CODE2

Cogeneration Observatory and Dissemination Europe

D5.1 Final Cogeneration Roadmap non pilot Member State: ***Malta***

July 2014

Leading CODE2 Partner: **FAST – Federazione delle associazioni scientifiche e tecniche**

Malta is part of non-pilot Member States of the South-West CODE2 Region.
The CODE2 Region 'South-West' comprises the following Member States:
France, Italy, Malta, Portugal, Spain

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

Introduction

The CODE2 project[1]

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

The input of all experts has informed these roadmaps. The content of the roadmaps and opinions expressed reflect the conclusions of the CODE2 project only.

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

Draft roadmap methodology

This roadmap for CHP in Malta is written by CODE2 partner FAST – Federazione delle associazioni scientifiche e tecniche, based on a range of studies and consultation.

It has been developed through a process of discussion and exchange with experts.

Acknowledgement

FAST and the CODE2 team would like to thank all experts and policy-makers who on different level have been asked to give their valuable contribution to this roadmap.

It has to be stressed anyway that the statements and proposals in this paper do not necessarily reflect those of the consulted experts.

N.B.
The roadmap was written over the period September 2013 – March 2014. The national policy framework around CHP has continued to evolve in Malta and this should be taken into account when using the material in the roadmap.

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

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1. Executive Summary

Malta had not historically a very active CHP market, because of its geographical condition that limit the demand of heat for space heating. Moreover some infrastructural and market barriers (absence of a NG grid, absence of connection of power grid to the continent, high taxations of combustibles and others) tie the development of a CHP demand. This situation is also represented by a restricted awareness among most of the market players and customers mainly due to the hard competition with other RES technologies which could be more attractive to all sectors of consumers.
Both Renewables Directive, 2004/08/EC, and Energy Efficiency Directive, 2012/27/EU, have been transposed in the Maltese Regulations system. The Maltese National Renewable Energy Action Plan, focused on onshore and offshore wind energy, solar photovoltaic and solar thermal energy, as well as waste to energy. Specific measures in support of CHP (green tariff and others) are today under elaboration but not still active.
In Malta, at present there is only one plant in operation considered as a high efficiency co-generation station fed by waste biogas . The system was licensed on October 2011 to Wasteeserv Malta Ltd, consisting of two engines, the first with a peak power of 1MWe and a second of 716kWe. The plant on average generated 2,73GWh electricity and 2,52GWh of heat was utilized till end of 201, with a reduction in CO2 emissions of 10.000 ton/y .
Market opportunities are today very limited, due to the characteristic of internal energy market. Promising sectors for installation of CHP are large tourism facilities and public services (hospital in particular), but so far a few number of application for CHP authorization are registered. A growth is expected by 2020, in particular in waste to energy sector and, in case of availability of supporting measures and realization of energy infrastructures, investments could be activated in tertiary and industry sectors too.
The potential of cogeneration is constrained in the space heating sector by the short heating season and the relative immaturity of cooling technologies based on CHP. There are opportunities in infrastructure , industry and commercial applications.
The Comprehensive assessment envisaged under Article 14 of the Energy Efficiency Directive should go a long way to establish holistically the way forward and possibly identify new ways of how heating and cooling needs can be more efficiently obtained.
In consultations between the Energy unit at the Ministry for Energy and various market operators, it has been underscored that the latter are closely watching the potential economic benefit of the various high-efficiency CHP technologies for a possible implementation.

2. Where are we now? Background and situation of cogeneration in Member State

2.1. Current status: Summary of currently installed cogeneration

In Malta, there is at present only one cogeneration plant in operation considered as a cogeneration station which utilises the biogas generation from waste.

The Maltese national electricity grid is an isolated one and is not connected to any other electrical network. Therefore, all the electrical energy that is required is generated in Malta. This is operated by EneMalta Corporation. At present EneMalta Corporation operates **two Power Stations**, which supply all the **Electrical power needs of the Islands of Malta and Gozo**, for a total combined nominal installed capacity of 571 MWe. Malta has no indigenous primary energy resources and therefore EneMalta Corporation relies entirely on imported fuels, mainly heavy fuel oil and light distillate[2].

To address energy isolation Malta has laid plans through EneMalta Corporation to install an 220 HVAC electricity link with Sicily. The electricity interconnector with Sicily is expected to become operational by end of 2014. Connection to the European energy grid will thus increase energy supply security and enable the phased switching off of the highly inefficient Marsa power station. Malta continues to diversify its energy mix and improve its security of supply through a number of actions. On 4th December 2013, Enemalta awarded a power purchase Agreement (PPA) and a Gas-supply Agreement (GSA) to ElectroGas Malta Consortium following an expression of interest. The consortium is tasked with the building, owning, operating and maintaining of a new LNG delivery, storage, re-gasification and natural gas supply facility, and a new natural gas-fired 215 MW combined cycle gas turbine electricity generation plant, together with all necessary infrastructure connections to Enemalta's electricity distribution network, at Delimara, by mid-2015[3].

Government is also assessing the feasibility of a connection to the trans-European Natural Gas Network to deliver natural gas for the generation of electrical power and explore its potential for use for domestic, commercial and industrial purposes. Malta had submitted a concept proposal in May 2012 for a project aimed at connecting Malta to the European Gas network. The concept project consists in a Floating Storage Regasification Unit (FSRU) and a pipeline connecting it to both Delimara (Malta) (1 2 km approx.) and Gela (Sicily) (150 km approx.) for transmission of natural gas[2].

Malta had used cogeneration meaningfully and extensively for thermal seawater desalination in the late 1960's to late 1980's, when sea-water distilling plant was supplied with steam from power-station pass out steam turbines. Thermal desalination is now superseded by high efficiency reverse osmosis technology for the production of potable water and hence is now longer used. There is currently (2014) **one CHP plant** in Malta, under operation at the Sant'Antonin Waste Treatment Plant (**1,7 MW**), the main waste treatment plant in Malta. The Sant'Antonin Waste Treatment Plant includes a biological treatment plant for the production of biogas through the anaerobic digestion of biodegradable municipal solid waste. The biogas produced is to be used by a combustion engine, and excess of power is fed to the grid[4]. This CHP plants, licensed on October 2011 and managed by WasteServ Malta Ltd, consists of two reciprocating engines one capable of generating 1 MWe and a second capable of generating 716 kWe. The plant on average generated 2,73 GWh electricity and

[2] Source: http://www.enemalta.com.mt/
[3] Source: Malta National Reform Program under the Europe 2020 Strategy, April 2014, Ministry for Finance
[4] Source : e-mail from Enemalta Corporation - Inġ. Sylvana Scicluna - Professional Executive - Regulatory Affairs Office

2,52 GWh utilised heat till end of 2013[5], and CO2 emission reduction has been estimated of around 10.000 ton/y (excluding emissions saving from waste management). The thermal energy produced by the Sant'Antonin Waste Treatment Plant is used for emission treatment and to provide heat to nearby swimming pool [6].

