CODE2

Cogeneration Observatory and Dissemination Europe

D2.3 First draft of final CHP roadmap
GREECE

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Table of Contents

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

1.1 Current status: Summary of currently installed cogeneration

Until 2000, in Greece, there was a poor environment for the promotion of cogeneration; mainly due to a warm climate, low industrial base, a monopolistic electricity utility, a lack of natural gas and a weak legal framework[1]. Today, the above situation has changed in many of the above-mentioned parameters; Greece is now supplied with NG from 3 different points, is equipped with strong legal framework for cogeneration, and the monopolistic electricity utility is under structural changes, leading, at the end, to privatization.

The Table 1.1 shows the cogeneration statistics for Greece, based on Eurostat data.

	Total installed electricity capacity (MW)	Total electricity generated (MWh)	Total heat supplied (MWh)	Total cogenerated electricity generated (MWh)	Total CHP share on electricity (%)
2008	9,517	63,749,000	no data available	1,211,231	1.9
2009	9,667	61,365,000	no data available	1,840,950	3.0
2010	10,075	57,392,000	no data available	2,467,856	4.3

Table 1.1 - Data for cogenerated electricity

According to the Hellenic Operator of Electricity Market, LAGIE, during the years 2008–2010, the following cogenerated electricity[2] was reward with the HECHP "F-i-T"[3], which analysed in later section, and is shown in Table 1.2.

	Installed CHP capacity, MW	Cogenerated electricity, MWh	Contract-based HECHP, MW
2008	98,73	34.792	56,28
2009	133,07	144.122	97,07
2010	134,71	114.560	98,71
2011	101,07	141.638	-[4]
2012	89,32	148.858	-

Table 1.2 - Data for HE cogenerated electricity in Greece

[1] SAVE XVII/4.1031/P/99-"Future Cogen" Project, Final Report
[2] Monthly bulletin regarding the Feed-in-Tariffs for RES and HECHP; www.lagie.gr
[3] Set by Art. 9 of L.3468/2006
[4] "Since 2011 all the measured installed CHP capacity is considered to be contract-based only. The rest cogenerators are considered to be inactive auto-producers" according to LAGIE.

The difference between the two data is that the data in Table 2 deals only with cogenerated electricity from High Efficiency CHP units and does not take into account the cogenerated electricity by non-HECHP units or auto-producers. Typical example is PPC's-operated district heating systems, which are supplying heat from coal-fired power stations to three near-by cities in Northern Greece and Peloponnese and of other cogeneration producers that they are not characterized as HECHP. As a result of the economic crisis, during 2010, many cogenerators closed down their installations, due to their financial difficulties of paying NG bills to DEPA[5] and a more than six month-delay of the Operator of Electricity Market, LAGIE, to pay off the cogenerators for the cogenerated electricity injected to the Network or Grid. This situation worsens the next coming years resulting a delay of more than 8 months, creating serious cash problems to the cogenerators.

Analysing the cogeneration market, the Hellenic Association for CHP-HACHP-has conducted a detailed study, in 2011, on behalf of the Centre for Renewable Energy Sources, CRES, which is the national entity for the promotion of RES and Energy Efficiency, by recording all installed HECHP units, in or out of operation H.E or not, above 50 kW_e and the results are shown in Table 1.3.

HECHP units above 50 kW_e	
Total installed Capacity	88.15 MW_e
Industrial sector capacity	77.67 MW_e
Tertiary, other	10.48 MW_e

Table 1.3 - HECHP units above 50kWe in Greece6

	Area of installation	**Capacity MW_e**	**Fuel**	**Sector**	**Status**
Aluminium of Greece	Aspra spitia Viotia	110	NG	Industry	From 1/2008 to 12/2012 in monitoring phase until Jan 2013 when final the permit was given, but still no "premium" has been issued
Thessaloniki Refineries	Thessaloniki	5.9	Ref. gases	Industry	Operating
Psyttalia island – EYDAP	Psyttalia Athens	5X2.4=12	biogas	Athens Sewage & Water Co	Operating
Two greenhouses[7]	Alexandria & Drama	2x4.9=9.8	NG	Agriculture	Operating
National University	Athens	2.7	NG	Tertiary	Operational problems
8th floor apartment building	Thessaloniki	0.004	NG	Tertiary	Missing agreement for connection to the national electricity grid[8]

Table 1.4 - Notable Projects with HECHP units

[5] HACHP data.
[6] Data in accordance with the data provided monthly by LAGIE, the Operator of the Electricity Market.
[7] Equipped with flue gas treatment and using installations for CO_2 enrichment of greenhouse crops.
[8] Missing the official agreement between the TSO for LV and the cogenerator, for the connection of the unit to the Network, for selling the cogenerated electricity.

As for district heating, this sector in Greece is underdeveloped and not widespread. There are five (5) DH systems in total; 4 are operating by PPC – 3 in Northern Greece, 1 in Peloponnese of a total cogeneration installed capacity of 175 MWth– and 1 by a private company in N. Greece, with 16 MW_e cogeneration units capacity, provide heating for 12900 households, operating from 2007. A new DH system, of a capacity of 70 MW_{th} [9] is scheduled to be in operation by 2015, in Florina, a city in northern Greece with harsh winter conditions and will provide heating for 2300 households.

In 2009, CRES composes the annual report concerning Energy Efficiency and RES, where it is strongly supported the dissemination and development of cogeneration, by setting the 2015 and 2020 projections for cogeneration capacity. According to these projections, the increase of cogeneration electricity, compared to 2010, will be 77% by 2015 and 107% by 2020. Also the predictions about cogeneration thermal capacity will be 59% for 2015 and 79% for 2020 (Table 1.5).

Development of electric and thermal capacity of CHP [10]						
	2010		**2015**		**2020**	
Area	**MW_e**	**MW_{th}**	**MW_e**	**MW_{th}**	**MW_e**	**MW_{th}**
Tertiary Sector	21	39	62	93	89	134
Residential Sector	0	0	0	0	24	39
Industry	609	1136	1111	1841	1271	2020
Refineries	70	107	70	107	70	107
Total	700	1282	1243	2041	1454	2300

Table 1.5 - Development of Electric and thermal capacity of CHP

It should be added that in these projections were included the PPC's DHS in the industrial data. It is true that, in 2008/9, the capacities for HECHP units granted permits by RAE were summed to these numbers, as new DHS were designed to be installed, but the economic crisis and the lack of financing completely stop these high capital investments.

1.2 Energy and Climate Strategy of Greece

The entity responsible for Energy and Climate Strategy is the Ministry of Environment, Energy and Climate Change, YPEKA, which has been established in 2009, in order to confront the continuous environmental retreat and to promote further penetration of RES to the system and Energy Efficiency, the gasification of the electricity sector and the security of supply of the country. The target set by EU, regarding CO_2 emission for 2010, was an increase of 25%, compared to 1990's emissions, while there

[9] Municipality of Florina: http://www.cityofflorina.gr
[10] CRES annual report for 2009

was finally an increase of only 12,6%[11]. Most of the targets set by the EU concerning climate and energy package are reached, not as a result of applied policies, but due to financial crisis as a result of the reduction of energy consumption by the end-users. Unfortunately, the same reason works as a barrier for the promotion of cogeneration, since the public and private investments have been reduced to minimum levels. Thus, the predictions about cogeneration will not be easily reached although several positive steps to that goal, such as legislation framework and promotion actions, have already been concluded.

The Ministry of Environment, Energy and Climate Change in order to achieve its mission, has developed a strategic plan[12] based on 4 pillars amplified into strategic objectives. According to the strategy plan in order to deal with climate change, the actions chosen will need to entail a change of the current development model towards to a more sustainable low carbon economy. This will be achieved, among other actions, through energy efficiency that cogeneration provides.

The most relevant pillar to cogeneration is No 1, which is dealing with "Combating Climate Change", moving towards to a competitive economy of low carbon consumption. The strategic objectives of Pillar 1 are:

- Improve energy efficiency: cogeneration plays one of the most important roles toward this target.
- Increase the share of Greece's energy use from renewable sources and natural gas, whilst ensuring the reliability of energy supplies. Cogeneration systems, using RES as fuel is part of this objective.

More analytically, the strategy axes of pillar 1 are:

- Energy savings for industry, transport, buildings and residential sector:

  The penetration of cogeneration in industry, although low compared to other M-S, has already shown important results. An effort towards the increase of cogeneration in building sector is made through the obligation, where by 31/12/2019 at the latest, all new buildings should meet all their needs for primary energy from energy supplying systems based on RES, cogeneration plants, district or block heating systems, as well as heat pumps[13]. Also the energy efficiency certificate of buildings indicates, among others, the use of cogeneration systems in order to improve their energy classification. A Technical Directive of the Technical Chamber of Greece, adopted by YPEKA, was issued in 2012, titled **"Cogeneration in buildings"** and it is used as an information tool to the building energy auditors, architects and engineers, which shows the benefits of cogeneration and provides methodologies for designing a cogeneration installation in tertiary sector, up to 1 MWe.

