

PROPOSAL:

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# SPAIN - CHP IN THE CO<sub>2</sub> NATIONAL ALLOCATION PLAN

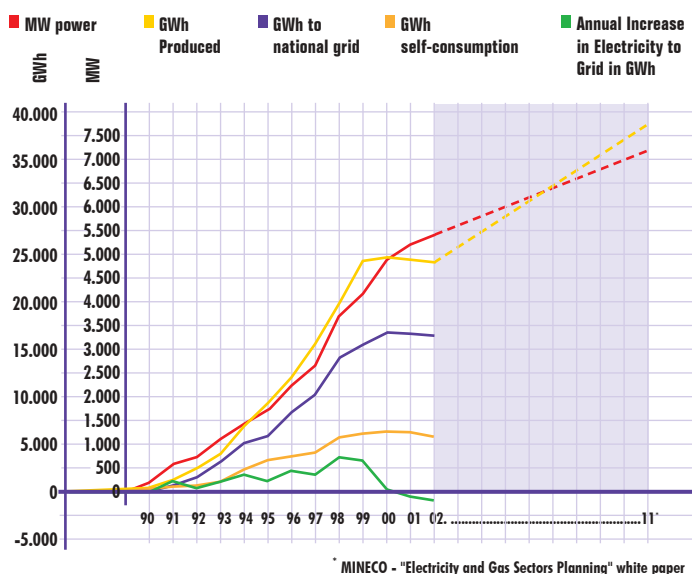
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JUNE 2003



## What is CHP?

Co-generation, also named CHP, is the production of electricity and useful thermal energy (heat) within the same process. Co-generation uses the waste heat produced when generating electricity in an industrial process that consumes it as useful heat. Thus, the installation of a CHP plant is intrinsically linked to the existence of an industrial facility requiring heat.



## Electricity Production through Co-generation in Spain

	MW power	GWh Produced	GWh to national grid	GWh self-consumption	Annual Increase in Electricity to Grid in GWh
1990	356	809	566	243	-
1991	597	1.976	1.383	593	817
1992	648	2.594	1.816	778	433
1993	1.150	4.536	3.175	1.361	1.359
1994	1.402	7.373	5.161	2.212	1.986
1995	1.721	9.007	6.305	2.702	1.114
1996	2.310	12.394	8.676	3.718	2.371
1997	2.665	15.563	10.894	4.669	2.218
1998	3.724	20.059	14.041	6.018	3.147
1999	4.222	24.174	16.922	7.252	2.881
2000	4.946	24.311	17.018	7.293	96
2001	5.355	24.243	16.970	7.273	-48
2002	5.443	22.980	16.086	6.894	-884
2011*	7.100*	38.000*			

\*MINECO - "Electricity and Gas Sectors Planning" white paper

## Possible Electricity Production through CHP in Spain 2002 & 2011

	Year 2002	Year 2011
Installed Power rating MW	5.443	7.100*
Registered/forecast Electricity Production in CHP*	22.980	38.000*
Possible N° Working Hours	6.000	6.000
Possible Electricity Production In CHP in Gwh/year	32.658	42.600
Variance between Production Capacity and registered/forecast Production Gwh/year	9.678	4.600

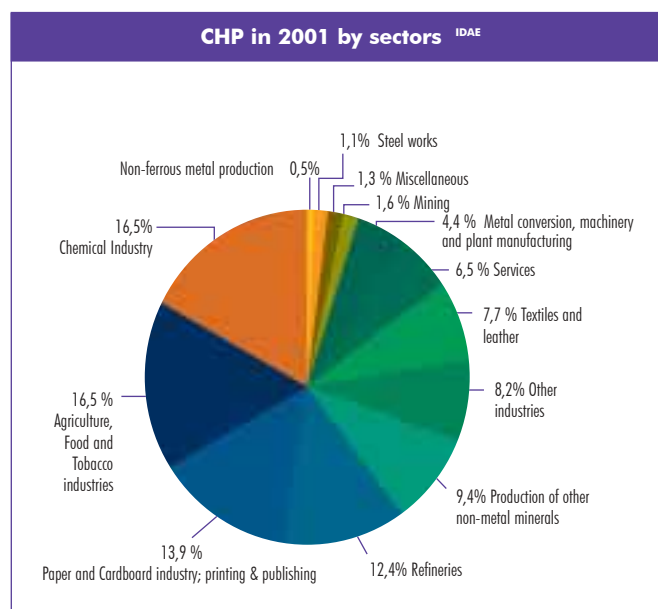
\*MINECO - "Electricity and Gas Sectors Planning" white paper

## CHP IN SPAIN

CHP has grown significantly in Spain since 1990. In the year 2002, 10.58% of the national electricity demand was produced by co-generation, whose installations accounted for an installed power of 5,443 MW, i.e. the equivalent of seven modern 800 MW Combined Cycle Gas power plants.

