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Climate disturbances, the new industrial policies and ways out of the crisis

Synopsis

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A study by Syndex, S. Partner and WMP Consult, ordered by ETUC in partnership with EMF and EMCEF

Contributors

General Coordination: Philippe Morvannou
Coordination low-carbone: Christian Duchesne
Coordination clean coal: Alain Mestre and Jean-François Poupard
Authors:
Aluminium: Philippe Morvannou
Automobile: Peter Wilke, Philippe Darteyre et Christian Duchesne
Cement: Sidoine Chavanet
Chemical industry: Fabrizio Giacalone
Electricity: Christian Duchesne, Philippe Gouin
Insulation materials: Nordine Ait Larbi
Refineries: Jean-François Poupard
Renewable energies: Kim Schuetze
Steel industry: Philippe Morvannou
Glass: Fabrizio Giacalone
Clean coal, Germany: Kim Schuetze
Clean coal, Paland: Andrzej Jakubowski
Clean coal, United-Kingdom: Jean-François Poupard

Documentation: Annick Boico
Correction: Alice Boussicaut et Jacquemine de Loizellerie
Lay-out: Jacquemine de Loizellerie

Summary

Methodological introduction

What impact will policies designed to combat climate change have on employment in quantitative and qualitative terms by 2030?

In addition to this initial level of enquiry, which we covered in a previous study[1], we also have to factor in the systemic crisis in 2008 and 2009 and the possibility of grasping its effects and consequences to accelerate the transition towards a low-carbon economy, with or without economic growth.

Faced with this complex question, with all the considerable issues involved, the reader quite rightly wonders about the quality of the results and how he will be able to take them on board: how, for example, to incorporate them into a reflection or a practice, both personal and collective, which fits into the debates determining the choices to be made in December 2009 in Copenhagen, at the forthcoming United Nations conference on climate change? It is only from this point of view that a study conducted for the European Trade Union Confederation (the ETUC), with the backing of the European Commission, has any social purpose.

The present reflection will serve to reinforce the conference that the ETUC is devoting to the interrelationships between 'climate disturbances, the new industrial policies and ways out of the crisis', to be staged in London. In fact it provides some tools to help to reveal and clarify the necessity and the capacity, as well as the risks and opportunities, presented to European industry by the battle against greenhouse gas emissions, with due regard for the balance between the three pillars of sustainable development.

Let us now set out the path followed and the methods used.

This work, which is a multi-sectoral study confined to the industrial sectors responsible for greenhouse gas emissions, does not seek – be it via an input-output matrix or any other method of macroeconomic relationships – to report on the direct and indirect impacts on employment in general of any given measure or any given new technology to combat climate change available. We concentrate our attention here on industrial employment in the broad sense, in other words those jobs that fall within a process for the production of goods and services with added value which are directly concerned by the low-carbon transition. Accordingly, while subcontractors and service providers in the industrial sectors studied do form part of the projections made, the job of a chef in a restaurant or a nurse in a hospital, even though an inter-sectoral income effect does exist, will fall outside the scope of this study.

Consequently, for each sector, we have looked at precisely the technologies available or planned which will enable producers and users of products that emit carbon to reduce their emissions. We have focused each time on the temporal, financial, economic, social, societal and institutional dimensions of these technologies, insofar as their deployment will represent sizeable investments and take a long time, modifying the structure of production costs and the nature of jobs, as well as having implications on the life of the city and influencing the dynamic cartography of the powerful players.

To achieve this result, we required an in-depth picture of the status of industry within the EU-

[1] Syndex, in cooperation with Istas and Wuppertal, *Climate change and employment*, ETUC, Brussels, 2007.

27, in order to understand the dynamics of its adaptation and its contribution to the fight against greenhouse gas emissions. Each part was entrusted to a sectoral expert, whose command of the current state of knowledge was supplemented by contributions from many specialists, thanks to whom we were able to measure both the evolutionary forces acting on our economies and the difficulties besetting what we might call 'the transition from high-carbon to low-carbon'. The trend in employment here therefore does not result from forces external to the social dimension, but on the contrary, constitutes a vector of transformation of society, once we consider it as a fundamental given.

So we shall not simply bemoan such a dramatic loss of jobs in any given sector, because of adaptation to policies and measures to reduce greenhouse gas emissions, we shall instead be anticipating the future developments so as to enable the famous **fair transition** between jobs lost and jobs created to occur under optimum conditions for workers. This is the only way to ensure a 'fair social transition' as an accompaniment to the switch towards a low-carbon economy.

Nevertheless, the vexed issue of putting figures on the numbers of jobs under threat, the jobs created, the jobs lost and the jobs saved across all the sectors in Europe remains. We have opted to start from the current situation of industrial companies so as to construct a reference employment base and then to apply that base to the sector as we perceive it today and over the twenty years to come. The employment forecasts contained in this report therefore include important rupture factors, linked to the technologies implemented both in the industrial production processes and the actual products coming out from those production processes.

However, this study does not aspire simply to collect sectoral analyses: it seeks equally to show the attentive reader the transverse elements which reveal similarities between sectors, especially when these industries are carrying out their activities in a common framework such as the CO_2 emissions trading scheme set up in Europe from 2005.

Accordingly, the economic prospects, these meso-economic scenarios, use the data available to evaluate, as far as possible, the impact of the carbon factor on employment in a number of industrial sectors in the EU.

In parallel, we have also tried to equip ourselves with some common references on the economic prospects of the sectors studied, on the strength of the three main scenarios by 2020 and 2030 which have served as our analytical framework:

- the DG-TREN scenario (*base line* or *business as usual*);
- the DG-Environment scenario (including the effects of the measures entered in the EU's climate and energy package by 2020);
- the Fonddri scenario, which is very useful in assessing certain sectors (Copenhagen COP, by 2030).

Before we can put the alternative scenarios drafted in the study into concrete shape, we need to define and implement some voluntary measures and policies, a key part of which is the establishment of a new European industrial policy dedicated to low-carbon technologies.

Finally, the study relies on the drafting of sectoral scenarios, in order also to evaluate the transverse issues involved in these sectors that have been studied, and to define the conditions for a low-carbon industrial policy which will enable us to overcome the adverse effects, find a way out of the crisis, and give industry a chance to survive in Europe.

Part I

The low-carbon imperative applied to industry and employment

1. Regulating the carbon market

The risks of carbon leakage: three answers instead of one

Many industrial emitters of greenhouse gases are opposed to the cap-and-trade policy[2] being implemented today, arguing basically that it distorts competition between the countries subject to a carbon constraint and those that are not, owing to the history of capitalism, and that it could also give rise to dramatic social consequences in the developed countries. Their main argument nevertheless resides in the fact that such a policy can encourage carbon leakage, a phenomenon that can be described as follows: by raising production costs in Europe, the system works to the advantage of non-European producers that emit more GHG per tonne. A policy to combat GHG emissions in Europe thus produces the opposite effect at international level and can even lead to the creation, through "environmental dumping", of "polluters' havens". Commercial competition is nevertheless not the only issue involved: the relocation of industrial investments – from areas imposing carbon constraints to those without such rules – is the main issue. This explains why the European Commission has agreed to study compensation mechanisms to be set up in the industrial sectors that combine:

- high energy intensity, implying a high level of emissions (the cost of carbon makes European producers less competitive);
- significant openness to international trade (effective non-European competition and a penalising impact of price increases due to carbon costs). The example of prices on global markets for a number of non-ferrous metals such as aluminium or copper is symbolic of a situation where any further costs result in an erosion of the competitive position of the producers on which they are imposed.

Cement and steel are the sectors concerned first and foremost, although they are not alone.

An initial measure was adopted as a temporary solution to this problem: the gradual auctioning of CO_2 emissions allowances will be delayed, becoming effective between 2013 and 2020 at the earliest, with free emissions allowances being granted to these sectors. Everyone is aware of the temporary nature of this solution.

Two other options are being promoted to solve the problem: on the one hand, the signature of a comprehensive international agreement and/or international agreements by sector, and on the other, border compensation measures that equalise access conditions for producers in terms of emissions allowances.

Yet while carbon leakage is a problem in itself within the framework of globalisation founded on free trade in industrial products, remedies can also fly in the face of the goals being sought.

Subsidies in the form of free emissions allowances are an incentive to postpone making any changes for as long as possible, using employment as blackmail, especially because, combined with an emissions allowances market, the situation can quickly become profitable. We saw proof of this during the 2005-2008 probationary period, when industrial operators received excessive allowances and sold them for handsome profits – which were transformed into dividends for shareholders. We have been seeing it again since the end of 2008 when, because of the crisis, the allowances granted are well above real emissions and their sale and resulting profits are sometimes used to

[2] The term means that once the ceiling ("cap") for free allowances has been reached, industry must buy allowances on the carbon market.

maintain dividends. We must emphasize the lack of connection between subsidies – the use of which is not imposed – and R&D for cleaner technologies.

For identical reasons, **border compensation measures** can also be seen as a protectionist measure if they are not matched with implementing conditions that guarantee a reduction of emissions. This measure must be considered transitional in nature, to be used for the time it takes to give the industries concerned the institutional and technological tools needed to pursue the objective of reducing greenhouse gas emissions. Yet, in contrast with free emissions allowances, this mechanism does not constitute a subsidy to industry. To be effective, it has to be applied to both importers and exporters.

The third remedy being proposed, international sector-level agreements promoted by certain industries, is in keeping with a movement of opening up the discussions to all players within the framework of a globalised economy.

Each of the tools or solutions outlined briefly here can be combined with another and is therefore not exclusive of the others. On the other hand, application of the three systems requires a common technical and economic reference framework among the industries and countries to quantify the exposure of a sector or industry to the danger of carbon leakage. Otherwise, how can a connection be established between emissions saved and protection?

Lastly, the dangers represented by the adverse effects of a protection policy that has no counterpart at present must be evaluated and corrected by complementary measures that encourage the reduction of GHG emissions. This will require the promotion of regulatory instruments that are essential to this new economy in the pipeline, the CO_2 and GHG economy. All regulation systems must be based on a consensus on measurement of the phenomenon. This is the challenge of the creation of a system of GHG environmental benchmarks.

The imperative of benchmarks

Many industries have recently embarked upon the creation of technical data banks, with economic derivatives on the best available techniques, with the aim of determining and presenting what is possible and what is not. They argue that they cannot be compelled to emit less CO_2 if the target is technically and economically out of reach. In parallel, research has been undertaken to establish the best available techniques in energy efficiency and CO_2 emissions[3]. Lastly, certain branches of industry have determined what they have agreed to call benchmarks, in order to establish references in terms of GHG emissions.

Quarrels over technical definitions, which can sometimes have major consequences on the allocation of emissions allowances, have demonstrated the complexity of the subject. These differences can also sometimes stem from regulations whose discrepancies should not be under-estimated and the origin of which resides in rules rooted in the cultural realities of European and global industries.

This explains why the definition of benchmarks and best available techniques must be established at a level "above the parties": only a European (and international?) agency whose scientific work is recognised by all the parties is capable of giving intangible bases to the decisions to be taken in this area.

Self-regulatory measures by the industrial sectors does not offer the necessary guarantees of independence and impartiality that are absolutely essential. Experience with the REACH Regulation, adopted recently by the European Union countries, shows the way forward in this area.

This nonetheless supposes that certain stalemating tactics will be dropped, for instance over the possibility for carbon traceability of

[3] OECD, IEA, *Tracking Industrial Energy Efficiency and CO_2 Emissions*, 2007. European Commission, BREF reports.

industrial products, whether in the form of semi-finished or finished products. We think that it is essential to implement this arrangement and that it will be less costly than some would like to have us believe[4]. How can it be claimed that organising such carbon traceability would have a disproportionate cost when today we are accustomed, for food and medicines, to name only two sectors whose products are traded widely at global level, to being informed of their exact composition in spite of the high number of ingredients or components?

Critics of border compensation measures for semi-finished products maintain that if exports of steel or cement from the emerging countries were to take place under today's competition conditions, the competitiveness of their cars and their prefabricated products would increase through the use of materials made less expensive through the lack of impact of the price of CO_2 – which in contrast would be imposed on European producers. This criticism is no longer valid with a generalised carbon traceability system.

We cannot argue that climate change is one of the main challenges with which the planet is confronted without giving ourselves the means to include it in global trade in goods, which constitutes one of the vectors of the globalisation process under way. It is interesting in this connection to take note of the recent report published by the WTO and the UNEP[5]. This document points out in particular that case law on border compensation mechanisms is founded primarily on the principle of non-discrimination between national producers and importers, including when the latter are not highly cooperative.

Similarly, governance by this European carbon benchmarking agency should be thought of as one of the major institutions for steering the fight against climate change in its dimension applied to industry. It must therefore integrate the three pillars of sustainable development:

- the environmental pillar, through the definition of best available techniques;
- the economic pillar, through the discrepancies between implementation of these techniques and industrial and competitive realities;
- the social pillar, through the conditions in which adaptation and mitigation actions will apply to the labour force: respect for human rights at the workplace and socially responsible management of restructuring.

Taxation or compensation?

At present, in Europe, a distinction is made between a European quota allocation system for emitters of concentrated GHG and national taxation systems for diffuse emissions, within a common European political framework adopted in December 2008 – the Climate-Energy package.

For regulation at borders, compensation is preferred to taxation for the following reasons:

- taxation policy is still essentially the responsibility of the European States and any decision (regulation or directive) with respect to taxation at European Union level (VAT, for example) is subject to a unanimous vote in the EU Council of Ministers (this will still be the case with the Treaty of Lisbon if it is ratified), making it still more complicated to adopt;
- the complexity of taxation at European borders lies in the fact that the State that would collect the tax on entry may not be the final destination of the imported product, thus creating a new and absolutely unwanted source of tax competition for attracting the revenues from this tax;
- compensation, in our view, means asking the importer to buy emissions allowances in order to be entitled to sell its products in Europe when CO_2 emissions resulting from production of the imported goods exceed

[4] Julia Reinaud.
[5] Trade and Climate Change, WTO and UNEP, 2009.

the benchmark. These emissions allowances, bought on the market by importers, are a source of income for those selling them, who have surplus rights corresponding to their reduction of emissions below the European benchmark;

- the price is determined by the market, which in these conditions should remain based on a *cap and trade* system, which is itself based on emissions per unit produced.

Avoiding financialisation of the fight against climate change

In the third phase of the European Union's emissions trading scheme (ETS), the shares put up for auction will increase significantly (from less than 4% in phase II to more than 50% in phase III). In the same way, several states in the North East of the United States that participate in the regional initiative on GHG have decided to auction all their annual allowances.

Supporters of auctioning put forward essentially two arguments:

- auctioning is the most transparent and most effective method because it corresponds most closely to the polluter-pays principle;
- auctioning makes it possible to combine a double dividend for the state and an emissions allowances market.

While the second argument seems valid to us – in particular because, in the case of Europe, it is specified that at least 20% of the income from auctions will be allotted to the fight against climate change –, the first seems to have little or no justification. It would be preferable to determine a minimum price for carbon, which would not be free, in order to give the public authorities the financial contribution needed for a carbon transition fund.

In the auctioning system being considered for the moment, the price of carbon becomes a price of opportunity alone, which will vary widely depending on the economic situation. That will pave the way to speculation that will place physical operators under the domination of financial logic, as is the case for industrial and agricultural commodities today.

The use of auctioning (emissions allowances futures market) without regulation will inevitably result in:

- excessive price volatility;
- the formation of liquidities bubbles;
- the domination of funds of all kinds in determining prices, which goes hand in hand with the eviction of physical operators.

To avoid these pitfalls, which will transform the carbon market into a speculative market like other futures markets, the distribution of emissions allowances at reduced prices must remain the rule for all production units that respect the unit standard, matched with a *cap and trade* system as defined above.

In addition, and to offset the dangers related to the lack of clarity of financial flows, simple measures should be adopted to ensure that the carbon and commodities market does not slip into the abuses of unregulated finance:

- creation of a public regulator for the carbon market: why not a carbon central bank[6], in order to avoid all risk of dominant position or price manipulation, to avoid excessively erratic fluctuations and lastly to create ties between the European market and other regional markets?
- the requirement of having information on the market, by operator and by contract, on volumes handled, positions taken, etc.;
- definition of limits for each category of operators authorised to intervene on the market, so as to make a distinction

[6] See in this connection, Christian de Perthuis, *Et pour quelques degrés de plus... Nos choix économiques face au risque climatique,* Ed Pearson, 2009.

between physical operators and financial operators[7].

The fundamental question remains the role assigned to the carbon market. We will limit its role to determining the price for supply and demand regulated by the allocation of allowances at minimum price and not an allocation of emissions allowances that in the end depends on players' anticipations and above all on their financial clout.

The carbon market concerns activities whose exposure to CO_2 varies widely depending on the energy share in their net prices or the possibility of easy access to energy-saving and low CO_2 emissions technologies in the short and medium term.

In other words, we will advocate an allocation mechanism that is separate from the price-setting mechanism. The allocation mechanism should be based not on auctions that allocate emissions allowances to the highest bidder, but on target figures set by industry and calculated in terms of best available techniques with respect to yield or energy efficiency, which would become the benchmark.

Additional energy consumption corresponding to surplus CO_2 emissions should be acquired on the market, whose participants would be limited.

Going beyond the price signal

In addition to limiting financialisation, there should also be an approach where the price signal would not be the only carbon transition instrument.

The market is still dependent on objectives set for the short term by economic and financial players which necessarily conflict with the long-term outlook required by respect for the environment. In addition, even though many economists – including the famous Sir Nicholas Stern – have tried to set a price on the environment, we know that life on earth cannot be reduced to a monetary dimension.

This is why there is a need to go beyond the price signal and to complement this factor with large-scale training and education actions in schools or in factories. Doing so will enable the vast majority to understand and accept the GHG emissions reduction targets.

New social and societal dialogue bodies should pave the way to a more democratic underwriting of GHG emissions reduction targets. They will offer real participation by the social partners and NGOs in the definition of a low-carbon policy that paves the way to concrete representations for forward-looking activities.

[7] Gaël Giraud and Cécile Renouard, Eds., *20 propositions pour réformer le capitalisme*, Flammarion, 2009.

2. The industrial sectors subject to the carbon market

2.1. Electricity

Potential impact on employment under the base line and NSAT[8] scenarios

We have built up our employment prospects by starting from two existing scenarios, one from DG-TREN (the base line) and the other from DG Research (NSAT). On this basis, the NSAT scenario, which is more recent and therefore includes the climate-energy package recently adopted, has been forced in order to include a bigger share of CCS technologies, which we deem to be indispensable in achieving the objectives of reducing GHG emissions. This is what is called the 'NSAT Syndex' deviation.

Table 1: Full-time equivalent jobs, annual average

FTE average/year 2005-2030 (thousands)

	2000-2005	Base line	NSAT	NSAT Syndex
Solids	5	85	39	13
Solids CCS	0	0	28	79
Oil	4	11	3	3
Nuclear	4	58	63	63
Gas	67	54	64	64
RES	147	191	452	452
Total	**227**	**399**	**650**	**676**

Source: Syndex

[8] P. Capros, L. Mantzos, V. Papandreou, N. Tasios, *Model-Based Analysis of the 2008 EU Policy Package on Climate Change and Renewables,* June 2008. The model used by DG-ENV relies on scenarios built up by using the reference scenario published in November 2007 by DG-TREN. Out of all the scenarios drafted for DG-ENV, we have adopted, in addition to this base line one produced by DG-TREN in November 2007, the NSAT scenario.

Under the NSAT scenario, as an annual average over the period 2006-2030, direct jobs linked to net investments would amount to 676,000 full-time equivalent (FTE), compared to the direct jobs generated by the investments relating to the base line scenario, which come to 399,000 FTE, a difference of 69% between the two scenarios. This trend is mainly caused by the development of renewable energies. Over two thirds of the investments can actually be attributed, under the NSAT scenario, to renewables, compared to barely one third under the base line scenario.