[11] Eurostat data
[12] http://www.ypeka.gr/Default.aspx?tabid=230&locale=en-US&language=el-GR
[13] L.3851/2010.

- Establishment of national targets for the penetration of energy generated from RES, the reduction of greenhouse gas emissions and energy saving. There are specific objectives concerning cogeneration using RES as fuel shown on Table 6.

Estimation of total contribution (installed capacity, gross electricity generation) **expected from each renewable energy technology**								
	2005		**2010**		**2015**		**2020**	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Hydro	2407	4424	2536	4211	2915	4910	2951	4873
Geothermal	0	0	0	0	20	123	120	736
Solar	1	0,9	184	242	1300	1754	2450	3605
Wind	491	1267	1327	3129	4303	9674	7500	16797
Biomass solid	0	0	20	73	20	73	40	364
Biogas	24	94	40	181	100	431	210	895
TOTAL	2923	5786	4107	7838	8658	16965	13271	27270
of which in CHP	-	-	20	73	20	73	40	147

Table 1.6 - Estimation of total contribution expected from each RE technology[14]

A growth is expected in tertiary sector with attention to public and private hospitals. Also, many hotels, mainly in Athens and Thessaloniki area, are applying for the required permits for CCHP (trigeneration), which can be a time-lengthy process, especially, if an environmental permit is required (i.e. large hotels, biomass/bioenergy cogeneration projects). As of micro-CHP (see Annexe3), mainly installed in the residential sector, there was a notable growth in the years before crisis, but now, this was declining, due to the high investment costs.

Additionally, the National Energy Planning Committee, in 2012, submitted the "*Energy Roadmap for 2050*". This Roadmap states "cogeneration *plays a necessary and important role to national energy efficiency and is an essential factor, in order Greece to fulfil the target concerning the reduction of* CO_2 *emissions"*. The Roadmap contains several scenarios about the development of electricity capacity of Greece. All of the scenarios refer to cogeneration as an essential factor, while in one of them distributed cogeneration industry stations will be constructed, using as fuel biomass, biogas and NG.

1.3 Policy development

1.3.1 Legal status

Until June 2006, *Law 2244/94* set out the legal framework for cogeneration in Greece. This law, titled "*Regulation of issues regarding electricity production from RES and other conventional fuels*" came into effect in October 1994, and introduced the distinction between "auto-producer" and "independent

[14] National Renewable Energy Action Plan, in the scope of the Directive 2009/28/EC.

producer" to the Greek energy market and allowed the installation of cogeneration plants by auto-producers (autonomous or connected to that period PPC-owned grid).

Directive 2004/8/EC of the European Parliament and of the Council of the European Union sets the framework for cogeneration and especially high-efficiency cogeneration, a key factor towards the fulfilment of energy efficiency EU goals. In legal status, Greece has transposes the 2004/8/EC Directive into the Greek legal system with *L.3468/06*, referring to High Efficiency Cogeneration.

Law 3734/2009 "Promotion of Cogeneration two or more useful forms of energy, regulation of issues related to the Hydroelectric Project Mesochora and other provisions" was adopting the Directive 2004/8/EC into the national energy legal system.

L.3851/2010 (Article 10) requires that, by 31/12/2019 at the latest, all new buildings should meet all their needs for primary energy from energy supplying systems based on RES, CHP plants, district or block heating/cooling systems, as well as heat pumps. This obligation shall apply to all new buildings housing services of the public and wider public sector, by 31/12/2014 at the latest. This legal regulation is expected to increase the prospects for the penetration of cogeneration systems in the residential and tertiary sectors.

L.4001/2011, transposes, into national legislation, the third Internal Energy Market Directive. Among others, it stipulates the unbundling of the system operators and enhances the role of the independent regulator, regarding security of supply, licensing, monitoring of the market and consumer protection, cancelling the 35 MWe barrier, as the upper limit installed capacity for a cogeneration unit to be characterized as "High Efficient" one.

In early 2013, YPEKA issued a Ministerial Decree for the license and permit procedures required for both HECHP and non-HECHP units, solving long-due problems in cogeneration permits and making easier the investment environment.

1.3.2 Support mechanisms

Promotion of HECHP plants has been supported by several **support mechanisms**, including investment subsidies granted within the framework of EU-funded "Operational Programmes on Competitiveness and Entrepreneurship" and of the national laws on investment, or by tax exemptions. The same actions aimed at providing financial aid are still in effect, with assistance from the activity of Energy Service Companies (ESCOs).

L.3908/2011 "Private investment aid for economic growth, entrepreneurship and regional convergence" has provided for supporting investment plans, including construction of HECHP plants, by offering (a) income tax exemption; (b) subsidy consisting in payment by the State of an amount of money, free of charge, for covering part of the subsidised expenditures; (c) financial lease subsidy consisting in coverage by the State of part of the instalments paid for the acquisition of mechanical and other equipment.

Currently, the EU-funded Operational Programmes: "*Environment and Sustainable Development*" and "*Competitiveness and Entrepreneurship*", part of the National Strategic Reference Framework (NSRF) 2007-2013, are financing several investments referring to cogeneration systems as eligible expenditures, in the following programmes:

"*High efficiency cogeneration of heat and power in hospitals*" aiming of installing HECHP units in conjunction with cooling systems using NG in hospitals; of a budget of 15 million €;

"*Green Tourism*" aiming at supporting tourist establishments with a view to improving their operating infrastructures and operational procedures, in a greener direction and in its actions include the installation of cogeneration systems The funds offered are approx. 30 million €;

"*Alternative Tourism*" aiming at supporting investment plans including the development of one or more specific and/or alternative forms of tourism, and its actions include the installation of energy saving, cogeneration and generation systems from RES (of a total capacity of up to 20 kW_e only for meeting own needs), under an "auto-producer" regime. The funds provided for are approximately 20 million €.

Furthermore, a call for proposals has been published for financing district heating actions, either through new projects or by expanding existing networks as part of the Operational Programme "Environment and Sustainable Development", of a total budget of 50 million €.

1.3.3 Feed-in-Tariff for HECHP

Regarding supporting HECHP investments, the key tool is ***guaranteed feed-in-tariffs*** for the cogenerated electricity fed into the System or Grid, including the Grid of the Non-Interconnected Islands, on the basis of a defined price, expressed in €/MWh of electricity of a definite time period

The F-i-T for cogenerated electricity injected to the Network or Grid is 89.97 €/MWh for the Interconnected network and 101,85 €/MWh for Non-Interconnected Network (islands), using **all** fuels except natural gas and biomass.

L.3851/2010 (Article 5) updated the tariffs for the electricity generated by HECHP plants by introducing a fuel clause coefficient (CC) used to adjust the price of electricity generated by HECHP plants in accordance with natural gas prices.

The «**premium**» for electricity from HECHP plants, using NG, was set as:

- 89,97*CC, for the Interconnected System and
- 101,85*CC for the Non-Interconnected Islands (€/MWh).

CC is set as 1 for all fuels except NG. The NG CC is calculated by the following equation:

$$CC = 1 + (MNGP - 26) / (100 \times n_{el}) \quad (1)$$

where: MNGP is the average monthly price of natural gas for cogeneration, in €/MWh of gross calorific value, sold to natural gas users in Greece, exclusive of power generation customers. The price is set by YPEKA and communicated to LAGIE on a monthly basis.

n_{el} is the electrical efficiency of an HECHP system in accordance with the gross calorific value of natural gas, which is set to 0.33 for HECHP units of an installed capacity of less than or equal to 1 MW_e and 0.35 for HECHP units of an installed capacity of more than 1 MW_e. The value of the clause coefficient may not be lower than one.

RAE took a decision (Decision 435/2011) stipulating that the clause coefficient (CC) used to set the price of electricity from HECHP for producers who have realised investments in flue gas treatment and utilisation installations for CO_2 enrichment of crops in greenhouses must be modified in accordance with the following equation: ***CC = 1.18 + (MNGP - 26) / (100 x*** n_{el}***)*** (2)

The «premium» for the electricity from a producer's or auto-producer's HECHP power plant are determined on a monthly basis in accordance with the MNGP of the previous month. The adjusted prices applied to the electricity generated by HECHP plants to which priority has been given by the respective Operator in allocating the load. The electricity sale contract executed between a cogenerator and the System Operator is valid for a period of 20 years.