Since the year 2000, CHP facilities have reduced their electricity generation due to increased fuel costs and lower income from sales of the electricity they generate. At present, it is estimated that a further 10,000 Gwh/year could be generated through co-generation if suitably profitable operating conditions existed.

In its white paper entitled "Electricity and Gas Sectors Planning", Ministry of Economy (MINECO) plans that electricity production through co-generation will reach the figure of 38,000 Gwh/year by 2011, a figure that could be increased to over 42,600 Gwh/year. These figures forecast by MINECO represent an increase of 65% in production over the 2002 register with only a 30% increase in the present installed capacity, which is a clear indicator of the operating economic constraints that co-generation has been facing in recent years. Feasible CHP potential by the year 2011 stands at around 9,000 MW.



## CHP AND HOW IT CONTRIBUTES TO REDUCING CO<sub>2</sub> EMISSIONS

"Promotion of high-efficiency cogeneration based on a useful heat demand is a Community priority given the potential benefits of cogeneration with regard to saving primary energy and reducing emissions, in particular of greenhouse gases." Proposed European Parliament and Council Directive on promoting Co-generation.

CHP makes a significant contribution to reducing the national figure for CO<sub>2</sub> emissions and given its potential growth, further reductions are possible. Co-generation plays an important and unique role in contributing towards EU and, to a greater extent, Spain's compliance with the Protocol of Kioto requirements.

- If Spain's present co-generation facilities were to shut down, the national CO<sub>2</sub> emission rate would go up by over 3%.
- In 2002, had the necessary policies and steps been implemented to favour electricity production by co-generation, the national CO<sub>2</sub> emission index would have been reduced by nearly 2%.
- If installed co-generation capacity as planned by MINECO were to be carried out by the year 2011 and full production encouraged, 20% of Spain's national effort to reduce CO<sub>2</sub> emissions in the period 2001-2011 in order to comply with Kioto, estimated as a net reduction of 46 million tons of CO<sub>2</sub>, could be achieved just by the contribution of co-generation (see Calculations Page 5)

To understand and acknowledge co-generation's contribution to reducing greenhouse gas emissions in Spain, one must consider the benefits that are intrinsically associated with the definition of CHP:

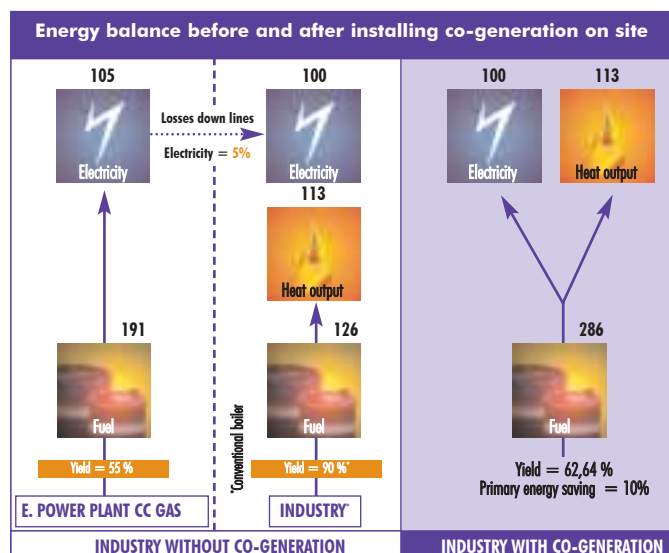
- It saves primary energy and contributes to improving efficiency, as it is the most effective way of producing both electricity and heat.

- It reduces energy losses throughout the national grid and improves the quality of our electricity supply. As electricity generation is de-centralised and nearer to consumption points, it avoids losses and investment in electricity transport and distribution systems, thereby improving the quality of the service overall.
- It contributes to improving the energy efficiency, productivity and quality of the electrical supply in those industries to which it is linked, thereby avoiding downtime due to electricity cuts or blackouts.

The installation of a CHP plant on an industrial site is unique from the point of view of CO<sub>2</sub> emissions in that it increases local emissions while reducing the overall emissions associated with the industry on site:

- The industrial plant reduces the CO<sub>2</sub> emissions corresponding to the thermal load that it now receives from the co-generation plant and which beforehand it had to conventionally produce itself.
- The grid electric power plant decreases its emissions by as much as corresponds to the amount of electricity it is now generated from the co-generation plant and therefore no longer produces.
- Emissions from the co-generation plant are higher than from the industrial plant, but always lower than the sum of the industrial plant and the grid power plant.