Table 2: Renewable energies, full-time equivalent jobs, annual average

FTE average/year 2005-2030 (thousands)

	2000-2005	Base line	NSAT
Total RES	**147**	**191**	**452**
Hydro	15	6	9
Wind onshore	87	85	121
Wind offshore	3	20	91
Solar	19	33	104
Geothermal	1	3	6
Biomass	21	44	120

Source: Syndex

Over the period 2000-2005, renewables have been the first element driving the creation of direct jobs, thanks in part to the development of wind power. The continued renewal of capacities with combined-cycle gas plants has been the second factor.

Under the Syndex variant, CCS investments, in phase with the European technological platform ZEP, reach 80 GW, against 24 GW under the NSAT scenario. So the share of jobs linked to investments in thermal power plants rises from 10% to 13.7% under the NSAT Syndex scenario.

Under the NSAT Syndex scenario, the jobs generated by investments in CCS plants would average 79,000 FTE per year (which corresponds to an average investment of 3.2 GW per year), compared to 28,000 FTE under the NSAT scenario (for an average annual investment of 1.1 GW).

Globally, under the NSAT Syndex scenario, jobs linked to investments in coal-fired plants (conventional technologies plus CCS) would average 92,000 jobs per year, which is 8% more than under the base line scenario for a level of investment that is 61% lower: 4.2 GW compared to 6.2 GW.

Table 3: Direct jobs generated per sector

FTE v-by sectors (thousands)

	2000-2005	Base line	NSAT	NSAT Syndex
Civil engineering	55	91	131	137
Engineering	37	72	112	118
Equipments	103	175	300	311
Assembly	33	61	106	110
Total	**227**	**399**	**650**	**676**

Source: Syndex

Under the NSAT scenario, the metallurgy sector overall (including engineering, equipment and assembly[9]) accounts for over three quarters of the jobs generated annually by emission reduction measures, or 518,000 jobs under the NSAT scenario and 539,000 jobs under the NSAT Syndex scenario. These figures compare to those from 2000-2005: an annual average of 73,000 jobs generated in metallurgy through investments in that period.

Depending on the scenarios, the potential direct and indirect jobs compared to employment in 2004 (source: Eurostat) represents between 8% and 13% of the jobs for the electromechanical construction industries and between 1% and 1.7% for the building and public works sector. This potential effect on employment should be set against the recent evolution in employment in the electromechanical industry[10]: –1.1% per year over the period 2000-2005. The development of low-carbon technologies thus emerges as a genuine opportunity for employment within this industry.

Table 4: Relative importance of the jobs generated per sector under the base line and NSAT scenarios compared to the employment situation in 2004

FTE (thousands)

	Eurostat 2004	2000-2005	Base line	NSAT
Civil engineering	10291	0,6%	1,0%	1,7%
Engineering, Equipments, Assembly	4874	4,5%	7,6%	13,0%

Source: Syndex

The crisis will inevitably have some repercussions on the electromechanical industry, partly because of the time slippage in a certain number of investments. However, the basics remain solid: the need for renewal, the extension of capacities, the carbon constraint and the GHG reduction policy. Ultimately, the questions arising around the degree of realisation of the NSAT scenario and its timing relate to:

- the uncertainty surrounding the crisis and the colossal investment financing needs, both in production and in the transport and distribution of electricity. We believe that reducing this uncertainty involves not just the EU Member States, but the EU itself, issuing big loans;
- the fact that the EU has to cope with two major challenges in striking a balance between its electricity production and demand
    - ⇨ promoting clean technologies and available capacities at affordable prices,
    - ⇨ ensuring the reliability of the network for the sake of greater diversity in electricity production modes.

[9] However, electrical works are very often attached to the building and public works sector.

[10] Aphametrics with Ismeri Europa 6 DG Employment, Social Affairs and Equal Opportunities, *Comprehensive sectorial analysis of emerging competences and economic activities in the EU – Lot 6: Electromechanical engineering, Final Report*, April 2009.

Potential direct and indirect jobs generated by investments in renewal and extension of electricity production capacities according to the scenarios adopted

Overall, the annual average local direct and indirect jobs (aside from relocated jobs linked to imports outside the EU-27) over the period 2006-2030, would be:

- 455,000 FTE under the base line scenario (399,000 direct + 56,000 indirect)
- 733,000 FTE under the NSAT scenario (650,000 direct + 83,000 indirect)
- 762,000 FTE under the NSAT Syndex scenario (676,000 direct + 86,000 indirect).

These estimates do not take account of the job losses in certain industries such as equipment goods for mining extraction, where activity will decline, particularly in Poland. In the absence of statistical sources, we have been unable to put a figure on these losses.

In addition to the jobs linked to investments in Europe, we must also factor in the jobs generated by exports by European industry, which we have evaluated as follows (based on the IEA Blue Map scenario):

- 735,000 direct FTE as an annual average
- 318,000 indirect FTE for the equipment sector alone.

Obviously, these estimates do not take account of the impact of investments in the transmission and distribution of electricity. Under the Blue Map scenario, the IEA puts the investments to be made over the period 2005-2050 at some 5,000 billion dollars, compared to 3,600 billion dollars under the reference scenario (WETO 2008) for the transmission systems and 6,200 billion dollars compared to 8,300 billion dollars for the distribution of electricity. The fall in investments for distribution under the Blue Map scenario compared to the underlying scenarios is directly linked to the improvement in networks and energy efficiency policies.

Impact of revived interest in nuclear energy in Europe

Compared to the DG-TREN and NSAT scenarios, which both posit a drop in installed nuclear capacity in 2030, we have developed a variant to take account of the revival of interest in nuclear energy in Europe today. Under this variant, average annual investments would stand at 6.6 GW, compared to 2.2 GW. In return, investments in gas-powered plants would fall from 8.2 GW to 2.4 GW.

On the strength of these hypotheses, jobs linked to investments in nuclear energy would stand at 171,000 FTE, compared to 63,000 FTE under the NSAT scenario. Conversely, jobs linked to investments in gas would stand at 36,000 FTE, compared to 64,000 FTE.

For their part, jobs in nuclear electricity production would stand at 60,984 FTE by 2030, compared to 31,487 under the NSAT scenario. Those in electricity production in gas-powered plants would number 24,595, compared to 36,698, a reduction of 20% compared to 2010.

The new context in terms of European energy policy[11] imposes a major change in the electricity production infrastructure. Greenhouse gas emissions must be reduced, and this objective has a direct impact on the structure of the existing stock, given the part played by coal-fired plants in current carbonaceous electricity production.

Most coal-fired plants are scheduled to be replaced by 2020, making a policy of support for the development of CCS technologies of strategic importance for the EU, given the objectives of its new energy policy: security of supply and reductions in GHG.

Be that as it may, the period 2010 to 2020 would seem to be a key period which will largely shape the future of European industry. So we have to be sure today that we start anticipating the needs of tomorrow, in part by bolstering the sectoral social dialogue on the issues linked to the evolution of trades and skills, such as, for example, mechanical engineering methods: design and simulation technologies (noise, vibration), intelligence of mechanical systems, leading-edge materials and nanotechnologies.

Table 5: Direct jobs operation scenario base line and NSAT (source: Syndex)

Base line scenario FTE operation average/year (Thousands)					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	57	56	55	56	*-0,2%*	*-0,1%*	*0,1%*
Oil	14	13	7	6	*-0,6%*	*-5,6%*	*-2,2%*
Nuclear	39	35	32	29	*-0,8%*	*-1,0%*	*-0,9%*
Gas	20	33	38	42	*5,0%*	*1,5%*	*1,1%*
RES	17	29	39	45	*5,1%*	*3,0%*	*1,6%*
Total	**147**	**166**	**171**	**178**	***1,2%***	***0,3%***	***0,4%***

Base line scenario FTE operation average/year (Thousands)					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
RES	**17**	**29**	**39**	**45**	***5,1%***	***3,0%***	***1,6%***
Hydro	13	14	14	14	*0,3%*	*0,3%*	*0,1%*
Wind	2	11	18	22	*18,7%*	*5,4%*	*1,9%*
Solar	0,0	0,2	0,5	0,9	*36,2%*	*9,0%*	*5,5%*
Geothermal	0,8	1,0	1,0	1,3	*36,2%*	*9,0%*	*5,5%*
Biomass	1	3	5	7	*2,3%*	*0,3%*	*2,0%*

NSAT scenario FTE operation average/year (Thousands)					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	57	54	44	33	*-0,4%*	*-2,0%*	*-0,3%*
CCS	0	0	0	10			
Oil	14	13	7	3	*-0,9%*	*-6,1%*	*-7,0%*
Nuclear	39	36	32	31	*-0,8%*	*-1,0%*	*-0,2%*
Gas	20	31	31	39	*4,5%*	*-0,2%*	*2,3%*
RES	17	31	50	71	*5,8%*	*5,0%*	*3,6%*
Total	**147**	**165**	**164**	**188**	***1,2%***	***0,0%***	***1,3%***

NSAT scenario FTE operation average/year (Thousands)					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
RES	**17**	**31**	**50**	**71**	***5,8%***	***5,0%***	***3,6%***
Hydro	13	14	14	14	*0,4%*	*0,3%*	*0,0%*
Wind	2	12	23	37	*20,4%*	*6,6%*	*4,7%*
Solar	0	0	1	2	*36,2%*	*12,6%*	*11,1%*
Geothermal	1	1	1	1	*36,2%*	*12,6%*	*11,1%*
Biomass	1	3	11	17	*2,8%*	*0,8%*	*1,0%*

[11] *An EU Energy Security and Solidarity Action Plan*, November 2008.

CSP development in Mediterranean Region: an opportunity

The Mediterranean Solar Plan was announced on 13 July 2008 at the Paris Summit for the Mediterranean region. The objective is to reach 20 GW of new renewable energy capacity by 2020 in the region. Of this, 3-4 GW would be covered by photovoltaic technology, 5-6 GW by wind and 10-12 GW by concentrating solar power. The physical interconnection of Tunisia-Italy and Turkey-Greece would be a pre-requisite for the implementation of such a plan.

The summit concluded that 'market deployment as well as research and development of all alternative sources of energy are a major priority in efforts towards assuring sustainable development' and that the 'feasibility, development and creation of a Mediterranean Solar Plan' will be examined.

A strong partnership between the European Union (EU), the Middle East and North Africa (MENA) is a key element to meeting the target of the plan. The Mediterranean region has vast resources of solar energy for its economic growth and as a valuable export product, while the EU can provide the technologies and finance to activate those potentials.

If the potential in the region for the technology could provide an opportunity for local industry and european industry however, the plan's success would depend on high-voltage connections between Tunisia and Italy and Turkey and Greece. The conventional electricity grid is not capable of transferring large amounts of electricity over long distances. Therefore, a combination of the conventional alternate current (AC) grid with High Voltage Direct Current (HVDC) transmission technologies must be used in such a Trans-European electricity scheme.

A number of assessments of the employment effects of solar power have been carried out in Germany, Spain and the USA. The assumption made in the GreenPeace scenario is that for every megawatt of new capacity, the annual market for concentrated solar power will create 10 jobs through manufacture, component supply, solar farm development, installation and indirect employment. As production processes are optimised, this level will decrease, falling to eight jobs by 2030. scenario. In addition, employment in regular operations and maintenance work at solar farms will contribute a further one job for every megawatt of cumulative capacity.

Based on these ratios, the Mediterranean solar plan would create over the period 2010/2020 to about 103 000 jobs.

Evolution in electricity production and potential consequences on employment

Impact on employment in electricity production

Our own estimates indicate that direct jobs linked to electricity production (aside from the impact on staffing levels associated with transport and distribution networks, which will be marked by the emergence of 'smart grids', linked to the decentralisation of renewables) are driven globally by a growth dynamic, albeit with differences in pace between the two scenarios, on the one hand, and very divergent evolutions between the different types of energy on the other.

The number of direct production-side jobs, estimated at 188,000 FTE in 2030 under the NSAT scenario, would be almost 6% higher than under the base line scenario, estimated at 178,000 FTE. In contrast to the base line scenario, jobs under the NSAT scenario would stagnate between 2010 and 2020, starting to increase again between 2020 and 2030. The plateau around the 165,000 to 164,000 job mark under the NSAT scenario is attributable to the sharp drop in capacities in the thermal plants, which would translate into a job crunch of 23% in the coal-fired plants (from 57,000 FTE in 2000 to 43,000 FTE by 2020), and 50% in the heavy fuel oil power plants (from 14,000 FTE in 2000 to 7,000 FTE by 2020).

Although it is less marked than under the base line scenario, the fall in production staffing levels at nuclear facilities would nevertheless stand at –0.7% on average per year under the NSAT scenario, over the period 2000-2030.

Under both scenarios, jobs in the production of gas and renewables would increase, albeit at different rates: by 2.2% under the NSAT scenario and an average of 2.8% per year under the base line scenario, respectively, in the case of gas and +4.8% and 3.2% for renewables. By 2030, then, production jobs in gas plants would stand at 39,000 FTE under the NSAT scenario and 42,000 FTE under the base line scenario, compared to 20,000 in 2000. Jobs in renewable energies would amount to 71,000 FTE under the NSAT scenarios, compared to 45,000 under the base line scenario and 17,000 in 2000.

Ultimately, the key question raised via the NSAT scenario, in terms of production jobs, relates to the contraction of employment in the coal-fired plants, which cannot be offset by the development of jobs in renewable energies, for

Table 6: Jobs in electricity production

NSAT Syndex scenario FTE operation average/year (Thousands)					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	57	54	34	17	*-0,4%*	*-4,6%*	*3,3%*
CCS	0	0	13	31			
Oil	14	13	7	3	*-0,9%*	*-6,1%*	*-7,0%*
Nuclear	39	36	32	31	*-0,8%*	*-1,0%*	*-0,2%*
Gas	20	31	31	39	*4,5%*	*-0,2%*	*2,3%*
RES	17	31	50	71	*5,8%*	*5,0%*	*3,6%*
Total	**147**	**165**	**167**	**192**	***1,2%***	***0,1%***	***1,4%***

Comparison of the NSAT and NSAT Syndex scenarios for CCS

	2020			2030		
	Base line	NSAT	NSAT/SYNDEX	Base line	NSAT	NSAT/SYNDEX
Solids	55	44	34	56	33	17
CCS			13		10	31

Source: Syndex.

the latter correspond to different jobs with a different status: a wind farm operator does not carry out the same job as a thermal plant operator.

In the thermal plants (coal and heavy fuel oil), job losses would globally amount to 21,000 FTE (14,000 coal and 7,000 fuel oil), concentrated primarily in the EU countries where coal accounts for the bulk of electricity production.

In the case of the coal-fired plants, the speed of their spread and the scale of their penetration are far from neutral in terms of direct production jobs. The simulation that we carried out on the basis on the one hand of the spread of CCS as from 2015, and on the other of a rate of stock penetration of 60% by 2030, leads to reducing the drop in production jobs by 9 points compared to the NSAT scenario.

This means that production jobs in coal-fired plants would amount to 47,000 FTE by 2020, compared to 44,000 FTE under the NSAT scenario. By 2030, they would be maintained globally at 48,000, compared to 43,000 under the NSAT scenario, a difference of +5,000 FTE compared to the NSAT scenario, albeit with a very different distribution: 23% of the FTE in CCS plants in the case of the NSAT scenario, compared to 65% under the NSAT Syndex scenario.

While it does deliver more jobs, the spread of CCS nevertheless poses the question of the evolution of jobs and training for workers, since the capture, sequestration and storage processes do not involve the same jobs as those linked to electricity production.

Impact in maintenance

In contrast to the situation that we have just looked at, jobs linked to maintenance would be globally more plentiful under the NSAT scenario than under the base line scenario: 102,000 by 2030, leaving aside the indirect impact from replacements.

Table 7: Jobs linked to maintenance

Base line scenario FTE maintenance average/year (Thousands)					*Annual % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	30	30	30	30	*-0.2%*	*-0.1%*	*0.1%*
Oil	4	4	2	2	*-0.6%*	*-5.6%*	*-2.2%*
Nuclear	7	7	6	6	*-0.8%*	*-1.0%*	*-0.9%*
Gas	14	23	27	30	*5.0%*	*1.5%*	*1.1%*
RES	9	17	23	28	*6.2%*	*3.5%*	*1.8%*
Total	**65**	**80**	**88**	**95**	***2.1%***	***0.9%***	***0.7%***

NSAT scenario FTE maintenance average/year (Thousands)					*Annual % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	30	29	24	18	*-0.4%*	*-2.0%*	*-0.6%*
CCS	0	0	0	5			
Oil	4	4	2	1	*-0.9%*	*-6.1%*	*-7.0%*
Nuclear	7	7	6	6	*-0.8%*	*-1.0%*	*-0.2%*
Gas	14	22	22	27	*4.5%*	*-0.2%*	*2.3%*
RES	9	18	31	46	*7.0%*	*5.7%*	*3.9%*
Total	**65**	**80**	**85**	**102**	***2.0%***	***0.6%***	***1.9%***

NSAT/Syndex scenario FTE maintenance average/year (Thousands)					*Annual % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	30	29	18	9	*-0.4%*	*-4.6%*	*2.5%*
CCS	0	0	6	15			
Oil	4	4	2	1	*-0.9%*	*-6.1%*	*-7.0%*
Nuclear	7	7	6	6	*-0.8%*	*-1.0%*	*-0.2%*
Gas	14	22	22	27	*4.5%*	*-0.2%*	*2.3%*
RES	9	18	31	46	*7.0%*	*5.7%*	*3.9%*
Total	**65**	**80**	**86**	**103**	***2.0%***	***0.7%***	***1.9%***

Source: Syndex

Table 8 – Fuel used in thermal plants depending on the scenarios

Base line scénario DGTREN Fuel inputs to thermal power Ktoe					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	223 114	232 445	257 475	256 705	*0,4%*	*1,0%*	*0,0%*
Oil (including refinery gaz)	39 172	18 358	13 366	10 522	*-7,3%*	*-3,1%*	*-2,4%*
Gas	103 572	132 475	153 813	148 530	*2,5%*	*1,5%*	*-0,3%*
Biomass	14 969	27 764	36 433	52 041	*6,4%*	*2,8%*	*3,6%*
Total	**380 827**	**411 042**	**461 087**	**467 798**	***0,8%***	***1,2%***	***0,1%***

Base line scénario NSAT Fuel inputs to thermal power Ktoe					*Annuel % change*		
	2000	2010	2020	2030	*00-10*	*10-20*	*20-30*
Solids	223 114	209 399	136 357	104 946	*-0,6%*	*-4,2%*	*-2,6%*
Oil (including refinery gaz)	39 172	9 201	3 518	3 526	*-13,5%*	*-9,2%*	*0,0%*
Gas	103 572	112 652	117 695	128 156	*0,8%*	*0,4%*	*0,9%*
Biomass	14 969	24 155	73 087	111 749	*4,9%*	*11,7%*	*4,3%*
Total	**380 827**	**355 407**	**330 657**	**348 377**	***-0,7%***	***-0,7%***	***0,5%***

Source: P. Capros, L. Mantzos, V. Papandreou, N. Tasios, Model-Based Analysis of the 2008 EU Policy Package on Climate Change and Renewables, *juin 2008.*

Table 9 – Impact of the scenarios on jobs in the mines

Fuel energy Production Solids Ktoe and employment					*Annuel % change*		
	2005	2010	2020	2030	*00-10*	*10-20*	*20-30*
Base line scenario	196 451	164 952	141 764	125 808	-1,7%	-1,5%	-1,2%
Employment	*202 570*	*170 090*	*146 180*	*129 727*	-1,7%	-1,5%	-1,2%
NSAT Scenario	196 451	160 708	124 815	112 465	-2,0%	-2,5%	-1,0%
Employment	*202 570*	*165 714*	*128 703*	*115 968*	-2,0%	-2,5%	-1,0%

Source: Syndex

From the qualitative point of view, of course, there will need to be changes in the job content. With the processes implemented being both enriched (CCS) and extended (with the development of renewables), a detailed examination by job/technology pairing is required, knowing that the evolution in technologies leads to an expansion in maintenance repair/assembly jobs, diagnostics and the provision of technical solutions. Maintenance jobs today have become key jobs in increasing the uptake of capacities and play a full role in the optimisation of production costs.

Indirect impact on jobs linked to fossil fuel

The drop in employment, while marked in the thermal centres, is equally striking across the whole supply chain, specifically in the industry with the highest employment level, the coal sector, and more particularly in extraction.