The following three graphs present the monthly variation of the «premium» for HECHP units, using NG, (interconnected Network/Grid) for the three distinctive cases discussed above for:

1. cogeneration units, with NG as fuel, up to 1 MW_e, which is characterized a priori as HECHP
2. cogeneration units, with NG as fuel, above 1 MW_e, which should follow specific validated procedures to proof that they are satisfying the conditions to be specified as HE ones,
3. cogeneration units, with NG as fuel, operating in primary sector – greenhouses.

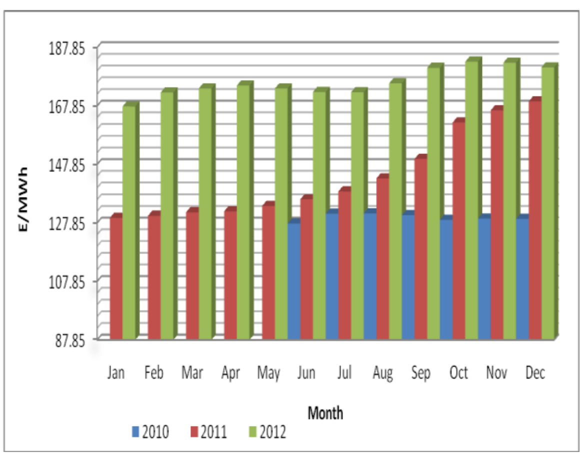


Figure 1.1 - F-i-T for CHP units up to 1 MWe

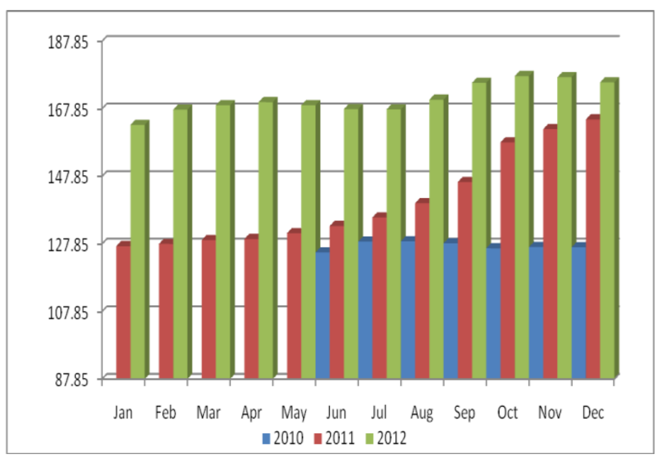


Figure 1.2 - F-i-T for CHP units above 1 MWe

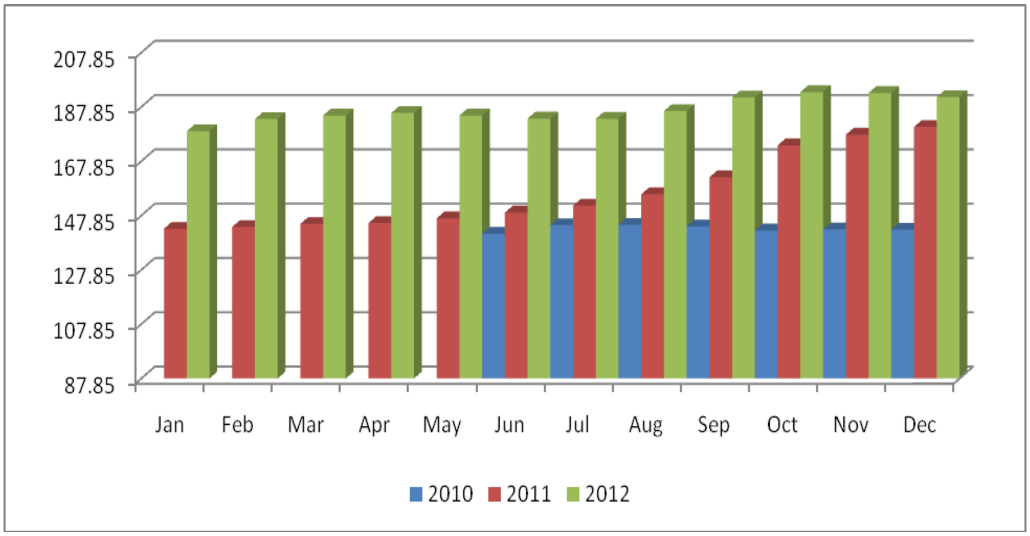


Figure 1.3 - F-i-T for CHP units in primary sector – Greenhouses

Regarding cogeneration units, with biomass or biogas as fuel, the F-I-T of cogenerated electricity, absorbed by the system or network, are:

- 200 €/MWh with biomass installed capacity up to 1 MW_e.
- 175 €/MWh with biomass installed capacity >1 MW_e and 5 MW_e.
- 150 €/MWh with biomass installed capacity >5 MW_e.
- 220 €/MWh with biogas installed capacity up to 3 MW_e.
- 200 €/MWh with biogas installed capacity >3 MW_e.

Concluding, the state support scheme is effective in a smooth operating economy, where high capital-intensive project, as cogeneration ones, can be financed and proceed. At the current economic environment all cogeneration projects are slowed down.

1.4 Awareness

The Greek cogeneration market is at its early stage of development showing a limited level of awareness. Nevertheless an increasing trend in awareness is triggered by specific socio-economic actors.

The Greek cogeneration market is at its early stage of development showing a limited level of awareness. Nevertheless an increasing trend in awareness is triggered by specific socio-economic actors. 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 improve sales of cogeneration if the customers are unaware or lacking support or if the supply chain skills and suppliers does not exist.

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.

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, energy consultants, architects, technology and equipment providers, banks/leasing.

• Policy structure: energy and climate legislators and all levels of government.

• Influencers: media, general public, academics, environment NGOs, associations, planners, energy agencies.

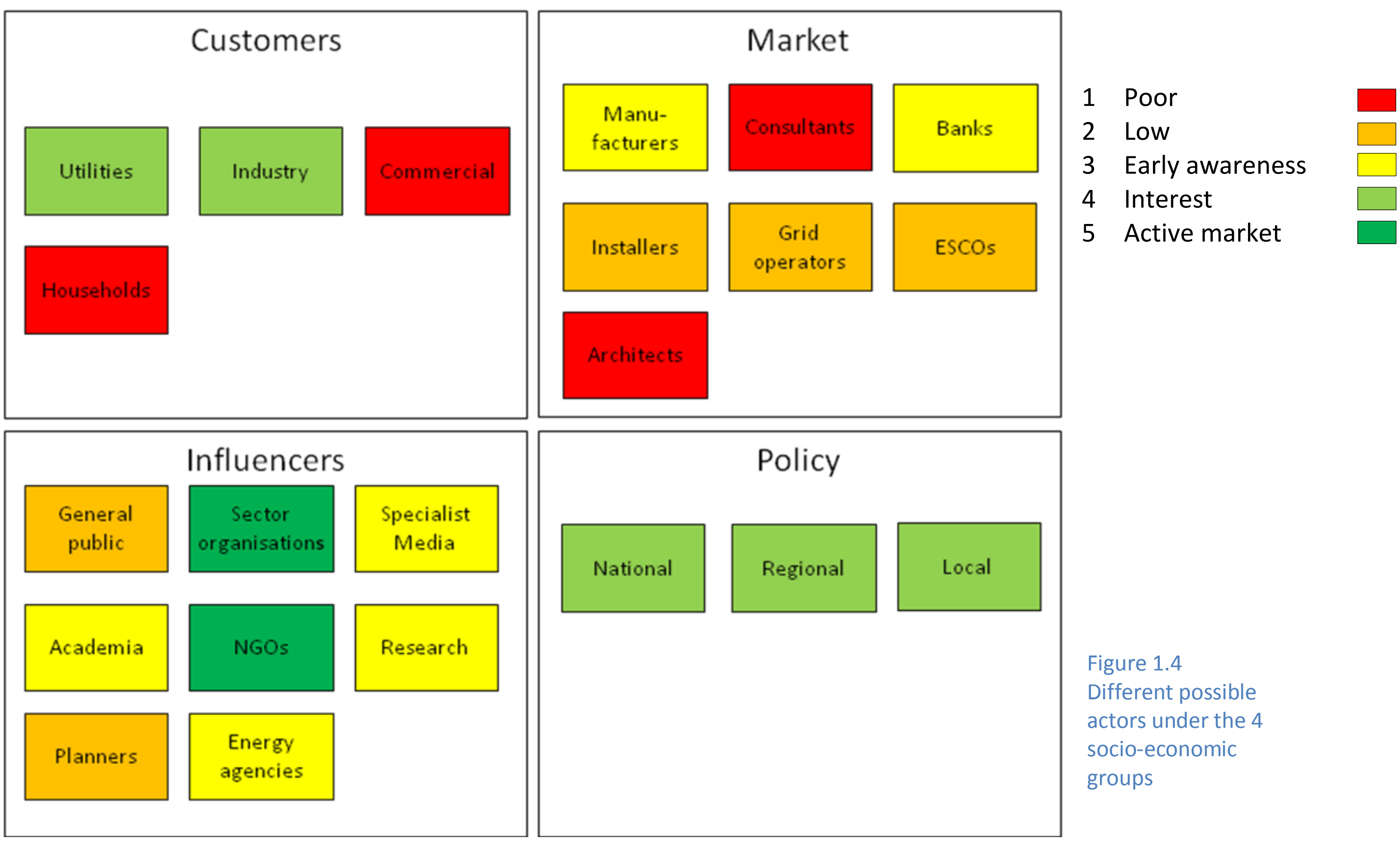
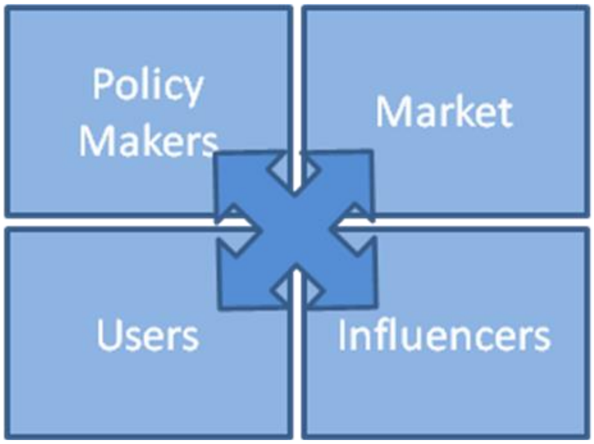