2.2. Energy and climate Strategy

Malta does not have an emission reduction target under the Kyoto Protocol. However the Government adopted a "National Strategy for Policy and Abatement Measures Relating to the Reduction of Greenhouse Gases" in 2009 and the National Renewable Energy Action Plan, which options focused on onshore and offshore wind energy, solar photovoltaic and solar thermal energy, as well as waste to energy.

In **2009**, Malta submitted a formal application for an amendment to the UNFCCC which inserted Malta in the list of Annex I Parties to the Convention. This amendment was accepted by COP-15 in Copenhagen in December 2009 and formally came into force in October 2010. However as an Annex B listed ,Malta **does not have an emission reduction target** under the Kyoto Protocol. As a Party to the UNFCCC and the Kyoto Protocol, Malta has taken various measures on a national level. In the recent years, Malta has adopted a number of strategies aimed at achieving its greenhouse gas emission reduction commitments and in adapting to climate change.

In **2009**, the Government adopted a "**National Strategy for Policy and Abatement Measures Relating to the Reduction of Greenhouse Gases**" containing mitigation measures aimed at reducing greenhouse gas emissions and including the implementation of renewable energy sources, electricity efficiency and conservation.

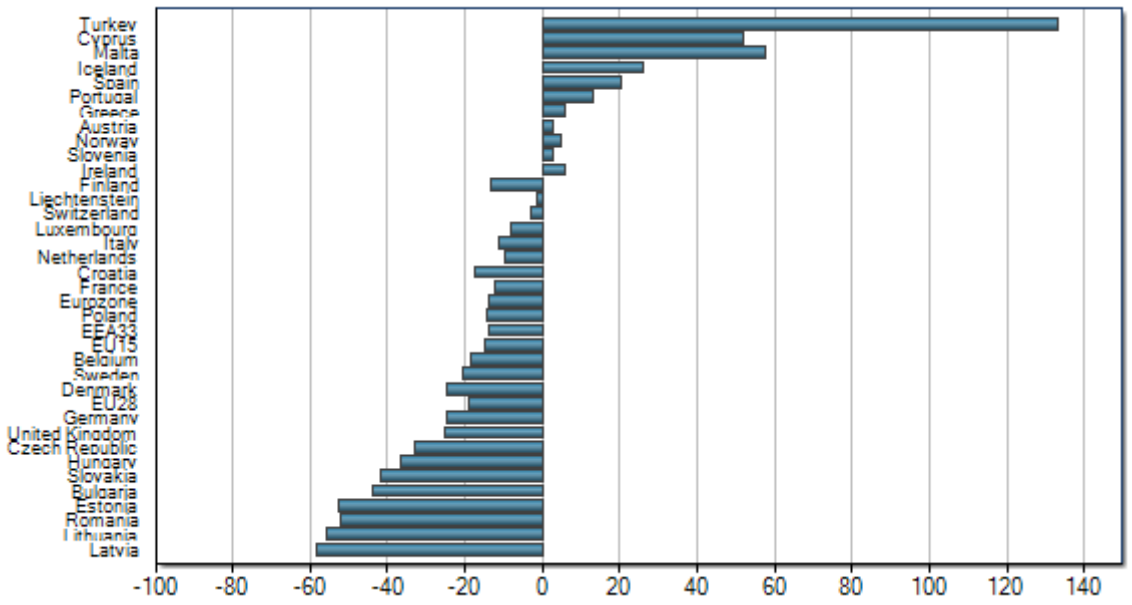


Figure 1 – Trend of the greenhouse effect gases emissions in the UE countries since 1990 to 2012[7]

[5] *The Sant' Antnin Waste Treatment Plant in Marsascala - Review of operations, July 2013, https://msdec.gov.mt/en/Documents/Downloads/WBRU/Exec%20+%20Full%20Report.pdf*

[6] Source : https://www.wasteservmalta.com/santantnin.aspx, information received by e-mail from WasteServ Malta and from M. Charles Buttigieg, Energy Analyst, Ministry for Energy and Health, Malta

[7] Source: European Environment Agency, 2011

Malta's renewable energy options are currently focused on onshore and offshore wind energy, solar photovoltaic and solar thermal energy, as well as **waste to energy**. Malta's NREAP is currently being revaluated so as to reflect the latest developments in the sector. The original NREAP projected a total contribution of 289 GWh from PV, onshore and offshore wind farms. The photovoltaic (PV) share was estimated at only 42,66 GWh (around 27 MWp). However, in view of the problems being faced with the deployment of wind farms, and the significant drop in prices of photovoltaic panels, the reviewed NREAP will address the potential shortfall through a wider deployment of PVs. In fact, as a result of a number of incentives, the electrical energy generated from photovoltaic has been steadily increasing. The data shows that while in 2009, 530 MWh of electricity was generated, in 2012, 13.620 MWh was generated in the Residential Commercial and Industrial Sector.

	2009	2010	2011	2012
MWh generated by photovoltaic cells	530	1.730	12.392	13.620

Table 1 – Trend of electricity production by photovoltaic cells in Malta since 2009 to 2012

A further potential, which has not been given due credit in the original NREAP, can be tapped through a wider use of heat pumps for heating purposes. Malta has one of the highest numbers of air conditioners fitted in households, offices and the industry. Their principal function is cooling, but since almost all of these are of the reversible type, they can be also used for efficient heating. Heating in Malta has traditionally depended on either gas heaters running on LPG or electric filament heaters. It is expected that the lower electricity tariffs introduced as from 2014, together with a much higher price of LPG (compared to 2009), would result in a shift towards a higher share of heating by heat pumps[8].

Malta submitted its **National Energy Efficiency Action Plan** (NEEAP) in April 2014 as required by the Energy Efficiency Directive (EED). The target of 3% energy end use savings for 2010 (established in the first National Energy Efficiency Action Plan) has been achieved, and marginally exceeded – the target was 126 GWh and the achievement was 153 GWh. The National Energy Efficiency Action Plan identifies a number of measures which should ensure that Malta achieves the targets set within this plan. In particular Malta is expected to **achieve cumulative end user savings of 691,9 GWh** between 2014 and 2020 through measures submitted in line with Article 7 of the EED. The NEEAP provides a clear snapshot of the current situation in Malta with regards to energy efficiency, and identifies areas, such as transport and generation were action is needed (and indeed being taken, especially in the generation sector). With regards to energy efficiency in buildings, the assessment clearly indicates that measures within the domestic sector and which would typically yield significant savings in colder climates may be difficult to justify in Malta through savings in the households' energy bill. The lack of any district heating/cooling further restricts the applicability of energy efficiency measures within the domestic sector.