Across the EU-27, jobs linked to the extraction of coal, lignite and peat account, according to Eurostat, for 203,000 workers.

The base line and NSAT scenarios show an average fall in the production of coal and lignite of 1.8% for the base line scenario and 2.2% for the NSAT scenario over the period 2005-2030. According to this assessment, jobs in extraction, which numbered 203,000 workers in 2005, would fall to 129,000 workers under the base line scenario and 116,000 workers under the NSAT scenario, giving 74,000 job losses in extraction under the first scenario and 87,000 under the second.

Current coal production accounts for 61% of final coal consumption in the EU-27. Moreover, 71% of coal consumption is linked to supplies to coal-fired power plants.

Under the base line scenario, the expected growth in coal consumption, taking account of the drop in production, will be covered by an increase in imports. Under the NSAT scenario, the drop in thermal coal consumption of an average of 2.5% over the period 2000-2030 translates almost entirely into the drop in local coal production. We may therefore assume that job losses in coal extraction in Europe will sit at between 77,000 and 87,000 workers, and that they will partly reflect the continued restructuring operations in the coal industry, and partly the 'decarbonation' effect of electricity production. Under the base line scenario, electricity production from coal is growing at an annual average rate of 1.4%. Under the NSAT scenario, it falls by 0.5% a year. We can therefore assume that the carbon effect is of the order of 10,000 jobs and the restructuring effect some 77,000 jobs. Irrespective of the question of the evolution of the stock of thermal plants, the question of the policy for securing the EU's long-term supplies then arises.

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2.2. The steel industry

The European steel industry in 2009: facing adaptation to the crisis, the evolution of its industrial model and CO_2 emissions

Steel, Europe and adapting to the crisis

The lessons to be drawn from the recent period

The European steel industry has been characterised by a number of structural elements since the beginning of the century:

- Asia has established itself as the place of growth for the decade to come. That being so, capacity investments will continue in this area;
- investments are being increasingly relocated in the countries producing raw materials;
- the bulk of the investments are intended for the traditional pig iron way technology, which does provide the most jobs but also emits the most CO_2;
- the growing financialisation of the ways of managing the sector will continue, with finance increasingly imposing its criteria and setting the pace, notably through the creation of new futures markets (billets, slabs, iron ore, alloy materials, etc);
- policies to combat climate change will contribute towards this financialisation through the creation of futures markets on CO_2.

Europe has been fully involved in the recent period: investments have been particularly plentiful in what are referred to as the 'Eastern' countries, with capacity increases being planned in East and West alike before the economic downturn at the end of 2008. The crisis interrupted these planned developments.

What matters is to establish the extent to which the climate change policy can form a strategic turnaround which will enable the European steel industry to maintain its place and its jobs in tomorrow's world.

European steel's adaptation to the 2008-2009 financial crisis: the internal boundaries are gradually fading away

The period of industrial and economic euphoria experienced by the world's steel industry between the end of 2003 and the end of 2008 marked the end of a period which saw production capacities saturated and occasional shortages, including in Europe.

Although the cyclical downturn has brought about some radical changes, existing production capacities still tend to be maintained as a rule, thanks in part to support from the public authorities right across Europe, who have extended short-time working measures and improved their allowance arrangements.

For the first time in the contemporary industrial history of the steel sector, producers have put in place some original strategies to limit their outputs:

- temporary closures of blast furnaces, tools whose regular use is at the heart of their technical and economic viability;
- curbs on the operation of active blast furnaces through a reduction of up to 60% of their daily capacity for pig iron production.

In social terms, temporary staff and subcontractors have been the first to bear the brunt of the stoppages of the installations. This phenomenon has very quickly been accompanied by a reduction in costs in many areas, and then by job cuts as part of voluntary redundancy schemes.

The measures taken to cut jobs can be described as structural, in the sense that their consequences on the organisation are felt in the medium and long term. Temporary stoppages of tools, on the other hand, remain measures driven by the economic climate, which puts them in the short-term category.

This distinction between a cyclical adaptation of the productive tools on the one hand, and structural management of the production labour force/indirect staff on the other, reflects a new way of looking at corporate finances. Under this approach:

- replacing or substituting the tool represents an extremely costly investment;
- the burden represented by staff may give rise, in due course, to contractualisations, which at present – rightly or wrongly – are considered to be easy to achieve on employment markets characterised by high unemployment;
- subcontracting extends to all work not deemed to be of strategic importance that is part of the production;
- the reserve of temporary staff rises progressively from 10% to 20%, if not more, of direct production staff;
- certain general and administrative services are outsourced.

When the integrated chain is operating in this way, with only the coking works continuing to run uninterrupted and with little variation in overheads, the advantage deriving from running an electric furnace compared to a blast furnace is reduced, if not zero, and the prospect that the blast furnaces might be gradually replaced by electric furnaces recedes in proportion.

Accordingly, the European steel industry, thanks to the adaptation of its workers and the reactive approach of the public authorities in terms of short-time working, has successfully maintained its production capacities intact in material terms.

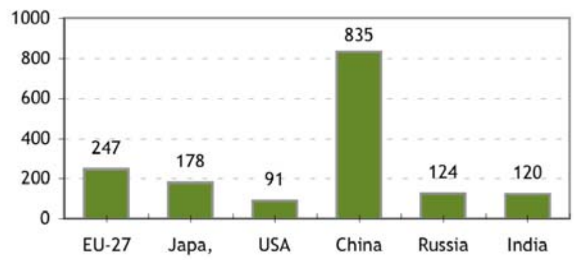
It is in this way that this financial, economic and social crisis differs from the preceding structural crisis. Europe today has no excess steel capacity, other than on a cyclical basis.

Steel, a sector generating CO_2 emissions

The steel industry emits a number of pollutants, including SO_2, NOx, CO_2, particulates, mercury, etc.

According to the sources, the sector accounts for 6 to 7% of global CO_2 emissions, and this figure rises to 10% if we include emissions from the extraction and transport of the raw materials.

Direct CO_2 emissions in the world steel industry in 2005 (source: IEA)



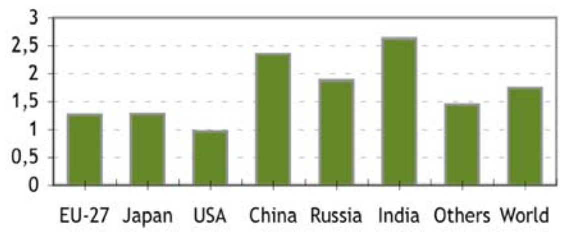
Steel accounts for 30% of the CO_2 emissions generated by all industries. China has the highest emissions, both because it is the world's biggest steel producer and because 90% of its steel industry depends on the pig iron way, represented by a massive range of technologies, from the most modern to the most artisanal.

CO_2 emissions per country

All these elements combine to give an average CO_2 emission per tonne of steel produced that varies widely from country to country and can be explained by various factors (in order of importance):

- the development trajectory;
- the composition of the sector, which refers in part to the availability of raw materials;
- the energy-efficiency of the installations.

Direct CO_2 emissions per tonne of steel and per country in 2005 (source: IEA and IISI)



European steel: towards the low-carbon economy

A European low-carbon industrial policy: the Ulcos programme and the European steel technology platform ESTEP

The European Ultra-low CO_2 Steelmaking programme (Ulcos), a flagship project of the European Steel Technology Platform (ESTEP), is the only one of its kind in Europe. Its origins lie partly in the European Coal and Steel Community (ECSC) and it has successfully mobilised 47 players both within and outside the steel industry, and got them to cooperate (they include chemical companies such as Air Liquide, Linde or BASF, and oil companies like Statoil). Ulcos was launched as a research programme funded as a public/private partnership in 2004. Its projects qualify for support funding under the European Economic Recovery Plan.

The ESTEP technology platform is designed to promote R&D cooperation projects for the development of both low-carbon processes and steel products that favour the reduction of CO_2 emissions in the sectors where they are used (renewable energy equipment, transport equipment, building, etc).

The new technologies developed by the Ulcos programme

The first milestone was passed in February 2008, after four years of research, when three families of technical solutions were put forward to classify the 80 or so technological possibilities examined:

- low-carbon iron and steel production by reducing the iron by hydrogen or electrolysis of the iron ore (hydrogen-based technologies known as Ulcolysis and Ulcowin);
- the use of CO_2 capture and storage as a complement to the techniques for obtaining new iron. There are three technologies: Top Gas Recycling (TGR), Hisarna and Ulcored;
- the use of biomass.

Indicative forecast timescale of the R&D phases before the technologies are deployed

Technologies	2007	2009	2010	2020	2025	2030
Top gas recycling with CCS	Pilots	Pilots	Demonstrators	Demonstrators	Deployment	Deployment
Reduction-fusion (Hisarna)	Pilots	Pilots	Demonstrators	Demonstrators	Deployment	Deployment
Ulcored			Pilots	Demonstrators	Deployment	Deployment
Ulcolysis / Ulcowin				Pilots	Pilots	Demonstrators
Hydrogen						?
Biomass						?

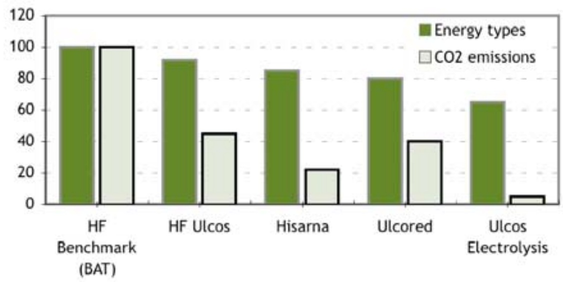
Legend

(light grey)	*Pilots*
(medium grey)	*Demonstrators*
(dark grey)	*Deployment*
?	*Uncertain*

Source: JP Birat Estp Mirror Group, Brussels, July 2009.

These three technical solutions might, according to the information communicated by the research programme, be deployed between 2020 and 2030. Each one makes for a substantial reduction in CO_2 emissions, while at the same time driving down energy consumption, in proportions still remaining to be confirmed.

Energy savings and reductions in CO_2 emissions by technology (source: Ulcos)



The CO_2 capture and storage technology thus complements the three technologies that can be quickly rolled out to substantially reduce carbon dioxide emissions by an installation producing new iron. These three quickly available technologies are:

- Top Gas Recycling (TGR), which concentrates the CO_2 from the blast furnace once it has been separated out from the other gases;
- Ulcored, which delivers a direct reduction thanks to natural gas;
- Hisarna, which relies on fusion-reduction with coal.

Because they make use of CO_2 capture and storage, these three technologies prove transitory. They are the forerunners of clean technologies, which at the moment are not available in the medium term.

Employment in European steel in the future

Up until 2020, steel is protected by the handing out of free emission rights, like the sectors identified by the European Commission as potential victims of carbon leakage, which are affected by both exposure to international competition and high energy intensity. In all likelihood, a solution involving the vast majority of the world's steel producers will be found by 2020.

On the integrated liquid steel production sites, we estimate that 175,000 jobs will be protected, for a production capacity of 200 million tonnes of steel. This is in addition to the jobs in cold processing, which we do not believe to be under the same threat, given their geographical proximity to the markets. In the case of tubes, on the other hand, a European location is more fragile, with much of the production being intended for export[12].

Evolution in jobs in European steel per activity between 2002 and 2006

	2002	2003	2004	2005	2006
Integrated sites	367 843	407 929	396 426	373 557	371 770
Cold processing	79 410	73 939	70 857	69 250	66 335
Tubes	121 374	118 538	117 081	114 964	110 132
Total	**568 627**	**600 406**	**584 364**	**557 771**	**548 237**

Source: Eurostat

The risk associated with asymmetrical competition due to the price of carbon in Europe is provisionally removed, thanks to the temporary measures taken. This does not mean that there will not be any relocations in the next twenty years with an impact on the staff employed on the production side or corporate management and administration, but they will have other explanations.

[12] In 2006, we estimated the probability of relocation of production at between 50 and 75 Mt of steel, leading to the loss of 45,000 to 67,000 jobs across the sector by 2030, plus 20% of outsourced jobs, making a total of between 54,000 and 80,000 jobs. Cf. *Climate change and employment, ibid.*

This is why we consider that European steel is likely to lose between 24,000 and 45,000 jobs for reasons other than climatic ones.

We regard this estimate as minimal in both cases.

Impacts of the new technologies on employment: forecasts and uncertainties

In tackling the impact of this new climatic parameter in investment strategies and in the ways that a sector such as steel is managed in Europe, we shall distinguish in analytical terms between two types of actions. One set involves ongoing actions to improve the energy efficiency of the installations and allow the consumption of energy per tonne of steel produced to be reduced; the other actions correspond to low-carbon projects, which change the industrial, economic and social configuration of the installations.

Energy efficiency and productivity of the installations

An improvement drive has the effect of consolidating the existing jobs and opens up recourse to specialist energetics qualifications. As far as we know, these belong at present in the field of general technicians.

Given the involvement of the management of energies at the heart of the process for the production of pig iron and steel, it is unquestionably relevant to promote the growth of a culture of energy efficiency among the production and maintenance operators. This would lead to an essentially qualitative evolution in European iron and steel jobs, at both the industry giants and their subcontractors who are involved in production.

Top gas recycling compatible with a steel industry offering lots of jobs

As we have seen earlier, low-carbon modernisation projects will have an impact in employment terms:

- if the deployment of top gas recycling is confirmed as from 2016-2020;
- as from 2020, if the tests confirm:
  - the value of the direct reduction (which we have little doubt about),
  - more hypothetically, fusion-reduction (this technique has been the subject of a host of efforts over the years, all of which have failed).

In the case of the top gas recycling technology, we can expect an increase in employment stemming directly from this transformation in every factory using the pig iron way.

On the other hand, can we assume that the development of the new Ulcored and Hisarna technologies might be propitious for a development along these lines?

Under the Syndex hypothesis, the European steel industry:

- would even out the commercial balance in steel and thus increase its production capacities in line with consumption;
- would benefit from a combined progression of electrical steel and pig iron steel;
- would reap average physical productivity gains of 2% per year, which is a figure below the average. The reason for this is the introduction of the new equipment, which will generate new jobs but will initially hamper the intensification of work by the necessity to learn the new industrial tools.

On these assumptions, there will be jobs lost, linked essentially to the increases in productivity.

In qualitative terms, account will need to be taken of the following trends:

- the move towards a process industry based on the running of the blast furnaces will entail some radical changes in ways of working: where the collective skill of the teams used to be indispensable to the proper running of the tool, the new technological situation will impose much more binding regularities, starting with tighter, computer-based control and measuring tools;

- the intensification of the operation of the tool towards greater energy efficiency and more precision and rigour in the operating standards will also have the effect of putting more pressure on tools and materials, which will certainly have consequences for workers' security.

We might also wonder about the consequences for the jobs performed by the factory staff whose energy consumption becomes one of the decisive criteria in its operation, or even its medium-term viability. Is there not a question of professional training in the broad sense, accessible to all staff?

Syndex TGR hypothesis (Mt)

	2010	2020	2030	2030/2010
pig iron	115	120	138	20,0%
electric	82	90	100	22,0%
Total	**197**	**210**	**238**	**20,8%**
physical productivity t/m/year	1,3	1,585	1,932	48,6%
physical productivity t/m/year	2,5	3,047	3,715	48,6%
direct pig iron employment with status	88,462	75,710	71,429	-19,3%
direct electric employment with status	32,800	29,537	26,918	-17,9%
Total	**121,262**	**105,247**	**98,346**	**-18,9%**

2.3. Refineries

European refineries face serious issues

After a spell of relative stability, global capacities should grow in the coming years

World refinery capacities have changed little over recent years, posting less than 3% growth between 2004 and 2008. The growth areas are Asia and the Middle East. The mature areas (Europe and North America) are limiting new projects and are more in a phase of restructuring their industrial tools to respond to demand-side developments.

Despite the current weakness in demand, a noticeable progression in capacities is expected between 2009 and 2013, with many projects being under construction in the Middle East and Asia. While certain projects have been slowed down because of the crisis, most will come to fruition, whether they be projects that have almost reached completion or projects where profitability is not the priority criterion. We might cite the planned construction projects in Saudi Arabia, which seek to diversify the country's industrial tool and reduce dependence on oil extraction; in Iran, where refineries are needed to reduce the dependence on imports of refined products; or in China, which is also anxious to reduce its dependence on imports.

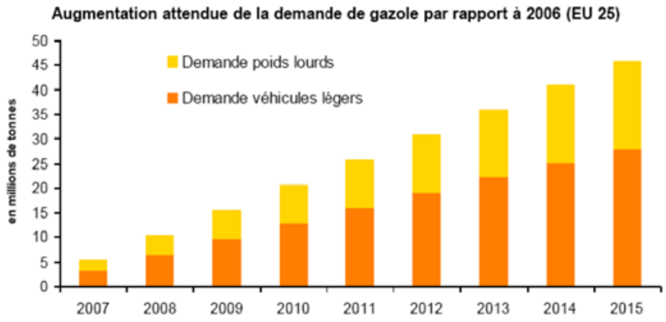
In the current situation of depressed demand, these projects will deliver global overcapacities which will impact on the European market.

The delicate balance between supply and demand in the European refinery sector

Europe has some 140 refineries, with a capacity of something in excess of 16 Mb/d (or 750 Mt/year).

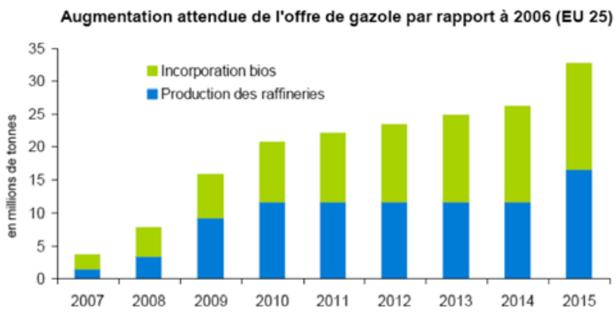
The European refinery sector is marked, despite an apparent balance between supply and demand, by a very pronounced dependence on imports-exports. One quarter of petrol production (40 Mt) is exported, essentially to the United States, while 15% of the demand for diesel and domestic fuel oil (30 Mt) is imported.

This dependence should increase in the years ahead, with the continuing decline in petrol compared to diesel, and European countries seeing an increase in the percentage of their cars running on diesel.



Source: UFIP – June 2008

However, we can take it that the impact of the crisis will blunt the expected evolution: it should fall within a bracket between 30 and 35 Mt of additional demand.



Source: UFIP – June 2008

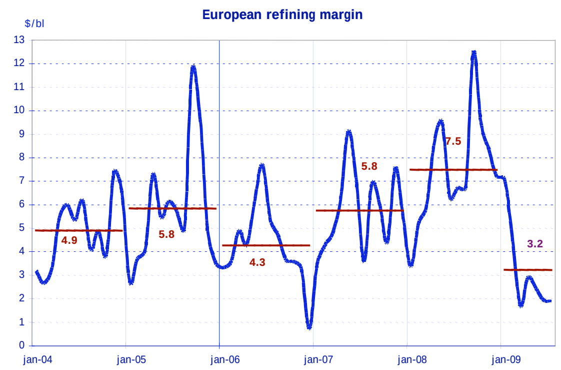
The expected increase in supply thanks to refineries' production investments and the incorporation of biofuels would make it possible to cover the expected rise in demand. This would keep diesel imports at their current level.

In 2009, for the first time in many years, capacity reductions are being envisaged by several major players: our estimates indicate that Europe could see a drop of 30 Mt of capacity, or 4% of current capacity.

In Western Europe, the giants (Shell, BP, Exxon, Total, Conoco) are pulling out from what they deem to be their non-strategic assets and seeking to reposition themselves on their best-performing tools in terms of size and profitability, tools that they invest in to the detriment of the smaller units passed on to independents[13].

In contrast, in Eastern Europe, the players (OMV, MOL, PKN Orlen) are participating in the concentration of the sector. Russian players like Lukoil are looking to boost their position in Europe, both East and West.

Driven by the crisis, margins have plummeted in 2009 and should stay low in the months ahead



Source: Syndex, DGEC

Since 2004, European refinery margins have been relatively high compared to the situation in the 1990s. For one thing, refiners have benefited from the regular increase in demand in a context of low capacity growth.