Figure 1.4
Different possible actors under the 4 socio-economic groups

1.4.1 Exchange of information and awareness



The interaction between the groups associated with the promotion of cogeneration is crucial for the creation of an awareness campaign in the country.

Unfortunately, until now, this interaction is not very intense, as the government spreads its information on the policy on CHP/EE/RES through its own departments, websites, energy agencies and sector organizations. On the other hand, HACHP represents a broad base of those organisations, entities and individuals involved commercial and academically on cogeneration. The Association is engaged with Greek policy makers, raising awareness and assisting in interpreting the European Legislation. The Association also holds seminars and workshops on cogeneration and participates in energy sector events (annual exhibitions etc). Currently, HACHP is increasing awareness of private companies and individuals to invest on cogeneration connectivity issues of small and micro-CHP systems to electrical grid.

IENE, the Institute of Energy for South-East Europe, an independent and non-profit organization established in Athens in 2003 by a group of scientists and business executives active in energy sector, constitutes a permanent forum where energy issues are discussed, analyzed, and participate in the formulation of energy policies, both in national and international level, within the broader region of SE Europe, contributing to the implementation of EU sustainable energy strategy. IENE's efforts to open up and promote the discussion on energy issues is backed by an infrastructure designed to develop and exemplify its positions and to foster an exchange of views through publications, but also through the organization of public events such as debates, workshops, seminars, conferences and educational visits to energy-related sites. Regarding cogeneration, IENE is giving the floor in an annual basis to HACHP to present its views on cogeneration in its annual Conference on "Energy and Development". Also, IENE organizes annually a half-day workshop on cogeneration, where its advertisement and the promotion is through their channels, with the participation of young-mainly-engineers and technicians.

1.4.2 Analysis

The Greek cogeneration market is at its early stage of development. The many other challenges of the energy market add to the difficulty of developing proper market awareness: the electricity market is still only partially liberalized; there are many distortions in both electricity and fuel markets, and, there are many barriers, in both the legal and administrative area to overpass.

Among the socio-economic groups the Policy makers appear to hold a high level of awareness. They are generally aware of the benefits of cogeneration and are implementing cogeneration technology in the legislative framework. On the other hand Market and supply chain do not have the required awareness needed for a more intense development, confirming the absence of the presence of manufacturers in the national market. Customers are divided in two opposite categories. Industries and utilities are aware of cogeneration technologies while SME's and households almost ignore them. Influencers are in general in an early awareness stage, excluding NGO's and Sector organizations that already play a key role in awareness rise. Now, it is clear, that due to the influence of the EU Directives, the target set by EU for Energy strategy for 2020 20% and that the country should fulfil it, and due to the influence of HACHP in the Greek Ministry of Energy and Environment –YPEKA, the cogeneration position is clearer, stronger and more positive. The importance of awareness in cogeneration is, now, an essential factor in the dissemination of cogeneration systems on a national level. Proper and thorough information produces well-informed investors. At the same time a total rise of awareness may trigger an increase for companies to enter the market by selling and installing cogeneration systems.

1.5 The economics of CHP

The current Feed-in-Tariff/Premium support scheme provides a good economic environment for HECHP investments with a foreseen 11-13% return on investment mainly for those using NG fuel.

According to L.3468/06 Art.13 the R.T for cogeneration is set as 87.85€/MWh of cogenerated electricity given to the Network. The current Feed-in-Tariff/Premium support scheme provides a good economic environment for HECHP investments with a foreseen 11-13% return on investment mainly for those using NG fuel, in spite of unfavorable economic situation of Greece. It is important to mention that before the economic crisis in Greece (up to 2009) the return on investment for NG fuel was around 18-20%.

- On 2010, taxation on all fuels, including NG, was imposed as a requirement of the 1st MoU between Greek government and lenders (EC-ECB, IMF).
- A 10% "special contribution" on the gross profit from the F-i-T/premium monthly payment was imposed by the 2nd MoU, for 2+1 years, starting 6/2012 until 6/2015.

An analysis on electricity, NG prices and the calculated "spark power ratio" is shown on Table 1.7 and Table 1.8.

Price/Year	Natural Gas, €/MWh			Electricity,[15] €/MWh	
	Industry Above 1MW[16]	Industry up to 1MW[17]	Household	Industry	Household
2009	-	38	38	94	105
2010	-	43	45	85	97
2011	48,73	55	59	91	102
2012	48,56	63	68	100	106

Table 1.7 - Natural Gas & electricity prices in Greece

[15] Eurostat.
[16] Data from an Industrial CHP user.
[17] EPA Attikis.

Price/Year	Spark ratio		
	Industry Above 1MW	Industry Up to 1MW	Household
2009	-	2,47	2,76
2010	-	1,98	2,26
2011	1,87	1,65	1,85
2012	2,06	1,59	1,68

Table 1.8 - Spark ratio

Regarding NG, only a deduction of 4.5–7.5 €/MWh is made for small and micro-CHP. The smaller in capacity the cogeneration installation is, the closer to 7.5 €/MWh deduction threshold it reaches. With this deduction the spark ratio for 2011 is 2.4 for households and 2.3 for industries.

Figure 1.5 shows the variation of spark ratio for households and industries.

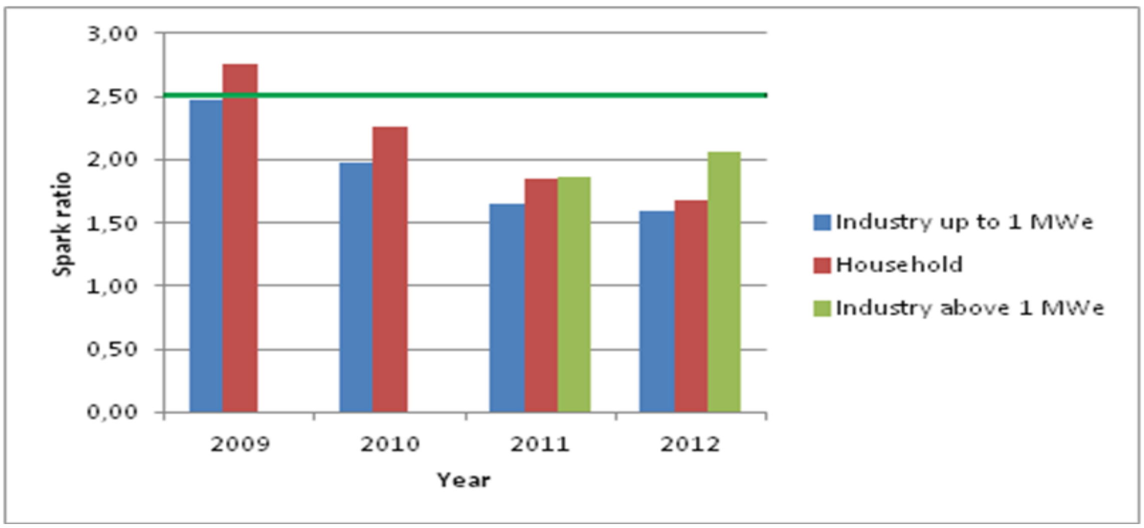


Figure 1.5 - Variation of spark ratio for households and industries

Greece	Micro		Small & Medium		Large		
	up to 50kW		*up to 10 MW*		*more than 10 MW*		
	NG	RES	NG	RES	NG	Coal	RES
SME/Industry							
District heating/cooling							
Services							
Households							

Table 1.9 - CHP economics matrix

Legend:

(green)	**"normal"**	CHP Investment has **good economic benefits**, return on investment acceptable (8-10%) for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.
(yellow)	**"modest"**	CHP Investment has **modest/limited economic benefits** and return on investment (5-7%), **limited interest for new investments**.
(red)	**"poor"**	CHP Investment has **poor or negative return on investment or is not possible due to other limitations**, **no interest/possibilities for new investments**.
(grey)		**Not applicable** for the sector
NG		**Natural Gas** or appropriate fossil fuel
RES		**Renewable energy sources** (wood biomass, biogas, etc.)