The industrial sector is more sensitive to energy savings measures which lead to cost savings and from the meetings held with major industries (main sectors are tourism, food, ship building and repair, pharmaceutical and textile) during the preparation of the NEEAP, it was clear that energy savings measures were already being taken, both as a result of incentives provided by Malta Enterprise as well as a means of a cost cutting exercise to reduce the energy bill[6].

The targets set by the relevant EU Directives for Malta are as follows:

- Energy End Use Efficiency: 9% by 2016;
- Renewable Energy Target: 10% of final energy consumption by 2020;
- Bio-fuel contribution in the fuel mix: 10% of final energy consumption of fuels by 2020;
- Reduction in GHG emissions under Effort Sharing Decision: +5% over 2005 levels by 2020.

[8] Source: Dedicated report received by e-mail from M. Charles Buttigieg, Energy Analyst, Ministry for Energy and Health, Malta

In **2011** the government also launched **The Strategy on Adaptation to Climate Change for Malta**, which focuses on certain sectors vulnerability to climate change and proposes various recommendations to ensure their resilience to its effects[9].

2.3. Policy development

Both Directive 2004/08/EC and 2012/27/EU have been transposed in the Maltese Regulations system. Nevertheless, the support system for the cogeneration is going to be implemented. Development of support mechanisms is an important condition for the major implementation of CHP in Malta.

In Malta the Directive 2004/08/EC has been transposed into the Legal Notice 2/2007 as amended. Regarding **incentives for the sale of electricity**, there are currently **feed-in-tariffs for photovoltaic and micro-wind systems only, not for CHP yet** [10].

A CHP tariff provision in currently being considered but would come into force at the earliest in end of 2015.

A recent law scheme - **Subsidiary Legislation 423.27** – came into force on **January 1st 2014**, relating to **Energy efficiency and Cogeneration**, as a **transposition of the 2012/27/EU Directive**. These regulations establish a framework as part of the common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the 2020 20 % headline target on energy efficiency[11].

These regulations also lay down rules designed **to remove barriers in the energy market** and overcome market failures that impede efficiency in the supply and use of energy, and provide for the establishment of **an indicative national energy target for 2020**.

In line with the Energy Efficiency Directive requirements, by the 31st of December 2015, the Ministry for Energy shall carry out a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling. With the results of the comprehensive assessment in hand the Ministry shall adopt policies which encourage that the potential of using efficient heating and cooling systems, in particular those using high efficiency cogeneration is fulfilled.

This comprehensive assessment will be carried out by experts following a call for tender. As indicated by the EED Directive a cost-benefit analysis shall have to be carried out by project promoters, to assess the cost and benefits of providing for the operation of the installation as high-efficiency cogeneration installation, after the 5th June 2014, in case of :

- installation of a new thermal electricity generation plant with a total thermal input exceeding 20 MW;
- conversion of an existing thermal electricity generation installation with a total thermal input exceeding 20 MW;
- planning of an industrial installation with a total thermal input exceeding 20 MW generating waste heat at a useful temperature level;

The **National Energy Policy for the Maltese Islands (2012)** contains the following proposals which could have an impact on cogeneration in Malta:

[9] Source: http://mra.org.mt/
[10] Source: http://mra.org.mt/
[11] Source: Energy Efficiency and Cogeneration Regulations – Subsidiary Legislation 423.27 – 1st January, 2014 – Legal Notice 196 of 2014.

- Recommendations related to the Primary Energy Sector
    - Optimal flexibility to maximize diversification of energy imports and maximize exploitation of indigenous sources of energy
    - Carry out a holistic study on all available sources of energy to be used as a basis for creating incentives for their rational use, depending on their characteristics and in line with Energy Policy objectives
    - Assess market incentives designed to influence consumers behaviour toward a more efficient use of cleaner energy sources
- Recommendations related to the Electricity Sector
    - Determine the best on-island generation mix and operational and market strategies in the event of full integration with European and other energy grids
    - Switch Island generation to natural gas
- Recommendations related to the Renewable Sector
    - Promote private investment in R&D&I in RES micro generation
    - Develop the legal and planning framework to develop RES
- Recommendations related to Energy Efficiency
    - **Investigate ways in which high efficiency co-generation may be promoted**
- Recommendations on Supporting Actions
    - Promotion of, and participation in, the EU Research Framework programme (FP)
    - Increase participation in national and transnational research projects
    - Increased research on the adaptation of technologies to the local market, especially in the case of RES
    - Training of the workforce at different levels for green jobs related to the uptake of renewable energy sources technology

The Ministry for Energy is analyzing the current potential of cogeneration and preparing a legislation that will possibly include a feed-in-tariff for those industries which may find the use of CHP viable with minimal intervention.

2.4. Awareness

Malta had not historically had a very active CHP market, because of the peculiarity of its territory. This situation is also represented by a restricted awareness among most of the market players and customers.

Good awareness about the benefits of cogeneration, among the different actors, is one of the basic conditions to create an active CHP market. This is necessary to achieve the full potential of CHP. Good awareness corresponds with well-informed customers, enough qualified market players, policy makers that provide the correct framework for a functioning market and influencers that inform and advise the other groups. The actors on the CHP market, classified into four social-economic groups, are show in Figure 4. The level of awareness was assessed for each of the actors and rated 1-5, (1 poor and 5 Active market), as shown below. The detailed comments on each group are described in Annex 1.