Despite the slowdown in demand which began in the second half of the year, 2008 set a record. This was due to two peaks: the first in April-May (the period when demand is driven by the building up of petrol stocks in the United States ahead of the 'driving season'), and the second in September-October, because of the hurricanes in the Gulf of Mexico which shut down a number of refineries.

However, while hurricanes, followed by a hard winter in the northern hemisphere, shored up the margins until early 2009, we have witnessed a fall in margins since February. This state of affairs, a direct result of the drop in consumption linked to the crisis, should continue into the months ahead, with any upturn in consumption depending on the strength of the economic recovery.

Scrappage payments, brought in by many countries in response to the crisis, should also bring a reduction in average vehicle consumption figures, with older cars being replaced by newer models which are more economical (especially with smaller engines being the big winners from these allowances).

Finally, the construction of new refinery capacity, referred to earlier, should more than offset any rise in demand and help to maintain margins at a low level (except for any external factors such as hurricanes or climate).

In the years ahead, European refineries will therefore have to cope with two major issues:

- improving their capacity to handle heavy crudes while complying with specifications (in product and environmental terms) which are becoming increasingly tough;
- facing up to increased consumption of diesel, in the knowledge that demand for petrol is falling, which impacts on margins.

Evolutions in refining change its CO_2 emissions

Impact of the evolution in demand

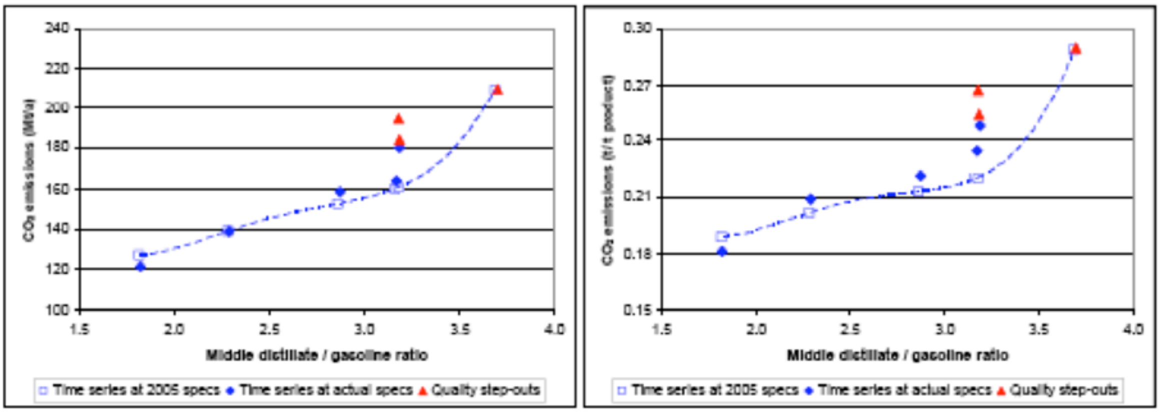
The various evolutions are leading, year on year, to a growing gulf between production capacity and the needs of the market, calling for imports of diesel and exports of petrol and heavy fuel oil. In such a situation, the refiners have adapted their tools.

[13] In the space of three years, therefore, Petroplus has grown into Europe's fifth largest refiner, thanks to the departure of the big players.

In schematic terms, in the 1960s, the refineries were using little energy, and their role lay essentially in splitting the crude into petrol, diesel and heavy fuel oil. In the 1980s and 1990s, refining developed in response to the production of electricity and the development of car numbers. To respond to demand, there was a need to install conversion units to transform heavy fuel oil into petrol and diesel, which resulted in an increase in energy and hydrogen consumption.

Today's refineries are increasingly exporting their heavy fuel oil. The conversions are becoming deep (high pressures and high temperatures), energy consumption is rocketing and hydrogen production units need to be developed as a backup. A European refinery today thus consumes some 7% of the crude that it processes, compared to 4 to 5% twenty years ago. In the United States, where deep conversions are more highly developed, this percentage is as high as 11 to 13%.

Estimated evolution of CO_2 emissions as a function of the diesel/petrol production ratio, globally and per tonne processed



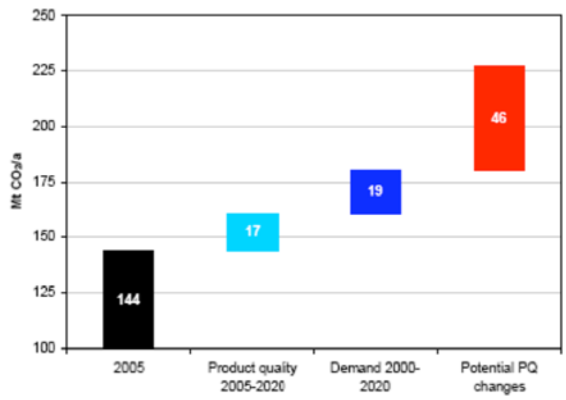
Source: Concawe

Impact of the regulatory evolutions

Environmental stipulations will continue to increase substantially in the years ahead:

- reduction of sulphur in heavy fuel oils, domestic fuel oil and petrol and diesel;
- switch from fuel oils for agricultural, railway and site machinery use to diesel qualities;
- application of new European directives (CO_2, IPPC, etc);
- the CAFE programme (Clean Air For Europe).

In order to meet these new specifications, severe hydrogenation techniques will need to be used. This shift will result in an increase in the energy consumed and thus in the CO_2 emissions, as may be seen from the graph below.



Source: Concawe

According to Concawe (pre-crisis estimates), CO_2 emissions from European refineries might rise from 144 to 225 Mt/year by 2020. Assuming that the rise in demand will be cancelled out by the crisis and the energy-saving measures, we end up with emissions of 200 Mt/year, the reinforcement of the specifications leading to a rise of 63 Mt: 17 Mt linked to the regulations already in force and 46 Mt for future developments.

The investments necessary

These trends (demand and evolution of regulations) would call, according to Concawe, for the investment of 61 billion dollars in adapting European refineries between 2005 and 2020: half to respond to the trend in demand, and half to cope with the new specifications.

However, these figures need to be viewed with caution, because in the past, the refineries have consistently greatly overestimated the sums necessary to cope with adaptations to the specifications. We believe a figure of 30 to 40 billion dollars would be more likely.

Impact of the ETS on the refinery sector

A minor impact until 2012

The first phase from 2005 to 2007 was painless for the refiners, with quotas having been awarded on the basis of the sites' historic emissions and taking account of the planned growth. Overall, the quotas awarded for free were 6% above the actual emissions.

The second phase (2008-2012) has revised the allocations downwards, but this should not automatically mean a major burden on the oil companies.

Some have used their phase I surpluses to convert them into coverage for phase II or have already purchased phase II quotas. The big players are also making use of the possibility of obtaining quotas (CER) by investing in projects to reduce emissions in the developing countries (CDM: Clean Development Mechanisms).

The drop in CO_2 prices (15 €/t in September 2009, after a low of 8 €) places tight limits on the burden corresponding to the purchase of quota shortfalls.

The post-2013 phase, on the other hand, might prove more complex for the refiners to manage

The bulk of the effort required to achieve the objectives in the EU's Climate-energy package will fall on the industries subject to emissions quotas, including refining.

Refining would fall into the category of industries exposed to the risk of carbon leakage (this sector being, as we have seen, already very exposed to imports), which will enable it to continue to enjoy the benefits of free quotas until 2018. However, the introduction of the benchmarks will favour the more energy-efficient units to the detriment of the less efficient ones.

This constraint will come on top of the intrinsic areas of fragility in certain units: the level of the margins (in the case of European overcapacities), the level of conversion, the weakness of the local outlets, energy performance (notably in the case of crude price rises) and the lack of petrochemical synergies.

This will therefore pose a risk to those tools which would not benefit from investments in improvements to their energy efficiency.

Possible actions to reduce CO_2 emissions

The refiners are working in various directions:

- improving the reliability of the factories: no stoppages to avoid restarts which cost a lot in terms of fuel, steam, product reprocessing, untimely flaring, etc
- improving energy efficiency:
  - improving the thermal integration of the units,
  - waste heat recovery,
  - recovery of steam condensation,
  - steam network audits,

  - ⇨ optimising fuel and steam management,
  - ⇨ optimised fractionation, thereby using a minimum of energy for the fractionators;
- improving conversion rates, in other words the quantity of fuel obtained per tonne of crude oil refined;
- improving the performance of the catalysts;
- increased use of cogeneration installations.

The first four thrusts relate to constant improvements to the operation of the existing tools. Judging by the history of the improvements over recent decades and the existing technologies, we can assume that the energy efficiency improvements that can be achieved (and therefore the reductions in CO_2 emissions) will amount to about 1% per year.

The major lever in moving any further lies in wider use of cogeneration installations, which will allow for efficiency gains of 20 to 30% where they are fitted.

Only thirty or so European refineries are equipped with cogeneration, which represents a major development potential. Unfortunately, it does not seem that all the conditions have been met. The point is that cogeneration represents a sizeable cost, which is more profitable for the larger refineries, most of which are already equipped. In addition, the small refineries are suffering from the current context of low margins, and their owners do not seem to be prepared to invest in it in the long term (cogeneration takes twenty years to become profitable), because some might have closed down before then. Finally, the independent players are suffering from the credit crunch and will find it hard to secure financing for long-term projects like this.

The development of cogeneration involves:

- the need for a long-term vision of the price of CO_2 (an issue at the Copenhagen conference);
- guarantees from the public authorities and the regulators on purchase prices for the electricity produced (refinery cogeneration produces more electricity than the site needs);
- financial support for the setting up of the units.

The issue after 2020: CO_2 capture and storage

CCS offers the greatest potential for a reduction in refineries' CO_2 emissions, but its deployment is complex because of the particularities of this industry:

- relatively low emissions compared to coal-fired plants or other industries: an average of 1.4 Mt for the European refineries;
- emissions distributed across a large number of units within a single refinery;
- a low concentration of CO_2 in the smoke.

This indicates that the CCS technology will first need to have proved its viability on big emission sources and enjoyed major economies of scale before it can be deployed on a large scale in refineries.

In addition, the configuration of the existing refineries means that zero emissions cannot be achieved. This could, however, be envisaged for future constructions: some current projects provide for the possibility of future retrofitting.

Concawe indicates that CCS is unlikely to be economically viable for the refinery sector before 2025 at best. Our view is that this time could be cut if voluntary policies to accelerate and increase the number of demonstration pilots were introduced.

At present, only two projects, preselected by the ZEP platform, are planned at European level:

- Statoil is launching a pilot at its site in Mongstadt in Norway;
- Shell, through its Pernis refinery, is participating in a project in Rotterdam, in collaboration with other industry players.

Transporting and storing the CO_2 captured in refineries will call for the setting in place of clusters with other industries, because a single refinery on its own, however big, does not warrant the laying of a pipeline. The minimum size for transport and storage is estimated at emissions of 10 Mt per year.

Measuring the impact on employment

Europe's refineries employ some 120,000 people directly and indirectly.

By 2020, we estimate that there is a risk of ten or so of the smaller refineries closing down. This is the result in the short term of the impact of the crisis on demand and margins, coupled in the medium term with measures to reduce consumption by vehicles. These closures might lead to the destruction of 6,000 jobs (half direct and half indirect).

The risks of closures and jobs being destroyed over the period 2020-2030 are hard to evaluate, and will depend on the pace of the introduction of electric vehicles (hybrids or all-electric) and competition by refined products from the areas on the periphery of Europe (the Middle East and North Africa).

Some positive effects can be expected from the development of cogeneration and CCS: here, too, everything will hinge on the pace and scale of the investments made, which are difficult to assess today.

CHP, an opportunitie for low carbone industry

Combined heat and power (CHP, also referred to as cogeneration) captures waste heat in electricity production or industrial processes and recycles it into useful electricity and thermal power. CHP systems utilize 75–90 percent of fuel input, far more than a typical coal-fired power plant (33 percent) or natural gas–fired plants (60–64 percent). About 80 percent of CHP systems worldwide are used in energy-intensive sectors like paper and printing, chemicals, metal and oil refining, and food processing. They help increase industrial energy efficiency and thus reduce carbon emissions.

A number of European countries are already using CHP fairly extensively. Compared with a an average global share of 8 percent of electricity needs being met with the help of CHP facilities, Denmark derives 52 percent of its power needs in this manner. In Finland, CHP accounts for 39 percent, in Russia for 32 percent, in the Netherlands 29 percent, and in Poland and Romania 26 percent each.

In accordance with WWF, in the United States, a rough estimate suggests that about 25 workers are required for operating and maintaining 10 MW of existing CHP capacity. European countries have a CHP capacity of 104 GW—32 percent of the global total. Applying the U.S. job per MW estimate to the European context yields the following calculation: 25 x (104,000/10) = **260,000 jobs.** Of course, by WWF, this figure needs to be seen with some caution. Not only is the U.S. formula no more than a rough estimate, but it is unclear whether it is typical of European conditions.

Also according to WWF, applied to Germany, the formula suggests roughly 52,000 CHP jobs in Germany. The Öko-Institut concluded in 2003 that some 15,000 CHP jobs (gross) could be created in Germany over a 7-year period (by 2010).

Beyond the direct employment are jobs at supplier companies, site developers, firms involved in designing, constructing, and installing CHP facilities and related equipment, as well as those in energy efficiency consulting. All in all, the pursuit of CHP promises more employment than can be generated by conventional power plants.

2.4. Cement

An industry that accounts for 3% of the EU's CO_2 emissions

According to Cembureau, in 2006, the cement industry in the EU 27 emitted an average of 0.8 t of CO_2 per tonne of cement (0.75 t of direct emissions and 0.05 t of indirect emissions related to electricity consumption). For production of 261 Mt (see below), this is equivalent to 196 Mt of CO_2 in direct emissions. This figure, also according to Cembureau, accounts for around 3% of the European Union's CO_2 emissions. Statistics from the European institutions show lower emissions: 105 Mt in 2006, or 2.5% of emissions.

A concentrated industry with strong entry barriers

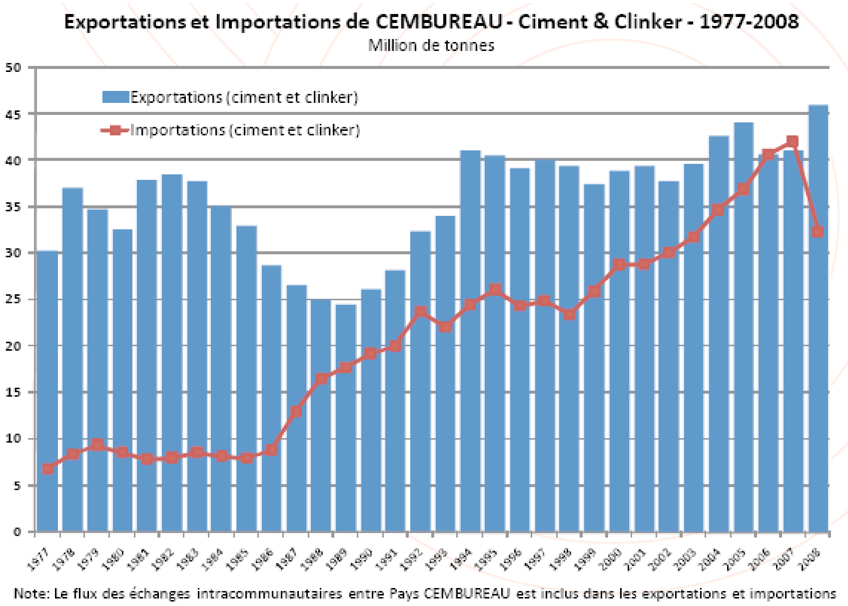
The cement industry is a capital-intensive industry that is characterised by a high level of profitability. These two indicators (high profits and heavy investments) speak in favour of an oligolopolistic market structure, where competition exists but is subject to strategies far removed from the preponderance of price in determining demand (even in the absence of agreement, the leader's role in setting prices is important). Most large cement enterprises are also present upstream in the sector (aggregates, concrete) and often also produce other construction materials (plaster).

An industry whose trade balance became negative in 2007

In 2006, production by the EU25 amounted to 268 Mt, for consumption of 261 Mt. Exports (including within the EU) added up to 32 Mt and imports to 38 Mt.

2008 emerges as an exceptional year compared with the trend observed since the 1980s, a period during which imports began to rise sharply. Although these are not consolidated data (the intensification of intra-European trade contributes to the tendency), it can be concluded that there is increased competitiveness in imports from outside the European Union (in particular from Northern Africa), since the balance between total exports and imports has deteriorated.

CEMBUREAU exports and imports – Cement & clinkers



Risks of carbon leakage?

The EU's imports from countries not subject to carbon constraints amounted to 15.5 Mt in 2005, compared with 13.5 Mt in 2004.

A study by Boston Consulting Group, commissioned by Cembureau in the context of lobbying the European institutions, paints an apocalyptic picture of the future of cement works in Europe: at €25/t of CO_2, 80% of European production is allegedly at risk of relocating and, at over €35/t, all cement production would disappear from European territory.

Another study, based on the CSIM3 model, confirms the existence of risks of very significant relocation but explores more carbon constraint hypotheses and details ways in which these constraints can be respected (CO_2 sequestration, alternative fuels, reduction of the clinker factor and energy efficiency). This study also gives a way out of the alternative of "insufficient emissions reduction effort or relocation": the taxation of imports from countries without carbon constraints. It states that such taxation would be effective in terms of protecting employment while encouraging emissions reduction.

Another element that could create a risk to the European cement industry is the availability of additions. Blast furnace slag could become scarce in regions far from coasts, which implies finding alternative supply sources or different additions. If the materials needed to reduce CO_2 emissions had to be imported, maintaining clinker production on European territory could become more problematical. Here too, taxation at borders is one way of keeping the danger at bay.

Pronounced decline in production in 2008

For the 27 countries of the European Union, there was a very pronounced decrease in the volume of production between 2007 and 2008 (around a 7% decline to 254 Mt).

In 2008, total exports of clinkers and cement from the countries belonging to Cembureau increased sharply (by 11.8%). The total stands today at 46 Mt. Conversely, imports declined by 23% (to approximately 32 Mt). For 2008, clinkers represented 20% of total exports and 36% of total imports.

Comparative analysis of companies in the sector

Analyse comparative des entreprises du secteur

Profils (Base 2007)

		Chiffre d'affaire (M€)	Effectifs (Nombre de salariés)	Production (Mt)	Capacité de production (Mt)	Implantations (Nombre de pays)
Membres fondateurs	Cemex	21673	67000		96,7	> 50
	Cimpor	1966	7530	24,5	28,4	11
	CRH	20992	92000	15,6		32
	Heidelberg	10 862	67916	88		50
	Holcim	27052 CHF	89364	149,6	197,8	> 70
	Italcementi	6001	23706	65		22
	Lafarge	17600	77721	148,4		72
	Portland Valderrivas	1886	5066	18		7
	Titan	1497	6034	15,5	16	11
Participants CSI	Siam Cement (ciment seulement)	268 MMTHB	5918		24,2	9

Source: Lafarge

Compared with 2007, cement consumption has declined due to lower demand in the majority of countries belonging to Cembureau. In 16 of these countries, consumption is showing negative growth. Four of the five biggest countries (which account for more than 60% of total production) registered a decline of more than 2% in cement production or even a much higher percentage.

The number of workers in the cement industry in the European Union of 15 has been halved in 30 years: from more than 90,000 in 1975, they dropped to fewer than 45,000 in 2005. This trend is to be compared with productivity gains: 1,700 t per man and per year in 1970, compared with 3,500 t in 1991. These productivity gains were achieved through the use of bigger and highly automated production plants.

