CODE2

Cogeneration Observatory and Dissemination Europe

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

July 2014

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

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

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Introduction

The CODE2 project

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

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

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

Draft roadmap methodology

This roadmap for CHP in Spain is written by CODE2 partner FAST – Federazione delle associazioni scientifiche e tecniche, based on a range of studies and consultation. It has been developed through a process of discussion and exchange with experts.

Acknowledgement

FAST and the CODE2 team would like to thank all experts and policy-makers who on different level have been asked to give their valuable contribution to this roadmap.
It has to be stressed anyway that the statements and proposals in this paper do not necessarily reflect those of the consulted experts.

N.B.

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

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1. Executive Summary

After a continuous increase during the so called Special Regime until 2007. In the subsequent years two connected and concurrent facts happened.
The economic crisis that hit the industry and the demand of useful heat and the change of legal frame that intervened to limit the dramatic tariff deficit caused by the special regime itself.

The cogeneration situation rapidly began worsening and the decline doesn't seem to stop since then. As a result of this trend Spain has lost almost 25% of production only in 2013.

All the stakeholders agree on the fact that, if the government will not invert its policy maintaining low the remuneration and contemporaneously high the tax on electricity sale, in the next future maybe 50% of existing cogeneration plants shall close and, even worse, also the associated industry.

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

1.1. Current status: Summary of currently installed cogeneration

After a continuous increase until 2007 there has been drop in cogeneration installed power due to the stop of new plants and to the lack of upgrading of the old stock of plants.
The present installed power is at level of 6 MWe.

The latest values regarding CHP installed power report 5.969 MW in February 2014 according to CNMC (Comisión Nacional de los Mercado y de la Competencia), whilst according IDAE (Instituto para la diversificacion y ahorro of the Ministry of Industry and Energy) this value is higher and equal to 6.620,7 MW taking into consideration cogeneration coming from waste treatment and bioenergy.

Looking at the development of CHP installed power it's possible to observe a steady increase until 2007 and then a sudden drop of new installed power, which finally became negative as many plants stopped due to the economic crisis in front of the practical absence of new plants installation in the last five years in line with the decrease of the industrial applications.

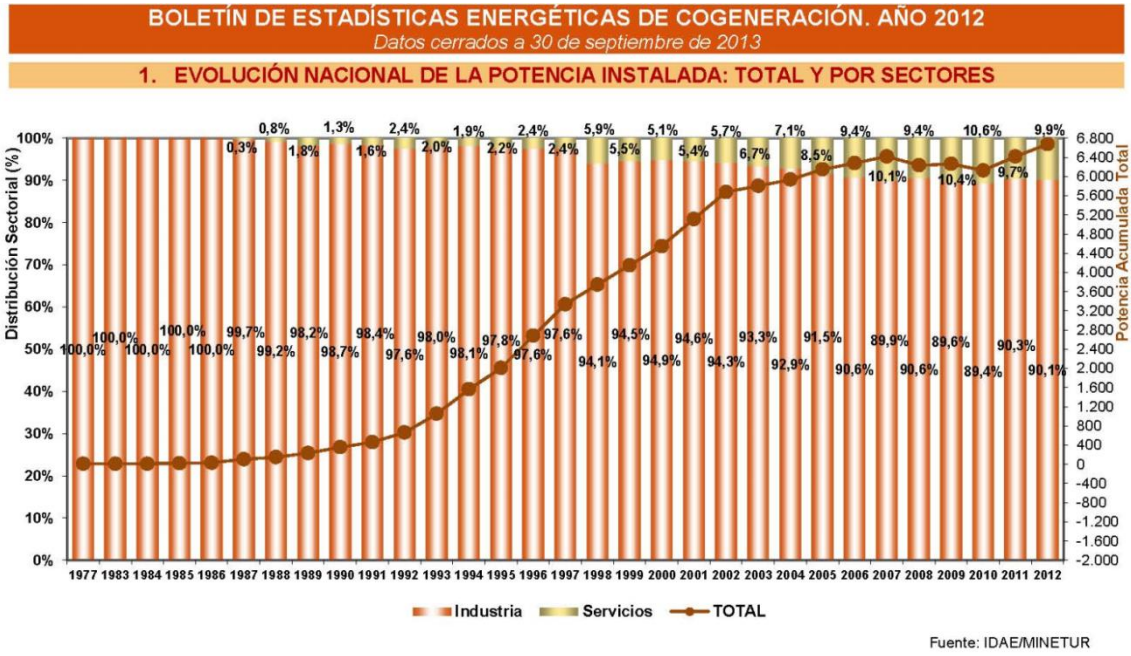


Fig. 1 Development of total installed power and percentage distribution in sectors

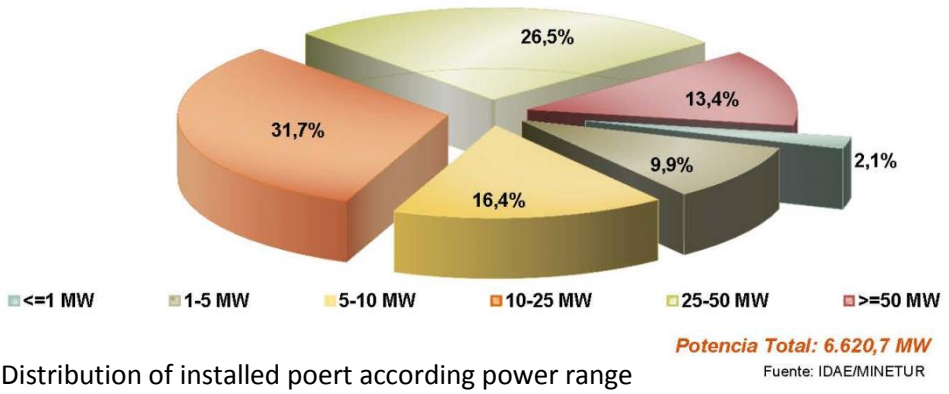


Fig.2 Distribution of installed poert according power range

1.2. The Energy and Climate Strategy in Spain

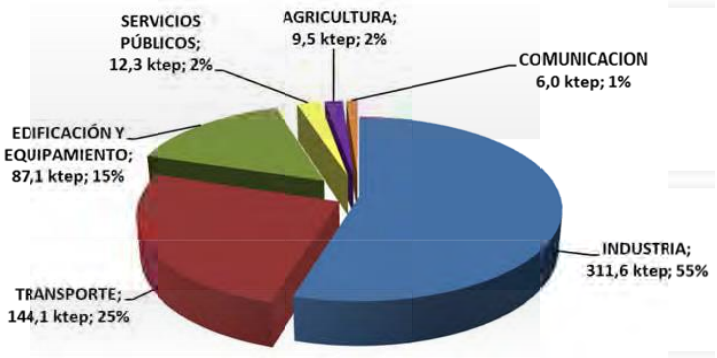
1.2.1. Overall Energy Background

The Action Plans following one another before their original extension and contradicting has provoked not a few difficulties in the sector. The present PNAEE does not provide specific measures and objectives of promotion of cogeneration.

