CODE2

Cogeneration Observatory and Dissemination Europe

D5.1 - Final Cogeneration Roadmap

Member State: **Cyprus**

October 2014

Leading CODE 2 Partner: Hellenic Association for Cogeneration of Heat and Power, HACHP

Cyprus is part of the non-pilot Member States of the SE Europe CODE2 Region.

The CODE2 Region 'SE Europe' comprises the following Member States: Bulgaria, Cyprus, Greece, Romania

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

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Introduction and Summary

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 will launch and structure 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 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 Cyprus is written by CODE2 partner HACHP, based on a range of studies and consultations, with local experts and energy players, through a process of discussion and exchange of ideas and opinions on the promotion of CHP in Cyprus.

Acknowledgement

HACHP and the CODE2 team would like to thank all experts involved for their contributions to develop this roadmap, which has been valuable regardless of whether critical or affirmative. It has to be stressed that the statements and proposals in this paper do not necessarily reflect those of the consulted experts.

Summary

CHP is developing slowly in Cyprus, with few installations, mainly in agricultural sector operating with biofuels. The share of CHP to the gross electricity generation is below 1%.

There has been government participation for the development of CHP in Cyprus, either on legal basis or on introducing support mechanisms for cogenerated electricity.

In Cyprus, currently, economic viable are only micro- or small-scale CHP units, operating with biofuel. No district heating/cooling networks in operation, as no heat policy exists and the technology is unknown. For micro CHP, there is actually no market in Cyprus, due to a lack of natural gas supply and grid infrastructure.

With substitution method, developed within the project, PES for Cyprus through implementing the roadmap for CHP is estimated at 4.9 TWh per year and CO_2 savings are estimated to be between 0.30 and 0.47 million tons per year in 2030, due to high penetration of biomass/biogas, as fuel.

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

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

1.1 Current status: Summary of currently installed cogeneration

CHP is developing slowly in Cyprus, with few installations, mainly in agricultural sector operating with biofuels. The share of CHP to the gross electricity generation is below 1%.

CHP is not particularly developed in Cyprus, as the first small-scale CHP units were installed in 2003. In 2006, there were installed only seven units, four CHP units with solid fuel in a mine and three units in a non-metallic mineral product factory, of total installed capacity of 2.3 MW_e and oil, as their fuel, producing 8.70 GWh of cogenerated electricity and 38.70 TJ heat. All working CHP systems were auto-producers.

Afterwards, small-scale CHP units were operating mainly in agricultural sector, using biofuels, as the main fuel, as Figure 1 shows[2].

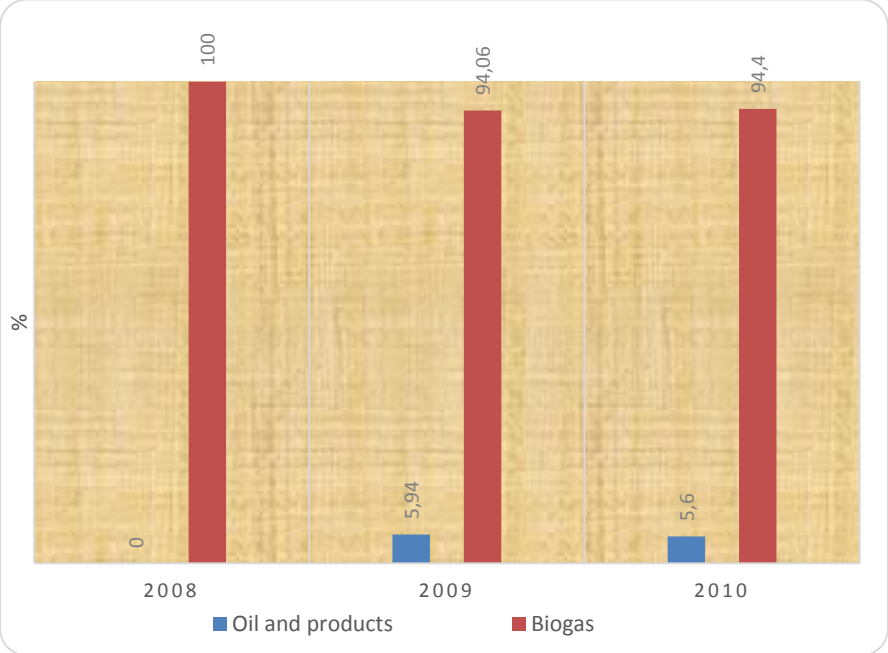


Figure 1: Fuel input for HECHP systems

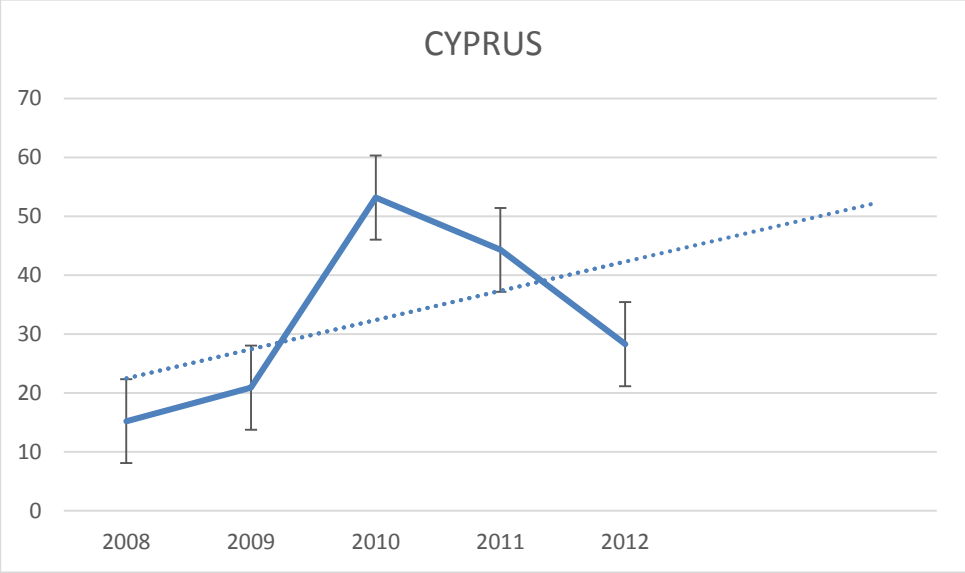
From Eurostat[3] the data for CHP in Cyprus, for the period from 2005 to 2012, is given in Table 1:

[2] CHP report 2011, Ministry of Commerce, Industry and Tourism

[3] Eurostat, http: //epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin= 1&language=en&pcode= tsdcc350

Year	CHP electricity generation TWh	Main activity producers	Auto-producers	Share of CHP in total electricity generation	CHP Electrical capacity, GW	CHP Heat production, PJ	Main activity producers	Auto-producers
2012	0,03	:	:	0,6%	0,01	0,0	:	:
2011	0,04	63,6%	36,4%	0,9%	0,02	0,2	58,1%	41,9%
2010	0,06	:	:	1,0%	0,02	0,1	:	:
2009	0,02	:	:	0,4%	0,01	0,1	:	:
2008	0,01	0,0%	100,0%	0,3%	0,01	0,1	0,0%	100,0%
2007	0,01	0,0%	100,0%	0,3%	0,01	0,1	0,0%	100,0%
2006	0,01	0,0%	100,0%	0,3%	0,01	0,1	0,0%	100,0%
2005	0,01	0,0%	100,0%	0,3%	0,01	0,1	0,0%	100,0%

Table 1: CHP data for Cyprus (2005-2012)



Cogenerated Electricity, in Cyprus, in MWh, for 2008-2012

From the data of Table1 and the graph, it can be seen that the installed CHP electrical capacity ranges from 0.01 GW_e (min) to 0.02 GW_e (max) with average operating hours of 2750 per annum.

Also, the majority of the cogenerators, are the so–called “main activity producers” who are injecting the cogenerated electricity to the Grid and the auto-producers are almost 1/3 of them; which changed the last five years, when F-i-T was introduced for cogenerated electricity by the Cypriot Energy law, transposing Directive 2004/8/EC to the legal system.