1.6 Barriers to CHP

The past few years there have been efforts towards the dissemination of cogeneration in Greece. A lot of changes have taken place, in order to achieve this goal. Nevertheless there are still many parameters that function as barriers concerning the development of cogeneration in a national level.

The barriers for the promotion of cogeneration, in Greece, are presented in this section of this report categorized as:

1. **Technical** barriers (i.e. weather conditions, energy connections, etc)
2. **Financial** barriers (i.e. electricity/gas pricing, etc)
3. **Administrative** barriers (i.e. legal issues, permit issues, etc)

1.6.1 Technical Barriers

1.6.1.1 Climatologic conditions of the country and their role in CHP operation

Greece is characterized by its Mediterranean climate, of mild winter and hot and dry summer. In different parts of Greece, a wide variety of climate is observed, due to the country's topology, the variety of altitude and the alternation between land and sea. This explains the dry climate in the east part to the wet one in the north and west part of Greece. According to the observations and results from simulation from the World Weather Organization and the National Observatory of Athens, the winters in Greece are shortening in length but more intensive and with extreme temperatures. In many northern cities in Greece winter temperatures, are low, while, in late June and July, the maximum temperature, in all parts of Greece, overpass +45^{o}C.

Even before the economic crisis, the energy intensive industries are constantly been reduced, while there is a small but constant growth of 'light' industries, as the food and beverage ones, which are requiring, except high electrical loads, high thermal and cooling loads, during the year. In tertiary sector, there has been recorded an increase in the construction of different types of buildings, i.e. sports halls, malls, expo areas, etc, which are requesting, also, high amounts of electrical and heating/cooling loads, in order to create thermal comfort conditions for their inhabitants.

Today the situation is more complicated, as no high-capital investments, as cogeneration, are currently on line. RAE (Regulatory Authority for Energy) issued applications for cogeneration permits of 1.457,822 MW_e from 2009- today[18] (1.074,14 MW_e for Biomass). According to HACHP all are on hold due to above mentioned situation.

Concluding cogeneration should operate more than 3500 hrs per year in order to become economically feasible, the operation a cogeneration unit used to cover only the heating loads, in Greece with the above mentioned climate, is not feasible and requires the introduction of appropriate cooling technologies, as absorption chillers, for covering the existing cooling loads. The tri-generation systems do not have the penetration expected in Greece due to their high purchase and installation cost, the lack of knowledge of these systems by the technical world and the investors. So, the Greek state should create more concrete mechanisms to overpass their difficulties.

1.6.1.2 Connection Procedures of micro - Cogenerators into the Network

The access of cogenerated electricity to the Network is a rather complicated issue for cogenerators, in Greece, as no clear and well defined regulations, from HTSO and PPC, exist, driving the cogenerators to negotiate with them the terms of access from a minor position.

Today in Greece, there is no define and concrete terms for connection of micro-CHP units to the Network, due to the lack of the agreement between cogenerator and the Administrator of Greek Electricity Distribution Network (AEDN) for the connection to LV/MV network. Similar agreement between micro PV and AEDN exists. HACHP is in negotiation with AEDN to overpass this barrier.

1.6.2 Financial Barriers

1.6.2.1 Fuel Pricing and Availability for CHP units

An important issue, regarding the further penetration of cogeneration into the Greek system, is the existing energy pricing policy, especially the low electricity pricing for both industrial, tertiary and household sectors and the high gas pricing, knowing the price connection of gas with crude oil and its implications.

According to many Greek cogenerators, both the electricity pricing by PPC and the gas pricing policy from 'high-pressure' providers (DEPA) and, also, 'low-pressure' ones (EPAs) is not adequate and appealing for the operation of cogeneration units of any type, creating major and serious problems for their viability.

[18] http://www.rae.gr/site/el_GR/system/docs/registry/ape_sithia.csp?viewMode=normal

As a result of these tariff policies in gas and electricity is the discontinuation of many, mainly small scale, cogeneration units, as they were creating negative financial conditions to the owners.

An analysis of the energy prices is given in section 1.5 (*The economics of CHP*), showing the background of this barrier.

1.6.3 Administrative barriers

1.6.3.1 1.6.3.1 Permit Procedures for all types of CHP units

The procedures for obtaining the permit, for any type of cogeneration units, are considered as complicated and time consuming, by both cogenerators and consultants. For the completion of permits it is required the involvement of different public authorities (i.e. RAE, Ministry Energy Environment and Climate Change, local authorities (i.e. Prefecture, Region, etc).

The most notable delay occurs during the procedures for the permit, titled 'environmental consequences' to the local environment by the cogeneration unit. According to consultants, the average duration for obtaining this permit is 6 months, as in general, the authorities in the Ministry are not fully aware of the benefits from the use of cogeneration to the Environment.

Currently, the situation is slightly improving, as cogeneration is becoming more understandable to the Greek authority.

2. What is possible? Cogeneration potential and market opportunities

2.1 Potentials and market opportunities

An economic potential of 1.455 MW_e and 2.299 MW_{th} of cogeneration for 2020 could be reached according to the "*Assessment of the National Potential for Combined Heat and Power in Greece, Ministry of Development 2008*" study.

Although the development of cogeneration in Greece is still quite limited, there are sectors where there appears to be an excellent potential for future growth. Figures 6, 7 and 8 show the market (economic) potentials of cogeneration in Greece taken from the "*Assessment of the National Potential for Combined Heat and Power in Greece, Ministry of Development 2008*" study.

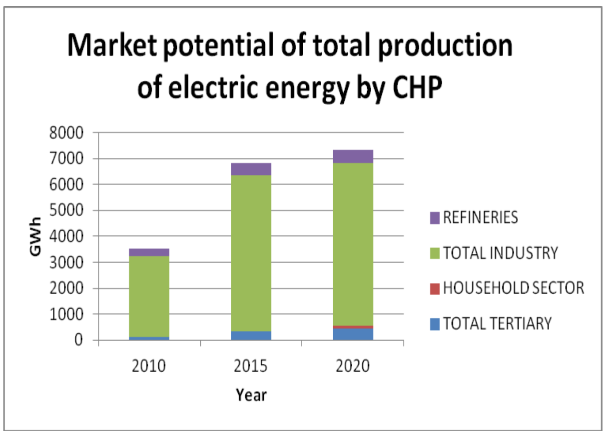


Figure 2.1 - Market potential of total production of electric energy by CHP

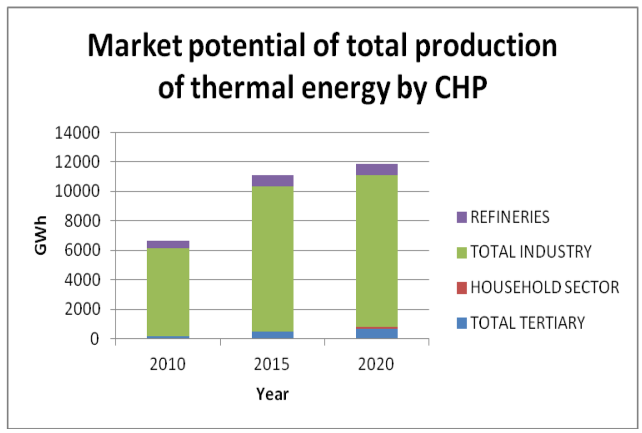


Figure 2.2 - Market potential of total production of electric energy by CHP

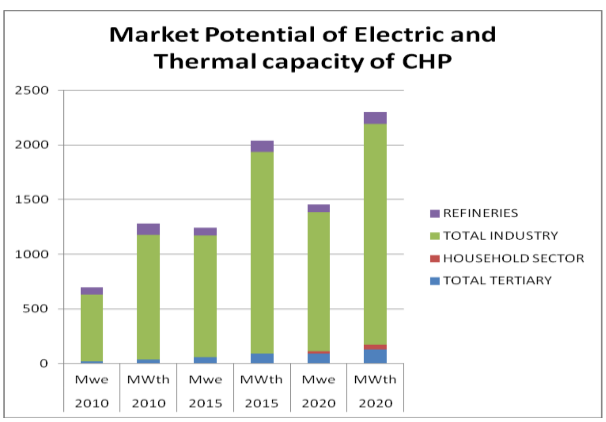


Figure 2.3 - Market potential of Electric and Thermal capacity of CHP

It is clear from the figures above that the higher potentials in absolute figures lie in the sector of industry. The clothing, food- beverages and non metallic minerals sectors are the ones showing the most intense future increase in cogeneration[19]. Especially clothing industries, holding a market potential capacity for 2020 of 40MW_e and 89MW_{th}, are underdeveloped and appear to hold a great opportunity for cogeneration expansion.