After the publication of the Plan of Action 2011-2020, that practically has never been applied, the Spanish Government published, and submitted to the European Commission, a new Plan replacing the previous, that is the Plan Nacional de Acciòn de Eficiencia Energetica (PNAEE) 2014-2020 addressed to the whole compartment involved in energy saving.
The 2014-2020 Action Plan presents the general lines to achieve the energy efficiency in the buildings, industry and services sectors and shall be updated every three years to take into consideration the actual savings progress.
This Plan contains the executive measures to comply with the European Energy Efficiency Directive, forcing Spain to save 571 ktoe/year between January 1, 2014 and December 31, 2020, equal to total saving of 15.979 ktoe.
Of those 571 ktoe/year savings, 15,3% (87,1 ktoe/year) correspond to the sector of Building and Facilities by means of energy rehabilitation through thermal isolation of existing buildings as well as the implementation of smart energy management systems.
The Plan foresees to adopt the actual economic support, especially for the actions relied to the Buildings rehabilitation.
The main points of this Plan are

- a system energy efficiency obligations will be created based on exchangeable certificates. Obligated parties are the traders of electricity, gas and oil products, including transport. Small traders and retailers shall be exempt from such obligations.
- National Energy Efficiency Fund will be created, as a backup to this system of obligations,
- Moreover Spain will make use of alternative measures to encourage saving efficiency especially of fiscal and financial nature as well as energy efficiency standards and information campaigns, many of which are already in operation.
- IDAE is responsible for issuing and registering energy performance certificates.

It is important to point out that the new National Plan for Energy Saving and Efficiency, contrary to what is indicated in the previous PAEE 2011-2020, does not provide specific measures and objectives of promotion of cogeneration beyond what already considered in the EED so that the indicated goals, previously foreseen, to create 3.751 MW of new cogeneration and 3.925 MW from renovation and other measures no longer apply.



Source: IDAE

Fig. 3 Distribution of target final energy saving (551 ktoe/y)

Again it is noted that Industry is charged with the greatest saving rate of 55%, equal to 311,6 ktoe/y, but the measures indicated to reach the goal don't go beyond a general "adoption of best available technologies in instrumentation and process and in part establishing energy managing systems", without mentioning cogeneration, that is undoubtedly acknowledged as the best available technology.
The Plan reflects the economic support measures currently in force consistent with the scenarios of consumption of final and primary energy integrated in the energy planning regarding renewable energies , according to the obligations of the Directive 2009/28/EC of 23 April 2009 promoting the use of energy from renewable sources.
Thus, the energy planning is a coherent set toward the target of improving the final energy intensity 2 % per year in the period 2010-2020.
The measures included in this Plan are foreseen to bring an energy saving by 2020 equal to 17,842 ktoe of final energy and to 35,585 ktoe of primary energy calculated with reference the year 2007 and according to the methodology proposed by the European Commission.
The savings in terms of primary energy includes the savings coming from the proposed measures for the Energy transformation sector primarily through the promotion of cogeneration and other measures regarding the change in the mix of electricity generation, in agreement the obligations deriving from the already mention Directive 2009/28/EC regarding renewable energy sources.
The new Action Plan 2011-2020 complies with the savings targets required by Directive 2006/32/EC and is consistent with the overall objectives agreed with the European Council on 17 June 2010 relating to an improvement of 20 % of the primary energy efficiency by 2020.

The accumulated savings of final and primary energy during the period 2011-2020 are respectively equal to 120.967 ktoe and 247.791 ktoe, allowing prevent emissions into the atmosphere of 1.012 Mton of CO2 .

As regards the sectors interested in saving the data of the following table applies

	Final Energy saving ktoe		Primary Energy saving ktoe	
	2016	2020	2016	2020
Industry	2.489	4.489	2.151	4.996
Transport	6.921	9.023	8.680	11.752
Buildings	2.674	2.867	5.096	5.567
Public services	56	125	131	295
Agriculture and Fishing	1.036	1.338	1.289	1.665
TOTAL SECTORS	13.176	17.842	17.347	24.275
Energy Transformation			9.172	11.311
TOTAL	13.176	17.842	26.519	35.586

Table 1 Action Plan 2011-2020 Global and sector energy target

As it can be seen the Transportation Sector accounts for 51 %. while the Industry Sector accounts for 25 % of total savings in 2020.
The Industry sector has set a yearly target in 2010-2020 of final intensity improvement of 2.5%.
The Buildings sector savings are located in the tertiary sector, as in houses, where final energy saved for heating will be practically compensated by the penetration of domestic air conditioners. At the same time It is expected significant improvement in the general performance coming from the announced introduction of District heating networks.

These facilities provide the incorporation of thermal renewable technologies and cogeneration, promoting distributed generation power and decreasing energy losses in transmission and distribution.
Finally, in the sector of energy transformation the primary energy savings coming from CHP is equal to 15% of the total savings in this sector, where are accounted also energy savings from other renewable sources.
The proposed target of installing 3.751 MW of new cogeneration within 2020 and the renewal of up to 3.925 MW of cogeneration plants over 15 years old is no more valid nor mentioned.
This document refers to a Plan defined at the beginning of the crisis period and has not been updated nor substituted, unless with single orders.

1.3. Policy development

Even if Special Regime has been repealed, its effects in the Tariff Deficit is still impending. The deficit is even now the main element that leads the choices of energy policy.

1.3.1. Foreword

To explain the energy policy in Spain and the related problems it's necessary to introduce some concepts characterizing the Spanish energy model.

- Special Regime (SR) (Régimen Especial)

  The SR is a treatment reserved to electricity produced by plants with an installed power less than 50 MW utilizing all the renewable sources or cogeneration.
  SR is not assimilated to any renewable energy in particular and includes cogeneration technology.
  In 2011 33% of electricity has been generated in SR. This energy in general is not cheap nor competitive and requires to be subsidised.

- Incentives to SR

  Till July 2013, the installations assigned to SR have the right to sell the produced electricity at a regulated price.
  The electricity generated under the special regime was subsidized. It's crucial to note the annual incentive was continuously growing. In 2010 it was 7.066 billion euros and the accumulated incentive value since 1998 amounts to 38.690 million and the expected premium, according CNE, in 2012 is equal to € 6.984 mio.