The cogenerated electricity share on the gross electricity generation is constant for three consecutive years and then shows a rising trend from 2008 to 2010, with a small drop on 2011. Nevertheless, the percentage is quite low, showing the limited penetration of CHP in the national electricity market (Figure 2).

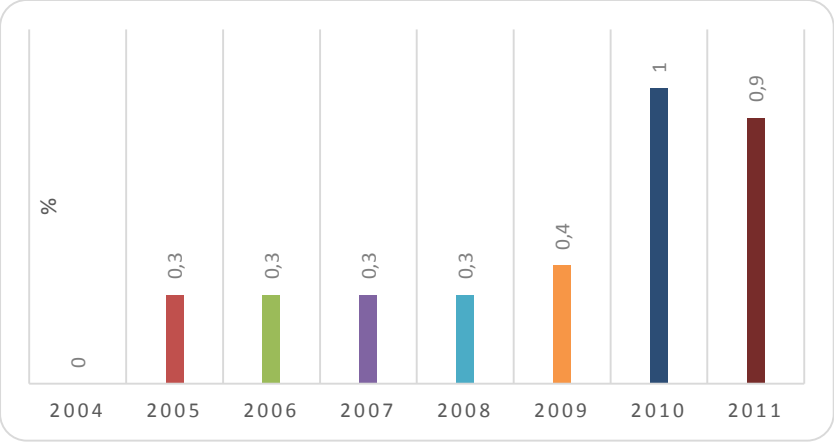


Figure 2: CHP share of gross electricity generation[4]

1.2. Energy and Climate Strategy of Cyprus

Cyprus is highly dependent on imported oil, as it represents 94% of PE supply, with the remaining 6% are from RES. Cyprus transposed all energy directives on time and it has a coherent policy on Energy security, Energy efficiency and for Climate Change.

Cyprus economy is heavily based on tourism and commerce and its local industrial sector is small, of low-energy intensity. Cyprus exhibits a low level of energy supply diversity, with oil dominating the primary energy supply representing 94% of total (EU-27 38%) and by the absence of a natural gas grid[5]. There is a notable small, but growing, share from RES, (wind, PV and micro-hydro) of 6%. There are no district heating or district cooling networks operating in the island.

The Energy Policy of Cyprus is fully harmonized with the EU's. The main axis of the energy policy involves both the safeguarding of a healthy market competition and the security of energy supply, with the least possible burden on the national economy and the environment[6]. The implementation of the above policy is formulated by:

- The liberalization of the electricity market, by abolishing the monopoly of the Electricity Authority of Cyprus (EAC) on the generation and supply of electricity, through a 35% market have allowance to free competition.
- The liberalization of the oil sector, by abolishing the pricing control system and the cross-subsidization between the different oil products and the adjustment of the prices on the basis of the market events and the excise duty in force, as well as the establishment and operation of a strategic oil stock terminal.
- The implementation of development programs related to the use of energy conservation, EE technologies, including HECHP systems, the utilization of ingenious RES and the protection of the environment from industrial pollution.[7]

[4] Eurostat, http: //epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin= 1&language=en&pcode= tsdcc350

[5] South East Europe Energy Outlook, 2011, p.155

[6] http://www.mcit.gov.cy/mcit/mcit.nsf/dmlenergyservice_en/dmlenergyservice_en?OpenDocument

[7] http://www.mcit.gov.cy/mcit/mcit.nsf/dmlenergyservice_en/dmlenergyservice_en?OpenDocument

Regarding its international responsibilities on Climate Change, Cyprus ratified, in December 2008, the UNFCCC, as a non-Annex I party, and the Kyoto Protocol, as a non-Annex B party, giving no limitations or obligations regarding greenhouse gases emissions under the international regime. Cyprus has been allocated with the reduction target of 5% by 2020, compared to 2005, for sectors not included in the Emissions Trading System[8].

The entity responsible for the Energy Policy Strategy and Climate Change is the Ministry of Energy, Commerce, Industry and Tourism of the Republic of Cyprus (http://www.mcit.gov.cy).

1.3. Policy development

There has been government involvement for the development of CHP in Cyprus, either on legal basis or on introducing support mechanisms for cogenerated electricity.

In 2003, the Cypriot Parliament passed a number of laws concerning the liberalization of the energy market, on RES, on energy savings and CHP. Of most important is Law 122/25.7.2003, titled "Regulating the Electricity Market". This law incorporates EU Directive 96/92/EC concerning common rules for the internal market in electricity. Combined Heat and Power is defined in Article 2 of the Law. Also, in Article 86, para 1-3, the Law resolves serious issues regarding independent producers' access to the Grid, as required by the Directive. Article 89 states that the "*regulatory decision or Regulations issued pursuant to Article 88 may impose on any licence holder the obligation to make any arrangements necessary to ensure that, in any calendar year, said licence holders shall have at their disposal a specific amount of electricity from power stations that have been selected through a tendering procedure and which use as their primary fuel source RES or operate as CHP plants*". Law 239/05.11.2004, titled "Regulating the Electricity Market (Amendment)" harmonises the country's current legislation with Directive 2003/54/EC, concerning common rules for the internal market in electricity. The new provision grants an exemption for the "*auto-production of electricity not exceeding 1 MW by any person(s) of a particular category*", which can also apply to Combined Heat and Power applications. Law 174/29.12.2006, titled "Promoting Combined Heat and Power" fully transposing Directive 2004/8/EC, on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC. Up until July 2008, only HECHP can benefit from Law 174, while the entitlements of CHP that does not fall within the scope of the definition of HECHP remain unclear, given that a method for calculating HECHP, under the terms of Directive 2004/8/EC had yet to be adopted at European level. On 2007, the preliminary report of the "*Assessment of national potential for cogeneration in Cyprus*" was published, while the final report of the assessment was presenting the current situation and also projections about the development of CHP in Cyprus (2009). Law 54/25.5.2012, titled "*The modification on the Promotion of Cogeneration and Heat Law*" modifies some of the articles issued in Law 174. On legal status, Cyprus has worked consistently to transpose EU Directives referring to CHP and to EE, even in periods that no cogenerated electricity was injected to the network.

In 2011, the 2nd National Energy Efficiency Action Plan (2nd NEEAP) published, setting the primary energy savings target, for Cyprus, for saving 14.3% of primary energy up to 2020 and the appropriate measures needed to achieve this goal. Also, introduced the target for the contribution of RES to 13% of the total energy production, by the year 2020. The importance of these targets of NEEAP are also pointed in Cyprus National Reform Programme, published in 2013. The key strategy measure for

[8] Decision 406/2009/EC on the effort of MS to reduce their GHG emissions to meet the Community's GHG reduction commitments up to 2020

implementing the national potential for energy savings is the use of natural gas in power generation, after 2015, fuel from its own gas fields, which will replace expensive and more polluting fuel, as oil.

On support mechanisms, grants scheme for energy savings and the implementation of additional measures for promoting HECHP, the crucial role of energy audits are proposed as mandatory measures in the 2nd NEEAP. In addition, additional capital grants to small and very small CHP for the tertiary sector of an electric capacity of less than 1 MW_e are proposed. Other measures consist of additional implementation on energy savings measures in buildings, of the commitments of municipalities and communities to prepare their Energy Action Plans, of the new Action Plan for Green Public Procurement[9] and the implementation of measures in the transport sector, where in many of those Cogeneration can play an important role when is applied (i.e. CHP in buildings, etc) Also, the "*Project grants to encourage the use of renewable energy and energy efficiency*", published in 2012, is aiming at providing financial incentives in the form of government sponsorship and/or subsidies or special allowance for investment for encouraging the use of Renewable Energy Sources (RES) and saving energy. The scheme sets the amount of subsidies for energy projects. Regarding support mechanisms for CHP, there are two aid programmes, operating by the Cypriot Government, namely:

1. "*The Special Fund Management Committee for Renewable Energy Sources and Energy Savings*"
2. "*The Grant plan for energy savings and encouraging the use of RES for natural and legal persons and for state agencies not performing economic activities*".