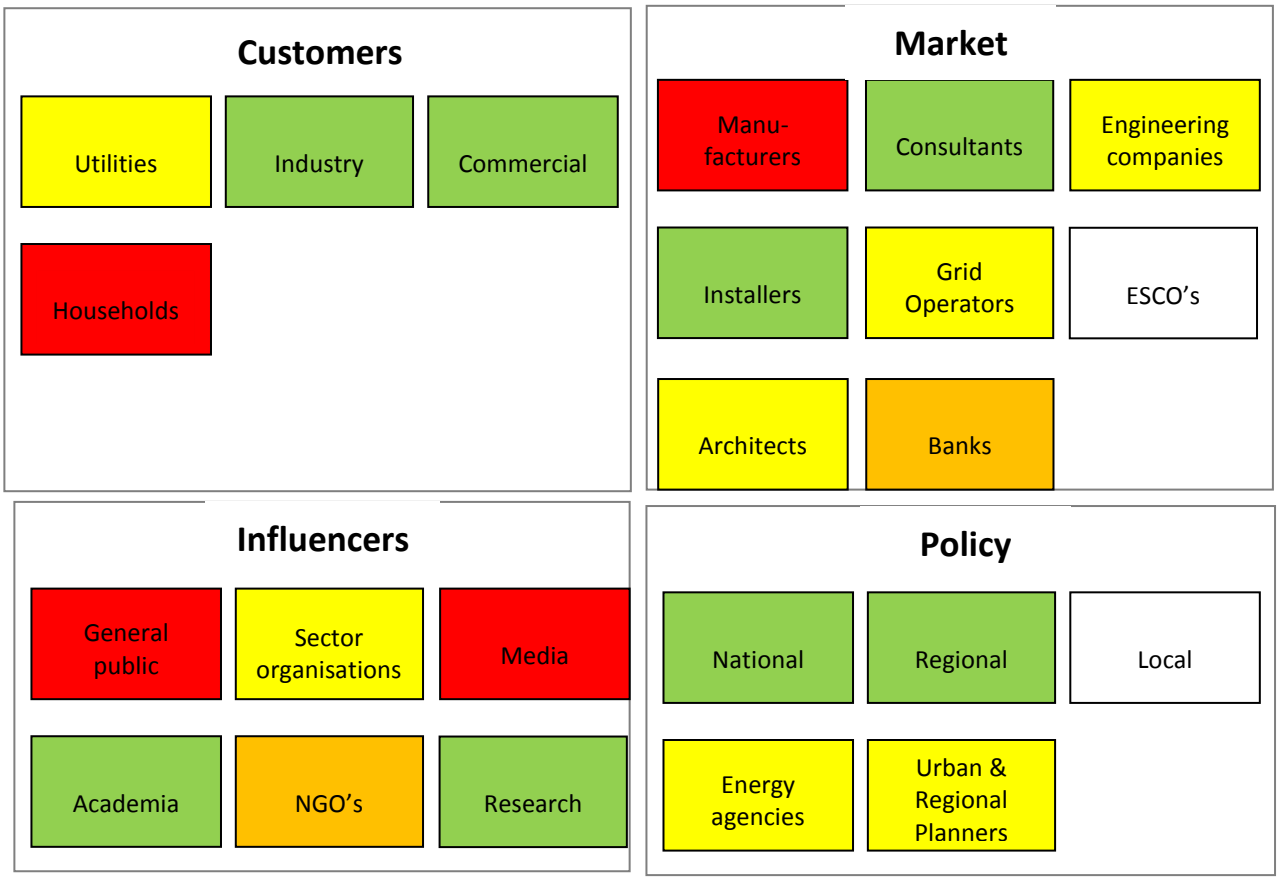


Figure 4: Level of awareness among key actors under the four socio-economic groups

1		Poor	4		Interest
2		Low	5		Active market
3		Early awareness	6		n.a.

Customers

Of the potential customer groups the commercial and industry customers are the most aware, both having sizeable energy bills and an interest in saving money. End users are unaware , there is no district heating on Malta and the absence of a gas grid means that stand alone heating is mainly electric. The utilities express no interest in CHP.

Market players

Some training courses, for assessors of dwellings in Malta intended for Engineers and Architects who would like to become registered as EPB (Dwellings) Assessors, have been organized in the last years on the alternative energy sources or methods - such as cogeneration, solar cooling possibilities, heat pumps, geo-thermal possibilities or alternative heat recovery methods.
There is generally a lack of interest and promotion from the manufacturing companies producing CHP units due to the limited market on the Islands.

Influencers

There are no specific sector organisations on cogeneration. General public and media do not know cogeneration. NGOs do not mention CHP, they are more focused on energy efficiency measures

other than CHP. There are research centres and laboratories which are interested in developing research programmes related to CHP issues.

Policy makers

Energy policies are today introducing CHP amongst the measures to be considered and possibly developed under the recently approved National Efficiency plan, but the elaboration of a policy scenario is waiting for the end of a CHP national potential analysis expected by the end of 2015. The CHP technology is known but there is a lack of promotion of the related technologies..

2.5. The economics of CHP

A feed-In-tariff specifically for CHP is in the drafting (2014). These tariffs are directly linked to avoided costs in terms of new generation equipment, avoided fuel, O&M and network costs, and finally a factor accounting for network losses.
The document "Analysis of Potential for Co-Generation on the Maltese Islands" of 2009 reports that at that period, the use of cogeneration in Malta was not economically viable due to the high fuel price , and in particular for high fuel excise. The return of investment of
CHP unit , fed by oil fuels due to the lack of extension of gas grid, have been estimated large than 5 years. The high price of fuel make uncompetitive CHP generation power with the grid power. The absence of a feed in tariff for CHP generated power is another factor affecting the financial viability of these investments.

Focus on District Heating & Cooling

Malta's mean temperatures of the winter period and the summer period indicate that the (i) housing heating period is only between mid December to mid February and mainly in the night period, and (ii) the cooling period runs between mid May to September. Thus the heating/cooling period is around seven months a year. These figures already could indicate that cogeneration could not be viable due to the restricted heating/cooling requirement however the barrier in this sector is also technology. The fact that piped natural gas is not available to the residential sector the choice for a micro CHP unit is restricted to diesel engines which could prove non-financially feasible due to both initial and operating costs[12].

Central heating and cooling is adopted in localised high-density top-end commercial developments where heating and cooling are managed holistically and effectively. In these circumstances, heating and cooling energy is obtained through heat pumps. Sea water boreholes are used as an effective heat sink, where access to seawater is possible. Access to the fresh water aquifers are permitted in certain well-regulated cases. Even in the high-density commercial developments mentioned above, cogeneration has been found difficult to justify economically because of the relatively low thermal loads and low heat/power ratios required.

The drive to higher efficiencies in industry and the higher standards demanded in the residential and hospitality sector as well as development of new technology has kindled interest in more competitive heating and cooling. Industry has determined the most cost-effective technology to adopt in different circumstances including in niche segments in industry and commercial establishments.

[12] Source: Section 3.2.1 on Energy Efficiency in buildings comments in detail on the heating and cooling characteristics and the energy used in maltese homes for these purposes

The NEEAP goes into the specifics of the Heating and Cooling scenarios of the Maltese Islands and explains that by mid-2015, a comprehensive assessment of the potential for the application of high efficiency cogeneration will be carried out for Malta. Efficient district heating and cooling will be included in the scope to obtain an informed assessment of possible niches that could be cost-effectively exploited, such as a group of neighbouring hotel joining together in one project.