In the year 2002 in Spain, each KWh produced by co-generation represented an estimated CO<sub>2</sub> emission saving of 0.44 Kg of CO<sub>2</sub> per KWh produced with co-generation, compared to the national average register for thermal electricity generation in non-nuclear power plants.



### CO<sub>2</sub> Emissions reductions with Co-generation in Spain

	Año 2002	Año 2011 <sup>**</sup>
Power rating MW	5.443	7.100
Total output - GWh/year	22.980	38.000
CO <sub>2</sub> Emissions <sup>*</sup> saving - million tons/year	10,111	?

#### Basis:

Average emission rates (2002) from Mainstream Non-nuclear power stations = 773 Kg CO<sub>2</sub>/MWh  
 Average saving (2002) per MWh generated with co-generation compared to average for non-nuclear power stations = 0,440 Ton CO<sub>2</sub>/MWh  
 Saving is calculated as the difference between the average emission from Mainstream non-nuclear power stations and emission levels attributed to electricity produced by co-generation, based on a fuel composition of 80% natural gas and 20% fuel oil. Down-line losses are estimated at 5% and emission attributable to the heat output from co-generation is calculated on the basis of its equivalent emission rate using conventional generation methods at 90% efficiency.

<sup>\*\*</sup> MINECO - "Electricity and Gas Sectors Planning" white paper

## CHP IN THE CO<sub>2</sub> GAS EMISSION ALLOWANCE TRADING DIRECTIVE

*An emission allowance trading scheme that in any way adds extra costs to the Co-generation sector will lead to additional reductions in their production level and therefore increased CO<sub>2</sub> emissions at a national level.*

The Gas Emission Allowance Trading Directive includes co-generation plants on two accounts:

- Combustion plants with a nominal thermal power rating of over 20 MW (thermal)
- Co-generation facilities associated with an industrial activity listed in Annexe 1 (refineries, pulp & paper, ceramics, etc.)

It is important to recall that co-generation plants as business entities may be incorporated as legally independent companies with different shareholders from the industry to which they are connected, or they can belong to the same legal entity as the industry to which they supply heat output. This makes the definition of a facility and share-out of the emission allowance ownership in the Directive enormously complicated. Furthermore, auxiliary combustion plants may be the legal property of the industrial company or of the co-generation enterprise, in itself a complex starting point that calls for the prompt sorting and revision of criteria to determine which plants should be included in the emission allowance trading scheme.

With regard to the Directive's classification of business activities, it is estimated that acceptance of the co-generation as a combustion installation of over 20 thermal MW would mean that over 70% of the total co-generation power currently installed would be affected. The number of affected plants is difficult to determine as for each installation, the total combustion power including its auxiliary plants and the legal ownership of the facility itself have to be taken into account. If those co-generation plants associated with industries listed in the Directive are counted, over 44% of overall co-generation output would be included, according to the distribution study of co-generation per sector carried out by IDAE in 2001 (See chart on Page 1).

Annexe III of the Emissions Trading Directive contemplates affording specific treatment to Co-generation, when it says: "The plan shall include information on the way in which clean technologies are to be taken into account, including energy-efficient technologies". Several initiatives are underway as the Directive goes through the European Parliament to include amendments that acknowledge Co-generation's contribution to reducing greenhouse gas emissions, and this contribution should be quantified by the member states.

The treatment of Co-generation in Allocation Plans in other European countries is being differentiated (see Table below).

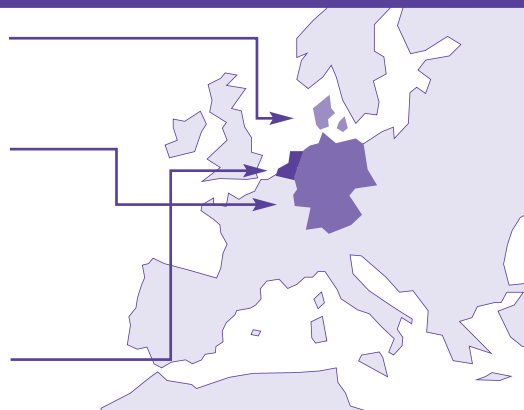
### Total Gross CO<sub>2</sub> Emissions. National Emission Inventory