The first one is operating on a "de-minimis" basis and encouraging the use of RES and EE, including CHP. The "de minimis" aid is granted up to a level of 30% of the eligible budget costs, setting the maximum grant that may provide to a CHP investor up to €170,850. Subsequently, it subsidises cogenerated electricity, injected to the Grid, at two distinctive prices; one for day-time cogenerated electricity at 29.3 €/MWh and 25.7 €/MWh for electricity n night-time, with a fuel cost adjustment applicable.[10] For the second aid program, the grant beneficiaries are school boards and charity organisations, municipalities and communities and other non-governmental organisations, to the extent that they do not carry out any economic activities, and the grant, if they install a CHP system, can reach up to 45% of the eligible budget cost, at a maximum amount of €85,425. The aid program subsidises, also, the cogenerated electricity generated in daytime at a price of 36.05 €/MWh and for night-time at 31.61 €/MWh. Cyprus' only electricity producer, Energy Authority of Cyprus, EAC, defines the above mentioned purchase tariffs for cogenerated electricity, which are linked to the fuel price and is subject to a fuel cost adjustment. This may be amended only by a decision by the Cyprus Energy Regulatory Authority (CERA). Additionally, over and above the above-mentioned prices, a subsidy will be granted to CHP electricity producers from the Special RES Fund, only for cogenerated electricity injected to the grid and depending on the CHP system in use. Should the price paid by the EAC be revised, the subsidy will be adjusted so that the overall price offered to the producer remains constant in the course of the relevant contract entered into between the producer and the EAC.[11]

[9] 2nd NATIONAL ENERGY EFFICIENCY ACTION PLAN OF CYPRUS (2nd NEEAP), July 2011 & Laws 11(I)/2006 and 12(I)/2006

[10] Assessment of national potential for cogeneration in Cyprus (2009)

[11] Assessment of national potential for cogeneration in Cyprus (2009)

1.4 Exchange of information and awareness

Cyprus CHP market is still immature with a limited number of CHP installations and the awareness level is low in many different groups.

During the past decade, the CHP market in Cyprus was maturing slowly, reflecting the awareness level of the stakeholder groups. Nevertheless, an increasing interest is caused by political decisions towards energy efficiency and energy security and was further triggered during the transposition of the Directive 2004/8/EC for HECHP. The Ministry of Energy, Commerce, Industry and Tourism is making efforts to raise awareness for HECHP, either by publishing studies and annual reports on CHP installations, or by amending laws, introducing favourable incentives, etc. Knowing that the EU's policy intervention to support cogeneration and assist the removal of market barriers is an important element of creating a good commercial proposition, but not sufficient by itself to grow CHP sales if the customers are unaware or misinformed about the benefits of the technology, a CHP awareness assessment among key market actors has been developed in Cyprus. Using qualitative interview techniques with experts and market players, four groups of the socio-economic actors for cogeneration were assessed. The four groups and their subsectors are below showed in Figure 3. The list is not exhaustive, but contains all the most relevant players. More detailed analysis of the socio-economic actors is given in Annex 1 (Stakeholder group awareness assessment). The different colours indicate the level of awareness in each actor.

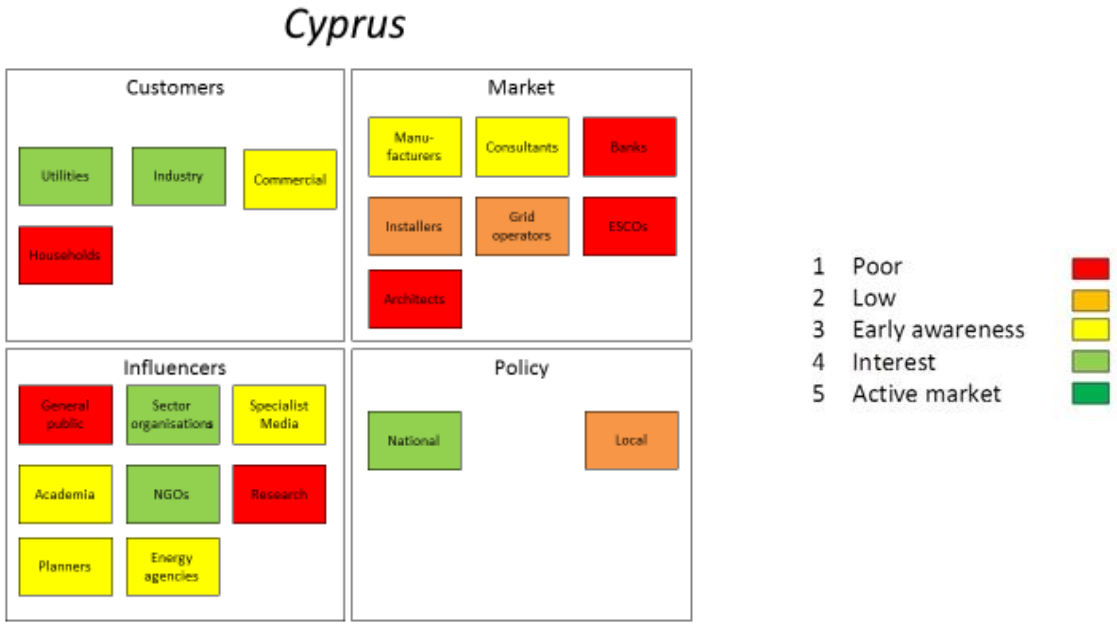


Table 2: Ratings of the awareness of CHP in the different groups

The interaction between groups is still loose, and although the efforts performed by the policy makers, the market is showing signs of stagnation, due to the current economic recession. The most intense interaction is between policy makers and users, where the latter are always asking for a clearer and supporting path towards CHP development. On the other hand, the market group holds low level of awareness making the interaction bonds weak. Utilities and industries show a good level of awareness, while commercial customers and especially households are almost unaware of the benefits of CHP

technologies. Policy makers are well aware of making suggestions and implementing measures that could benefit the development of CHP. There is not any actual presence of manufacturers and/or ESCO's based in Cyprus and this absence is a clear hindrance to wider CHP development. Local consultants and architects are not familiar, in depth, with the technology and banks are in early stages of awareness. General public and research show the lowest level of awareness. NGO's and sector organisations seem to have adequate level of awareness. The awareness of key groups in a quite specific and new market is important, not only for the understanding of the technology through the appropriate channels, but also for a productive relationship between policy makers and investors.

1.5. The economics of CHP

In Cyprus, currently, economic viable are only micro- or small-scale CHP units, operating with biofuel. No district heating/cooling networks in operation, as no heat policy exists and the technology is unknown. For micro CHP, there is actually no market in Cyprus, due to a lack of natural gas supply and grid infrastructure.

As mentioned in previous sections, due to the absence of a natural gas supply, CHP systems in Cyprus are mainly micro- or small-scale, using biogas/biomass and diesel oil, as fuels; also that EAC defines the purchase tariffs for cogenerated electricity, which are linked to the fuel price and that there are subsidies for the installation of HECHP that can reach 30-45% of the total investment. Table 3 gives a screen shot on the current 2014 economic situation of CHP in the main use areas mainly with and bio energy and oil. For micro CHP in the area of households there is currently no market in Cyprus.

Table 3: Economic situation of CHP in major user groups

Cyprus	Micro		Small & Medium		Large		
	Up to 50 kW		*Up to 10 MW*		*more than 10 MW*		
	LPG/Oil	RES	LPG/Oil	RES	LPG/Oil	Coal	RES
SME/Industry/Agriculture							
District heating/cooling							
Services							
Households							

Legend:

"normal"	CHP Investment has **good economic benefits**, return on investment acceptable for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.
"modest"	CHP Investment has **modest/limited economic benefits** and return on investment, **limited interest for new investments**.
"poor"	CHP Investment has **poor or negative return on investment or is not possible due to other limitations, no interest/possibilities for new investments**.

	Not applicable for the sector

1.6. Barriers to CHP

Immature energy market, complexity connecting HECHP to the electricity grid, lengthy licensing procedure, fuel prices and low awareness level are some of the major barriers of CHP, in Cyprus.

The main drawback for the further penetration of CHP in Cyprus is the total absence of natural gas and the dependency from imported, but expensive, oil/oil products. Further to that, in the progress report (2009), in accordance with the EU-CHP Directive 2004, the Cypriot Government recognized the existence of three main types of barriers for the promotion of HECHP, namely: Technical - Administrative and Economic Barriers.