2.6. Barriers to CHP

In Malta, CHP has strong competition from other RES technologies, due to the geographical situation of the islands, being more favourable to PV, solar and wind. But others policy and infrastructural barriers are limited the expansion of CHP, in particular absence of NG distribution and heavy authorization procedures.

As discussed in previous Chapters, Malta does not have an active CHP market. Chapter 1.4 shows that many actors are well informed on the benefits of CHP mainly due to (policy planning exercises and planned future diversification of fuel supply and expectations on launch of incentive schemes. The barriers are ordered in descending order of importance.

Barrier 1: Lack of consistent heat demand for space heating and hot water applications makes space heating with CHP a challenge due to the low operating hours.
The mean temperatures of the winter period and the summer period indicate that the housing heating period is only between mid-December to mid-February and mainly during the night the cooling period runs between mid-May to September. Thus, the heating/cooling period is around seven months a year. This already could indicate that cogeneration could not be viable space heating due to the restricted heating requirement. The lack of consistent heat demands during the whole year increases the pay-back period. Reducing the operating hours makes CHP viability more challenging.

Barrier 2: Malta's climatic conditions drive investors towards other technologies for electricity and space heating /cooling
The island of Malta enjoys an abundance of sunshine more than 62% of the year, while only 11 days (3%) may be considered as very cloudy days . This follows with an appreciable installation of solar PV and solar Thermal units on the premises of the industrial and commercial sector coupled with top up LPG boilers as these would present a more attractive alternative for their energy use to interested parties. Cooling requirements are currently served by from conventional electric-compressor driven chillers (COP > 3 or appreciably higher if sea water cooled). This is attractive when compared to a further investment of absorption chillers of much lower COP.

Barrier 3: Current energy policies and regulation are not prizing environmental and energy benefit generated by CHP, and this make other technologies more competitive
Until now, the benefits of CHP are not sufficiently validated in the market. The market takes little to no account of environmental costs, congestion in the network, additional network costs, energy storage, flexibility, the vulnerability of large systems, both technical and political and the opportunities for heating/cooling. Those market imperfections make spilling energy and polluting possible without any penalty, while saving energy and the environment is not financially rewarded. CHP superior efficiency is financially not rewarded until now to compensate for the extra costs involved.

Barrier 4: Power grid source diversification and creation of new infrastructures are expected to lower down grid power prices, making CHP less competitive
Investments in the Maltese public utility electricity generation scenario has seen the generating efficiency increase to over 47 % making thereby available to the residences and the

industrial/commercial sector reductions in electricity cost. The connection of Island's power grid to EU is another factor that is expecting to low down grid power prices. Hence the gain in sourcing electricity and heat from CHP, when compared to conventional ones (grid electricity supply and boiler fuelled by cheaper oil fuel) is marginal and the operational window of such gains is very restrictive

Barrier 5: The absence of a gas distribution grid drives CHP technologies to choose higher cost fuels reducing financial viability of investments

The fact that piped natural gas is not available to the residential sector means that the choice for micro CHP units is restricted to diesel engines that prove non-financially feasible due to both initial investment and operating costs.

Barrier 6: Heavy grid connection authorization procedures discourage electrical RES-E and CHP installations.

There are rules and procedures for connection of RES-E plants to the grid in place in Malta. In 2012, their application, however, was only theoretical, as they referred to large RES-E plants, which were not present at this moment. Most of RES-E generation is provided by small generation plants (e.g. rooftop-mounted PV systems) that do not require to follow the procedure laid out for connection. The remaining larger RES-E plants (>16 A per phase) would require a prior permit from the Malta Resources Authority (MRA). Furthermore, administrative procedures were quite inefficient also due to the current sharing of responsibilities. Nowadays, the situation has been improved, introducing web application at MRA website.

Barrier 8: CHP is not promoted by market players due to the limited market demand on the Islands and absence of favourable investment conditions

Energy market players and technology suppliers are not promoting cogeneration in their market offer portfolio, due to the low financial and economic viability of CHP exploitation and a limited demand of heat and power for residential, tertiary and industrial sector,. The expected change of local market conditions (i.e. the introduction of a CHP feed in tariff) and infrastructural investments (NG grid) could stimulate the demand , making offer more active in particular towards the tourism, healthcare and industrial sectors.

3. What is possible? Cogeneration potential and market opportunities

Due to Malta's geographical and energy market conditions, CHP is niche market technology and, so far, waste to energy CHP are the only expected investment in the coming years. But the expected introduction of CHP support measures in Malta energy market could trigger new investments in tourism and industrial sectors but. A recent regulation in support of small CHP is attracting the interest of some market initiators .

In its report under Article 7 of the Energy Efficiency Directive (EED), Malta indicated energy savings in the hotel industry and niche opportunities where cogeneration could be used. The report indicates that these savings could be up to 135 GWh, cumulatively, by 2020. In consultations between the Energy unit at the Ministry for Energy and various market operators, it has been underscored that the latter are closely watching the potential economic benefit of the various high-efficiency CHP technologies for a possible implementation.

According to the report dedicated to "**Malta Indicative National Energy Efficiency Target for 2020 in accordance with Article 3 of Directive 2012/27/EU"**, one of the potential sectors for the development of CHP is the waste sector. In this sector, **the target by 2020 are the following: electricity production of 136,22 GWh and thermal energy production of 171,14 toe**. Energy to Waste projects currently operating in Malta include the municipal waste and waste water treatment plants at Wasteserv Ltd and Water Services Corporation. These plants begin to operate at partial load (2014) but , after this initial trial period, are expected to operate at full load in the next couple of years. New plants are also envisaged to operate in the Gozo and the Southern part of Malta. These include:

1. A Mechanical Biological Treatment Plant for the North of Malta for treatment of Municipal Solid Wastes and livestock manure. At this facility waste shall be processed to have the organic fraction and the Waste Derived Fuel extracted from the remaining waste which shall be directed from the landfill. The digestion plant shall treat the organic fraction resulting from MSW and will also include a potential for the treatment of the livestock manure not managed directly by farmers. This plant shall contribute to the achievement of Malta's 2013 and 2020 targets for reduction of biodegradable waste going to landfill.
2. A CHP Anaerobic Digestion plant in Gozo for the digestion of the organic fraction of MSW and animal manure generated in Gozo.
3. An additional CHP digestion facility for the treatment of animal manure in Siggiewi.
4. A waste to energy facility for the treatment of refuse derived fuel and other waste streams which cannot undergo other treatment. The process related to the preparation of the relevant studies to establish this facility has been initiated but it's not clear if this plant will operate under CHP mode or for power generation only .