Gas = CO <sub>2</sub> - Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total Gross Emissions (Gg CO <sub>2</sub> )	227.233	234.518	243.023	229.942	242.657	254.411	242.215	261.369	270.130	295.233	306.632	307.247
Annual Index compared to Reference year (ref. year = 100)	100,00	103,21	106,95	101,19	106,79	111,96	106,59	115,02	118,88	129,93	134,94	135,21

Source: Ministry of the Environment, National Inventory

### CHP treatment in Allocation Plans in other countries

- **DENMARK:** Within the emission allowance trading system or electricity generation, Co-generation is given favourable treatment, excluding emissions corresponding to heat generation in allowance presentation.
- **GERMANY:** All possible options of a specific treatment for Co-generation are under analysis, including, among others, full allocation for all demand for co-generation plants, allowance allocation based on benchmarking (grCO<sub>2</sub>/Kwh Index between 500 and 600), and treatment that may be given to new entries. The Öko Institute's Directive Implementation Report states "At least 10% of the reduction of between 90 and 95 million tons CO<sub>2</sub> that has to be achieved by 2005 is set to be covered exclusively by expanding co-generation".
- **HOLLAND:** Co-generation is treated differently from other industrial sectors. Co-generation emissions are attributed separately to both products - electricity and heat, based on separate emission standards.



## SPAIN'S NATIONAL EMISSION ALLOWANCE ALLOCATION PLAN AND CHP

*In Spain, in order to aid compliance with the Kyoto Protocol, co-generation needs to receive differentiated treatment in the National Allocation Plan.*

Given that co-generation is a regulated business activity, each Regional Government keeps a Licensed Production Facilities Register, as does the Ministry of Economy on a national level through its General Directorate of Energy Policy. Every facility has to send in an annual report that covers fuel inputs, production levels and end use of the electricity, heat output generation, as well as extensive data concerning its energy efficiency, as a requirement of the current legislation in force. These registries and data enable analysis of co-generation by sector and installation to be performed with total transparency, supervision and control, which in turn makes the work of carrying out the Allowance Scheme much easier.

The sectors and associations undersigning this document hereby request that the Administration take the following steps when considering Co-generation within the National Allocation Plan:

1. Separate treatment of Co-generation activities within the National Allocation Plan as an independent activity included in the Emission Allowance Scheme.
2. Allocation of emission allowances for Co-generation should be based on the independent allocation of two different products: allocation for heat production and allocation for electricity generation.

Individual allocation for different products (heat output and electricity) would allow for the establishment of allocation formulae based on the principles of simplicity, efficiency, subsidiary ownership and transparency. From the information already available in the Register of Licensed Producers, a "bottom-up" approach would appear to be suitable to identify affected installations and determine heat output and electricity generation, as the basis of effective allocation to CHP.

The following are concrete formulae that are proposed as a way of treating Co-generation within the National Emission Allowance Allocation Plan:

$$\begin{array}{c} \text{Allowances allocated to useful heat output} \\ + \\ \text{Allowances allocated to electricity generation} \\ \text{II} \\ \text{Allowances to be granted to Co-generation} \end{array}$$

$$\begin{array}{c} [\text{Useful Heat output (MWh)} / 0.9] \\ * \\ \text{Emission factor fuel used (Ton CO}_2\text{/MWh thermal)} \\ \text{II} \\ \text{Allowance granted to useful Heat Output} \end{array}$$

The previous formula is equivalent to allocating to useful heat output from co-generation the same CO<sub>2</sub> emission allowances as for heat output from conventional high-yield boilers, as per the terms of the formula in force in the current Royal Decree 2818/98 on Co-generation.

$$\begin{array}{c} \text{Electricity generation (MWh)} * \text{Prevented loss-to-grid factor} \\ * \\ \text{Emission Benchmark (Ton CO}_2\text{/Mwh electricity)} \\ \text{II} \\ \text{Allowance granted to Electricity} \end{array}$$

Whereby

$$\begin{array}{l} \text{Avoided down-line loss factor} = 1 + \% \text{ of prevented losses} \\ \text{Electricity emission benchmark (Ton CO}_2\text{/Mwh electricity)} = 0,538 \end{array}$$

The justification and transparency of the previous benchmarks is based on:

- The percentage of prevented losses in this country stands at around 5%, which gives a loss factor of 1.05.
- The proposed emission benchmark for Co-generated electricity of 0.538 Ton CO<sub>2</sub>/Mwh electricity was obtained as the average of two scenarios depicted for the year 2006 by the National Energy Commission in its "Framework Report on Demand ...2002" and which represented an allocation 27% lower than the reference emission level recorded in Spain in 2002.
- Formulating by means of benchmarks or indexes, adds simplicity and transparency to the proposed scheme, and enables it to be updated, controlled and developed in line with the electricity generation sector reference benchmarks.