These barriers are prioritized and presented below:

Barrier 1: Difficulties occurring as the country is moving from an island-mode energy market to a liberalized one and the implementation of an Electricity and Heat Policy

The Cypriot energy market is characterized by its immaturity. One produce-provider-distributor of electricity, EAC, and until very recently there are very few CHP installations operating in Cyprus, as auto-producers. This causes investors to doubt about these high capital investments as there are few examples to use as reference and BAT. The absence of coherent policy for useful utilization and distribution of the heat produced is also a barrier to mention, along with the technical experts' lack of knowledge on Central Heating and Cooling Plants (CHCP) and HECHP systems, making experts and planners reluctant to suggest such systems to their clients. Finally, the lack of any incentive for the creation and operation of a district heating/cooling to the near-by communities of an installed HECHP system prolongs the absence of district heating and cooling in the island. As a result, until now, there is no plan for the development of a district heating and cooling system in the island.

Barrier 2: **Complexity in licencing procedure and for connecting a HECHP system to the electricity grid**

Different public services, each with their own bureaucratic structures and with no previous experience on these types of high-capital investments are involved in the various licensing stages of a HECHP investment, creating delays in evaluation, particularly at the initial stages, reaching to two years, according to local investors. Access to the Grid is a complex problem encountered by cogenerators. It is a relative new task for the Cyprus Transmission System Operator (TSO) and Electricity Authority of Cyprus (EAC), having arisen first less than a decade ago. Connection costs must be paid by the CHP producer. However, there is a willingness to change this policy and for connection costs for CHP systems to be calculated in the same way as for RES investments (50-50%). In addition to that there are bureaucratic procedures that add major delays in the connection time.

Finally, a legal issue on priority in load allocation for CHP plants creates extra difficulties for a cogenerator. Article 8, of Law 174/2006, states that "*priority is given to power plants generating up to 7 MW_e*". Moreover, it is mentioned in par. 8(4b) that "*in the event that an auto-producer generates electricity by means of high-efficiency cogeneration, priority is given to power plants generating up to 11 MW_e*".

Barrier 3: Electricity market prices and F-i-Ts impede investments in new HECHP plants

Cyprus imports most of the fuels used from the international energy markets. In addition to that these fuels reach the island by sea through oil-tankers. The result is a higher cost of purchased fuel, which is transferred to the final consumer, making CHP investments with higher ROI period than in other EU M-S The Energy Authority of Cyprus, EAC, defines the purchase tariffs for cogenerated electricity, which are linked to the fuel price and these prices are only partly subsidized, giving only small profit margins for the cogenerators. Additionally, these prices are quite often are revised making difficult for the investors to calculate return on investment rates.

2. What is possible? Cogeneration potential and market opportunities

An increase of CHP electricity production to 228 MWe by 2020, as stated in a report of 2009, is regarded as an appropriate target, if Cyprus exits soon the current economic recession and an active CHP policy, with natural gas as fuel and full implementation of EED is achieved.

As mentioned earlier, in 2009, the "Assessment of national potential for Cogeneration in Cyprus" study was showing the HECHP penetration in Cyprus, an economic potential from the prospective of the national economy, which is based on international trends in average fuel prices.

Activity Type	Electricity – Installed Capacity (MWe)			Heat – Installed Capacity (MWth)		
	2010	2015	2020	2010	2015	2020
Hotels	3.5	11.3	27.9	5.4	17.2	42.5
Hospitals	0.3	1.0	3.2	0.6	1.8	5.7
Office Buildings and Shopping Centres	0.7	2.1	4.0	1.1	3.4	6.5
Tertiary Sector Total	4.5	14.4	35.0	7.0	22.4	54.7
Food Products, Beverages and Tobacco	4.4	14.2	29.8	9.0	28.7	60.1
Non-metallic mineral products	2.3	50.4	100.9	5.1	111.0	222.0
Non-ferrous metals	0.1	9.9	22.0	0.2	21.8	48.4
Industry Total	6.8	74.5	152.6	14.2	161.4	330.4
Agriculture – Animal production	5.5	17.8	20.2	9.6	30.6	34.8
Biogas	4.0	12.8	14.6	6.8	21.8	24.7
Waste treatment and landfill sites	1.5	4.9	5.6	2.6	8.3	9.5
Total	22.4	124.4	228.0	40.2	244.6	454.2

There is no recent official statement or study after this report, which will include the recent economic recession of the Cypriot economy and its influence on CHP penetration. According to CyTSO – Cypriot Transmission System Operator – there were CHP projects, applied for licensing by the state, totaling 18 MW, by early 2010. So, it is clear that the target of 22.4 MW_e would have been an obtainable target, or in a less optimistic scenario a 60% of the above-mentioned target, based on the penetration of natural gas in the country.

Also, the report assumed that by 2010 the natural gas grid will available in the island, which was proven to be quite optimistic and this is moved further in time, to 2020 at the earliest, as the oil/gas drilling are under way, in Cypriot EEZ, in order to provide a rigid conclusion on the existing oil/gas stocks.

This CODE2 roadmap, aiming to focus on the opportunities than the existing limits and barriers of CHP, proposes to revisit the 2009 projections and the current EED Directive is the most suitable instrument for that. In any case, the previous experience shows that the Cypriot government is transposing the EU Directives on due time and the legal instruments in EED are appropriate ones for the promotion of CHP in Cyprus. The overcome of the barriers, presented in section 1.6, the exit from the economic recession and the introduction of a natural gas grid will lead to the target of 228 MW_e, proposed by the study of 2009.

Bio energy

According to the Assessment of the National potential for Cogeneration for Cyprus (April 2009) the economic potential for HECHP, excluding industry and tertiary sector, is estimated to 20 MW_e, where 10 MW_e with solid biomass as fuel and 10 MW_e with biofuel.

A bio CHP potential analysis carried out in CODE2 project, which is based on a "score card analysis" shows that under current conditions, as oil as fuel is expensive for agriculture purposes, the share of biofuels for micro- and small-CHP units is estimated to grow slowly up to 2030.

Micro CHP

Currently there is little or no opportunity for micro- or small-scale CHP units due to lack of heating networks in urban areas and of natural gas infrastructure in the island. The profile of this type of CHP application is so low in Cyprus that it does not feature in as a category in the national CHP statistics.

Based on the above-mentioned study of national potential for CHP for Cyprus (2009), CHP systems in the household sector do not appear to be financially viable even for trigeneration purposes, due to lack of knowledge of the technology by local experts and authorities. Generally speaking, small HE-CHP systems are financially viable only in large tertiary-sector buildings, but when natural gas will be introduced in the island's energy system, late 2020's. (see Annex 2).

3. How do we arrive there? : The Roadmap

3.1. Overcoming existing barriers and creating a framework for action

Key proposal is to take the obligations resulting from the Energy Efficiency Directive, EED, as an opportunity for reviewing the current CHP policy, removing the existing barriers and revising the potential and opportunities of CHP further development.

3.1.1. The obligations resulting from the EU-Energy Efficiency Directive should be taken as an impulse for reviewing the CHP policy.

The full transposition of EED into the Cypriot energy legal system and especially Article 16's requirement to make cogenerated electricity equal to the RES one in terms of network access will provide easier connection to the cogenerators to the grid, with better financial terms. The best way to obtain this is by providing a 50% reduction in the connection cost for HE-CHP systems. The TSO should provide, within a short period of time, binding connection reports. HECHP systems developed in the tertiary (small-scale CHP, up to 1 MW_e) and residential (micro CHP, up to 50 kW_e) sectors must be provided with a simpler, non-discriminatory access to the electricity grid. Simple rules should be established for micro-cogenerators to connect to the Grid and the rules provided by the EAC should be clear and unambiguous. Additionally, TSO personnel should be trained on these issues by experienced agencies

Also, the existing limit-threshold of 11 MW_e in load allocation for priority, which is not based on any specific study or assessment analysis but it is applied as a "cut-copy" from the Greek Law 3468/2006 should be repealed, following consultation with the EAC. Cypriot Government should follow the EED, which sets no capacity limits on the promotion of CHP and the implementation of the EED in Cyprus is a clear opportunity to address this.