Recommendations for optimising alternatives to a business-as-usual scenario for 2020 and 2030 and for a European cement industry policy

- Continue efforts already under way (reduction of the clinker factor, greater use of alternative fuels, switchover to dry process).
- Stimulate R&D and European demonstration and deployment projects for new processes (cements without clinker, new binding agents, eco-cements, etc.) by giving fresh impetus to cooperation between players in the sector.
- Include the participation of the cement sector in European R&D projects and demonstration-deployment projects on CO_2 capture and storage technologies carried out by other sectors (producers of electricity from fossil fuel, steel, refineries, etc.).
- Mobilise all players in the decision-making chain (industrial, administrative and political) to establish benchmarks for the composition of cements; the absence of such benchmarks hampers the development of new processes.
- Introduce border compensation systems to be applied to imports not subject to carbon constraints, before concluding a global agreement for the sector (negotiations for which were launched on an initiative of the WBCSD).
- Develop sectoral systems and tools for forward-looking management of employment and competences dedicated to new processes and products.
- Propose appropriate training programmes for managers and workers of cement groups, but also for those in companies in the client sector (building and public works), not to mention individuals.

2.5. The chemical industry

The chemical industry and low carbon: situation and issues

In the face of a combination of profound upheavals, regulation is difficult and an analysis impossible: there is a need for an industrial policy

The chemical industry is complex, because it is not homogeneous: it includes thousands of industrial sectors involved in processing and tens of thousands of different products.

This complexity has increased with technological innovation and the destructuring of the industrial sectors caused by the competitive patterns that have spread over recent decades. The strategic areas and the value chains have been revisited by reference to the financial principles: the landscape of players and organisational models has undergone profound changes in the mature countries. In the so-called 'emerging' regions, a new chemical industry is mushrooming.

Because of the coexistence on the one hand of a phase of profound restructuring in the mature countries, and on the other the rapid development of a new industry in the emerging countries to serve the local markets or the major export markets, it is difficult to make any general, global conclusions. This likewise complicates the possibility of regulating a sector using nothing but the mechanisms of the market. So the issue of industrial policy is particularly fraught.

An important industry from the point of view of GHG emissions ...

The chemical industry is a major contributor to GHG emissions: it is responsible for approximately 15 to 16% of global GHG emissions from industrial sources worldwide (4% across all sources), or approximately 2.4 billion tonnes of CO_2 in 2005 (525 Mt equivalent CO_2 in Europe that same year). It is the most energy-guzzling industrial sector, accounting for 28% of world energy consumption in 2005.

Lying behind 90% of the volumes of GHG produced by the chemical industry, eight sectors (ammonia, nitric acid, adipic acid, glyoxylic acid, petrochemicals, chlorochemicals, carbon black and sodium carbonate) have been covered by the ETS since the January 2008[14] directive. Other chemical activities are affected by quotas imposed in respect of combustion in the process itself (boilers, furnaces). Finally, part of the chemical activity lies outside the ETS.

The United States, Japan, China and the European Union are the four big petrochemical producers, accounting altogether for two thirds of the sector's CO_2 emissions.

... already committed to reducing GHG emissions ...

The chemical groups focus in their strategic models in mature zones on issues which are not without an impact on GHG emissions. Innovations in procedures have sought to increase energy efficiency. Innovation in products has sought to achieve an improvement in functional and applicative qualities. The implementation of these innovations has helped to drive down emissions per unit produced of GHG over the past fifteen years at global level: since 1990, the production of chemicals has risen by an average of 3.2% per year, while emissions have risen by 'only' 1.7% per year.

However, these developments are not geographically homogeneous. The rise of 1.7% covers the virtual stability of emissions in Europe (the carbon intensity of the European chemical industry is the lowest, at 0.36 kg of CO_2 per 1 dollar of turnover in 2010-2011) and in North America, while emission levels in the rest of the world have rocketed, particularly in Asia, where

[14] Ammonia, nitric acid, adipic acid and glyoxylic acid have been subject to the ETS since 2005, and petrochemicals, chlorochemicals, carbon black and sodium carbonate since 2008.

the rise is linked to the very sharp growth in production capacities in a more carbon-intensive chemical industry.

... without the potential for improvement having been exhausted, provided that two major challenges are addressed

Pursuing the reduction of GHG emissions implies a substantial effort, including for Europe's chemical industry: without this exemplary mobilisation, which the industry admits, GHG emissions would rise by approximately 34% in Western Europe between 2005 and 2030 (+90 $MtCO_2$) and approximately 78% (+200 $MtCO_2$) in Eastern Europe.

An economically viable potential for reduction has been identified by 2030[15]. However, it raises a twofold challenge. The first aspect relates to the pursuit, or even the acceleration, of the process of improvement that has already begun in the mature countries, while the second concerns the emerging countries, which, even if they do reduce their carbon intensity, would need to increase their GHG emissions with the development of their production capacities (CO_2 emissions from the chemical industry in China would need to rise from 27% of the world total in the sector in 2005 to 34% by 2030).

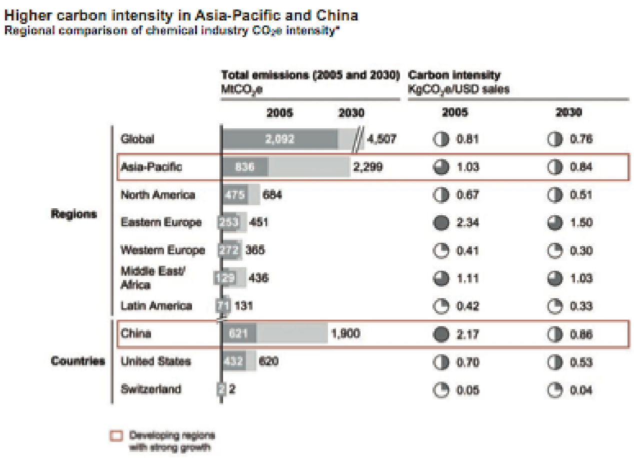
A major potential for improvement which remains to be tapped ...

A potential for improvement has been evaluated (and validated) and can be translated technologically relatively quickly, and at a maximum cost of 60 € per tonne equivalent CO_2. Global investments are estimated (probably rather generously) at 520 billion € between 2010 and 2030. In return, savings of 280 billion € would be achieved through improvements to energy efficiency.

Energy intensity would be reduced by 25%, while production would double, according to four major technological thrusts:

- the constant improvement of energy efficiency would contribute 55% of the reduction expected;
- 21% of the potential for improvement is attributed to the rolling out of the carbon capture and storage techniques. However, these new techniques, which have yet to bed in (it is not expected that they will be rolled out on any significant industrial scale in the chemical sector before 2020) will not be able to be applied to the whole chemical industry, but only to units producing large volumes of CO_2 emissions);
- 16% of the potential reduction in GHG emissions could come from the substitution of oil-based or coal-based raw materials by materials generating fewer emissions (new generations of 'clean' fuel oils, replacement of oil by gas, coal by biomass, etc);
- finally, 8% of the improvements could come from the reduction of GHG other than CO_2, in particular nitrous oxide (N_2O), which is involved in the production of nitric acid and adipic acid.

... and disseminated at global level



Source: ICCA, Innovations for Greenhouse Gas Reductions, July 2009

[15] McKinsey study, *Pathways to a Low-Carbon Economy.*

Risks identified for the European chemical industry: the question of carbon leakage

The question of relocations raises the problem of the increasing fragility of the European chemical industry. One reason for this vulnerability is the strategic choices made over the last fifteen to twenty years by the big players in the sector (investment strategies based on refocusing, rationalisation and geographical redeployment which have helped to weaken the European industrial bases). If no initiative is taken in terms of industrial policy, then the geographical relocation of the chemical industry should continue regardless of the carbon factor, of which the risk can thus be played down. In employment terms, the future of the chemical sector lies in innovation, and therefore in skills.

An industry which destroys employment ...

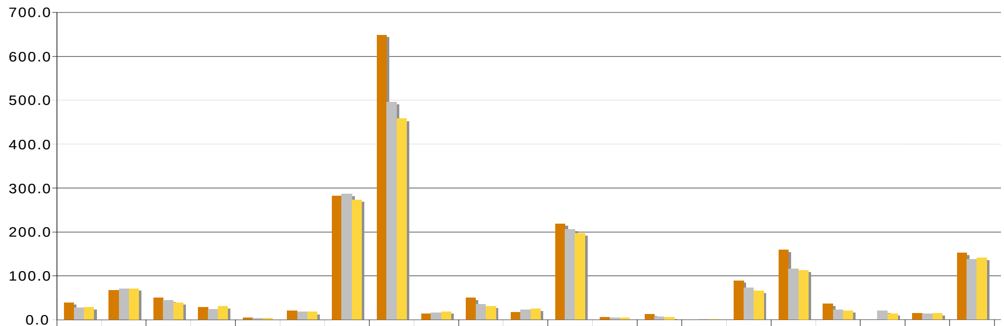
The statistical data on employment in the European chemical industry are too crude to allow any detailed analyses to be drawn, in particular on the employment impact of the carbon factor. The growing systemic dimension of the European chemical industry causes problems regarding jobs deployed on the extended perimeters beyond the direct jobs, by including indirect and ancillary jobs.

The European chemical industry tends to destroy jobs as a result of productivity gains, restructuring operations and repositioning of players, and this is more acute in the north of Europe than in the south. The number of chemical industry jobs in the EU has fallen from 2.2 million in 1991 to 1.8 million in 2008, a reduction of 430,000 jobs (– 19%). Among the countries in the north of Europe, Germany and the United Kingdom lost almost a third of their jobs between 1991 and 2008. Only Belgium has enjoyed slight growth in its employment levels. In the south of Europe, the adjustments have been significantly less dramatic, but the chemical industry there is structurally more fragile and more directly exposed to the rise of the new competitive front that is emerging in the Middle East and the Mediterranean basin.

... while transforming it

This entrenched movement of destruction is accompanied by another movement of a more qualitative nature, involving the evolution of trades and skills, notably in connection with the rise in environmental issues, the REACH regulation and the carbon factor.

Distribution and evolution of employment in the European chemical sector



	Austria	Belgium	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Netherlands	Poland	Portugal	Slovak Republic	Slovenia	Spain
1991	38.6	67.0	49.2	28.7	4.4	19.8	282.7	648.9	14.3	49.4	16.5	218.6	5.7	12.9	0.0	89.4	159.5	35.9	0.0	14.9	151.9
2000	27.1	70.1	44.4	23.6	3.2	18.6	286.6	495.5	15,5	35.4	23.1	206.3	4.2	6.4	1.6	72.1	115.4	22.6	19.6	13.6	136.8
2008	28.1	70.6	38.8	29.9	3.0	17.6	273.1	457.3	18.4	31.0	25.2	196.3	4.	5.	1.1	65.7	113.2	20.5	14.2	14.7	140.9

Source: Eurostat

The changes in the chemical industry and the issues around jobs and skills linked to the carbon factor: linking the short term to the long term along various thrusts

'Transition management' in the process of adapting the chemical industry to the carbon factor

Major issues:

- to create a European fund to finance these transitions with eligibility conditions to be defined and rules ('rights and duties') to be constructed on an offensive basis;
- to design, or extend through reinforcement, the mechanisms to accompany the changes in the field of GHG. What is at stake is to manage the transitions in such a way as not to pass all the risks and the associated costs on to employment;

'Initial training and ongoing training' in the field of skills linked to sustainable development and the carbon factor

- to develop the sectors or areas of training in connection with sustainable development in general (specifically the REACH regulation) and GHG; to support the contribution made by the chemical industry in the rise of eco-industries and to promote the development of sectors of green chemistry through the development of skills in the fields of research and scientific expertise;
- to promote the emergence of a new professional culture and the adoption of a new type of governance in companies angled towards the sustainable development and low-carbon dimension (as opposed to the financial short term).

All the big issues of the carbon factor for the chemical industry are dimensions around which recommendations can be structured

The first issue: a snapshot for the sake of better visibility[16]

Recourse to benchmarking as advocated by the chemical industry suggests a major prior stage of negotiation. This requires obtaining more accurate evaluations on the distribution of the industrial tools in each of the sub-sectors emitting the most GHG (and covered by the ETS mechanism), in terms of performances in technical and environmental terms (including GHG emissions) as well as in financial and social terms. However, if such information is available in the various systems of benchmarking used by chemists, it is nevertheless regarded as confidential … and so it is not fed into the debate about the evaluation of the risks that the transition to a low-carbon economy entails for the chemical industry and the employment that it mobilises both directly and indirectly.

This means there is a central issue in terms of the stakeholders in the framework of the negotiations gaining access to information that is relevant and best suited to facilitate more rigorous evaluations.

The second issue: finding the mechanisms best suited to influence the behaviour of the players in the chemical industry

In the context that we have outlined above, no public or collective mechanism can make do with exclusively incentive measures. The need to

[16] The statistical system is not suited to the evaluation of the prospective industrial and social issues. The various nomenclature schemes available at world or European level, or even within each country, are not sufficiently analytical, given the complexity of the segmentations in the various branches of chemical activity. So the sub-sectors in chemicals which are subject to the GHG emissions trading scheme cannot be identified from the existing statistical systems.

coordinate and regulate must become a reality. It is not possible to count only on financing and the mechanisms of the market alone. The regulatory and economic instruments cannot produce immediate large-scale effects as demanded by the problem of GHG, but they are essential. However, they must be addressed in a fresh way, a way that remains to be invented, tying in at least three levers: the accountability of consumers (via certification and labelling mechanisms, specifically), that of businesses, and the adoption of a specific regulatory framework.

The third issue: to create, in a fragmented universe, the foundations for cooperation between operators in the chemical industry

The issue relates primarily to the relations between big businesses and SMEs / SMIs, within a value chain that is fragmented between the upstream and downstream sides or between the subcontracting operators and the principals, while the dissemination of innovations is severely curtailed. The principle of benchmarking does not foster cooperation between big players and smaller ones.

The fourth issue: to create the mechanisms for coordination between chemicals and the applicative areas

This fourth issue refers to the manifold interconnections linking the chemical sector and the various applicative areas:

- it is hard to imagine an industry in a zone that has lost all its chemicals...
- chemicals are involved in innovation in the other sectors, in terms of both processes and products.

Creating mechanisms for coordination between chemicals and the applicative areas would help to stimulate the shift in production methods or the design of finished products incorporating chemical products towards 'low-carbon' solutions, insofar as the overall balance along the whole value chain reveals a genuine advantage.

The fifth issue: to foster international cooperation

The objective is to favour the promotion of the economic model that is the most effective in energy terms by limiting the risks of carbon leakage.

There is an international cooperation issue, which notably involves the question of technology transfer. Hand in hand with this, we also have an issue of solidarity between the areas which involves regulatory mechanisms on borders.

2.6. Glass

The glass industry is not among the biggest industrial polluters. Nevertheless, glass fusion is a high-temperature process which is a source of atmospheric pollution. The main components in this pollution are those resulting from combustion, notably NOx, SOx and particulates. Moreover, the manufacturing processes in the glass industry require a lot of energy.

The major environmental issues for this industry and its various sub-sectors are therefore releases into the air and energy consumption.

Evolution of estimated emissions of dust and GHG between 1997 and 2005, Europe-wide

	1997	2005
Dust (tonnes)	9 000	6 500
NOx (tonnes)	103 500	105 000
SO2 (tonnes)	91 500	80 000
CO2 (millions of tonnes)	22	22
As a% of European industry	0,7%	0,8%
Energy consumption (TJ)*	265	311
EU glass production (millions of tonnes) **	29 (EU-15)	37,7 (EU-25)

** in 2005, energy consumption breaks down as follows: 15% electricity, 30% fuel oil and 55% natural gas.*
*** the growth on the EU-15 perimeter was greater in the field of flat glass, tableware and reinforcing fibre than in hollow glass.*

At the European level, emissions of CO_2 from the glass industry represent some 1% of emissions from industry.

Technologies such as the substitution of fuel oil by natural gas (where CO_2 emissions are 30% lower), glass recycling (cullet) or preheating of the glass composition have been developed for the sake of significantly reducing CO_2 emissions from glass furnaces. Widely mobilised, they have already made for reductions in fossil fuel consumption (for example, –5% per tonne of glass produced in France between 1996 and 2005).

However, beyond that, any more profound technological breakthroughs are faced with technical, political and – above all – economic obstacles. Their profitability is sensitive to the price of carbon and the various fuels. Insofar as it is very hard to establish reliable forecasts for the price of carbon or that of fuel oil or gas, the glass industry is reluctant to make heavy investments, all the more so because in the short term, its carbon position is relatively comfortable.

This means that the conservative positions adopted by the glass industry are subject to debate. In the big companies, the efforts made in terms of quotas are not very offensive, insofar as they focus on an internal rebalancing of the quotas (as between installations) and complementary recourse to the market for compliance purposes. The European federation has succeeded on its side, after intense activism, in getting the glass industry admitted among the sectors exposed to 'carbon leakage', thereby securing it the benefit of a support scheme in terms of allocations of quotas built on benchmarking.

However, there is certainly more room for manoeuvre than the companies in the sector will admit to. The entire potential for improvement of energy performances through technological innovation still has not been fully exploited. It is important to continue driving forward the innovation effort and deploying it via investments.

Yet on this point, the investment strategies in the glass industry focus on the construction of production capacities away from the mature areas and the rationalisation of capacities in the mature areas. The objectives being pursued are more to do with access to new markets than relocation, as the glass markets tend to be organised on a regional basis. This is the case with the bulk of flat glass and hollow glass, which together represent almost three quarters of the volumes produced in Europe. Exposure to competition from outside Europe is high in some sub-segments (tableware, reinforcing fibres, glass packaging geared to the mass market, etc).

The operational margins of the glass industry have been rather well oriented in recent years, despite the rise in energy costs, thanks in particular to the practice known as the 'energy surcharge' in the majority of the glass sub-sectors (rebilling to clients of rises or falls in energy costs). They have been influenced by the cyclical dynamic which characterises much of this industry. The current crisis has had an impact on the results of the glass companies (more markedly on those focusing on the building and automobile markets than those serving the consumer markets). The players' repositioning strategies which could lead to consolidation and restructuring operations are very active in Europe, especially in hollow glass, tableware and reinforcing fibre, and they focus the risks in terms of employment. The crisis is not changing the underlying strategic tendencies.

For the glass industry, climate change is more of an opportunity than a threat. Indeed, several areas of application are positively involved in the issue of the migration towards a low-carbon economy. These are mainly the flat glass sector, whose applications for building purposes are particularly in demand in improvements to energy performances (low emissions, insulation, etc). This likewise concerns automobile applications (lightening and reducing consumption), as well as specialist applications (photovoltaic glass, solar panels). As a complement, the glass fibre sector is equally involved in the development of energy applications (wind power).

Exploiting this significant potential requires an adaptation of the technologies so as to increase the share of technical glasses and to develop processing skills and capacities. In fact it seems that pockets of employment exist not so much in the flat glass production sector (a capital-intensive sector employing some 16,000 people in Europe) as in processing (some 100,000 people), organised into SMIs which are sometimes part of large glass groups, particularly in 'low-energy consumption building' applications. The number of buildings in this category is marginal, but its development will be faster and on a larger scale as incentive mechanisms begin to be rolled out in financial and fiscal terms. Potential growth levels of over 10% per year have been suggested by 2030. As to conventional construction, the speed of growth and renovation should remain at sustained levels (growth in GDP of +1 to 2 points). Employment is directly concerned by this dynamic in quantitative terms (enlargement of the field of applications by virtue of the development of the surfaces and the volumes of glass installed in old and new construction projects) and in qualitative terms, upstream of the flat glass sector to support glass innovation, and downstream in the glass processing techniques (cutting, shaping, tempering jobs, insulating glass and laminates), as well as in jobs involved in glazing.

2.7. Aluminium

Direct emissions

Like all non-ferrous metals, aluminium is not one of the sectors concerned by the first phase of application of the Kyoto Protocol, at least not directly. The first reason is the relative share of non-ferrous metals in greenhouse gas emissions, since CO_2 emissions from this sector are estimated at 3% of the total emitted by industry, i.e. a little more than 0.5% of overall emissions.

As from 2013, however, the inclusion of direct emissions of CO_2 and fluorinated gases will put European aluminium in a new position. According to figures compiled by the sector[17], direct emissions break down into:

- 2 t of CO_2 per tonne of aluminium for the production of alumina, an intermediate product manufactured primarily in mining countries and in countries that have abundant low-cost energy, two conditions of competitiveness that have not existed in Europe for many years;
- 0.3 t of CO_2 equivalent per tonne of aluminium for the production of anodes;
- 1.7 t of CO_2 per tonne during the consumption of anodes in carbon for the transformation of alumina into aluminium;
- 1.2 t of CO_2 equivalent per tonne in the form of fluorinated gases.