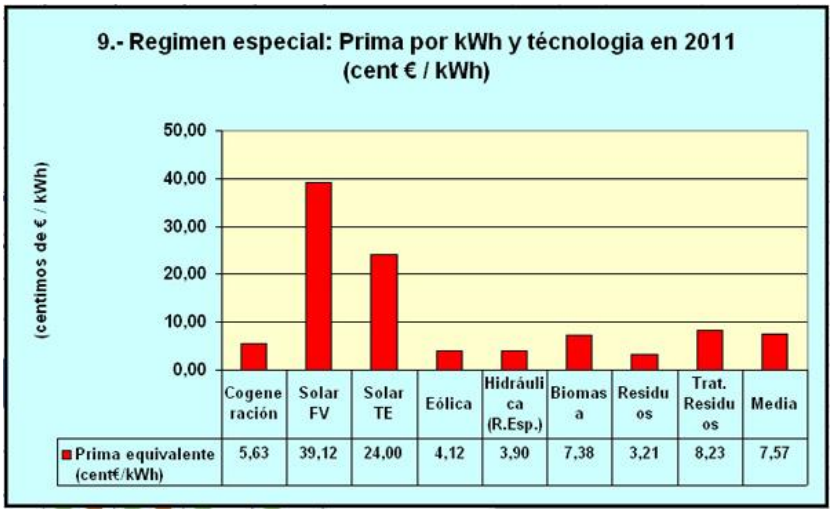


Fig. 4 Value of the incentives for each technology in 2011 in €cents/kWh.

- Electric Tariff Deficit (TD) (Déficit de tarifa eléctrico)

  According to the fact that the Government has the task to approve the electric tariffs, since year 2000 it approved tariff not including all the costs that utilities were claiming, thus creating a tariff deficit , a kind of postponed consumer debt toward the utilities . The Government goal was to maintain electricity prices low and avoid negative effects on inflation.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
year deficit	0	289	100	1149	0	0	3830	3046	1223	5819	4616	5553	3850	5609
cum deficit	0	289	389	1538	1538	1538	5368	8414	9637	15456	20072	25626	29476	35085

Table 2 Annual accumulated Tariff Deficit in € mio

After the issue of the new Law 24/2013 the distinction between ordinary and special regime is no more valid, the latter being substituted by the diction “plants with right to specific remuneration”, but it’s important to remember here that , although the term is no more valid, its consequences are still severe and constitute one of the major financial problems concerning energy market.

1.3.2. Current situation

Since 2012 Spain has begun an Energy Reform to terminate the huge accumulated deficit of electricity tariff. This reform began with the publication of RDL 1/2012 , which paralyzed the development of new plants (in the special regime) and the substantial restoration of existing plants , and continued with the issue of various Royal Decrees regarding income topics (tax reform Law 15/ 2012) and Draft Royal Decree regulating renewable and cogeneration , etc. .

1.3.2.1. Weak points of the proposed Reform

- The Energy Reform proposed by the Ministry is not appropriate for cogeneration development, given that
  - it clearly shows that it has been elaborated looking at the renewable energies that are characterized by a virtually zero marginal cost and that, once the investment has been recovered, can profit selling to the production market
  - conversely , cogeneration using fossil fuels may NOT compete in the wholesale market with other technologies that use cheaper fuels (coal , nuclear) or with gas plants with much lower investment costs due to economies of scale
  - however cogeneration can really favourably compete at user level providing economic and technical advantages that are not included nor acknowledged in the proposed Energy Reform
  - this reform seems focused on CHP as power plant producing "electricity only " for the grid avoiding the self-consumption operation, that is the normal way to operate a cogeneration plant.

  Furthermore some Ministerial Orders are changing the way of payment and create support mechanisms highly complex, difficult to implement and not always congruent with the legislation in force .

  The characteristic of cogeneration to be operated according to consumer demand and not to the market of electricity production is absolutely not taken into account in the Decree and therefore its proposals, addressed mainly to renewable energy, are highly detrimental to cogeneration.
- The parameters used to calculate incentives must be calculated on the basis of minimum required values. This affects specific investments , efficiency , and operational costs.

- Ministerial Orders calculations do not follow the criteria of the Law 54/1997 and, unlike what the State Council establishes, introduces a principle of retroactivity, because of which many investors don't see any more the profitability used for their investments with the consequence of stopping further plant implementations and even operations

➢ The proposed legislation applies retroactively also penalties.

- The legislation does not affect the entire cogeneration plants, but only those which input the entire electricity to the grid.
  The Law 54/ 97 forced to input into the system only surplus of electricity not self-consumed. Since the RDL 7/ 206, the cogeneration plant could input all of its electricity production to the grid and purchase its own consumption, that is it could choose between the self-consumption or all-inclusive modality.

The now proposed Royal Decree only refers to plants which supply their entire electrical production to the grid and self-consume the total thermal output.

All these new measures creates difficulties for whom have decided to self-consume or intended to do in the future because the supplied electricity could not meet the minimum number of hours required to be remunerative and also constitutes an infringement of the principle of non-retroactivity.

1.4. Awareness

The Cogeneration was the first incoming technology to develop within the Special Regime and therefore is well known in Spain since the 80s and 90s of last century. Subsequently the "boom" of renewable in the first ten years of this century took it away from the preferred options in alternative energies and therefore CHP power has not increased significantly in Spain since 2002..

1.4.1. Role of key actors

The main aspect of cogeneration in the 80s and 90s was the capacity to provide more economic power and also supporting national natural gas network and industrial expansion . In those times when the electricity of the "utilities" was produced by Rankine cycle power plants, cogeneration allowed big savings. The development was very fast in the industrial energy use until the early years of the twenty-first century.

Very few electrical companies supported this power production system taking part to plant investment together with the industrial customer. Even considering that both had benefits in a time of significant and rapid growth in the national economy, CHP activity was seen by utility sector as a foreign competitor -also subtracting a client- rather that a win-win partner.