In the residential and building sector an increase in cogeneration systems will take place, especially because of the L.3851/2010 (Article 10) which requires that, by 31/12/2019 at the latest, all new buildings should meet all their needs for primary energy from energy supplying systems based on RES, cogeneration plants, district or block heating/cooling systems, as well as heat pumps. This Law creates new potentials for Trigeneration systems set as an option according to TOTEE 20701-5/2012 (Technical Chamber of Greece), concerning the fact of high demands both in heating and cooling needs. This obligation shall apply to new buildings housing services of the public and wider public sector by 31/12/2014 at the latest.

The potential in micro-CHP systems (see also Annexe 3) is quite good because of the relatively small investment capital and the fact that according to the EED[20] these systems will be authorized to connect to the electricity grid and therefore be able to sell surplus electricity. The penetration of micro-CHP is limited to areas where NG exists, therefore the availiability of micro and small cogeneration systems is going to be directed to cases of small hotels, clinics, athletic centers and residents. There is an economic potential of cogeneration of 24MW_e and 39MW_{th} by 2020 in the residential sector according to the "*Assessment of the National Potential for Combined Heat and Power in Greece, Ministry of Development 2008*" study.

Bio-CHP (see Annexe 4) is alredy showing signs of development. There is a projection, incuded in the "*Assessment of the National Potential for Combined Heat and Power in Greece, Ministry of Development 2008*" study, of an increase of 30% in the biomass consumption of cogeneration from 2010 to 2020. Apart from the general rise of awareness towards bio-CHP (see Annexe 4) the economic benefits of such systems are satisfactory since the guaranteed feed-in-tariffs for the cogenerated electricity fed into the grid of such systems are quite high.

Regarding SME's there have been EU development programs giving subsidies for energy upgrades especially in the tourist section. Many SME's hold high heating, cooling and electricity demands. Cogeneration and trigeneration are technologies that could offer economy and lower their operational expenses. In addition to that, due to their relatively small size, their need for investment capital is not very big. Nevertheless the current financial crisis struck the specific sector in a very brutal way making a great number of SME's to shut down. Hopefully this is a temporary situation and since great part of Greek economy is based on SME's it is a matter of time to rise again and become prosperous again.

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[19] "Assessment of the National Potential for Combined Heat and Power in Greece"-Ministry of Development 2008.
[20] 2012/27/EU

3. How do we arrive there? : The Roadmap

3.1 Overcoming existing barriers and creating a framework for action

Recommendations and proposals are based in cogeneration experts and users suggestions. Indicates ways to overcome existing difficulties that could launch the national cogeneration market to higher and more stable levels.

One of the most important challenges towards the development of cogeneration in Greece is overcoming the existing barriers; therefore, recommendations concerning these barriers are essential for this analysis.

3.1.1 Recommendations for the main economic barriers

- Developing a secure investment environment and overcoming financing problems is a challenge that Greek government should win. This could only become possible with the help of EU and the implementation of several measures that will strengthen national economy and dissolve any negative impressions about the national investment possibilities.
- Redesigning the subsidies system and expanding them will give a significant economic incentive for investors to turn to cogeneration. It is time for the Greek government to direct national and EU funds to more efficient investments, like cogeneration. The positive results of such movement could be immediate.
- Expanding the guaranteed feed-in-tariffs for the cogenerated electricity fed into the grid by a wider range of cogeneration systems.

3.1.2 Recommendations for the main policy barriers

- Bureaucracy holds the highest level in policy barriers in Greece. Procedures should become shorter and simpler, which is already mentioned in EED 2012/27/EU. A "one stop shop" could clear the path for candidate investors and provide confidence to the public services responsible for the authorization procedures. In addition the reduction of authorization time plays among others an economic motive towards investors since they will be gaining profits from selling power sooner.
- Another very important policy issue that needs development is the inability of connection to the grid system of electricity produced from micro-cogeneration units. This is already indicated by EED 2012/27/EU and hopefully, in a short period of time, the micro-CHP producers in Greece will get the opportunity to connect to the electricity grid. This could change radically the CBA for such systems and make such investments attractive.
- In Greece, DH and DC are underdeveloped. This has got to change by obligating municipalities and regions to perform a specific plan and CBA for DH and DC. By doing that, there will be

specific data that could indicate whether or not such systems are advantageous for the community.

3.1.3 Recommendations for the main non-economic, non-policy barriers

- Lack of awareness about cogeneration is holding back further development and eliminates any possible dissemination. An information campaign about cogeneration and its advantages could raise public awareness and expand the options of enterprises and consultants.
- Limited technical knowledge and know how could be improved by a cooperation between Greek government and educational institutes. This could bring closer experts of cogeneration and professionals who influence prospective investors.

3.2 Possible paths to growth

Three National Energy Strategy scenarios are introduced in "National Energy Planning Roadmap to 2050" composed by the Ministry of Environment, Energy and Climate Change. The implementations of the measures described in the scenarios are estimated to be completed by 2020; therefore the quantitative differentiations are calculated from 2030 to 2050.

The "*National Energy Planning Roadmap to 2050*" composed by the Ministry of Environment, Energy and Climate Change in Greece, introduces three scenarios concerning the national energy development: the "*Existing Policies*" scenario (EP), the "*RES Maximization Measures*" scenario (RMM) and the "*Environmental Measures of Minimum Cost*" scenario (EMMC)[21]. The main characteristics of each scenario are:

a) "Existing Policies" scenario:

- Conservative implementation on energy and environment policies.
- Moderate level of reducing greenhouse gas emissions by 2050 by at least 40% compared to 2005.
- Provide modest penetration of RES and Energy Efficiency technologies such as cogeneration as a result of conservative political implementation.

The results of the EP scenario would be:

- Containment of the average annual investment costs for electricity production and lower total cumulative investment cost of electricity production by 2050.
- Maintain participation of indigenous fossil fuels for electricity generation.
- Capacity utilization of electricity generation from RES.

[21] "National Energy Planning, Roadmap to 2050", Ministry of Environment, Energy and Climate Change, March 2012.

b) “RES Maximization Measures” scenario:

- Maximization of RES penetration in electricity generation reaching the level of 100%.
- Reducing greenhouse gas emissions by 60% by 2050.
- High energy efficiency in buildings and transport.
- Further penetration of cogeneration systems in industries.
- Increase of cogeneration installations in households and SME’s.
- Development of DH and DC.

The results of the RMM scenario would be:

- Achievement of environmental objectives with optimal electricity generation technologies (minimum costs solution for the national economy).
- Reduction of energy dependence and greater protection from fluctuations in fossil fuel prices and geopolitical unrests.
- Optimum utilization of domestic capacity in renewable energy without significant high needs for storing electricity.
- Low requirements for use of new technologies for electricity generation and storage.
- High contribution shares of RES in gross final energy consumption in total and per sector (electricity, heating and cooling, and transport).
- Slight increase in the average investment cost for electricity generation and smart grid development.
- Enhancement of competitiveness and creation of new job positions.

c) “Environmental Measures of Minimum Cost” scenario:

- RES penetration in electricity generation reaching the level of 85%.
- Reducing greenhouse gas emissions by 60% by 2050.
- High energy efficiency in buildings and transport.
- Construction of great number of cogeneration plants using biomass, biogas and NG as fuels.
- Further penetration of cogeneration systems in industries.
- Increase of cogeneration installations in households and SME’s.
- Development of DH and DC.
- Development of trigeneration systems.