Altogether, production of a tonne of aluminium emits 5.2 t of CO_2 equivalent.

[17] Jerry Marks, International Aluminium Institute, Bonn, 12 June 2003.

Indirect impact dominates

Indirectly, aluminium producers – who form part of producers of energy-intensive non-ferrous metals – are also concerned by the repercussions of the price of CO_2 by electricity producers.

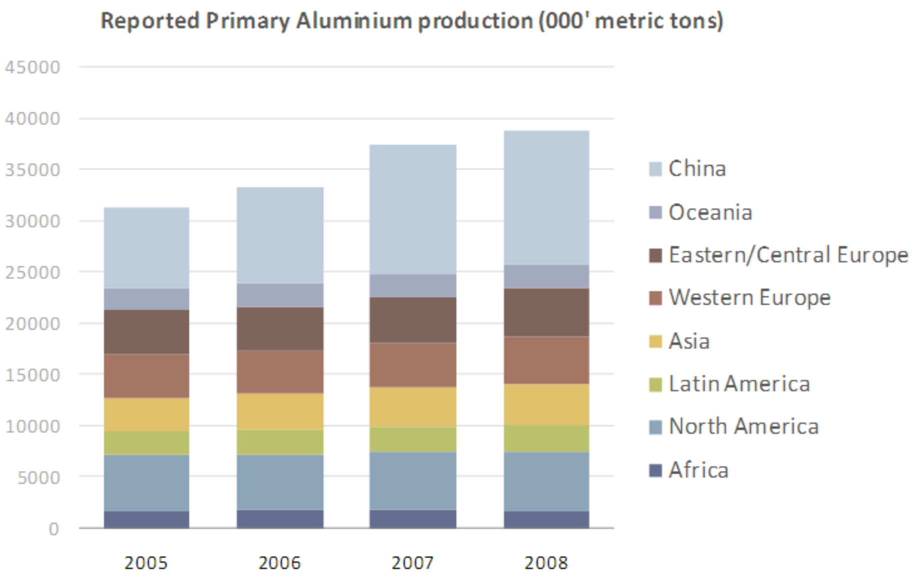
Higher electricity prices, due partly to the price of CO_2, could substantially change the sector's competitive position in Europe, due to the simultaneous existence of two phenomena:

- more than half of the long-term low-price electricity supply contracts concluded by aluminium producers will be renegotiated within the next five years;
- electricity producers will have to buy 100% of their emissions allowances at auctions as from 2013 according to the European rules adopted in 2008, this choice being legitimised by the possibility of passing on the cost of CO_2 in their sales prices.

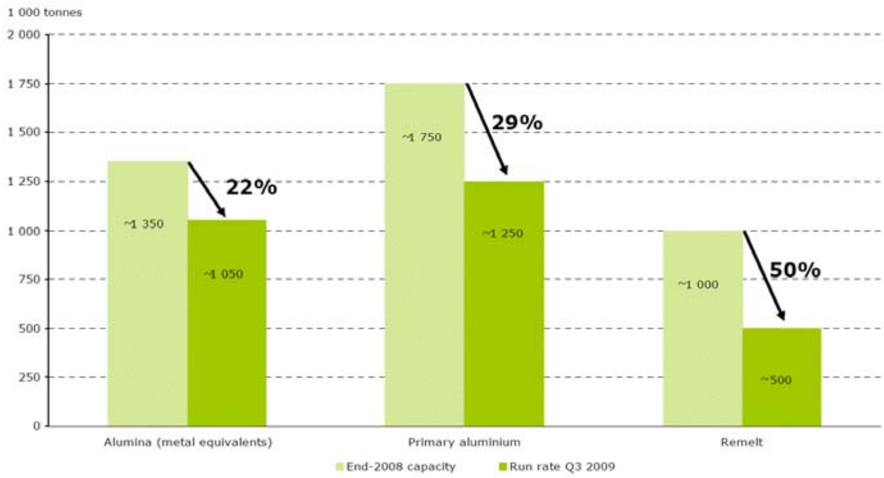
Considering these circumstances, the dangers of carbon leakage are real in the absence of an international agreement that enables European aluminium producers to equal the conditions of importers not subject to a carbon constraint, i.e. half the producer countries[18].

This is particularly the case because aluminium is covered by futures contracts on the London Metal Exchange, which in recent decades has become the exchange of reference for global prices. This being the case, how can one imagine a European aluminium price that includes the cost of carbon built into electricity prices, i.e. consumption of 15.6 MW/h per tonne of aluminium, or an average of 4.8 tonnes of CO_2, according to the sector?

[18] Source: IAI.



Production in 3rd quarter 2009 compared with capacities



The impact of the crisis

The situation in 2009 is nonetheless not really comparable with the progression of recent years, since numerous production stoppages have lowered global production by 15% to 20%, increasing the vulnerability of the least competitive manufacturers, notably those who have access to the least favourable energy mix. Hydraulic energy offers a decisive competitive advantage for the continuity of this industry.

Since 2008, the decline in primary aluminium production has had multiple repercussions on the production of secondary aluminium, although recycling is considerably less costly in terms of energy consumption than the production of primary aluminium. The result has been numerous plant stoppages accompanied by staff reductions and short-time working.

The crisis interrupted concentrations in the sector, where a few groups had gradually formed an oligopoly representing a vast majority of global aluminium production. The first signs of recovery seem to be relaunching these transnational transactions in primary metals, including aluminium. In parallel, however, the separation of aluminium production from its processing recomposes the matrix of groups in the sector in a context of increasing financial constraints.

All analysts concur, however, that the outlook for aluminium production at global level remains positive owing to its properties. In some major sectors, competition between materials could nevertheless work to the disadvantage of this metal (aeronautics and automotive industry in particular).

Jobs in Europe

The distribution of jobs in this industry in Europe demonstrates the importance of processing, although there is a recognised strategic link with upstream phases[19].

Production and employment in the aluminium industries in the EU 27

	Production (Mt)	workers	Imports (Mt)
Bauxite	2,8	2000	15,1
Alumina	6,9	3700	
Aluminium	3,1	22800	5
Recycled aluminium	5,1	6500	
Total		35000	
Processing		215000	

It is difficult not to imagine a general weakening of a European industry that would no longer master the technologies of aluminium production.

What industrial policy?

From our point of view, two dimensions must be given priority with the goal of safeguarding an industry threatened with a major loss of competitiveness. Such a decline would have serious negative consequences on employment in Europe. It is vital to:

- solve the question of access to electricity at a competitive price through access to dedicated sources, since liberalisation measures have not succeeded in guaranteeing competitive prices;
- encourage technical solutions that help reduce emissions of CO_2 and fluorinated gases through the development of pre-competitive research: the example of inert anode developed in certain research projects can prove to be promising quite quickly.

The principal handicap, even though it does not appear to be definitive, nevertheless lies in the weakness of producers in Europe compared with the world's giants.

[19] Eurométaux, *Climate Change Impact Risk on Employment*, June 2009.

3. The industrial sectors subject to the carbon regulations

3.1. The automobile sector

Branch profile: the European automotive industry

The automotive industry is one of the most important industries in Europe and is one of the backbones of industrial production in Europe, holding a share of around 31,8% of the global automotive production.

According to the European Automobile Manufacturers' Association (ACEA), the automotive industry and its supplying industries employ a total number of 12 million people in Europe. Directly involved in the production of vehicles were approximately 2,3 million employees in 2007. The supplying industry has 10 million employees. The automotive industry is of great importance for other economic branches such as the metal, plastic, chemical, textile, electrical and electronics industry. The majority of European production sites are located in Germany, France and Italy. The export rates of the European automotive industry reached a total amount of 42,8 billion € in 2007. The industry also is one of the leading driving forces of European innovation processes with annual research & development investments of averagely 20 billion €. In 2007, the European vehicle fleet had 251 million vehicles, thereof 87% passenger cars. The number of newly registered vehicles per year was 37 million.

Until 2007 the number of produced vehicles increased every year. However, the energy consumption in the production process of passenger cars was reduced from 2005 to 2007 by 0.9%. According to ACEA the average energy consumption per produced vehicle decreased between 2005 and 2007 by 6,5%.

There are two determining objectives for the automotive industry in regard to lower CO_2 emissions: the reduction of emitted CO_2 of cars and commercial vehicles in operation and the reduction of CO_2 emissions in the production process of vehicles.

CO_2 emissions resulting from the production of passenger cars increased in sum between 2005 and 2007 at a rate of 1,4% due to the growing number of produced passenger cars. Efficiency rates are measured by the amount of CO_2 emitted per vehicle produced, which fell by 5% to 0,83 tonnes CO_2. This is mainly a result of higher efficiency rates in the production process.

The percentage of CO_2 emissions caused by cars and commercial vehicles currently reaches 12% of transport related CO_2 emissions. Various innovations and technologies contributed to a decrease of CO_2 emission rates caused by new vehicles. In 2008, the average amount of CO_2 emitted by new vehicles was 154g/km. In 1995 only 3% of new vehicles had lower emission rates than 140g CO_2/km. Currently already 42% of new vehicles reach this CO_2 emission rate.

The European Parliament and the European Council have published new regulations on the CO_2 emission rates of passenger cars in December 2008. Over 65% of newly registered vehicles shall have an average CO_2 output of 130 g/km until 2012. Until 2015, even 100% of newly registered vehicles shall comply to this target by technological measures.

The recycling process of cars is also a source of CO2 emissions. 2 to 5% of the entire amount of CO2 emitted during the life time of a vehicle is caused during its recycling. Around 8 million vehicles reach the end of their life time cycle in Europe every year.

Due to innovation in recycling technologies, the management of materials and information systems has improved and the automotive industry was able to fulfil the preferred governmental quotas and to optimise the entire recycling process.

The European automotive industry in change

The automotive industry was significantly hit by the financial crisis and the economic turndown in the second half of 2008. In the last quarter of 2008 sales rates of vehicles in Europe fell on average by 19,3%, in few EU countries even by over 50%. The decreasing demand in 2008 has caused a decrease in production of 20%. This trend of demand had a negative impact on employment, budgets and caused even closure of production sites.

In its environment and industrial policy, the European Union has decided to reduce greenhouse gas emissions until 2012 according to the Kyoto-protocol by 8% compared to 1990. The emission of greenhouse gases shall decrease by 20-30% until 2020. While other branches demonstrated decreasing emissions rates in the same period of time by averagely 3%, the transport sector had an increase of CO_2 emissions at a rate of 35% between 1990 and 2006. The share of CO_2 resulting from the transport sector reached 21% in 1990 and 28% in 2006.

In this regard, the pressure on the automotive industry to produce vehicles with higher efficiency rates and lower emissions has increased. Apart from numerous trends like hydrogen fuel cell cars or eco-driving, the main technologies are hybrid, plug-in hybrid and electric vehicles. These key technologies are part of the following projections until 2030, to differing extents and contribute remarkably to the resulting CO_2 emissions.

Comparison of estimates for the development of passenger cars

The majority of experts estimate a growing number of hybrid vehicles on the market within the next years. There are different scenarios on the number of hybrid and electric vehicles, CO_2 emission rates and the energy consumption of the European automotive industry. The main difference among the projections is the overall number of cars and the development of hybrid vehicles and electric vehicles. In order to have comparable numbers between European and global scenarios we have recalculated all numbers to the European region

Scenario	Year	Vehicle fleet passenger cars Mio.	Share of vehicle fleet ICE %	Hybrid %	Electro %	Energy Demand Mtoe	CO_2-Emissions $MtCO_2$	Change %
McKinsey	2006	219	100	0	0		930	Decrease
Mixed-technology	2030	390	88	11	1		750	19,35
DG TREN	2005	213	100	0	0	180	881	Increase
	2030	352	97	3	0	198	1003	13,85
FONDDRI	2006	227	98,8	0,6	0,5	293	861	Decrease
Basic data	2030	241	67	21	8	185	479	44,37

Urban Transport and rail tranport more climate-Frendly and more employment intensive

A climate-sensitive transport policy needs to go beyond more efficient automobiles and address the severe imbalance among different modes. This means promoting and reinvigorating urban public transport, as well as inter-city rail. Though not without its share of environmental issues, urban transport is more climate-friendly than the automobile system. A shift would help meet climate goals and create net employment gains.

According to the International Association of Public Transport (UITP), an estimated 900,000 people are employed in urban public transport in the 25 member states of the European Union. UITP has 2,900 members from 90 countries, and national statistics from these countries suggest that the number of direct jobs in public transport amounts to about 1–2 percent of total employment. Urban transport agencies are major employers. In Paris, RATP (Régie Autonome des Transports Parisiens de France) employs 43,600 people. STIB (Société Transport Intercommunaux de Bruxelles) in Brussels has more than 6,000 employees .

Public transport investments in Europe have an average job multiplier effect of 2 to 2.5 (but reaching as high as 4.1 in some cases). Studies in Europe and the United States show that about 30 jobs are created for each €1 million invested in public transport infrastructure, and 57 jobs for the same level of investment on the transport operations side. An Öko-Institut study estimated in 2003 that even in the short-run, an expansion of local public transport could yield a net gain of **200,000** jobs by 2010 in Germany. Denmark will likely see an expansion of transport jobs, since its parliament decided to focus the country's economic stimulus package on transport, and especially on public modes.

A 2005 survey of about 170 cities by UITP found that inefficient and polluting diesel buses account for about 90 percent of all urban buses in EU countries. Less-polluting alternatives are particularly prevalent in Helsinki and Athens (CNG), Vienna (LPG), and Luxembourg (biodiesel, hybrids). In addition to job gains from replacing old, polluting buses, there are also employment opportunities in retrofitting buses to reduce air pollution.

Rail transport is more fuel-efficient and more labor-intensive than road transport. German studies suggest this is true for track construction relative to road construction as well. Indeed, highway construction generates the fewest jobs of any public infrastructure investment.

Yet, in many countries, trends in inter-urban transport have been strongly in favor of road vehicles, moving away from rail transport for both passengers and freight. Although the quantity of passenger-kilometers and ton-kilometers in Europe increased in absolute terms, in 2005, rail transport's share of passenger and freight traffic decreased, and stood at 5.8 percent and 10 percent, respectively. In the EU-25, the road and motorway network accounts for 95 percent of the length of all transport routes. Road length grew by 22 percent between 1990 and 2003, whereas the railway network shrunk by 8 percent to under 200,000 kilometers.

In the EU-25, a total of 8.2 million people were employed in all transport services combined in 2004. Railway transport—far less fuel-intensive and polluting than trucking and other road transport—accounted for just 11 percent, or 900,000 jobs. Rail employment has fallen in the last few decades; in just the short span of time between 2000 and 2004, the number of jobs was cut by 14 percent even as value-added grew 3 percent. Road passenger and freight transport jobs, by contrast, number some 4.3 million, and air transport jobs number 400,000.).

In 2004, transport equipment manufacturing employed about 3 million persons in the EU-25, accounting for 9 percent of the EU-25's manufacturing workforce. The manufacture of motor vehicles, trailers, and semi-trailers represented more than two-thirds of these jobs. The manufacture of railway and tramway locomotives and rolling stock in the EU-25 employed just 140,000 people in 2003, or half a percent of all industrial employment.

Even though a sustainable transport policy may ultimately lead to fewer jobs in car manufacturing and related fields such as vehicle retailing and repair services, it offers more jobs in manufacturing of buses, light rail, subways, and railways; in the provision of the required infrastructure for these modes of transport (including tracks, signals, stations, etc.); and in planning, running, and maintaining transport systems (bus drivers, conductors, and other operators; route planners, maintenance staff, etc.).

The study led by the ETUC 2005-2006 offers a useful light on the question of the impact of a modal tranfer to rail and urban.

Two scenarios have been selected starting from the projections carried out by the Commission's DG-TREN for the 2001 White Paper. These are the 2005 reference scenario ("Business As Usual", BAU) and the "Extended Policy" scenario, which is the one which, compared with the BAU scenario, leads to the greatest reduction in CO2.

In addition, two variants of the "Extended policy" scenario have been constructed to analyse the impact of lowered passenger and freight activity and road/rail rebalancing.

In firts altenrative scénario (lower freigt activity), for passenger transport: a lowering of private road transport activity by 25% in 2030 in comparison with the "Extended Policy" scenario, compensated by an increase in public road and rail transport.

For freight transport: an overall lowering of freight activity by 15% in 2030, and a rebalancing of rail in relation to road taking the share of rail to 26% in 2030 as against 14% for the "Extended Policy" scenario. Thus the share of rail would be returned to its 1990 level.

In this scenario, CO2 emissions may be estimated at 845.5 Mt at the 2030 horizon, or an increase of 7% compared with 1990 (compared with 10% in the BAU scenario) and a decrease furthermore of - 3% with regard to the scenario " Extented policy ".

In sceond alternative secenario (lover freight activity and passengers), a lowering of passenger transport activity of 8% at the 2030 horizon compared with the "Extended Policy" scenario, and, in addition to the 15% reduction of freight activity in the preceding scenario.

Emphasising policies that favour a reduction in private passenger transport, within the technological hypotheses of the "Extended Policy" scenario, leads to a reinforced reduction of CO2 emissions, namely a 1,2% increase compared with the year 1990 and a 17% reduction of CO2 emissions compared with the year 2000.

In these scénario, The number of employees directly linked to rail freight transport would so pass of about 200 thousand employees to 477 thousand employees on the horizon 2030, against 234 thousand employees for the extented policy scenario.

On the basis of a hypothesis of a 10% per decade reduction in road freight transport activity over the period 2000/2030, the employment induced would post an average annual reduction of 1.05%.

the number of employees directly linked to road freight transport would thus be brought down from 2.3 million in 2000 to 1.6 million in the Europe of 25, i.e. a reduction of 0.7 million employees (on average more than 25,000 employees per year).

In the context of the hypotheses of the "Lower Activity" scenario, rebalancing the lessening of private transport activity partly towards public road transport, would lead to a greater level of employment growth than the losses observed in road freight transport.

Of course, to be sustainable, this scenario requires a partial conversion of motor technologies, depending on distance, to natural gas, hybrid, electric, while waiting for hydrogen, and also an urban and regional planning policy giving priority to clean public transport.

Overall, policies aiming on the one hand to restrict transport activity and on the other hand to rebalance transport modes in favour of rail in particular for both freight and passenger transport, far from being unfavourable to employment, **these policies would lead to a growth in overall employment** of around 2% on average per year over the period 2000/2030 for passenger transport and 1.25% for freight transport.

Recommandation for transport policy

- Implement a wide range of economic, regulatory and market based instruments
  - ⇨ develop trans-european transport networks contributing to reduce emissions from transport as well as those necessary for new fuels such as hydrogen
  - ⇨ develop appropriate measures in financing of research and development (clean motor technologies)
  - ⇨ fiscal policy for all transport networks – roads, motorways, railways- aiming at internalising external social costs of various transport modes
  - ⇨ policy of localisation of activities, control of urbanisation and planning of urban roadways, evaluation of planning policy
- Issues for job quality
  - ⇨ improvement of social conditions in the road transport sector
  - ⇨ development of combined unaccompanied transport
- Social dialogue as a facilitator of change
  - ⇨ In a voluntarist scenario of reduction of road transport, social dialogue may also contribute to the design of social policies aiming at supporting job mobility from road transport towards public transport or other activities
  - ⇨ Investing in training

The „mixed technology scenario“ of the McKinsey study „roads toward a low-carbon future” assumes that CO_2 emissions resulting from passenger cars will decrease between 2006 and 2030 at a rate of 19,35%. This is based on the assumption that the total number of vehicles will increase by 78% until 2030 and that 42% of the produced new vehicles are hybrid or electric vehicles. In 2030 this accounts for 12% of hybrid and electric cars of the entire vehicle fleet.

The DG TREN study represents a rather conservative assumption on the share of hybrid and electric vehicles among new vehicles with the effect that CO_2 emissions will rise by 13,85% until 2030, irrespective of lower growth rates in the entire vehicle fleet.

FONNDRI estimates the greatest decrease of CO_2 emission rates by passenger vehicles. This comparably great decrease is explained by very low increase in the number of vehicles until 2030 and a high share of hybrid and electric vehicles.