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

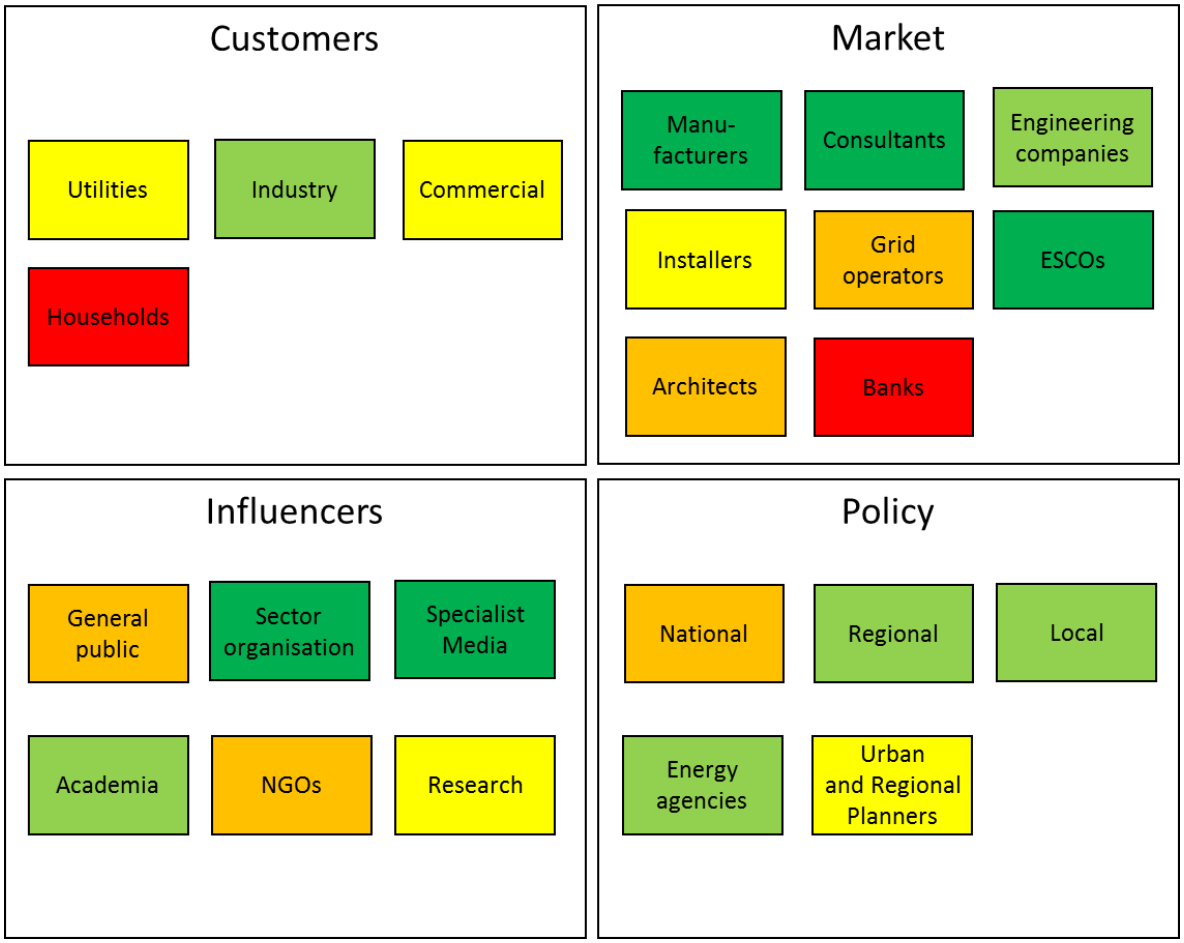


Table 3 Level of awareness among key actors under the 4 socio-economic groups

1.4.2. General consideration on CHP in Spain

In general the cogeneration technology and its potential and benefits are perceived only by the most involved stakeholders, namely by manufacturers and big consumers industries beyond the category associations, engineering companies and electric institutions.

No specific mention has been paid by generic media and public, where the attention is normally gained by renewable energy and by a general perception of energy saving and efficiency.

As policy makers, both national and local, the level of awareness is currently poor and this is widely demonstrated by the measures adopted by the government in the recent years and namely the actual reform that clearly prevents the development of cogeneration without taking into account all the energy market aspects and economic impact.

The actual perception seems that in general terms cogeneration is felt as a technology from the past, complicated, with high regulatory risks, and therefore customers are ready to abandon it, with the sole except of energy intensive industries and long term strategies.

1.5. The economics of CHP

The current environment in the Spanish cogeneration sector is extremely adverse. After the entering in force of law 24/2013 the cogeneration operations are not remunerative practically for all sectors, even if at different level and according to the technology in use. In general a serious impact is foreseen on revenues of plants with a reduction that could reach around 30%. The insecurity of further operations is strongly discouraging investments.

Table 4 , that offers a view of the current market economic situation of cogeneration in Spain, shows only one segment that, if equipped with recent installations, can survive with moderate attractiveness. This segment refers to large industrial natural gas installations.

But at the same time it has to be recalled that new investments have almost stopped, mainly due to the recent review of the regulated remuneration scheme, and not to any decline of industrial activities.

The regulating legislation is inadequate to promote small scale CHP installations and, even the field of application in Service sector could be interesting, the capital and operations costs advise investing as a future perspective.

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

Table 4 Economic situation of CHP in user groups

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
NG	Natural Gas or appropriate fossil fuel
RES	Renewable energy sources (wood biomass, biogas, etc.)

1.6. Barriers to CHP

Due to the economic crisis from one side and the new legal frame entered in force on the other side, the barriers to the development of cogeneration have become more appropriately barriers to the survival of the entire sector.

The current state of emergency for survival of the cogeneration sector in Spain is so high that speaking in this moment of barriers to the development appears at the very least inappropriate and shows little sensitivity to the dramatic industrial, economic and social problems that cogeneration sectors is currently facing.
In fact, it is more appropriate to speak of barriers to the survival and operation continuity of cogeneration plants and by far the greatest barrier appears today the law 24/2013 related to the electrical system, and especially the recent law 413/2014 on the "Production of electricity from renewable energy sources, cogeneration and waste" and their implementing decrees. To support this assertion could be sufficient to consider that as a result of these laws

- in twelve months 1800 MW from cogeneration plants have been disposed, of which 600 MW in only one week
- the category associations forecast, in absence of sudden and effective measures, the risk of losing well over half of Spain's more than 6 GW capacity by 2015.
- today for half of the cogeneration plants stock there is no more economic viability and there is the practical impossibility to revamp and refinance plants reaching 15 years of operation.

Anyway here we try to identify the main barriers toward the operative feasibility and hence the survival of cogeneration sector in Spain, connected with the above cited laws.

Reference is made to a series of articles and statements in the press, reporting the opinions of operators and cogeneration associations.

Barrier 1: Lack of awareness
Even if the measures considered in the laws can find their reason in the present economic crisis, it seems evident the lack of awareness from part of policy makers, not only about the cogeneration technology, but overall of the economic and environmental benefits involved. It is also to be noted the lack of timely advisory from part of energy agencies which should have warned about the consequences of the proposed measures. This lack of awareness chapter, constitutes a severe ideological and cultural barrier against cogeneration, that has produced in recent years a lot of erroneous prejudices against cogeneration.