The results of the EMMC scenario would be:

- Independence from imports and decarbonisation of electricity generation to the maximum extent.
- High participation of RES in gross final energy consumption.
- Significant penetration of electricity and biofuels in the transport sector.
- Domestic industry development of RES technologies and high energy efficiency systems such as

cogeneration due to high demanding.

- Possibilities for exchange or export of energy from RES.
- Enhancement of competitiveness and creation of new job positions.

The perspective of the above scenarios is for 2050, while the implementation of the needed measures will be completed by 2020. Therefore quantitative differentiation of the scenarios is calculated for 2030 and afterwards. On Figures 2.4 and 2.5 are shown the Potentials of Electric and Thermal capacity of cogeneration in Greece for each of the three scenarios (a: EP, b: RMM, c: EMMC) by 2030.

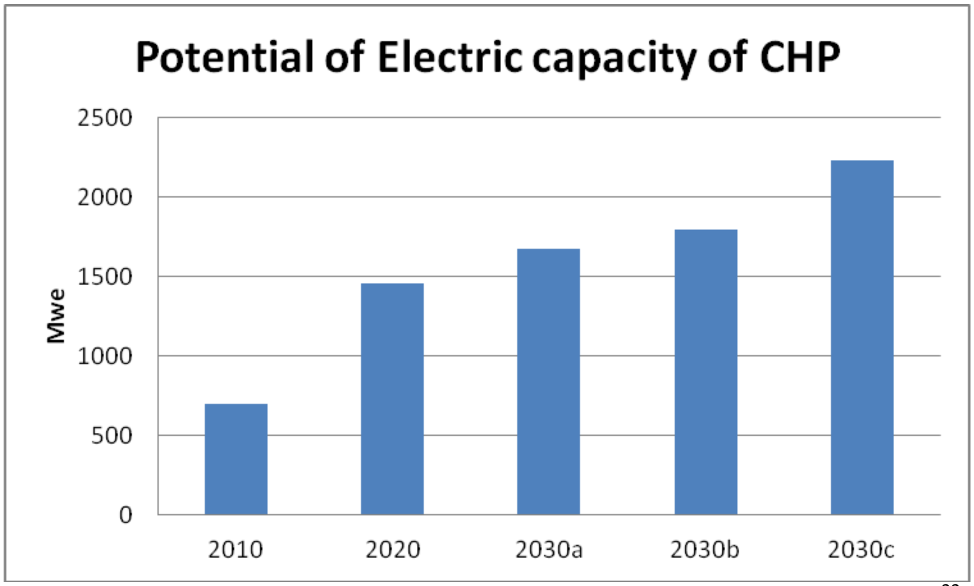

Figure 2.4 - Potential of the electricity capacity of CHP for each of the three scenarios by 2030[22]

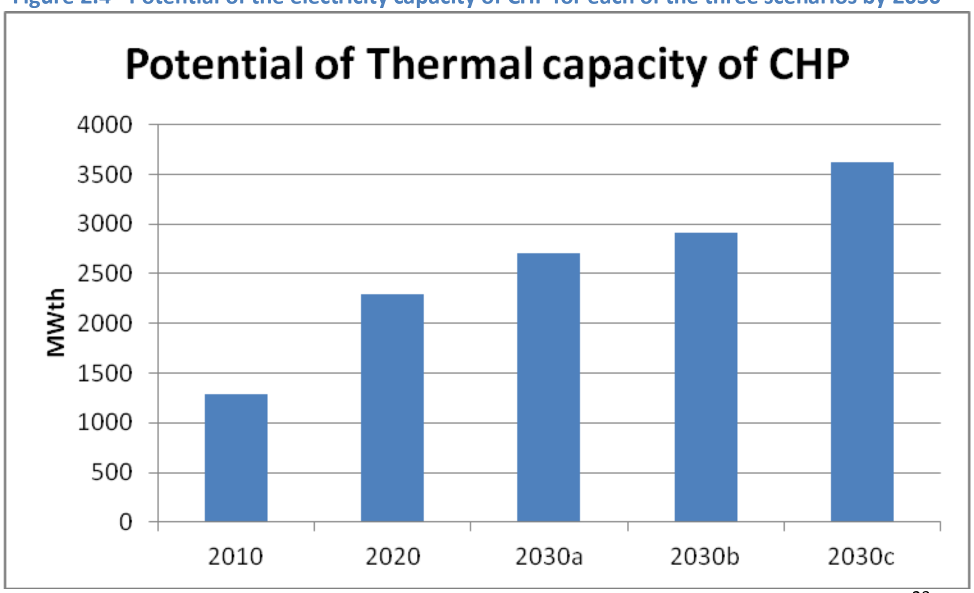

Figure 2.5 - Potential of thermal capacity of CHP for each of the three scenarios by 2030[23]

[22] "EU energy trends to 2030 — UPDATE 2009", EUROPEAN COMMISSION Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG

[23] "EU energy trends to 2030 — UPDATE 2009", EUROPEAN COMMISSION Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG.

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Annex 1: Stakeholder group awareness assessment

Customers	
Utilities	Cogeneration is commonly known in the utilities sector.
SMEs	Cogeneration is quite known in some of these groups. Nevertheless there are only a few examples of completed cogeneration system installations up to 1 MW_e. Due to lack of own funds, subsidies are often necessary for such investments to be made. Small family-run companies or individuals are not well informed and with limited cash flow and without any loans from the banks they don't invest to any energy efficiency technologies.
Households	For the ordinary citizen, cogeneration is an almost unknown technology. Although most of them are aware of terms such as "energy efficiency" and "green energy" they still are not familiarized with cogeneration technology. Small and micro-CHP systems are good means to raise awareness of the efficiency of a cogeneration approach, since these systems could interest individuals, who with a relatively low cost would like to improve the energy efficiency of their houses.
Industry	Cogeneration is well known in principle. Due to today's financial crisis in Greece, most of the businessmen hesitate to invest even knowing cogeneration's benefit.

Market and supply chain	
Manufacturers	There is not a strong presence of cogeneration manufacturers in Greece. Although manufactures hold a high level of awareness, most of cogeneration systems are promoted and distributed by local resellers.
Installers	Cogeneration is known in principle and detailed know-how is at a good level. Unfortunately, due to the low level of interest among user groups there are only a few installation companies in Greece.
Grid operators	Cogeneration is known in principle and detailed know-how is at a good level.
Consultants	Cogeneration is known in principle, but often the detailed know-how design is missing.
Architects	Cogeneration solutions are mostly known only superficially. The focus is on solar thermal, heat pumps and pellets. HACHP in an effort to increase awareness on CHP made several contacts to engineering offices to promote cogeneration. Also a Technical Directive titled "Installation of micro and small cogeneration in Buildings", issued by Technical Chamber of Greece, can be a useful guide to all engineers, working on buildings. There, also, could be more informative activities towards construction companies and engineers.
Banks, leasing	There are major problems for cogeneration financing. Although a few years ago financing of CHP systems was secured, nowadays due to the economic crisis, this is minimized.
ESCO's	Cogeneration is known in principle and detailed know-how is at a good level.

Policy	
Policy development at different levels:	Regulations such as "General Regulation of Buildings" and "Regulations on energy assessments of Buildings" contain many references on micro-CHP systems. Also a Technical Directive titled "Installation of micro and small CHP in Buildings" is offered as a guide to all engineers working on buildings, provided by the Technical Chamber of Greece. There has been a successful campaign in the field of Energy Efficiency from devices to buildings, which is also an essential market factor. Nevertheless, there have been few steps concerning CHP systems.

Influencers	
Information of the broader public	For the ordinary citizen, cogeneration is an almost unknown technology. Although most of them are aware of terms such as "energy efficiency" and "green energy" they still are not familiarized with cogeneration technology. There are exceptions of well informed individuals, where many of them have already or are thinking about investing in micro-CHP systems. Small and micro-CHP systems are good means to raise awareness of the efficiency of a cogeneration approach since these systems could interest individuals, who with a relatively low cost would like to improve the energy efficiency of their houses.
Specialist Media	Cogeneration technology is quite known among the specialized on energy media. Media generally hold a good image about CHP, which is considered, decentralized, environmentally friendly and close to the citizen. The daily papers and TV programs mention cogeneration infrequently. The problem could be that specific technology terms are difficult to process for ordinary journalists and there is a low level of interest by the general public.
Universities/ Colleges	Only some of the polytechnic schools and universities and technical colleges deal with cogeneration either in research or including cogeneration in their syllabus.
Research	There is research in some polytechnic schools and universities dealing with cogeneration. There is a good knowledge only in a few institutes.
NGOs	Good image: decentralized, environmentally friendly, citizen close.
Planners	Cogeneration is known in principle, but often-detailed know-how is missing.
Energy agencies	Cogeneration is well known, but there have been little steps in disseminating this awareness among interest groups.