As a consequence the various projections on the development of CO_2 emissions for 2030 show great differences. This is mainly a result of assumptions on the share of hybrid and electric vehicles in the entire vehicle fleet and the overall number of the vehicle fleet.

Scenarios 2015-2030 on the automobile sector

Construction of the scenarios

Starting from the various forecasts in the sector, three hypotheses have been drawn up for 2015, 2020, 2025 and 2030. Each one thus presents three hypotheses about the degree of penetration of hybrid and electric vehicles: *the low hypothesis (LH), the median hypothesis (MH) and the high hypothesis (HH).*

Low hypothesis (LH)

The low hypothesis relies on strong concentration among industry players to improve conventional engine types and existing technologies. Under this scenario, support from the States and the institutions is regarded as weak, thereby curbing the development of R&D in the sector on alternative engine types, the development of ancillary infrastructures and the incentive to purchase 'low-carbon' vehicles. The low hypothesis thus rests on limited penetration by hybrids, because they still cost a great deal more and demand is low, and minimal penetration by electric vehicles (EV). It also takes into consideration a low price per barrel of oil (working in favour of conventional engine types).

Median hypothesis (MH)

The median hypothesis relies on a big improvement to alternative technologies and engines rendered possible in part by a reduction in additional production costs. Under this scenario, support from the States and the institutions to the sector is taken to be modest. The median hypothesis thus rests on a surge in hybrids and still limited penetration by EV. Moreover, it assumes a stable price per barrel of oil (neutral effect).

High hypothesis (HH)

The high hypothesis relies on a significant improvement to alternative technologies and a serious reduction in additional production costs. Under this scenario, support from the States and the institutions to the sector is taken to be strong. The high hypothesis thus rests on significant penetration by hybrids and modest penetration by EV. It also assumes a high price per barrel of oil (working in favour of electric engine types).

Scenarios and impacts on employment

A positive employment balance

The employment impact on the engine assembly sector would remain limited in Europe by 2030 in the case of low penetration by 100% electric vehicles and because of the hybrid transition, which guarantees, over the period, a persistently sizeable share of conventional engines in tomorrow's vehicles.

Figure 1: Scenarios showing the evolution of the production of alternative engine types 2015-2030

Année	2015			2020			2025			2030		
Pénétration (%) vs Hypothèses	HB	HM	HH	HB	HM	HH	HB	HM	HH	HB	HM	HH
Conventionnels	98%	96%	93%	94%	87,5%	80%	88%	80%	73%	80%	73%	60%
Hybrides	2%	4%	6%	5%	10%	15%	10%	15%	20%	15%	20%	30%
100% électric	0,1%	0,5%	1%	1%	2,5%	5%	3%	5%	8%	5%	7,5%	10%

Mln unités	80			90			105			120		
Année	2015			2020			2025			2030		
Pénétration (Mln unités) vs Hypothèses	HB	HM	HH	HB	HM	HH	HB	HM	HH	HB	HM	HH
Conventionnels	78,7	76,4	74,4	84,6	78,8	72,0	91,9	84,0	76,1	96,0	87,0	72,0
Hybrides	1,2	3,2	4,8	4,5	9,0	13,5	10,5	15,8	21,0	18,0	24,0	36,0
100% électriques	0,1	0,4	0,8	0,9	2,3	4,5	2,6	5,3	7,9	6,0	9,0	12,0

Figure 2: Overall potential losses and gains

	2015			2020			2025			2030		
Balance	HB	HM	HH	HB	HM	HH	HB	HM	HH	HB	HM	HH
Potential job losses	336	1680	3360	3150	7875	15750	8453	16905	25358	16800	25200	33600
Potential job gains	13529	40857	66406	36511	79714	136302	68469	117731	166993	79211	112613	158421

Employment linked to the development of electric engines would have an impact of some tens of thousand of jobs, notably with regard to the emergence of the electric technology inside the hybrids.

By 2030, then, losses linked to the substitution of conventional engines by electric engines would represent – according to the three hypotheses – between 17,000 and 34,000 jobs.

Jobs gained might largely offset these losses by 2030, with some more significant gains: of the order of 80,000 to 160,000 jobs according to the hypotheses established[20].

Industrial and social recommendations and prospects

Broadly speaking, the employment issues linked to the development of low-carbon vehicles depend to a large extent on the policies and measures framed at European level, and the measures taken by each State in the Union.

The compromise secured with the automobile industry around the directive on light vehicle emissions (at 130 g of CO_2 per km) will need to be revised quickly to achieve the target of 95 g of $C0_2$ per km advocated by the Commission. Making thermal engines cleaner implies a greater effort, as recommended by the T&E network at European level, with a target at 80 g of CO_2 per km by 2020 and 60 g by 2025.

Reaching this target implies the reinforcement of the technological platforms at European level, but also clusters between the industries and the research and development centres.

Driving forward the demand for cleaner vehicles implies that the members of the European Union implement some incentive policies, both positive and negative, such as tax breaks or a carbon tax (the social acceptance of which will depend on its fiscal neutrality for the poorest households).

Europe is lagging behind Japan when it comes to hybrids, and needs to redouble its efforts if it does not want to be faced with competition from heavyweights such as China in the field of electric vehicles. Without a substantial industrial player in the field of batteries, the employment expected in the electrical sector is liable not to materialise.

Engine downsizing, hybridisation and electrification of vehicles offer opportunities in terms of employment, but equally imply the mobilisation of sizeable resources to accompany the inevitable restructuring operations along the thermal engine value chain. To this end, a low-carbon vehicle adjustment fund might be created to finance the professional mobility measures linked to the development of the carbon constraint across the entire automobile sector, from refinery to distribution, not forgetting automobile repair, where trades will increasingly have to evolve in order to incorporate electromechanical and electronic skills.

[20] NB: The impact calculated is limited at present to the vehicle production perimeter (direct jobs including equipment manufacturing) and does not take account of the potential impacts upstream and downstream.

3.2. Machinery and Electric Equipment

Description of branches – economic role in Europe and in the context of globalisation

Machinery and Equipment

In the EU-27, in 2006 the Machinery and equipment sector counts around 164,000 companies which have 3.7 million people and generate Euro 178 billion of value added (comparisons for that and the other structure data: Eurostat 2007 and 2008, Electra and VDMA, 2009). This was equivalent to a share of 3.4 percent of the overall value added and almost 2.9 percent of non-financial business workforce. On the whole, the industry is made up by around 50 percent SMEs which often act as suppliers of larger companies or establish themselves in special niches on international markets. Germany, Italy, the UK, France and Spain have the highest shares with Germany being the largest manufacturer in all sectors except arms and ammunition concerning value-added. In relation to the national economy, the industry is furthermore of particular importance in Finland, Slovakia, Slovenia, Sweden and Hungary.

The industry is strongly export-orientated. Extra-EU-27 exports of machinery and equipment were valued at EUR 171 bn in 2006 and the EU has a trade surplus in machinery and equipment with the rest of the world. Still, intra-EU trade accounted for more than 50 percent of exports. In the future, demand, from India and China is expected to increase particularly in infrastructure, energy generation, energy efficiency and green technologies.

Electrical equipment

Electrical equipment (NACE DL) has with Euro 190 bn of value added and 3.7 million employees a similar high importance within the European industry as Machinery and equipment. Germany, France, Great Britain and Italy account for two thirds of production and a good half of the employees. Intra-EU trade accounts for almost two thirds of exports (2006: Euro 354 bn).

It is, however, to be considered that machinery and equipment obtains around one third of its advance investments from sectors producing in an energy-intensive way – iron/steel, non-ferrous metals, foundry, metalware and synthetics. Thus, the (indirect) energy costs included in the pre-production are more than twice as high as in machinery and equipment itself. In important "energy-relevant" sectors of electrical equipment the direct energy costs tend to be a bit higher, the induced indirect energy costs on the other hand are lower than in machinery and equipment (Table 1).

Table 1 - Energy costs of the production value of important "energy-relevant" lines of industry*

Line of industry	Energy consumption		
	direct	indirect	total
Machinery and equipment	0.8%	1.9%	**2.7%**
Devices of the generation of electricity	1.1%	1.5%	**2.6%**
Measurement and control systems	0.9%	1.3%	**2.2%**

** The energy consumption contained in the advance investments from domestic production was calculated with the aid of the inverse coefficients of the current input-output-table 2006 for Germany, the imported energy was estimated from the input-coefficients of the table. Source: Federal Statistical Office, national accounts (Fachserie 18, Reihe 2) August 2009; own calculations.*

Against this background the contribution of mechanical and plant engineering as well as individual lines of electrical equipment to reduce energy consumption and so avoid greenhouse gases consists

- on the one hand of an intensified employment of less energy-intensive materials for own products
- on the other hand of the development and production of more efficient and at the same time eco-friendly installations and equipment. Thereby a particular importance for improved techniques for the process industry can be ascribed to.

Owing to the extremely differentiated product structure, statements to the dimension of potential energy saving – as they are for example made for automobiles and lighting appliances – are nearly impossible to make[21]. In consideration of the key role and the high export quota of machinery and equipment and electrical equipment, indications on the energy-specific sales and employment potential of the industry are, above all, to be given here.

Method and Significance of the Potential Estimations

The Lead Markets "Energy Efficiency" and "Low-Emission Energy Production" are studied. Worldwide designed projections until the year 2020 by McKinsey are used as framework data. Predictions for the development after 2020 are not at hand[22]. The data used allow a view differentiated by sectors. On the other hand the estimations can be regarded as rather careful, because they are concentrated on such technologies and products with which the increase of the energy efficiency or rather the reduction of CO2 emissions is considerably above the historical trend.

Assumptions for individual production sectors are:

- Product line-specific world market shares of the EU 27 from 2006 will not change until 2020. In consideration of partly clear shifting in the large-scale production structure this expectation is rather ambitious

than to be regarded as a target value.

- Shares of machinery and equipment as well as electrical equipment for the output value of the surveyed goods will generally decline by 10 per cent by 2020. With this assumption the increasing diversification in the environmental technology is to be accounted for. With a proportion of value added of 50 per cent machinery and equipment is in fact still a key industry within the growth field energy efficiency and environmental technology; the proportion of services is, however, highly increasing.

To derivate the employment potential it was assumed that:

- In Germany (as the most important location of mechanical and plant engineering within the EU) the prevailing proportion of value added on average of the sector of 35 per cent will stay unchanged until 2020 and generally apply to the EU 27.
- Labour productivity rises - on average of the sectors - by three per cent annually.
- Serious relocations into countries outside of the EU 27 do not take place; the import share of advance investments of both industrial sectors will not change.

Development of the lead markets:

- According to studies by McKinsey the *Lead Market „Energy Efficiency"*, the market for products which offer innovative solutions for

[21] a comprehensive study of the International Energy Agency with the title: „Energy Technology Transitions for Industry - Strategies for the Next Industrial Revolution" will be published in September 2009. The German Engineering Federation (Verein Deutscher Maschinenbau Anstalten VDMA) has commissioned two scientific studies , which are also to be closed in the autumn of 2009

[22] McKinsey & Company: Wettbewerbsfaktor Energie, 2009 (energy as a competitive factor).

Table 2 - Solutions for optimising energy efficiency – relevant growth fields for machinery and equipment and electrical equipment

Centres of growth/submarkets	Tasks/technologies
industry-specific solutions	• Energy and heat from process waste • Product drying by waste heat • Employment of ultrasound for cleaning and mixing processes
automation and control	• integration power-management-approach in IT-systems • optimisation of heat distribution in machines/installations • reduction of changeover times with growing product range
heat recovery	• reuse of steam in preceding production stages • utilisation of waste heat to generate power • retrofitting of recovery plants in newly industrialised countries
industrial drives	• employment of low-friction materials • increased employment of electronics in pumps, ventilators, compressors and other installations • employment of magnetically soft steels to increase the efficiency of motors
building technology	• consumption optimised heating systems, household appliances and lighting technology

Source: own compilation on the basis of Projections by McKinsey (2008) und McKinsey (2009), BMU (2008), ifeu et al.(2009).

- energy consumption or transformation, will grow by 13 per cent annually between 2008 und 2020. Table 2 shows the broad spectrum of action fields and starting points, which are especially interesting for businesses of machinery and equipment and electrical equipment.

Based on the expected development of the total market it is calculated for mechanical and plant engineering in the EU-27 an increase in the production potential by nearly eight per cent annually (Table 3). This development stays in fact behind the average growth, but results, however, above all, from the fact that fundamental improvements cannot be expected at the high technical maturity of the products to such a degree as for example in the lines of building insulation or mobility[23]. In addition to that there is also a shifting in industry structure. Engineering companies and contractors are playing an increasing role in the optimisation of complex production with regard to energy efficiency or rather CO_2 reduction; but these are assigned to the service sector or rather the energy sector.

On the Lead Market „Low-Emission Energy Production“ the production potential for mecanical and plant engineering is growing by nearly 13 per cent annually and thus distinctly faster than in the Lead Market „Energy Efficiency“. In this process, growth leader is the

[23] measured by the expected growth of the mechanical and plant engineering of 2.2 per cent annually for the period 2005 until 2030 by the EU (Compare: DG TREN-Energy and transport trends to 2030, pdf), the segment “energy efficiency” nevertheless develops by far above average.

wind power technology – a segment, in which the EU-27 dominate the market (yet) (Table 4).

Consequences for the employment potential

With a constant share of the products produced within the EU-27 on the world production and with observing the mentioned prerequesites for the development of labour productivity and regional integration around 670,000 additional jobs can be created within the two examined lines of industry until 2020. Two thirds of this account for techniques and equipment for energy production (Table 5).

As a result of this intensive and, in addition to that, growing intersectoral division of labour this development implies a potential of 250,000 jobs with advance investments by the industry and the service sector. So, more than a total 900,000 additional jobs can arise.

Table 3: Lead Market "Energy Efficiency": Estimations of the production potential of machinery and equipment and electrical equipment within the EU-27 (bn Euro)

Centers of growth /submarkets	2008	2020	2020/2008	Annual growth rate
Industry-spectific solutions	6	25	19	12,6
Non sector-specific solutions	17	35	18	6,2
Automation/controlling	7	17	10	7,7
Heat recovery	8	13	5	4,1
Drives	2	5	3	7,9
Building Services technology	19	41	22	6,6
Air conditioning/CHP	2	5	3	7,9
Domestic appliances	12	24	12	5,9
Lighting technology	5	10	5	5,9
Total	**42**	**101**	**59**	**7,6**

Sources: McKinsey, Electra, ifeu et al., VDMA, own calculations and estimations.

Table 4 - Lead Market „Low-Emission Energy Production": Estimations of the production potential for innovative systems within the European Union (EU-27) (bn Euro)

Technology	2008	2020	2020/2008	Annual growth rate 2020/2008
Wind power	24	132	108	15,3
Solar	11	38	26	10,9
Biomass	9	28	19	9,9
Nuclear power	5	34	19	13,9
CCS	0	7	7	
Total	49	229	180	13,7
Therof Machinery equipment/electrical equipment	33	141	108	12,8

Sources: McKinsey, Electra, ifeu et al., VDMA, own calculations and estimations

Table 5 - Employment Potential in the energy relevant sectors of machinery and equipment and electrical equipment in the European Union (EU-27) in 2020

Leading market / industrial sector	Number of employees changes 2020/2008
Energy efficiency	+ 220,000
Energy production	+450,000
Machinery and equipment / electrical equipment	+ 670,000
Added for information: with suppliers	+250,000*
*estimated from the input-output-calculation 2006 for Germany.	

Sources: Electra, Eurostat, VDMA, own calculations.

Conclusion: Chances and requirements

Both with the technologies for energy production and with the methods for increasing the energy efficiency, the European machinery and plant engineers as well as their affiliated engineering and service providers have a leading position in the world.

On important submarkets the share of EU 27 in worldwide production is more than 40 per cent. In the course of global expansion, Europe has, however, already lost market shares. This applies to wind technology in particular.

With the supposition of an unchanged relative position on the world market, approximately 670,000 additional jobs in machinery and equipment and electrical equipment alone can arise within the EU 27 by 2020. In addition to that about 250,000 jobs with suppliers.

European manufacturers can only hold their share in the growing world market for progressive energy solutions or inhibit outsourcing if the number of (high) qualified labour rises significantly.

To achieve this, the proximity of industry and academia must, among other things, be increased specifically, the offer of energy-related degree programmes must be expanded and the attractiveness of technical professions must be better communicated.

At the same time the better qualification of personnel for the new technologies and markets becomes an essential prerequisite for the safeguard of the chances of growth.

With machinery and equipment, whose structure is characterised by small and middle-sized companies, in particular the environmental industry, the innovation potential can only be used, if access of small and medium-sized companies to regional competence networks is further facilitated.

Existing obstacles of the integration of such companies into the - probable further expanding – project support programmes must be removed.

3.3. Insulation materials and construction

Structure of the markets and employment

The mineral wool sector is oligopolistic or even virtually monopolistic in the case of certain products and in certain areas (in rockwool, the concentration of production capacities in certain trade areas, for example). It is marked by major barriers to entry, the first one being **the capital intensity** of production and the level of investment required. The production of more artisanal, plant-based types of wool requires less capital, even if some big insulation groups are interested in it for marketing diversification reasons. The products cost the end consumer substantially more. In the case of terracotta products, a major concentration process is underway in the north-west and centre of Europe. In the south of Europe, SMEs dominate the landscape. The market for timber houses seems at the moment to be the preserve of respectable-sized SMEs, although larger groups such as Saint-Gobain and Ikea are developing a supply.

The tile and brick industry employs 84,300 people across about 3,000 companies (data from Eurostat). The average number of employees per factory varies between 21 in Denmark and 66 in the United Kingdom. In the mineral wool industry, employment stands at around 20,000 people (according to the only estimate available, supplied by Eurima several years ago, which is consistent with our own) in several groups. The production of plant-based insulation materials (cellulose, hemp, etc) could occupy an equivalent number of people, although the tonnages would be far lower.

Most insulation products tend to be traded in their production zone.

Impacts of the crisis and structural evolutions

Sales of insulating materials and monomur bricks have increased in recent years. This can be seen as an economic consequence of the construction boom, as well as a more structural movement linked to energy regulation and the trend in energy prices.

Bricks have progressed at above market rates (to the detriment of breeze-blocks), as have certain tiles. Despite the crisis, sales of certain types of bricks are progressing. Thanks to some well-chosen marketing trends (the ease of laying offered by 'vertical perforation' bricks and mechanical tiles), terracotta has been gaining market shares since the year 2000.

All the materials cited have suffered from the crisis since the second half of 2008, going into recession one after the other. The British Isles, certain countries in Eastern Europe and Spain were the first to be affected, followed at the end of 2008 by the big continental European countries (France, Italy, Germany):

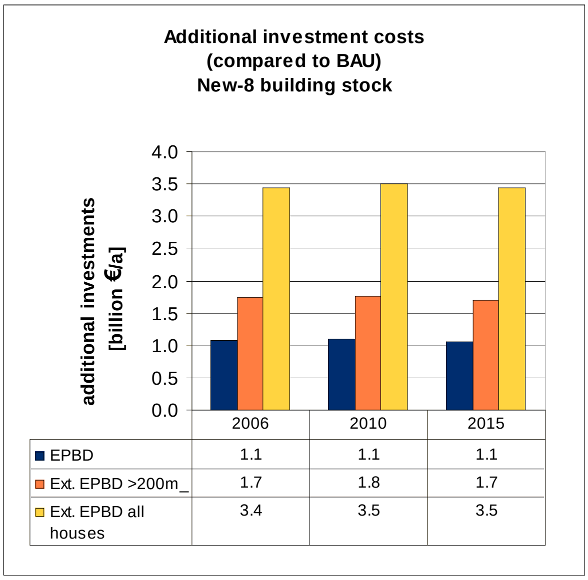
- in response to plummeting sales volumes, most of the players in the insulating materials sector have trimmed their production capacities by closing factories (Saint-Gobain in Ireland, Ursa in Hungary, etc) and/or by cutting employment levels (precarious and internal);
- the slump in the tile and brick industry speeded up as from the second half of 2008 (aside from the product mentioned).

Against this background, while the big materials producer groups have had to recapitalise, there have not – so far – been any recompositions of the scale of the competitive landscape or production relocations.