Barrier 2: New regimen of remuneration
According the parameters to calculate the remuneration, the whole remuneration reduction will reach 470 mil €/year, to which are to be added new energy taxes reaching the amount of 934 mil € in 2013, impacting on a wide range of industry lowering their degree of competitiveness jeopardizing their survival on the market. This amount is calculated equivalent to 30% of overall cogeneration plants income.

Barrier 3: Taxes
Spain raised taxes on all power generation by 7% while also reducing subsidies for renewable energy and CHP plants. Moreover the government imposed a 2,8 €/MWh tax on natural gas, which is the primary fuel used by 90% of cogeneration plants, putting in practice at the same level the gas price and the electricity pool price.

Barrier 4: Bureaucracy

Two exemplary cases refer to the text of the norm regarding new plant settlement that occupies 1761 pages the norm regarding the remuneration calculation referring to standard plant typologies based on variables as technology, power, starting year of operation, fuel and other technical features identifies 548 types of standard plants only for cogeneration.

Barrier 5: Overcapacity

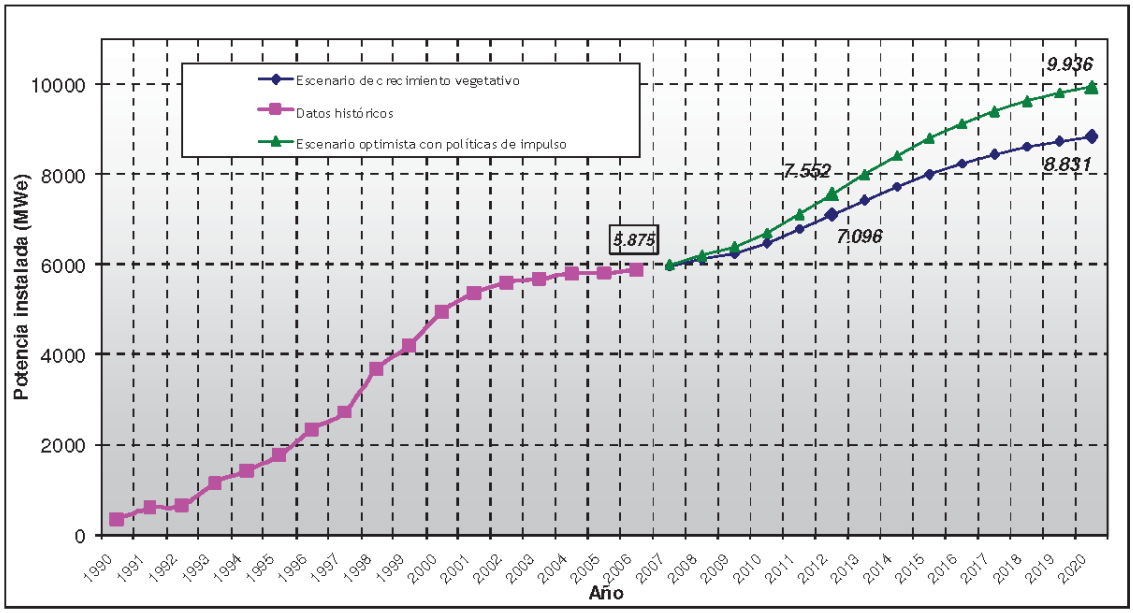
Overcapacity is an old problem caused by a series of not far-sighted controversial policies, now worsened by the powerful entry on the market of RES and the almost contemporary decrease of industrial useful heat.

2. What is possible? Cogeneration potential and market opportunities

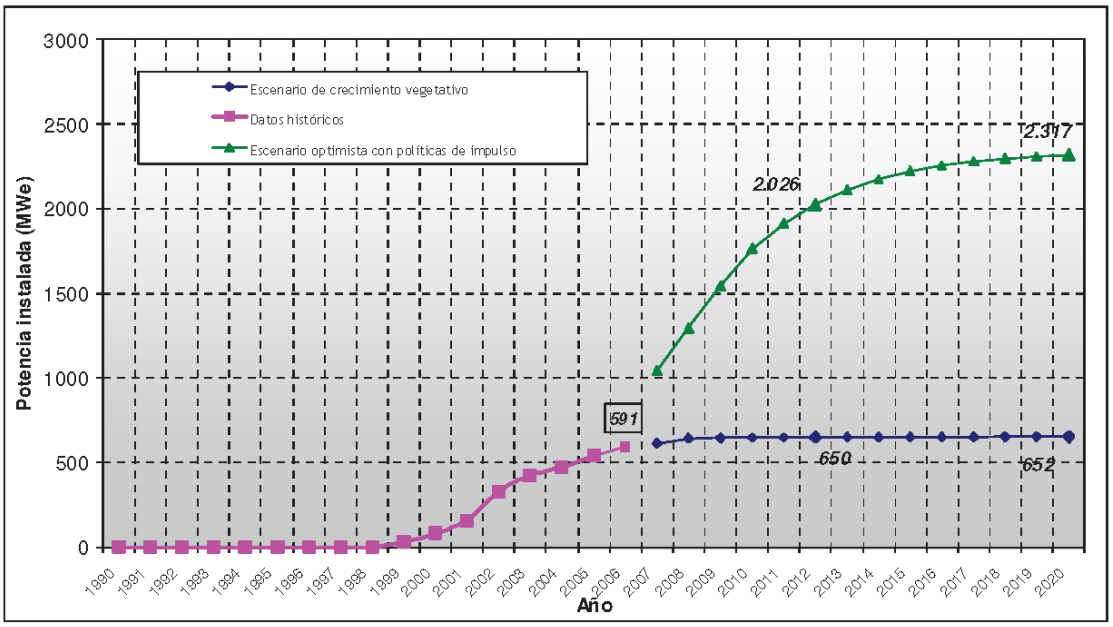
The cogeneration potentials calculated in 2008 will not be realized not even in the worst scenario due to the sudden change occurred in the economy and the policy after that date.
The untapped potential still partially remain in the plants that have no yet shut down or reduced their operations until the moment a neat trend reversal will prevail in a stabilized legal framework.