When determining a possible "cap" for the Co-generation sector, it is imperative to take into account the affected co-generation facilities, installed capacity and forecast growth rates as estimated by MINECO. By considering the proposed scheme and using the methods prescribed in "Study of Emission Allowance Allocation Criteria - PNADE" by R.L. Klein, February 2003, by applying separate allocations for electricity

and heat, the resulting formulae for sector allowance allocations for Co-generation are shown below:

**Allowance to be granted 2005 = Allowance for Electricity 2005 + Allowance for Useful Heat Output 2005**

**Electricity Allowances 2005 =**

**Emissions associated with electricity Base Year \* (Electricity production 2005/Electricity production Base Year) \* "Cap" adjustment factor I**

**Useful Heat output allowances 2005 =**

**Emissions associated with heat output Reference Year \* (Heat output 2005/Heat output Base Year) \* "Cap" adjustment factor II**

Emission associated with electricity and useful heat in the reference year are calculated as proposed and the respective cap adjustment factors as well as any efficiency improvement factor, should be 1, given that

these considerations have already been included in the emission benchmark proposed for co-generation produced electricity.

#### Determining and comparing emission benchmark for electricity in Co-generation

- The emission index proposed for Co-generated electricity of 0.538 Ton CO<sub>2</sub>/Mwh electricity was obtained as the average of two scenarios depicted by the National Energy Commission in its "Framework Report on Demand ...2002", which placed specific emission levels for the national combustion-based electricity production network for 2006 at 0.6204 or 0.455 Ton CO<sub>2</sub>/Mwh electricity, based on the two scenarios with new combined cycles.
- There exists a clear difference between the proposed factor for co-generated electricity of 0.538 Ton CO<sub>2</sub>/Mwh electricity and the established ratio for 2002 in Spain's heat-based electricity generation system of 0.773 Ton CO<sub>2</sub>/Mwh electricity; i.e. to produce the same kWh of electricity, the co-generation sector requests an allowance level 27% lower than the emission reference recorded in Spain for 2002.

#### Calculations justifying the contribution of CHP to CO<sub>2</sub> emissions in Spain

- If co-generation in Spain were to close down now, national CO<sub>2</sub> emission rates would go up by over 3%..'

CO<sub>2</sub> saving through co-generation in 2002 = 10,111 thousand Ton CO<sub>2</sub>  
Spanish CO<sub>2</sub> emissions in 2001: 307,247 thousand Ton CO<sub>2</sub> (index 135.21)

$10,111/307,247 = 3.3 \%$

- If in 2002, the necessary policies and steps had been implemented to favour electricity co-generation, the national CO<sub>2</sub> emission index would have been reduced by nearly 2%.'

Average CO<sub>2</sub> saving per kWh by Co-generation in 2002= 0.440 (Ton CO<sub>2</sub>/MWh)

Maximum possible output from Co-generation at power capacity as installed in 2002 = 32,658 gWh/year → Difference 2002 = 32,658-22,980= 9,678 gWh/year

Possible additional saving = 9,678 gWh/year \* 0.44 Ton CO<sub>2</sub>/Kwh = 4,258 thousand tons CO<sub>2</sub>

Spanish CO<sub>2</sub> emissions in 2001: 307.247 Miles Ton CO<sub>2</sub> (index 135.21)

Spanish CO<sub>2</sub> emissions in 2001 with full co-generation capacity = 307,247 - 4,258 = 302,989 (Index = 133.33)

Index 135.21 - Index 133.33 = 1.88 ~ 2 %

- If installed co-generation capacity as planned by MINECO were to be carried out by the year 2011 and full production made possible, 20% of Spain's required effort to reduce CO<sub>2</sub> emissions in the period 2001-2011 to comply with Kyoto, estimated as a net reduction of 46 million tons of CO<sub>2</sub>, would be achieved simply thanks to co-generation.'

Spanish commitment to Kyoto = Emission 1990 + 15% = 227,233 \* 1.15 = 261,318 thousand tons CO<sub>2</sub> (index 115)

Reduction to be achieved in 2001 on emissions in 2001 = 307,247 - 261,318 = 45,929 thousand tons CO<sub>2</sub>

Possible saving at full co-generation capacity in 2011 = 42,600 \* 0.44 = 18,744 thousand tons CO<sub>2</sub>

Saving through Co-generation 2011-2001 = 18,744 - 10,111 = 8,633 thousand tons CO<sub>2</sub>

$8,633 / 45,929 = 19 \%$



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