It should be taken into consideration that the EED requires that in the obligatory "comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling" according to Art. 14 a cost-benefit analysis shall be carried out based on socio-economic and ecologic criteria. It is also important that the discount rate used in the economic analysis for the calculation of net present values shall be chosen at a low value according to Annex IX of the EED and be nearby the discount rate as defined by the European Central Bank[12]. Generally the cost-benefit analysis should be based on a socio-economic consideration and not on common business level criteria (e.g. discount rate 2 to 3 % instead of > 10 %).

3.1.2. The Government should consider revision of the existing license policy, in order to make more appealing new investments in new CHP.

The existing license procedures for obtaining the final permit for operating a CHP unit in Cyprus, as explained in previous section, is considered as lengthy, as it reaches two or even more years, according to local cogenerators. This should be improved in order to minimize the period especially for small-scale CHP units that considered as high efficient by definition and explained in the CHP law.

3.1.3. Implementation and operation of CHP by energy service companies (ESCOs) should be established and strengthened, following the implementation of EED

[12] Part 1 of Annex IX EED: "The national discount rate chosen for the purpose of economic analysis should take into account data provided by the European Central Bank."

Energy service companies (ESCOs) can play a key role in mobilising additional CHP potentials, particularly in industry and commercial sector, in principle everywhere in the heating/cooling market, where no district heating is supplied. ESCOs use to calculate with longer payback times than industry. So, in many cases, ESCOs are able to bring the cogeneration potentials into reality, where otherwise "business as usual" would apply, meaning inefficient heat and steam production in boilers. As specialised experts on energy efficiency, ESCOs do have the necessary know-how on both technical and legal issues and they can offer solutions by "contracting" even as a part of an integrated efficiency package, including other energy saving measures regarding the supply of power, heat and cooling. CHP related energy services may be offered either by existing energy supply companies or by new suppliers. The implementation of Article 18 EED, requiring that "*Member States shall promote the energy services market …*" could be a core element for bringing the cogeneration potential of the industry into the reality. The same may apply for many other energy users e.g. in the commercial sector who are not able to invest and operate cogeneration units. It is important to make sure that cogeneration implementation by external ESCOs is explicitly supported, especially in its initial stages, as in Cyprus.

3.1.4. Government should boost development of a new support mechanism for cogenerators, using different types of fuel (i.e. RES, oil, etc).

The existing support mechanism for cogeneration, with the capital subsidies and/or feed-in-tariffs for cogenerated electricity injected to the grid, is reaching its limits and is not supporting sufficiently a new emerging energy efficient technology, as CHP. So, the Cypriot government should work on new support schemes for CHP, with a variety of mechanisms for cogeneration, based on EED's proposals and on different fuels used by the cogenerators. A new sufficient proposal is the use of tax exemption for electricity produced by CHP units, using biomass as fuel. Also, it is important to give higher attention to favourable incentives for the installation of trigeneration systems for large households and for tertiary sector and district cooling networks, especially for the large hotel buildings.

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

This is a combined effort by policy makers and experts from Government, NGOs, Energy agencies operating in Cyprus, as Cypriot Energy Agency, SMEs and local industrial associations to raise a new awareness campaign on the benefits of CHP, and particularly the micro-scale CHP units, and trigeneration, through specialized seminars, published best cases studies that could provide more practical information to local engineers and planners, in order to get the needed knowhow and, then, promote this technology.

3.2. Possible paths to growth

Possible paths to grow CHP in Cyprus are presented with the use of three scenarios, simulating the effect of energy efficiency measures have been set up in the 2nd NEEAP.

To simulate the effect of energy efficiency measures on national energy consumption, three distinct scenarios have been set up, in line with the needs of the Cyprus Energy Service and the Cypriot Regulatory Authority for Energy, leading to three different energy forecasts.

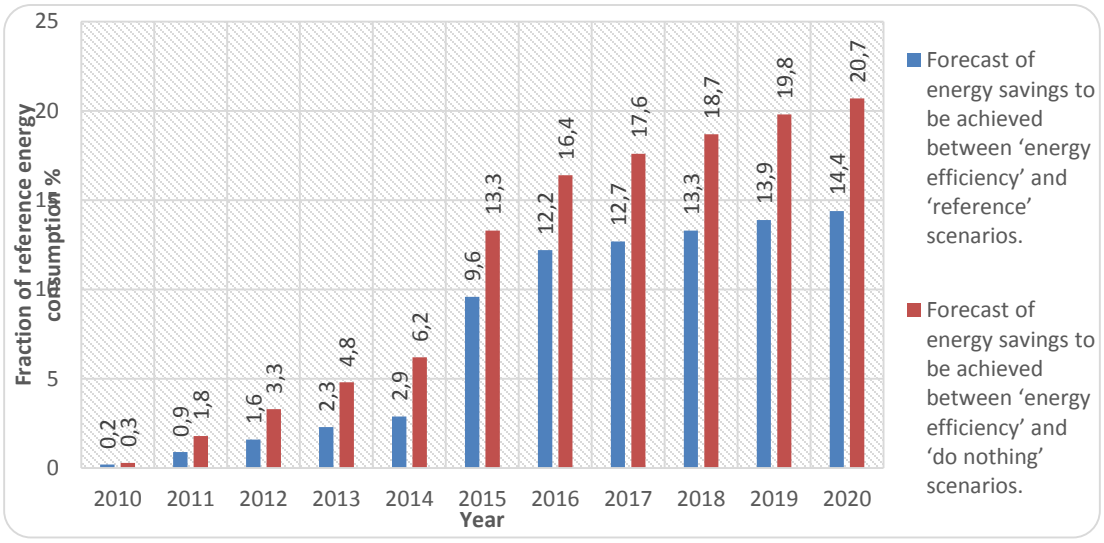
More specifically, the following scenarios were considered:

- A "**do nothing**" scenario, simulating what would happen until 2020, if no energy efficiency measures had been taken after 2005. This is a rather theoretical scenario as it assumes that even

the existing EU legislation and national measures are not implemented. As a result of this scenario, no autonomous efficiency improvement is assumed to take place from 2010 onwards. The only possible increase in energy efficiency is induced by higher energy prices.

- A "**reference**" scenario, which assumes that no additional measures – at EU and national level – are implemented after 2010. In other words, Directives adopted in 2010 and national subsidies up to the year 2010 are assumed to take effect, but no post-2010 actions are included. According to bottom-up calculations of the Cyprus Energy Service, measures included in this scenario will lead to savings – compared to the 'do nothing' scenario – of 163.8 ktoe in final energy consumption (50.5 ktoe in final electricity consumption and 113.3 ktoe in final consumption of all other fuels).
- An "**energy efficiency**" scenario, assuming that further energy efficiency measures are adopted in the post-2010 period, such as a continuation of national subsidies for investments in energy saving technologies, the implementation of the "recast Buildings Directive" at EU level and the adoption of further legislation on near-zero energy buildings later in this decade, and generally the gradual implementation of the EU Energy Efficiency Action Plan 2011.

For all three scenarios, the thermal efficiency of power generation, under the case with natural gas, as fuel, was calculated on the basis of the official forecasts of the Regulatory Authority. Overall thermal efficiency of non-renewable power plants is forecast to increase considerably thanks to the introduction of natural gas, from about 35% in year 2009 to 49.2% in 2020. According to the Regulatory Authority's forecasts, most of the power generation in year 2020 will take place in natural gas fired combined cycle gas turbine (CCGT) power plants. A considerable fraction of electricity will be produced by renewable energy sources, and only a tiny fraction of fuel oil and diesel oil will be used.



In the "Assessment of national potential for cogeneration in Cyprus (2009)" short-term and mid- to long-term prospects for CHP penetration are described.