2.1. Potentials and market opportunities

The analysis of cogeneration potential sets as important result the fact that there is a large potential market for this technology, which is estimated at 24.606 MWe in 2020 as regards cogeneration plants contributing useful heat, and 2.685 MWe for cogeneration systems relating to waste treatment and recovery.
Of the total technical potential for2020 14.903 MWe come from industrial sector and oil refining, while another 9.703 Mwe are attributed to domestic and commercial applications.
Regarding the present untapped potential the sectors presenting the greatest available potential are the tertiary with more than 97% availability and the waste treatment and recovery with more than 80% of potential yet to be realized.
Currently the number of installed cogeneration plants that provide useful heat is 5.800 MWe, with a degree of penetration over the potential of 33.6%, i.e.66.4% of cogeneration potential is still available. Moreover the maximum renewal potential till 2020 of the actual cogeneration park is an additional 1.652 MWe in front of the installed power in 2004.
Regarding the future development of installed capacity, this analysis presents two development paths: the first based on maintaining of the penetration level of the sector, while the second is based on increasing the penetration degree due to policies impulses favouring cogeneration. Any intermediate scenario between them is feasible.
The Figures here represented show the considered two scenarios related to a “natural growth” and alternatively to an “optimistic policies boost”, corresponding to cogeneration applications providing useful heat and cogeneration applications for waste treatment and recovery.



Trend of Cogeneration plants for heat production



As can be seen the values of installed capacity in 2020 would range between 8.831 and 9.936 MWe for cogeneration producing useful heat, and 652 and 2.317 for waste treatment cogeneration.

The scenario “optimistic policies boost” plans to reach an installed capacity of all cogeneration plant in 2012 of 9.579MWe, so exceeding the target of the Energy Efficiency Strategy in Spain in its Action Plan 2005-2007 which marks the achievement of 9.215 MWe in 2012.

Finally reference is to be done to the potential for the development of new applications and technologies such as the District Heating and Cooling and Micro-cogeneration that can contribute for an amounts of about 300MWand55MW respectively.

Unfortunately no other forecast study or data collection about CHP potential in Spain has been carried out after 2008, so these calculations remain purely theory and likely are going to realized in the foreseen times.

The untapped potential still partially remain in the plants that have no yet shut down or reduced their operations until the moment a neat trend reversal will prevail in a stabilized legal framework.

At present no actual cogeneration potential figure nor schedule could be proposed,

3. How do we arrive there? The Roadmap

The present situation of cogeneration in Spain calls above all for immediate measures to stop decline of generation, give impulse to modernization of aged plants and to commission new plants thanks to a trend reversal, initiated by the policy according the opportunity offered by EED, that shall facilitate new investments.

3.1. General Introduction

The new regulatory framework for cogeneration in Spain is determined primarily on the recent Law 24/2013 regarding the Electricity Sector, together with its decree and ministerial order, fixing the retribution parameters for each type facility established by the Ministry (about 2.000 facility types depending on the year, technology, fuels, and other parameters).

The Law 24/2013 is based on the principle that "the remuneration of energy produced from renewables, cogeneration and waste is based on their necessary participation to the market, supplementing the income from the market with a specific regulated remuneration allowing these technologies to compete with other technologies present in the market. This additional specific remuneration should be sufficient to achieve the required minimum level to cover the costs that cannot be recovered from the market, unlike conventional technologies, and to allow them to achieve a reasonable return with reference to each installation standard, where applicable "

The impact of the reform on cogeneration (beyond new energy taxes since 2012) constitutes a reduction in its total compensation of nearly € 1.000 mio. per year, i.e. a decrease of 30% of total remuneration for the production and historical sales of the sector, of which 13% would be attributable to new taxes applied to its electric generation and fuels and 17% to the new framework compared to previously existing one.

Continuing this remuneration level, more than 50% of cogeneration capacity is at risk closing in the next 2-3 years. In the first 5 months of 2014 has seen a decline of 30% of electricity production from cogeneration compared to the previous year.

However, there are still some impending norms concerning the development of the sector as the regulation of the self-consumption, the regulation of the system operator services considering the cogeneration plants participation, the new electric tolls, the review of fuel prices methodology applicable to cogeneration, the renovation plan for cogeneration plants and possible adjustments in energy tax framework, where effects are still to be assessed.

3.2. Proposals

If the Spanish government intends to promote cogeneration in line with the guidelines set by the European policy as stated in Energy Efficiency Directive, the following points should be adequately pursued and developed:

Action 1
Establish specific regulation for cogenerated heat and power, that permit to differentiate the cogeneration unique features in terms of costs, efficiency and benefits compared to renewable energy sources

Action 2
Issue immediate measures stopping the killing of CHP plants at least at the reached level, whichever it is, and follow a policy to save the plant production before the closure determine irreversible conditions both from the technical, market and labour point of view

Action 3
Review the remuneration plan to allow economic viable operations and favor new investments

Action 4
Review the costs of fuels applicable to the calculation of the remuneration of cogeneration operations, also together with the development of secondary markets of gas, in order to establish effective relationship between the electricity and gas markets and cogeneration operations.

Action 5
Put in use, as foreseen but not applied, a mechanism based on Energy Efficiency titles as they have already demonstrated, once properly tuned, to be rapid and effective tool for launching an asphyctic market. Measures on energy saved and CO2 emission reduction can also be implemented to reduce taxation and procedural measures to favor new cogeneration plants or revamping actions.

Action 6
Regulate the energy self-consumption in order to recognize the advantages brought by this practice in reducing losses in networks, assuring security of supply and increasing energy efficiency

Action 7
Establish a renovation plan for cogeneration plants in order to favor new investment in the sector, given that over 70% of the plants reached 15 years of operation.

Action 7
The next energy efficiency plans must account for and give visibility to primary energy savings provided by different technologies and efficiency measures, not limiting to final energy savings measurers, if cogeneration together with connected industrial and services sectors are to be maintained and supported.

Action 8
Given the high volatility of electricity and fuel markets and the high degree of integration of non-programmable renewable sources, especially for the Spanish system showing a low degree of energy interconnection with Europe, it is necessary for cogeneration to incorporate further criteria of flexibility and opportunity in its operation in order to economically optimize incomes while contributing with its undeniable advantages to the economy of the country.

Action 9
Introduce measures to favor a better understanding of benefits of cogeneration in order to increase awareness of energy policy makers, as well as of all other stakeholders categories, giving a strong impulse to the integration with other national and European policies regarding internal market energy, energy efficiency, climate change and "industrial renaissance ".

3.3. Saving of primary energy and CO2 emissions by CHP roadmap

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

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

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.

According both methodologies PES in Spain implementing the roadmap for CHP is estimated at 3-4 TWh per year corresponding to nearly 0,27% and CO2 emission reduction is estimated 2 Million tons per year in 2030. The actual saving practically null is due to the lack of upgrading and renovation intervention, because of the blocking phase presently suffered by cogeneration in Spain. To be noted that Eurostat data, on which the models are based, are not yet recorded the strong capacity drops due to plants shutdown occurred in 2013-2014. policy objectives and actions.