Table 5.1 - 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: Economic assessment of typical CHP project in Greece

Annex 3: CODE2 micro-CHP potential analysis for Greece

micro-CHP potential summary Greece

INTELLIGENT ENERGY EUROPE
FOR A SUSTAINABLE FUTURE

Country statistics

Population: 11 300 000 (2010)

Number of households: 4 350 000 (2010)

GDP per capita: € 20 100 (2010)

Primary energy use: 19 000 ktoe/year (2010)

GHG-emissions: 118 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kWe)

Boiler replacement technology

Present market (2013)

Boiler stock: 1 000 000 units
Boiler sales: 47 000 units/year

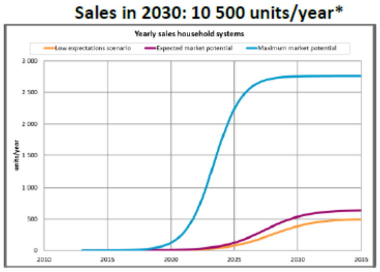
Potential estimation

Indicator	*Score*
Market alternatives	2
Global CBA	0
Legislation/support	2
Awareness	1
Purchasing power	1
Total	**4 out of 12**

Market share in 2030: 26% of boiler sales in Household sector

Yearly sales

Sales in 2020: 140 units/year*
Sales in 2030: 10 500 units/year*



Stock

Stock in 2020: 450 units*
Stock in 2030: 42 700 units*
Stock in 2040: 117 000 units*

Potential savings in 2030

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

SME & Collective systems (±40 kWe)

Boiler add-on technology

Present market (2013)

Boiler stock: 1 030 000 units
Boiler sales: 48 000 units/year

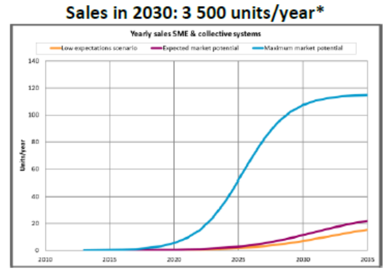
Potential estimation

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

Market share in 2030: 14% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 140 units/year*
Sales in 2030: 3 500 units/year*



Stock

Stock in 2020: 900 units*
Stock in 2030: 13 700 units*
Stock in 2040: 58 000 units*

Potential savings in 2030

Primary energy savings:
11 PJ/year*
271 ktoe/year*
GHG-emissions reduction:
2.1 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	2
Global CBA	0
Legislation/support	2
Awareness	1
Purchasing power	1
Total	**4 out of 12**

Market alternatives

The NG grid is well developed in many major cities, there is a plan for further development.

Global CBA

SPOT: ***not economical***

Legislation/support

Current incentives

For the time being no possibility to sell to the grid the surplus electricity for ±1 kWe systems (Households).

L.3851/2010 (Article 10) requires that, by 31/12/2019 at the latest, all new buildings should meet all their needs for primary energy from energy supplying systems based on RES, CHP plants, district or block heating/cooling systems, as well as heat pumps.

Current legislation in favour

L.4001/2011, transposes, into national legislation, the third Internal Energy Market Directive. Among others, it stipulates the unbundling of the system operators and enhances the role of the independent regulator, regarding security of supply, licensing, monitoring of the market and consumer protection, cancelling the 35 MWe barrier, as the upper limit installed capacity for a CHP unit to be characterized as "High Efficient" one.

Awareness

Are stakeholders aware of the microCHP technologies

Homeowners? ***For the ordinary citizen, CHP is an almost unknown technology***

Consultants? ***CHP is known in principle, but often the detailed know-***

±40 kWe systems (SME & Collective systems)

Boiler add-on technology

Scorecard

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

Market alternatives

The NG grid is well developed in many major cities, there is a plan for further development.

Global CBA

SPOT: ***not economical***

Legislation/support

Current incentives on microCHP

L.3851/2010 (Article 10) requires that, by 31/12/2019 at the latest, all new buildings should meet all their needs for primary energy from energy supplying systems based on RES, CHP plants, district or block heating/cooling systems, as well as heat pumps

Current legislation in favour

L.4001/2011, transposes, into national legislation, the third Internal Energy Market Directive.

Awareness

Are stakeholders aware of the microCHP technologies

Consultants? ***CHP is known in principle, but often the detailed know-how design is missing.***

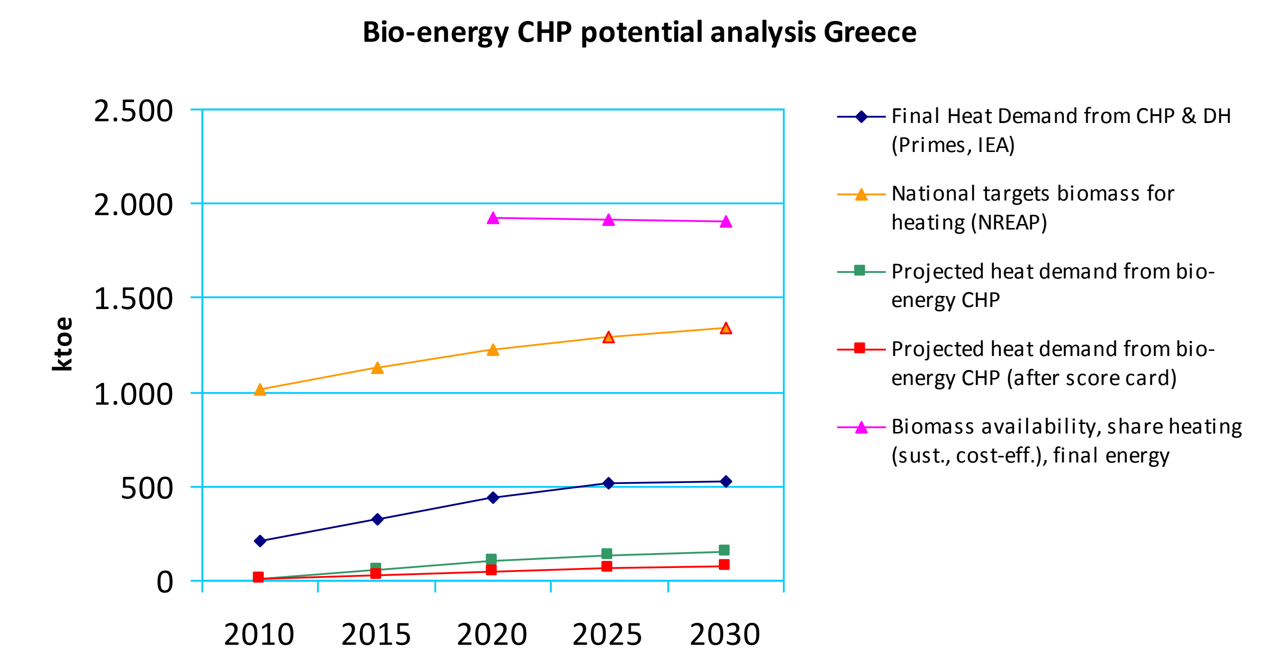
Installers? ***CHP is known in principle and detailed know-how is at a***

how design is missing. *Installers?* ***CHP is known in principle and detailed know-how is at a good level.*** *Planners?* ***CHP is known in principle, but often the detailed know-how design is missing.*** *Government?* ***CHP is known in principle.*** *Are manufacturers active in the market?* ***Only through resellers. There are no manufacturing companies in Cyprus.***	***good level.*** *Planners?* ***CHP is known in principle, but often the detailed know-how design is missing.***
Purchasing power	
GDP: ***€ 20 100 per year***	

Annex 4: CODE2 bio CHP potential assessment for Greece

Bio-energy CHP potential analysis Greece

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	207	442	524
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	7	48	73
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	3,4% (2009)	10,8%	14,0%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		1.922	1.906



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	+ 2 (of 3)	New Development Law with incentives on Energy Efficiency, including DH – There are private DH network in operation in GR, with good results
Suitability of heat market for switch to bio-energy CHP	- 0 (of 3)	Not yet an industrial attempt for bio-energy in industry
Share of Citizens served by DH	o 1 (of 3)	There is one DH system in GR with a partial biomass boiler, but the operating results are not known yet
National supply chain for biomass for energy	+ 2 (of 3)	New area with good potential
Awareness for DH and CHP	+ 2 (of 3)	There is an awareness for HECHP and DH, as well as for bio-energy

Annex 5: Assumptions used in the market extrapolation