- **Short-Term Prospects for CHP Penetration**

- Further penetration of CHP in industry
- Development of trigeneration in the tertiary sector, and more specifically:
  - Management of the heating/cooling potential using CHP in the hotel sector

- CHP penetration in large hospitals

- Management of the heating/cooling potential using CHP in large office buildings

- **Mid- and Long-Term Prospects for Penetration**

Mid- and long-term prospects include the penetration of small-scale CHP and micro-CHP systems, particularly in the tertiary sector, in which such systems in Cyprus must meet heat and cooling load demands owing to local weather conditions. It is, therefore, evident that a number of problems will arise, which will essentially constitute the installation initiation stage of such systems in the Cypriot market. There is also the opportunity to change the interconnected and non-interconnected energy system by introducing more rational energy production and better load management. The gradual improvement expected in absorption chiller efficiency will significantly aid trigeneration system penetration.

In the above assessment projections about CHP electricity and thermal capacity are presented for different sectors of the national economy (Figures 8, 9).

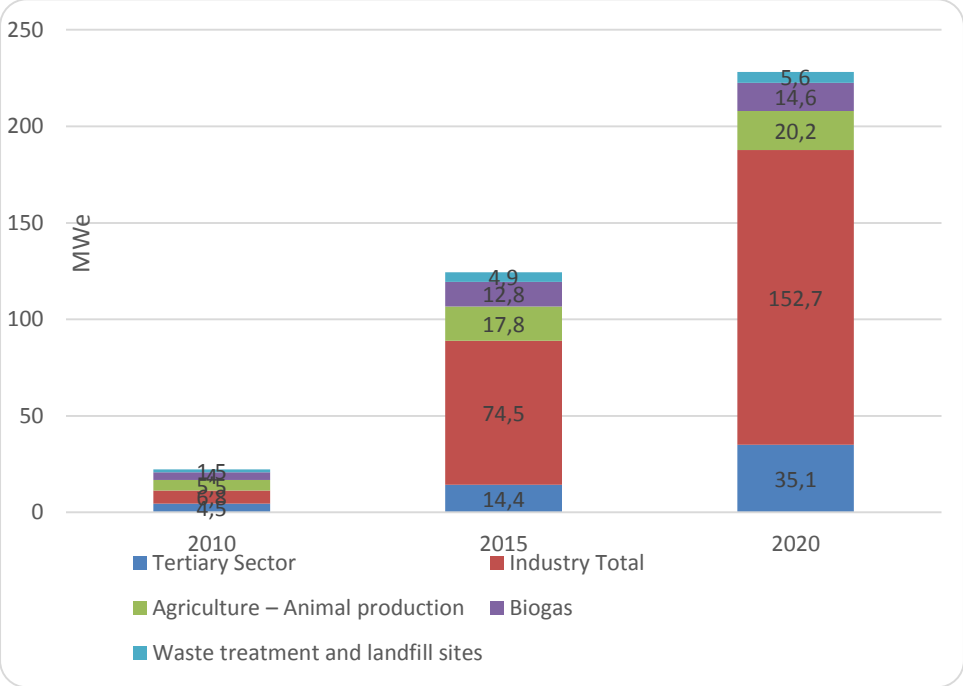


Figure 8 presents the potential of CHP electricity capacity for the different sectors of the economy for the period 2010 to 2020.

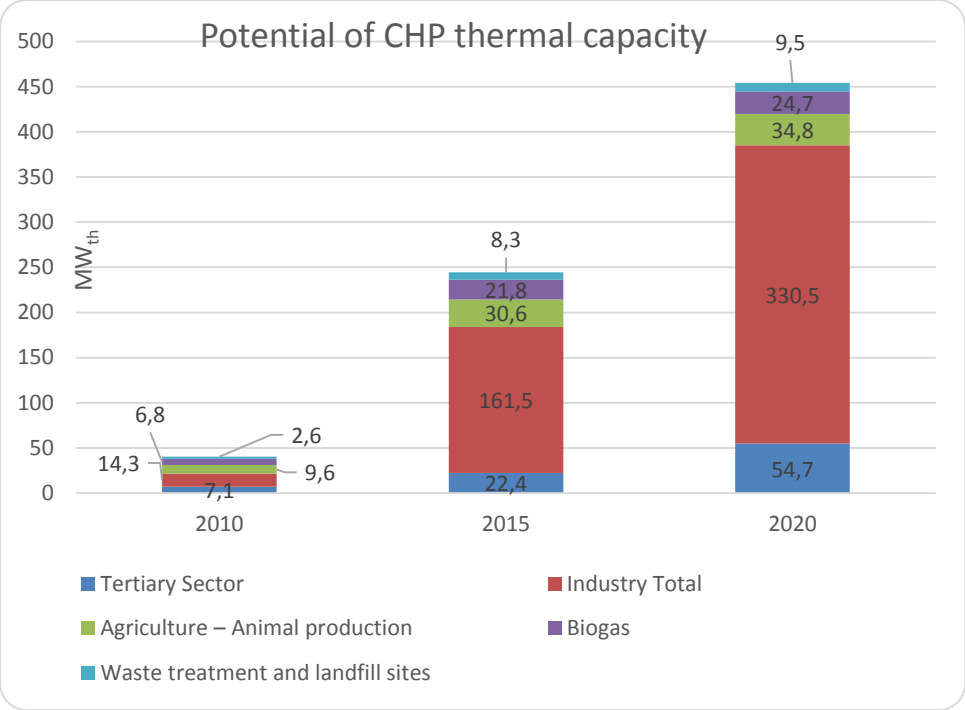


Figure 9 presents the potential of CHP thermal capacity for the different sectors of the economy for the period 2010 to 2020.

A common conclusion is the increase of the share of the industrial and tertiary sector, but with the main assumption that NG will be used as the main fuel.

3.3. Saving of primary energy and CO_2 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. These represent two different analytic considerations which are summarised here and more fully explored in Annexe 5.

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. With this method PES for Cyprus through implementing the roadmap for CHP is estimated at 4.9 TWh per year and CO_2 savings are estimated to be between 0.30 and 0.47 Million tons per year in 2030. The actual saving is particularly dependent on the efficiency increase through upgrading both current power plant and CHP technology efficiencies. The final share of bio energy in additional CHP has a major impact on the CO_2 savings which can be anticipated. The CO_2 reduction achieved is due to both higher energy efficiency and fuel switching towards low carbon

(natural gas) or non-carbon (bio energy) fuel, but CHP development and fuel switching are anticipated to be an integrated process driven by policy objectives.

Table 6: Saving of primary energy and CO_2 by the Cypriot CHP roadmap

	Substitution method		EED method	
	Low case	**High case**	**Low case**	**High case**
PE saving	4.93 TWh/a	4.84 TWh/a	1.91 TWh/a	1.91 TWh/a
CO_2 saving	0.47 Mio t/a	0.30 Mio t/a		
- per kWh el*	0.21 kg/kWh el	0.14 kg/kWh el		

* This value represents the CO_2 reduction of the power generation. It includes the avoided CO_2 emissions from fuel savings for separate heat generation in boilers; it must not be confused with the considerably lower CO_2 emissions of the substituted condensation electricity or with even lower emissions of compared power production according to the BAT approach in accordance with the EU CHP directive reference values.

ANNEXES

1. Stakeholder group awareness assessment

A questionnaire on awareness of CHP and its benefits in the main groups was sent to Cypriot CHP experts in 2013. They were asked to fill a table with the main user groups and to give back their personal opinion on the grade of awareness. Few answers have been received. The average results can be seen in table A.1. It should be underlined that these results cannot be regarded as representative in a scientific sense.

Table A.1 - Ratings of CHP awareness of different influential groupings

Customers	
Utilities	Cogeneration is commonly known in the utilities sector.
SMEs	Cogeneration is quite known in some of these groups. 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 Cyprus and lack of NG grid 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 Cyprus. 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 Cyprus.
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.
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. Limited number of such companies.

Policy	
Policy development at different levels	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.
Universities/ Colleges	Only some of the universities and technical colleges deal with cogeneration either in research or including cogeneration in their syllabus.
Research	Only limited 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.