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

Total CO2 reduction, Mio. t/a	**-2**
Share in total energy-related CO2 emissions	**0%**
Share in energy sector CO2 emissions	**1%**
Primary Energy Saving, TWh/a	**-3**
Decrease of PE, %	**0%**
Bio Energy Share in CHP Fuels 2030	**15%**
Share of modernised and replaced CHP plants in CHP power growth up to 2030	**73%**

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

Total CO2 reduction, Mio. t/a	**-2**
Share in total energy-related CO2 emissions	**1%**
Share in energy sector CO2 emissions	**1%**
Primary Energy Saving, TWh/a	**-4**
Decrease of PE, %	**0%**
Bio Energy Share in CHP Fuels 2030	**15%**
Share of modernised and replaced CHP plants in CHP power growth up to 2030	**84%**

Annexes

1 Stakeholder group awareness assessment

2 Micro CHP potential assessment

3 Bio CHP potential assessment

4 Methodologies used to calculate the saving of primary energy and CO2 emissions

5 Sources and contacts

Annex 1: Stakeholder group awareness assessment

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

Group	Comment
Customers	
Industry	CHP in Spain is mainly based on applications in Industry, which maintains its interest despite crisis and adverse legal frame
Utilities	The main electricity utilities are ignoring or even oppose
Commercial	Despite the potential, awareness is at early stage
Households	Micro-CHP is not yet promoted and there in no interest from the sector, given the absence of specific subsides
Market and supply chain	
Manufacturers	The interest is high and the commercial presence continuous
Installers	Installers and maintenance companies are generally informed but are not exclusively connected to CHP applications
Grid operators	Sufficiently informed, suffer of the sector blockage
Consultants	There is enough knowledge and experience
Engineering companies	There is enough knowledge and experience
Architects	Low interest at the moment
Banks	The knowledge is very basic and wait for better and stable conditions
CHP promoter /ESCOs	The knowledge is relatively high and the interest is lively though in stand-by
Policy	
National	The government seems not to acknowledge the benefits and the status of cogeneration. Despite declarations assuring the maintenance of the installed stock, the issued measures are contradicting
Regional	No relevant knowledge nor interest
Local	No relevant knowledge nor interest
Urban & Regional planners	No relevant knowledge nor interest in district heating

Energy agencies	The CHP technology is known but there is a lack of promotion of the related technologies. They are more focused on energy efficiency system in general
Influencers	
Sector organisations	The sector organisations are very active to defend the results obtained in Spain up to now and to promote CHP at national and regional level
General public	General public does not know cogeneration
Specialist media	Energy efficiency and renewable energies are common discussion, but CHP is occasionally and briefly mentioned as technology. Specialised media give more space to cogeneration as efficient alternative
Academia	Cogeneration technology is only part of energy courses in the Faculty of Engineering.
Research	There are research centres not specifically focused on CHP
NGOs	

Annex 2: Micro-CHP potential assessment

micro-CHP potential summary Spain

Country statistics

Population: 46 030 000 (2010)
Number of households: 17 050 000 (2010)
GDP per capita: € 24 700 (2010)
Primary energy use: 90 600 ktoe/year (2010)
GHG-emissions: 356 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kWe)

Boiler replacement technology

Present market (2013)

Boiler stock: 8 370 000 units
Boiler sales: 800 000 units/year

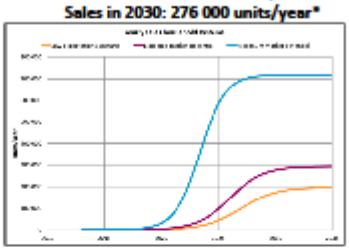
Potential estimation

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

Expected final market share: 37% of boiler sales in Household sector

Yearly sales

Sales in 2020: 4 500 units/year*
Sales in 2030: 276 000 units/year*



Stock

Stock in 2020: 9 100 units*
Stock in 2030: 1 300 000 units*
Stock in 2040: 2 900 000 units*

Potential savings in 2030

Primary energy savings:
27 PJ/year*
650 ktoe/year*
GHG-emissions reduction:
1.3 Mton $CO_{2,eq}$/year*

SME & Collective systems (±40 kWe)

Boiler add-on technology

Present market (2013)

Boiler stock: 1 490 000 units
Boiler sales: 142 000 units/year

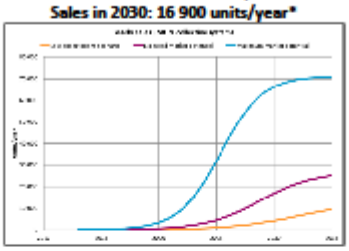
Potential estimation

Indicator	Score
Market alternatives	2
Global CBA	1
Legislation/support	3
Awareness	0
Total	4 out of 9

Expected final market share: 19% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 650 units/year*
Sales in 2030: 16 900 units/year*



Stock

Stock in 2020: 4 300 units*
Stock in 2030: 69 800 units*
Stock in 2040: 245 000 units*

Potential savings in 2030

Primary energy savings:
58 PJ/year*
1 380 ktoe/year*
GHG-emissions reduction:
2.8 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	±40 kWe systems (SME & Collective systems) Boiler add-on technology
Scorecard	**Scorecard**

Indicator	Score
Market alternatives	1
Global CBA	3
Legislation/support	3
Awareness	0
Purchasing power	2
Total	**8 out of 12**

Indicator	Score
Market alternatives	2
Global CBA	2
Legislation/support	3
Awareness	1
Total	**6 out of 9**

Market alternatives

SPOT: ***5 years***

Market alternatives

SPOT: ***7 years***

Legislation/support

Current legislation is favourable to CHP *in general and particularly to mCHP in case HEmCHP. The application norms are cumbersome especially for households, treated as bigger ones.*
In any case FiT, WC and tax incentives are foreseen.

Legislation/support

Current legislation is favourable *to CHP in general and particularly to mCHP in case HEmCHP. The application norms are cumbersome for small installation for households, treated as bigger ones.*
In any case FiT, WC and tax incentives are foreseen.