Currently there is only one CHP unit installed however the interest is growing and a small number of entities are trying to put projects into practice. The potential has been analyzed and specific sectors indicated that there is an economic feasibility under certain conditions .

The only data available are, again, from the document issued on June 2009 by the Malta Resources Authority, with the assistance of the UK Department of Environment, Food and Rural Affairs (DEFRA) "Analysis of Potential for Co-Generation on the Maltese Islands". The objective of this study was to explore the potential of CHP in locations where enough heat is produced or would be required in quantities that would justify the consideration of a co-generation project. The sectors studied were the hotel industry, the beverage Industry, laundries, health care (hospitals and old people's homes) and the educational sector. According to this document, there is a potential of 71 GWh in terms of Primary Energy Savings that could be achieved installing a total power of 4,3 MWe of CHP plants.

The Primary Energy Savings potential reaches 150 GWh allowing also for the waste treatment plants and industry running on thin fuel oil[13].

The June 2009 study did not identify any economic potential for high-efficiency cogeneration, except if certain conditions were met and high subsidies in the form of feed-in tariffs paid for the electricity generated. The conclusions of the analysis indicated that high-efficiency cogeneration would be viable with the then (high) conventional electricity prices, plus a more favourable excise duty regime for CHP fuel and a high bonus price for CHP-generated electricity over the market price. Even so, CHP was not viable in Industry. Following the 2009 MRA report, further academic thesis continued to indicate the lack of economic feasibility of cogeneration in general for Malta.

In the Malta Resource Authority[14] study a potential penetration scenario has been elaborated, under the conditions where all the three expected incentive measures were implemented on Malta energy market (high prices of grid power, de-taxation of CHP fuels, favourable CHP power feed in tariff) :

Malta potential Scenario in the commercial, public and Industrial sectors:

Type of Industry	CHP units installed	Tot. National primary Energy savings (MWh)	Tot. Electricity not generated by EMC (MWh)	Average CHP capital cost per installation (€)
Category A hotel	12	29.696	43.828	107.816
Category B hotel	12	22.336	32.559	80.098
Category C hotel	15	45.61	6.171	12.145
University pool	1	3.395	5.443	146.337
Hospital with high heat to power ratio	1	10.791	16.944	455.524
Hospital with high heat to power ratio	1	378	515	13.844
Industry with high heat to power ratio	2	15.069	24.715	1.293.424
Industry with high heat to power ratio	1	19.684	28.398	1.116.424
CHP from waste	2	44.592	50.953	
Total	**47**	**150.501**		

Table 2: Malta potential Scenario in the commercial, public and Industrial sectors

The technology is the internal combustion engine (ICE) and the assessments take into account only liquid fuel. There have been other considerations regarding use of other types of fuel (e.g. liquefied natural gas).

[13] Source: CODE project output – Review progress of Directive (2004/8/EC) – D5.1 Eastern Europe Region – Report on issues and progress with Directive – March 2011

[14] Malta Resources Authority, 2009 "Analysis of Potential for Co-Generation on the Maltese Islands"

Regarding district heating, the potential contribution from CHP has been estimated by JRC at 3 PJ in Malta, considering nearly 75 % of the domestic and commercial low temperature heat load could be provided by waste heat from CHP-DH[15].

In niche markets cogeneration could still prove economically viable and thus can make use of provisions in the Electricity Regulations LN 511/04 as amended by LN 17/07. These Regulations exempt producers of electricity from cogeneration plants with a total peak generation capacity of less than 10 kW peak and less than 16 Amps per phase form some authorization. However, such generators are still required to notify the Malta Resources Authority and submit such information as the Authority may request from time to time. This measure is intended to facilitate the installation and possible connection of small CHP units to the electricity grid. In the 2013 Malta Resources Authority[16] received the application for authorization of 6 small scale cogeneration units, all using diesel ICE, for tri-generation in the industrial and commercial sector. These projects are still in a very early stage, and the Authority is still in discussion with applicants.

[15] Source: Background Report on EU-27 District Heating and Cooling Potentials, Barriers, Best Practice and Measures of Promotion – JRC - 2012

[16] Malta 2nd National Energy Efficiency Action Plan, 2014

4. How do we arrive there? : The Roadmap

The main actions to implement in order to overcome the different barriers for the development of CHP are mainly: to support the implementation of CHP policies and incentives schemes, to optimize procedure to grid connection and to complete the natural gas distribution network, together to raise awareness level among stakeholders and promote operators aggregation.

4.1. Overcoming existing barriers and creating a framework for action

Infrastructural actions

Action 1: to support the completion of National NG distribution network

One of the major barriers is the non-connections of residences and industrial sites to the gas grid, and this force the use of expensive and high taxed fuels for cogeneration (LPG, Diesel), reducing the spark spread , efficiency of power generation, with higher emission factors in the atmosphere. The expected enlargement of the NG grid is a priority action in supporting the potential exploitation of CHP and , in general, the reduction of energy cost for Maltese industries and commercial activities. In this framework a policy lobby action should be implemented to ensure and accelerate the connection of industrial sites and large tourism facilities and areas to the NG grid, being those two sectors among the most promising one for CHP exploitation.

Specific CHP related actions

Action 2 : to support implementation of CHP policies and incentive schemes

Malta has already adopted EU directives in support of CHP, but need to accelerate the transposition of these regulation into supporting mechanism and , where possible, incentive schemes, that should prize the environmental and energy saving performance of CHP solutions. Studies demonstrates that acceleration of the implementation of such regulation could trigger CHP investments, in particular in tertiary sector (hotel and resorts). In this framework a policy lobby action should be implemented to accelerate the implementation of measures of the NEEAP for CHP and follow up the scenario development suggesting, when needed, corrective measures to maximize their impact on local market.

Action 3 : to optimize procedures for grid connection and implement double counting meters

The procedural phases for grid connection of CHP plants can be quite long and complicated, and this discourages investors in particular for small installation. Simplify and accelerate procedures of connection to the public distribution network CHP market could have benefits from the reduction of authorization period and associated metering, also by systematic implementation of double counting meters in order to simplify the procedures for metering and invoicing of electricity sold to grid.

Action 4 : to support value chain: training, promotion, awareness, aggregation

CHP value chain is sometimes dispersed and involves several competences and skills and, in particular for micro-CHP for residential and small tertiary sectors, is not adequately coordinated by suppliers to develop an high quality product and service. Thus, it would be important to structure a value chain support programme in co-operation with industry ,including actions like the creation of synergies among value chain actors to decrease CAPEX and OPEX of CHP investments, training, exchange of experiences, quality standards labels, financial scheme, together with coordinated marketing actions aimed to promote CHP and facilitate the introduction inside national market of innovative and promised technologies and systems. In several European Member States these actions are assisted by the activities of industry associations in the specific sectors who provide value to their members by co-operating with government on specific projects and initiatives which enable the Member State policy decisions.