Legend:

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

2. Micro CHP potential assessment

1. Country statistics

Population: 800 000 (2010)
Number of households: 320 000 (2010)
GDP per capita: € 23 700 (2010)
Primary energy use: 1 900 ktoe/year (2010)
GHG-emissions: 11 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kW_e)

Boiler replacement technology

Present market (2013)

Boiler stock: 40 000 units
Boiler sales: 3 000 units/year

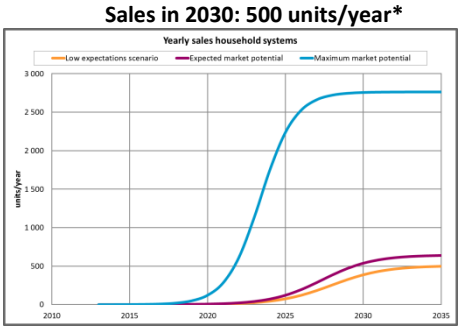
Potential estimation

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

Expected final market share: 21% of boiler sales in Household sector

Yearly sales

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



Stock

Stock in 2020: 15 units*
Stock in 2030: 2 100 units*
Stock in 2040: 6 300 units*

SME & Collective systems (±40 kW_e)

Boiler add-on technology

Present market (2013)

Boiler stock: 3 000 units
Boiler sales: 200 units/year

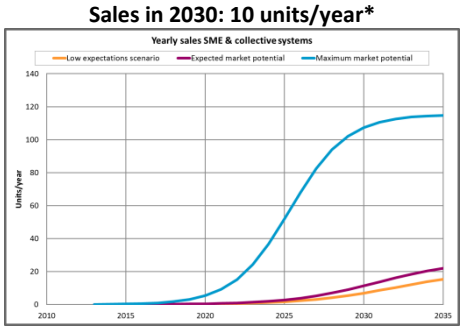
Potential estimation

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

Expected final market share: 12% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 0 units/year*
Sales in 2030: 10 units/year*



Stock

Stock in 2020: 3 units*
Stock in 2030: 45 units*
Stock in 2040: 200 units*

micro-CHP potential summary
Cyprus

micro-CHP score card
Argumentation

Potential savings in 2030	*Potential savings in 2030*
Primary energy savings: 0 PJ/year* 1 ktoe/year* **GHG-emissions reduction:** 0.0 Mton $CO_{2,eq}$/year*	**Primary energy savings:** 0 PJ/year* 1 ktoe/year* **GHG-emissions reduction:** 0.0 Mton $CO_{2,eq}$/year*

*Corresponding to the expected potential scenario.

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*	*±40 kWe systems (SME & Collective systems)* *Boiler add-on technology*
Scorecard	*Scorecard*

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

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

Market alternatives	*Market alternatives*
There is no NG grid.	***There is no NG grid.***
Global CBA	*Global CBA*

SPOT: ***not economical (no gas infrastructure)***	*SPOT:* ***not economical (no gas infrastructure)***
Legislation/support	***Legislation/support***
Current incentives ***The Grant Plan subsidises cogenerated kilowatt-hours – those generated during the daytime and those generated during the night time. The EAC's kilowatt-hour purchase price is subject to a fuel cost adjustment.*** *Current legislation in favour* ***Law 174(•)/29.12.2006 "Promoting Combined Heat and Power".***	*Current incentives on microCHP* ***The period 2007 – 2010, the Special Fund Management Committee for Renewable Energy Sources and Energy Savings issued a "Grant plan for energy savings and encouraging the use of RES for natural and legal persons and for state agencies not performing economic activities". Chapter DIII is devoted exclusively to the cogeneration of electricity and heat and/or cooling and states that beneficiaries of grants are school boards and charity organisations, municipalities and communities and other non-governmental organisations to the extent that they do not carry out any economic activities. Aid is granted up to 45% of the eligible budget, within the limits of the highest eligible expenses. However, the Plan sets the maximum grant that the Cypriot Government may provide an investor with at €85,425 or £CY 50,000. Current incentives on other technologies Guaranteed feed-in-tariffs for the cogenerated electricity fed into the System or Grid.*** *Current legislation in favour* ***Law 174(•)/29.12.2006 "Promoting Combined Heat and Power".***
Awareness	***Awareness***
Are stakeholders aware of the micro-CHP technologies *Homeowners?* ***For the ordinary citizen, CHP is an almost unknown technology*** *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 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.***	*Are stakeholders aware of the micro-CHP 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 good level.*** *Planners?* ***CHP is known in principle, but often the detailed know-how design is missing.***
Purchasing power	
GDP: ***€ 23 700 per year***	

3. Bio CHP potential assessment

Approach for bio-CHP potential analysis

EU Potential for bio-energy CHP

The goal of this analysis is to estimate the uptake and thus the implementation potential, not the theoretical maximum potential, for bio-energy CHP in the 27 EU-member states (MS) until 2030.

To this end, the following main sources have been used to arrive at country specific potentials:

1. Data on "Heat demand from CHP and DH" from the EU energy trends to 2030[13] (based on PRIMES database)[14]
2. Data of targets for "biomass for heating" from the National Renewable Energy Action Plans of the MS[15]
3. Current levels of biofuel inputs to CHP from EAA/Eurostat[16]
4. Biomass potentials from the "Atlas of EU biomass potentials" (Project Biomass Futures)[17]

The approach chosen to perform this bio-energy CHP potential analysis and the basic assumptions are as follows:

Scope and assumptions, analysis steps

The theoretical potential for bio-energy CHP is seen as the 100% fuel switch to bio-fuels in the CHP systems of a given country – in district heating (DH) as well as in industry. The aim of this study is to project on MS level the heat demand from bio-energy CHP systems – also in relation to the heat demand from all CHP systems – in 2030 with a milestone 2020.

Step 1: Heat demand from CHP and DH

The main data source for the development of CHP in the MS are the figures for *heat demand from CHP and DH* (Source: PRIMES) as published in the EU Energy Trends to 2030, Reference Scenario[18] (blue curve in country reports). In countries, for which specific energy trend data for CHP were available (e.g. Germany), these were chosen instead of the PRIMES data.

Step 2: Current and future bio-energy penetration rate

Coming from the current level of bio-energy CHP utilisation (EEA/Eurostat; 2010 value of green curve in country reports), the assumption is that the markets for bio-energy CHP will develop in close relation with the targets of the Renewable Energy Directive and the projections for renewable energy utilization as stipulated in the EU Energy Roadmap (30% in 2030). These figures are then further adapted on country level using specific national sources and in contact with national experts to arrive at a

[13] European Commission, DG Energy: “EU energy trends to 2030”; 2009.

[14] In some MS additional data or projections have been identified for "Heat demand from CHP and DH" or "bio-fuel input in CHP" and have been used instead of the sources mentioned here. Wherever this was done, the respective sources are mentioned in the respective country report.

[15] Energy Research Centre of the Netherlands, European Environment Agency: “Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States”; 2011.; no figures available for Romania

[16] European Environmental Bureau, Eurostat: "Fuel input to CHP plants in EU-27 and EEA countries in 2009", http://www.eea.europa.eu/data-and-maps/figures/fuel-input-to-chp-plants-4

[17] Alterra, IIASA: „Atlas of EU biomass potentials: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources“, 2012.

[18] Reduced by the share of non-CHP heat according to IEA and EUROSTAT statistics.

development path for the heat demand from bio-CHP for each MS (2030 value of green curve in country reports).

Step 3: Determination of growth curve

To determine the curve shape for the development of bio-CHP (green curve in country reports), two sets of data are used as reference (normally weighed 50:50): Firstly, the national target figures *Biomass for heating* (2015 and 2020, own extrapolation for 2025 and 2030) as laid down in the member states' National Renewable Energy Action Plans (yellow curve in country reports). Secondly, the development of the *final heat demand from CHP & DH* as projected by PRIMES (blue curve in country reports). Using IEA figures[19], the non-CHP parts of DH in the PRIMES figures has been eliminated.

The intermediate result is a *projected heat demand from bio-energy CHP* under favourable framework conditions (green curve in country reports).

Step 4: Assessment of framework conditions through scorecard

In a further step, the bio-energy CHP penetration curve is modified by assessing the national frameworks for biomass fuelled cogeneration with a score card[13]. In this scorecard, the following aspects have been assessed and weighed:

- Legislative environment
- Suitability of heat market for switch to bio-energy CHP
- Share of Citizens served by DH
- National supply chain for biomass for energy
- Awareness for DH and CHP

Applying the scorecard results then results in the projection of the bio-energy heat demand from CHP and DH (in ktoe) for 2020 and 2030 (red curve in country reports).