Awareness

Very low awareness as regards households*. Consultants, architects and installers are mainly proposing alternative technologies that don't include cogeneration*

Awareness

Low awareness*, supported mainly by ESCO's and manufacturers*

Purchasing power

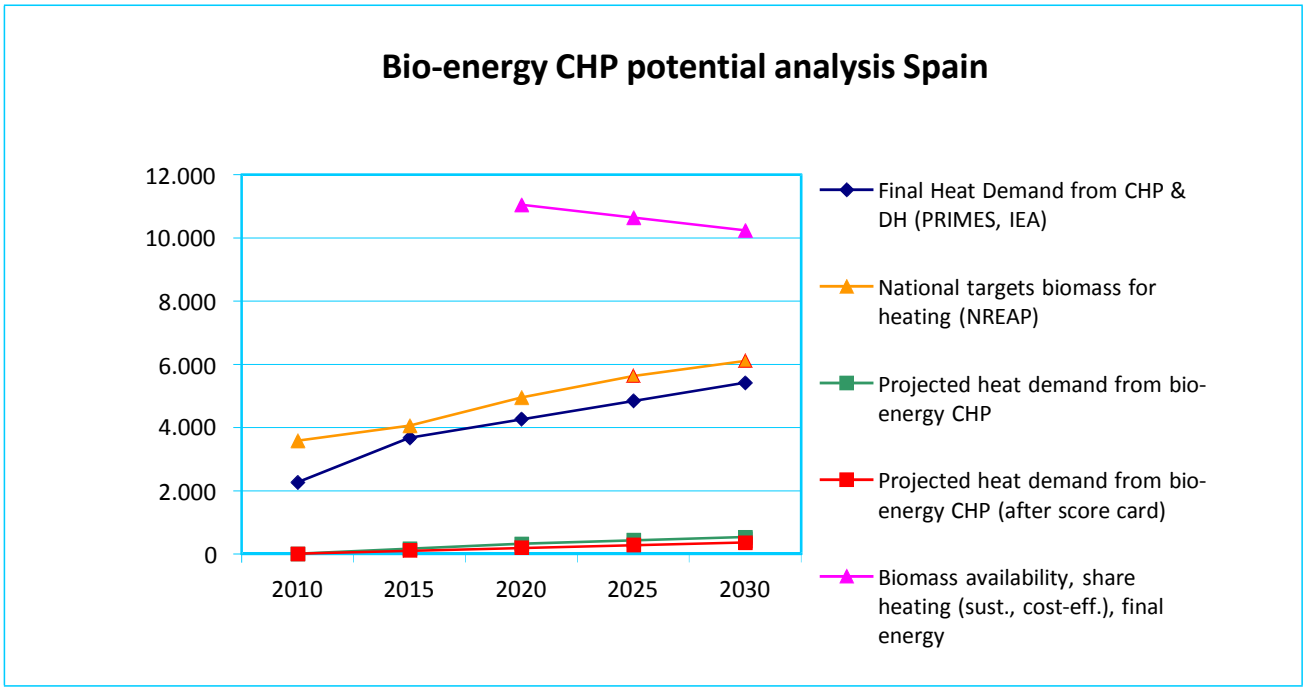
GDP: ***€ 25 100 per year***

Annex 3: Bio-energy CHP potential assessment

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

Bio-energy CHP potential analysis Spain

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	2.266	4.277	5.418
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	8	218	364
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	0,3% (2009)	5,1%	6,7%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		11.049	10.237



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	++ 3 (of 3)	Legislation and incentives are the key point to ensure any future development, as can be sawn in the history in spain for chp and eerr development.
Suitability of heat market for switch to bio-energy CHP	+ 2 (of 3)	Just a small portion of heat demand is supplied by DH in Spain (mainly because the low heat demand for households, as a south-european country)
Share of Citizens served by DH	o 1 (of 3)	
National supply chain for biomass for energy	+ 2 (of 3)	Not expensive biomass
Awareness for DH and CHP	+ 2 (of 3)	It is so important is Spain to educate community on how good is bio-chp. Some campaigns are being developed by the government

Annex 4: Methodologies used to calculate the saving of primary energy and CO2 emissions

EED method

The Primary Energy Savings methodology of the EED is used at a country level for national reporting to the Commission, and at project level for determining if CHP is highly efficient. In the methodology, each cogeneration unit is compared with the best technology for separate production of heat and electricity on the same fuel on the market in the year of construction of the cogeneration unit and the harmonized reference values are determined by fuel type and year of construction.

The underlying principle is that, knowing that regularly new investments have to be made in new energy production units, it is necessary to compare CHP with the centralized production installation which could be built using the same fuel rather than assuming a displacement of a different fuel or introduction of a new fuel. It is a logical approach when looking at the decision making process of investors or a member state government. By investing in or supporting CHP, a certain electricity generating capacity will be produced by CHP and NOT by centralized production based on the same fuel (= principle of 'avoided production').

For the timeframe of the roadmap (between 2010 and 2030), and especially in countries where there is no overcapacity, it is relevant to compare installing a certain capacity (at national level) of CHP compared to installing new capacity with another technology (power plant + gas boiler). Older installations being replaced with state-of-the-art technology.is a typical reinvestment decision. New CHP-plant (or combination of smaller installations) would not necessarily lead to less production in older production installations, but would rather preempt investments in e.g. new CCGT investments.

Substitution method

This method has been developed in the CODE2 project. In doing this, two other approaches have been considered: 1) the "replacement mix method[1]" 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[2], 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)

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

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

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
- replacement of carbon-rich by low-carbon fuels,
can be usefully seen only as an integrated process.
To account for the uncertainties in particular with regard to fuel shares and technology development, a window of possible developments with an upper value and a lower value of emission reduction and savings has been determined. The different levels of results are due to assumptions about key parameters such as current share of electricity from cogeneration, which is replaced by electricity from new or retrofitted units, fuel shares in the replaced CHP plants, power plants and boilers as well as in the new CHP plants.
The results have been calculated based on the following input values: growth of CHP power production, share of current old CHP to be replaced by new installations and retrofitting, fuel efficiency and electric efficiency of new CHP and replaced CHP for different fuels, electric efficiency of replaced power from conventional power plants for different fuels, heat efficiency of replaced heat from boilers, corresponding fuel shares.

Annex 5: Sources

- COGEN España www.cogenspain.org
- ACOGEN Asociación Española de Cogeneración - www.acogen.org
- Ministerio de Industria, Turismo y Comercio (MITYC) www.mityc.es
- Ministerio de Medio Ambiente y Medio Rural y Marino (MARM) www.marm.es
- Comisión Nacional de Energía (CNE) www.cne.es
- Red Eléctrica de España (REE) www.ree.es
- IDAE Instituto para la diversificacion y ahorro de la Energia – www.idae.es
- UNESA - Asociación Española de la Industria Eléctrica – www.unesa.es
- AESA - Asesoría Energética – www.aesa.net
- ADHAC - Asociación de Empresas de Redes de Calor y Frío – www.adhac.es
- Eleconomista energìa - www.eleconomista.es
- COGEN España "Ten errors that can kill cogeneration " cincodias.com/cincodias/2014/05/30/economia/1401459584_341830.html
- La energia en España 2011 - http://fide.es/newsletter/20132810/pdfs/energ%C3%ADa/Energia_Espana_2011_WEB.pdf