Action 5 : to support research and innovation actions

In order to support the development of innovative solutions able to overcome present technical limitation in use of CHP systems, : the external combustion engines (i.e. Stirling, ORC) that could support exploitation of solar energy or biomasses, or fuel cells that could increase the overall performances of power production. Both solution, together with others, could ameliorate the market penetration potential of CHP, but they are not still largely available on market at reasonable prices and have still need to be further developed by technological point of view. R&D actions and demonstration activities could be implemented in framework of EU funded project, European laboratories and in collaboration with industry through Horizon 2020 should enhance the R&D program area of interest focused on CHP. To do so is necessary to increase the collaboration among industry and academies for research activity, together with agreement with Local Authorities for the launch of demonstration action of early market CHP technologies.

4.2. Possible paths to growth

Growth of local CHP market highly depend on the expected evolution of energy policy and energy infrastructural investments. So far NEAAP has individuate Waste to Energy as the most promising market. Nevertheless other tertiary investments show a potential financial viability in particular in tourism sector. However CHP's contribution to National saving targets is expected to be very limited, with less than 25 MWe installed by 2020.

Malta NEEAP highlights the role of renewables in future island's energy scenario, but plans today accounts the contribution of Waste to Energy CHP only. It's difficult to foresee how and when favourable conditions for the launch of CHP investments will be present. At national level administrative procedures for grid connection are going to be simplified and optimised in order to overcome administrative barriers and incentive schemes are under elaboration, and this should give new perspectives for the launch of further investments in the coming years.

The path to growth for cogeneration is partly curtailed in the space heating sector by the short heating season and the relative immaturity of cooling technologies based on CHP. There's potentially more opportunity in infrastructure , industry and commercial applications where either due to the temperature of the heat required or the links to elements of agricultural and infrastructure policies there are additional opportunities. In term of heat and power demand Hospitals and Large tourism facilities (hotels) are the more favourable tertiary sectors for CHP, together with industries with an high heat to power ratio.

The most likely sectors for near term growth to 2020 is waste treatment (biogas and incineration) with an estimated capacity of 17 MWe[17]; and with full implementation of the EED and with Barriers 3 (policy regulations), 5 (NG grid) and 6 (Authorizations) addressed the penetration of CHP could reach globally 22 to 24 MWe, with 5 to 7 MWe potential for installation in tertiary and commercial sectors. The expected reduction of emissions of CO2 for the full scenario is around 57.000 tons and saving in primary energy of 150 GWh.

The lack of data makes challenging to give CHP projections to 2030. The expected radical changes in local energy market (increasing of large power generation capacities, access to NG, connection of Malta Power Grid to EU's one , expected reduction of power bills, evolution of other RES and energy saving programmes and others) make difficult to elaborate figures or estimate impact that CHP could have on local energy generation. Being CHP on the island at the stage of initial market, it's

[17] *Estimation, assuming the NEEAP 2020 target of waste CHP electrical production of 136.2 GWh and an 8.000 operational hours per year (average).*

necessary to follow up the contextual evolution of policy and the outcomes of the investments launched in the recent past years before estimating market trends for the medium large period.

4.3. Saving of primary energy and CO2 emissions by the CHP roadmap

Primary energy saving (PES) and CO_2 emissions saving projections resulting from increased use of CHP require assumptions about not just what types of fuel and technology are displaced, but also their operation on the market. Within CODE2 two approaches are developed, which represent two different analytic considerations which are summarised here and more fully explored in Annexe 4.

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

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

Malta has only one CHP plant and the calculations according both methodologies have been based on the switch to biomass CHP.

Total CO2 reduction, Mio. t/a	**-1,4**
Share in total energy-related CO2 emissions	**79,7%**
Share in energy sector CO2 emissions	**96,8%**
Primary Energy Saving, TWh/a	**-4,3**
Decrease of PE, %	**55,7%**
Bio Energy Share in CHP Fuels 2030	**99,8%**
Share of modernised and replaced CHP plants in CHP power growth up to 2030	**100%**

Table 6: Saving of primary energy and CO_2 according EED methodology

Total CO2 reduction, Mio. t/a	**-1,4**
Share in total energy-related CO2 emissions	**79,9%**
Share in energy sector CO2 emissions	**97,0%**
Primary Energy Saving, TWh/a	**-4,3**
Decrease of PE, %	**55,9%**
Bio Energy Share in CHP Fuels 2030	**99,8%**
Share of modernised and replaced CHP plants in CHP power growth up to 2030	**100%**

Table 7: Saving of primary energy and CO_2 according Substitution mix methodology

Annexes

1. **Stakeholder group awareness assessment**
2. **Micro CHP potential assessment**
3. **Bio CHP potential assessment**
4. **Methodologies used to calculate the saving of primary energy and CO_2 emissions**
5. **Sources and contacts**

Annex 1: Stakeholder group awareness assessment

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

Group	Comment
Customers	
Industry	The waste industry is active on the CHP field
Utilities	Water utilities are interested in CHP technologies. Regarding electricity utilities, the interest is low.
Commercial	
Households	Micro-CHP is not feasible for households, so this kind of products is not promoted to households.
Market and supply chain	
Manufacturers	Lack of interest and promotion from the companies producing CHP units due to the limited market on the Islands.
Installers	
Grid operators	
Consultants	
Engineering companies	Some training courses for assessors of dwellings in Malta intended for Engineers and Architects who would like to become registered as EPB (Dwellings) Assessors have been organized in the last years.
Architects	
Banks	
ESCOs	There are no Energy Service Companies
Policy	
National	
Regional	
Local	Not applicable
Urban & Regional planners	
Energy agencies	The CHP technology is known but there is a lack of promotion of the related technologies. They are more focused on energy efficiency system other than CHP which are more suited for the climate of the Maltese Islands.

Influencers	
Sector organisations	There are no specific sector organisations on cogeneration.
General public	General public does not know cogeneration.
Media	
Academia	There no specific courses on cogenerations, but the technology is explained in various courses given by the Faculty of Engineering and the Faculty for the Built Environment.
Research	There are research centres and laboratories are interested in developing research programmes related to CHP issues.
NGOs	NGOs do not mention CHP, they are more focused on energy efficiency system other than CHP which are more suited for the climate of the Maltese Islands.