Step 5: Assessing biomass availability

To cross-check, whether the projected demand can be satisfied with cost-efficient biomass available within the MS, the demand figures are compared with national biomass availability figures as published by the project "Biomass Futures" in the Atlas of EU biomass potentials (2012)[20] (pink curve in country reports). Due to the ongoing discussion in the EU about sustainability criteria for bio-energy, the figures from the Atlas' sustainability scenario were chosen, which take into account not only existing legislation but assume stricter sustainability rules to be applied in the future also for solid and gaseous biomass. As the Biomass Futures project also investigated price-levels, the figures used here describe a rather conservative assumption of biomass availability per country. It is assumed, that the technology to use the different sorts of cost-efficient biomass resources (largest groups: straw, manure, perennial cropping, forestry residues, waste) for CHP purposes will be available.

[19]: Website International Energy Agency, Statistics section: http://www.iea.org/stats/prodresult.asp?PRODUCT=Electricity/Heat Score ratings by member state CHP experts.

[20] Assumptions for arriving at the available biomass for bioenergy CHP: 65% of available biomass used for heating; CHP factor 0.8.

Areas not covered

Although being important factors for the future development of bio-energy CHP markets, due to limited availability of data the following aspects have not been incorporated in the potential this analysis:

- Small-scale CHP
- Trigeneration
- Regional or local biomass availability
- Biomass imports

Bio-energy CHP potential in EU-27

25 member states[21] have been assessed with the approach described and are summarised each in a 2 page country report. These reports will be subject to further discussions on MS level in the context of the CHP road maps which are presently under development.

For the European Union, an overall assessment was established by aggregating the individual country figures. As country specific frameworks and policies are important aspects, which were assessed through the scorecards, this section is not depicted in the EU summary.

Analysing the overall picture from the member state level bio-energy CHP potential analyses, the following trends and conclusions can be made:

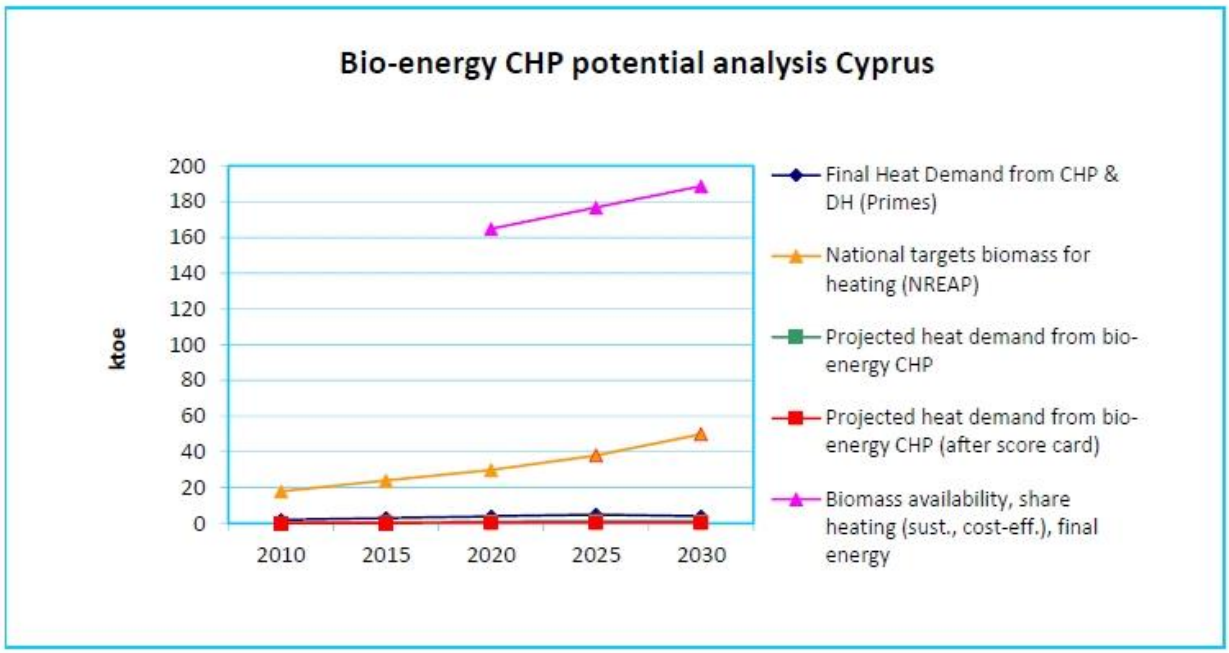
- There will be a steady increase in CHP heat demand in the EU until 2030
- *The strong increase in biomass for heating as stipulated in the MS's NREAPs will also* support the development of bio-energy CHP
- The expected penetration rate of bio-energy CHP in CHP markets is expected to reach 27,1% in 2030 (up from 19,5% in 2009)[22]
- The framework conditions – politically, economically, regarding awareness – for (bioenergy) CHP vary greatly throughout EU
- Under optimum framework conditions on national level, the penetration rate could reach 33% in 2030
- For the projected development, sufficient cost-efficient and sustainably produced biomass resources are available on a national level for further growth of bio-energy CHP. Again, the situation varies greatly between member states. In densely populated countries the nationally available biomass resources may fall short of the demand.
- To maximise the potential, technological progress towards the use of the whole range of biomass fuels should be promoted

[21] France: still in discussion with experts; Malta: insufficient data, no (foreseeable) relevance for CHP

[22] The three countries Germany (large CHP market by volume), Sweden and Finland (both good CHP markets with high biofuel share) account for 76% of the bio-CHP heat demand in EU-27 (2009).

Bio-energy CHP potential analysis Cyprus

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES), ktoe	2,0	4,0	4,0
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	0,0	0,2	0,2
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat, own assessments)	0,0% (2009)	4,1%	6,0%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		165	189



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	- 0 (of 3)	The use of district heating in Cyprus is not promoted, because of the inexistence of a heat distribution system.
Suitability of heat market for switch to bio-energy CHP	- 0 (of 3)	
Share of Citizens served by DH	- 0 (of 3)	Limited industry presence.
National supply chain for biomass for energy	o 1 (of 3)	There are no DH systems in Cyprus.
Awareness for DH and CHP	+ 2 (of 3)	New area with good potential

Comments on country analysis

General comments

• The national framework assessment through the scorecard results in a low score (3 of 15 possible points).
• Thus, it is projected that the growth potential for bio-CHP until 2030 will be exploited to 20%.
• The possible bio-CHP penetration rate in 2030 (2030 dot of green curve) under ideal framework conditions is seen at 30%
(the country's RE target according to RED (28/2009) is at 13% in 2020)
• The share of bio-fuels in CHP (bio-energy penetration rate in CHP markets) is expected to increase from 15% (2009) to 18% (2030)
• The national biomass availability (cost-efficient, sustainable; pink curve) is sufficient to enable the projected growth; however, these biomass resources include types of biomass which are currently not usually used in CHP, but are expected to be utilisable by 2030

Specific issues

• The projected development of CHP heat demand (PRIMES, blue curve) foresees almost no growth on a very low level
• National targets for biomass for heating (yellow curve) see a strong and constant growth
• The growth projections of the bio-energy CHP heat demand (green and red curves) apply the average growth rates of both the blue and the yellow curve (weighting 50:50)

To be re-confirmed

• 15% bio-CHP in CY at all today?
• 18% by 2030 realistic?

4. Assumptions used in the market extrapolation

Detailed economic analysis of four CHP cases was implemented in all pilot roadmaps and optionally in non-pilot ones.

As requested detailed economic data analysis of the four CHP cases were not available or are not sufficiently reliable for making objective conclusions about CHP profitability and comparison of economics with other member states, detailed calculations is not included in this report.

5. Methodologies used to calculate the saving of primary energy and CO_2 emissions under the roadmap.

Substitution method

This method has been developed in the CODE2 project. In doing this, two other approaches have been considered: 1) the "replacement mix method[23]" 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[24], 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.

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

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

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

- replacement of carbon-rich by low-carbon fuels, can be usefully seen only as an integrated process.

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

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

EED method

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.

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