifiche e tecniche (FAST) (Italy) – contact: giorgio.tagliabue@gmail.com
- COGEN Vlaanderen (Belgium) – joni.rossi@cogenvlaanderen.be
- Energy Matters (Netherlands) – contact: Arjen.deJong@energymatters.nl
- Berlin Energy Agency (Germany) – contact: hermann@berliner-e-agentur.de
- KWK kommt (Germany) – contact: adi.golbach@kwkkommt.de