Annex 2: Micro CHP potential assessment

Country statistics

Population: 450 000 (2010)

Number of households: 170 000 (2010)

GDP per capita: € 21 500 (2010)

Primary energy use: 500 ktoe/year (2010)

GHG-emissions: 3 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kWe)

Boiler replacement technology

Present market (2013)

Boiler stock: 1 000 units

Boiler sales: 70 units/year

Potential estimation

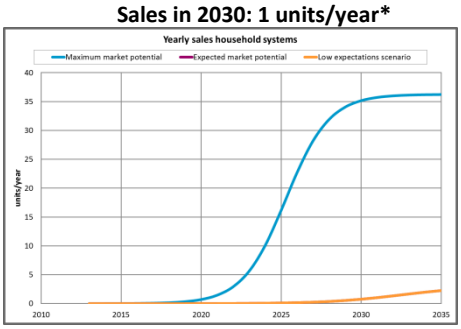
Indicator	*Score*
Market alternatives	0
Global CBA	0
Legislation/support	0
Awareness	0
Purchasing power	1
Total	**1 out of 12**

Expected final market share: 4% of boiler sales in Household sector

Yearly sales

Sales in 2020: 0 units/year*

Sales in 2030: 1 units/year*



Stock

Stock in 2020: 0 units*

Stock in 2030: 1 units*

Stock in 2040: 20 units*

Potential savings in 2030

Primary energy savings:

0 PJ/year*

0 ktoe/year*

GHG-emissions reduction:

0 Mton $CO_{2,eq}$/year*

SME & Collective systems (±40 kWe)

Boiler add-on technology

Present market (2013)

Boiler stock: 75 units

Boiler sales: 6 units/year

Potential estimation

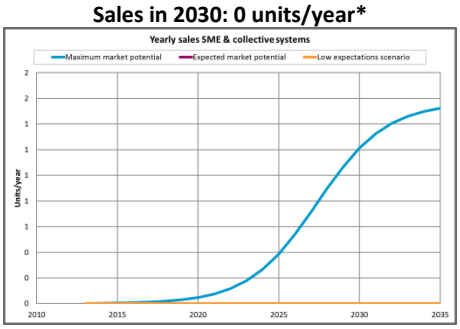
Indicator	*Score*
Market alternatives	0
Global CBA	0
Legislation/support	0
Awareness	0
Total	**0 out of 9**

Expected final market share: 0% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 0 units/year*

Sales in 2030: 0 units/year*



Stock

Stock in 2020: 0 units*

Stock in 2030: 0 units*

Stock in 2040: 0 units*

Potential savings in 2030

Primary energy savings:

0 PJ/year*

0 ktoe/year*

GHG-emissions reduction:

0 Mton $CO_{2,eq}$/year*

*Corresponding to the expected potential scenario.

Annex 3: Bio-CHP potential assessment

In the context of the CODE2 project, a potential analysis for bio-CHP was elaborated for the EU-27 countries in aggregate and per member state.
The national bio-CHP potential analysis is based on figures from the PRIMES database, Eurostat, the National Renewable Energy Action Plan (NREAP), and the project Biomass Futures.
The analysis has been discussed and, where necessary, refined in consultations with national energy experts.
The complete EU-27 analysis is found at
http://www.code2-project.eu/wp-content/uploads/CODE2-D2.6-European-report-on-potential-of-bio-energy-CHP.pdf

Both data sources depicted for 2010 no installed CHP systems in Malta. Therefore, the study's approach to assess the bio-CHP potential was partly not feasible, because no potential for switching conventional CHP fuels to bioenergy fuels could be assessed.
Due to the non-existence of CHP in Malta, according to the used data sources, at the time of the study, it was decided to not propose the assessment of Bio-CHP potential in Malta, as the exercise would have been merely speculative.

Annex 4: Assumptions used in market extrapolation

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

Annex 5: Methodologies used to calculate the saving of primary energy and CO_2 emissions.

In the context of the CODE2 project, the calculation of primary energy and CO2 emissions saving was based on Eurostat and the PRIMES database.
Both data sources depicted for 2010 no installed CHP systems in Malta.

EED method

The Primary Energy Savings methodology of the EED is used at a country level for national reporting to the Commission, and at project level for determining if CHP is highly efficient. In the methodology, each cogeneration unit is compared with the best technology for separate production of heat and electricity on the same fuel on the market in the year of construction of the cogeneration unit and the harmonized reference values are determined by fuel type and year of construction.
The underlying principle is that, knowing that regularly new investments have to be made in new energy production units, it is necessary to compare CHP with the centralized production installation which could be built using the same fuel rather than assuming a displacement of a different fuel or introduction of a new fuel. It is a logical approach when looking at the decision making process of investors or a member state government. By investing in or supporting CHP, a certain electricity generating capacity will be produced by CHP and NOT by centralized production based on the same fuel (= principle of 'avoided production').
For the timeframe of the roadmap (between 2010 and 2030), and especially in countries where there is no overcapacity, it is relevant to compare installing a certain capacity (at national level) of CHP compared to installing new capacity with another technology (power plant + gas boiler). Older installations being replaced with state-of-the-art technology.is a typical reinvestment decision. New CHP-plant (or combination of smaller installations) would not necessarily lead to less production in older production installations, but would rather preempt investments in e.g. new CCGT investments.

Substitution method

This method has been developed in the CODE2 project. In doing this, two other approaches have been considered: 1) the "replacement mix method[18]" from the Munich FfE institute, which however cannot be used directly for a long term comparison as needed in CODE2; 2) a method used to calculate the CO_2 saving resulting from a voluntary commitment of the German industry for CO_2 reduction[19], however this method has been considered as too simple. Therefor the following more differentiated approach has been developed:
Based on an estimate of the increase in cogeneration electricity the thereby caused decrease of CO_2 emissions and primary energy consumption is estimated. In this approach, an attempt is made to determine the actual quantities saved compared to the base year (e.g. 2010). Hence it refers to the actual saving of fuels for the production of the amounts substituted by modern CHP plants
a) of electricity and heat in the replaced or retrofitted old CHP plants
b) of electricity in power plants
c) of heat in boilers.
The savings result from a combination of three effects:
- CHP effect
- Technology effect (improved CHP technologies)
- Fuel switching (e.g. lower carbon content of natural gas compared to coal, CO_2 neutrality of bioenergy)

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

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

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

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

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

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

can be usefully seen only as an integrated process.

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

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

Annex 6: Sources and contacts

Contacts

- Charles Buttigieg, Energy Analyst, Ministry for Energy and Health, Malta
- Miriam Micallef, Malta Resource Authority
- Sylvana Scicluna, Professional Executive - Regulatory Affairs Office, Enemalta Corporation
- Rosemary Said, Customer Care, WasteServ Malta Ltd
- Albert Falzon, MIEMA (Malta Intelligent Energy Management Agency)