In the case of mineral wools, the eruption of the crisis coincided almost exactly with the arrival on the market of new production capacities, accentuating the overcapacities. The consequences might be, on the one hand, pressure on prices (and long-term profitability), and on the other, the arrival in Europe of products outside their usual trading area (mineral wools manufactured in North America would arrive on the European market). At present, the profitability of the big groups publishing their accounts remains far from negligible.

Positive impact of the extension of the Energy Performance of Buildings Directive (EPBD)

Eurima reports that the employment impact, including jobs in the building sector, would be between 220,000(EPBD) and 550,000 jobs (extended EPBD).



Source: Eurima, Ecofys IV and V UE 8

If we work on the assumption that the manufacture of other insulation materials accounts for roughly the same number of jobs and assume an EPBD extended to all existing buildings and correctly applied (a hypothesis identical to the Ecofys studies), taking account of the increase in demand for insulation, the current overcapacities linked to the crisis and the marginal rate of job creation when capacities increase, we can imagine that the potential for job creation should sit at between 2.5% and 20%, or between 1,000 and 8,000 jobs for the insulation industry, between EPBD and EPBD extended to all types of housing.

The entry into phase 3 of the ETS directive may stiffen competition between materials, to the detriment of the objectives being pursued

Considering the processes being used, energy expenditure is high in the case of mineral wools (some 10% of turnover) and for terracotta products (over 25% of the costs, according to the producers).

Globally, the markets for insulating products or terracotta are not very open to trade from outside the Community. Insulating wools (low density) or tiles and bricks (weighty character) are impossible, *a priori,* to transport at sufficiently low costs. However, in the European markets (in Greece, the Baltic countries and the Mediterranean countries), trade flows might develop with countries not subject to the ETS.

From the single point of view of CO_2 consumption to the production of the material, the energy balance of terracotta products is bad compared to concrete. However, from the point of view of the act of construction, a more insulating concrete solution and a terracotta solution deliver virtually the same emissions. On the other hand, terracotta offers advantages when we compare the product life cycle (life cycle analysis or LCA).

In the third phase of the ETS mechanism, terracotta products do not benefit from the so-called 'carbon leakage' protection, unlike concrete products and mineral insulation. Moreover, for the terracotta producers, the bulk of the energy efficiency efforts would have been already made, even though some progress remains possible (the recovery of methane from buried discharges is one example).

Green Building and its impact on employment

The building sector is responsible for 40 percent of EU final energy consumption. If Swedish standards were applied across Europe—the country has the best-insulated buildings on the Continent—energy savings of more than 50 percent could be achieved. The greatest energy savings potential—and thus job creation—is found in central and southern Europe. Italy alone represents 17.5 per cent of the annual energy loss from European dwellings, equivalent to 86,000 million tons of CO2 emissions per year.

The German programme to reduce CO_2 emissions from buildings

The programme is coordinated by the Federal Ministry of Transport, Building and Urban Affairs and financially supported by the KfW Bank, providing direct grants to house owners and public institutions in combination with public supported loans. This programme is directed to measures to improve the energy efficiency of buildings. There are special investment opportunities and loans for local authorities to participate for example in the modernisation of schools, day care centres for children and other buildings owned by non-profit associations.

After a successful start, the KfW Promotional Bank's programme to reduce CO_2 emissions from buildings was increased in 2006 almost three times by 1 billion € per year for the next four years. The programme provides an impetus to the construction industry and homeowners and gained positive feedback reflected in the great demand for financial assistance. In 2006, around 1,5 billion € was available for investments to tackle climate change. Recently, the Federal Ministry for Transport announced additional funds of 750 million € for the ongoing year 2009.

The benefit of the programme has positive effects for the construction industry, the tenants and the house owners. The results are better housing environments as well as lower energy costs and lower CO_2 emissions.

Results of the programme

The Ministry of Transport states that the national "GreenBuilding" programme led to a reduction of annually 3,2 million tonnes CO_2 from buildings since 2006. Within these years, about 1,1 million flats were energy efficiently modernised or newly built and approximately 1,1 billion € of heating costs were saved. The employment effect in Germany resulting from this programme included 220.000 additional or secured jobs in medium sized companies and craft companies.

Other studies evaluating the impact of the German GreenBuilding programme on employment also present positive employment effects, estimating 51.000 jobs in Germany for 2008. The highest employment effect of the funding programmes occurs in small and medium sized companies, mainly in the construction sector.

The Green Building programme of the EU

The GreenBuilding Programme (GBP) was initiated in 2004 by the EU commission with the objective to improve energy efficiency and to increase the integration of renewable energies in houses. Target group of the project in its pilot phase from 2005-2006 were owners of non-residential buildings. An infrastructure of so-called national contact points was set up in 9 participating EU countries. The European GreenBuilding programme raised the awareness on energy efficiency in buildings, which has already before led to comparable programmes on the national level of EU member states.

The Energy Performance of Buildings Directive (EPBD) requires EU countries to introduce energy certification schemes for buildings and to enhance building regulations like reviewing of requirements for new buildings, renovation of large buildings and mandatory inspections of air-conditioners.[1] A possible recast of the EPBD is a current topic of debate in the EU and might lead to a rather stringent version of the directive with increased use of EPBD standards

The modernisation of buildings complying to the concept of GreenBuilding has generated positive employment effects.

Building efficiency and impact on employment

In Germany, says a 2003 study by the Öko-Institut, retrofitting buildings could yield a net gain of 110,000 jobs by 2010. Building energy audits also promise employment. By 2003, only 7 percent of 1.3 million public buildings in Germany had been analyzed for energy savings. Increasing that portion to one-third could generate some 30,000 jobs. Even after job losses are factored in (in the energy supply sector, for instance), a net job gain of 10,000 would result.

In the general discussion on the recast of the EPBD, commission staff has examined a range of proposals and options and assessed the likely job implications. Between 280,000 and 450,000 new jobs might be created by 2020, chiefly among energy auditors and certifiers, inspectors of heating and air-conditioning systems, in the construction sector, and in industries that produce materials components and products needed to improve the performance of buildings[1]. Eurima, the insulation industry umbrella group, provides more optimistic projections, estimating additional employment figures ranging from 274,000 to 856,000 jobs. And a study by the European Trade Union Congress and others estimated that up to 2.59 million jobs could be created by 2030.

3.4. Renewable energies

Among renewable energy technologies,[24] four technologies can be considered the most promising ones with great application and growth potential: wind power (particularly off shore), hydro power, solar power (solar thermal energy, photovoltaic and concentrating solar power) and bio energy.[25]

Estimations on future development of renewable energies in the EU are based on following reports: Report to DG ENV: Model-based Analysis of the 2008 EU Policy Package on Climate Change and Renewables (NSAT), the European Renewable Energy Council (EREC), the Energy baseline scenario to 2030 of the DG TREN and own calculations. The NSAT calculations assume installed capacities of 557.9 GW in 2030 which corresponds to an investment of 389.8 GW additional capacities.[26]

The scenario of the DG TREN is a rather conservative projection and assumes a net generation capacity of 280 GW in 2020 and 330 GW for renewable energies in 2030. The discrepancy between the DG TREN scenario and NSAT estimates is great. According to the NSAT projections for 2020, experts assume a great amount of newly installed wind and hydro power plants, as well as photovoltaic installations in the EU.

Wind power

During the last 20 years, wind power is considered to be the fastest growing energy source of the world.[27] As figures indicate has the international market for wind power equipment shown great growth rates, with newly installed global wind power capacities of 28 GW in 2008. This was an increase of 38% compared to 2007. According to Eclareon, the EU has about 65 GW installed wind power in 2008, representing more than half of the globally installed capacity.[28]

Europe has dominated the global wind power sector, both in turbine manufacturing and installations until the US and China started large scale installations in 2008. Off shore wind park projects gained current attention and might have an estimated capacity of 8,7 GW at European coasts in 2015.[29] In 2008, average installation costs for wind power plants were 1.1 to 1.15 billion € per GW.[30] Averagely, offshore wind projects are 2.5 times the price of a similar onshore installation.

Solar power

Solar power or photovoltaic technologies (PV) generate electricity from light. There are three main technologies used under the term solar power: photovoltaic, concentrating solar power plants (CSP) and solar thermal collecting systems which are mainly used for heating water in houses or swimming pools.

The production of photovoltaic cells is continuously improving and directed towards reduced production costs. The IEA states that costs for PV has decreased with a learning rate of 15% to 20%.[31] In the overall investment, the costs for a PV module represent the major share

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[24] The equipment production of renewable energies can hardly be defined as one branch according to the NACE 1.1. With its fragmented structure, renewable energies belong to waste (NACE 90) under environmental services, electricity generation (NACE 40.11) and the manufacture of machinery and equipment (NACE 29).

[25] McKinsey Deutschland: Wettbewerbsfaktor Energie, Neue Chancen für die deutsche Wirtschaft, 2009.

[26] Balance between 2030 and 2005 NSAT Net Power Capacity.

[27] EREC et Greenpeace, p. 74.

[28] Estimations from EREC et Greenpeace in Eclareon, p. 5.

[29] EWEA in Eclareon, p. 7.

[30] According to the IEA, costs for onshore wind power installation vary according to country and reached 858 million €/GW in the case of Denmark. Costs for offshore wind power are higher and ranged from 1.6 billion €/GW to 2.1 billion €/GW in the case of the UK. See: IEA World Energy Outlook 2007.

[31] IEA: Energy technology perspectives 2008, p. 373.

with 75%, while costs for installation reach 15% and the balance of system components 10%.

Hydro power

Hydro power is a technology using water to generate electricity. Hydroelectric power plants with concrete dams, reservoirs or extensive collecting lakes have been used for power generation throughout the last century. Among renewable energies, hydro power is currently one of the cheapest ways of electricity generation. Capital costs of new large hydro power plant projects are estimated at 1.7 billion € per installed GW in OECD countries.

Biomass energy

Biomass covers several materials of biological origin that can be used to produce energy. Sources like wood, crops, algae or other plants as well as agricultural residues serve as sources for heating, electricity generation or as fuels for transportation. Biomass energy systems use these biological, renewable power sources.

Table 1: Projections on installed capacity of renewable energy in the EU

Type of energy	Eurostat 2006	NSAT 2005	EREC Projection 2010	NSAT 2015	EREC Projection 2020	NSAT 2020	NSAT 2030
Wind	47,7 GW	40,8 GW	80 GW	117,4 GW	180 GW	161,4 GW	259 GW
Hydro	106,1 GW	109,3 GW	111 GW	113,1 GW	120 GW	114,4 GW	115,6 GW
Photovoltaic / Solar thermal	3,2 GWp	1,8 GW	19 GWp	6,3 GW	165 GWp	14,9 GW	44,7 GW
Biomass	22,3 GWe	15,2 GW	30 GWe	45,4 GW	50 GWe	81,6 GW	131,4 GW
Geothermal	0,7 GW	1 GW		2,5 GW	4 GW	5,1 GW	7,3 GW
TOTAL	**180 GW**	**168,1 GW**	**240 GW**	**284,7 GW**	**519 GW**	**377,5 GW**	**557,9 GW**

** Projection 2030 are own calculations based on branch information Outlook for wind power O'Sullivan et al. in WWF for photovoltaic.*

Source: EREC 2008, NSAT in report to DG ENV. Rounded values.

Table 2: DG TREN EU 27 Energy Baseline Scenario to 2030

Type of energy	2005	2010	2020	2030
Wind	40 GW	111 GW	120 GW	146 GW
Hydro	109 GW	71 GW	114 GW	116 GW
Photovoltaic	1,8 GW	4 GW	9 GW	15 GW
Biomass	15 GW	23 GW	36 GW	51 GW
others	-	-	1 GW	2 GW
TOTAL	**166 GW**	**209 GW**	**280 GW**	**330 GW**

Source: Net generation capacity in GWe, DG TREN Baseline Scenario. Rounded values.

Table 3 - Average investment cost estimations for renewable energy technologies (as of 2007-2009)

Type of energy	Costs	Estimated investment costs per installed GW based on branch figures	Projection on net power investment in GW between 2006 and 2030 (NSAT)
Wind power plant	Installation costs	1.1 - 1.15 billion € / GW	262 GW
	Additional costs	0.3 – 0.4 billion € / GW	
Hydro	Installation costs	1.7 billion € /GW	6 GW
	Additional costs	n.a.	
Photovoltaic	Installation costs	4 – 6 billion € / GW	43 GW
	Additional costs	40 – 120 million €	
Concentrating solar power plants (CSP)	Installation costs	4 - 6 billion € / GW	
	Additional costs	n.a.	
TOTAL			311 GW*

Source: Eclareon 2009, Solarbranche.de, Wuppertal Institut 2009 and NSAT in report to DG ENV.

The operation of biomass power plants is comparable to conventional power plants. They are smaller in size and need to process their bio fuel before burning. Costs estimations for biomass depend on the costs for feedstock, which ranges from negative costs for waste or residual materials to more expensive energy crops. The IEA suggests that the actual costs per unit of energy produced from plants depends on the capacity factor such as maintenance costs and availability.

Investment costs of renewable energies

The IEA estimates investment costs for CSP of 4.1 billion € per GW in 2030 (Wuppertal Institut, p. 57). NSAT projections on net power investment are exclusive of biomass (124,4 GW) and geothermal (6,4 GW). The indicated investment costs per GW needed to construct new wind, hydro or solar power plants until 2030 may appear high, but do not exceed cost calculations for conventional power plants. Costs estimations on the construction of new nuclear power plants even reach higher dimensions and vary from 4.2 to 7.6 billion € per GW.[32] German energy providers RWE and Vattenfall have calculated investment sums of 1-2 billion € for their CCS demonstration power plants reaching a capacity of 450 or 500 MW.

Installation costs will decrease

According to EREC and Greenpeace, investment costs for various renewable energy technologies will decrease. The cost trends for 2030 (graphic 1) include respective learning curves and assume that most of the technologies will be able to reduce their investment costs to between 30% and 60% of current costs by 2020. Once the technologies have achieved a full development stage after 2040, costs reductions are higher

[32] Costs estimation on new nuclear power plant projects from various sources: Moody's Corporate Finance 2007, French nuclear power plant producer Areva NP or Synapse Energy Economics 2008.

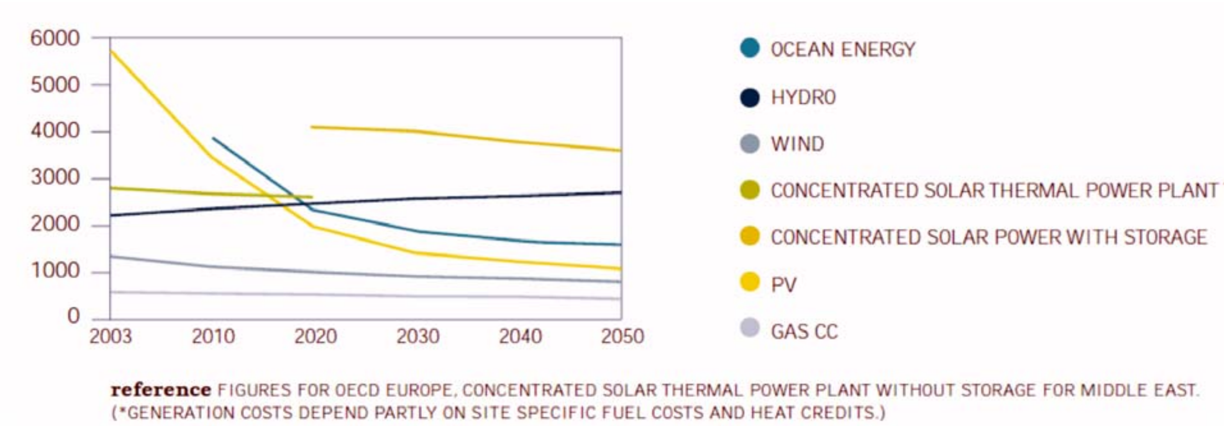
and may be between 20% to 50% of current levels.

The projections of NSAT and DG TREN on future installed capacities of renewable energies are comparable in 2010/2015 but clearly different in 2020. Whereas the scenario of the DG TREN is a rather conservative estimation with a share of 280 GW in 2020, NSAT projects a figure with 377,5 GW.

Impact on employment

All predictions show that employment linked to renewable energy in Europe will grow over the next decades. High investment sums for increasing capacities of renewable energies will lead to more employment in engineering, machinery and other branches.

Graphic 1: Future development of investment costs for renewable electricity generation technologies (in $ / kW)



Source: EREC et Greenpeace, 2007, p. 33.

Part 2

Impact of a European clean coal industry based on the 3 pillars of sustainable development

The role of coal for power generation by country in EU-27 (source Euracoal 2007)

About 27% of the overall electricity generation in the EU is provided by coal-fired power plants.

1. The European stakes of the clean coal technologies and industries

Power & Heat from solids fuels: 1 billion tonnes CO_2 emissions in EU-27 in 2007

Germany, Poland & UK representing together 58% of these emissions. About 27% of the overall electricity generation in the EU is provided by coal-fired power plants and for 40% at the worldwide level.

The stakes of low carbon coal-fired technologies and the ZEP Platform

Technologies for the sustainable use of coal must be based on an optimum combination of 'clean coal' technologies (Advanced IGCC, ultra critical cycle, Coal CHP) and CCS technologies. Continued development of these technologies and demonstrating their environmental, economic and social viability & reliability will lead to their large-scale use. The development of these technologies will make it possible to eliminate up to 90-100% of the carbon emissions from fossil-fuel power plants.

To achieve this, a very substantial increase in funding for research is required for the development of technological demonstration projects at both national and European level. Strong cooperation between the industrial sector and the public authorities is called for, via a coordination and support structure, based on the European Technology Platform « Zero Emission Fossil Fuel Power Plant » (ETP ZEP) launched in October 2006.

In order to achieve the commercial and operational viability of the large scale CCS projects related to coal-fired power plants in EU-27 by 2030, a significant increase to 80 GW of the installed capacity is necessary.

Power and heat production, solid fuels (hard coal and lignite): CO_2 emissions EU-27

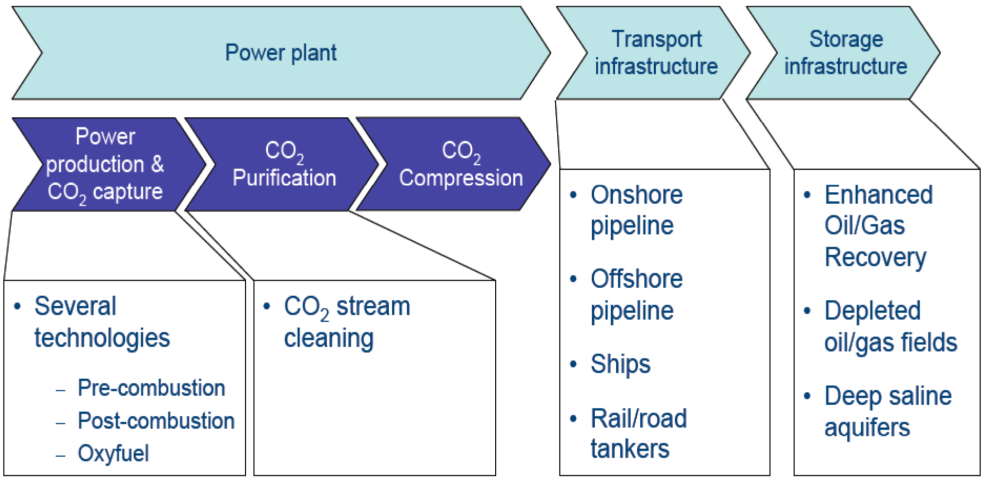
Member State	CO2 emissions in Millions Tonnes			share in EU27 emissions in 2007	Δ 2007-1990 (%)
	1990	2006	2007		
Germany	305	277	291	29%	-5%
Poland	215	169	165	17%	-23%
United Kingdom	183	126	115	12%	-37%
Σ these 3 countries	703	572	571	58%	-9%
EU-27	**1 128**	**988**	**998**	**100%**	**-11%**

Source : European Environment Agency

The targets of the ETP ZEP for the coal-fired power plants:

1 - Three CCS Routes

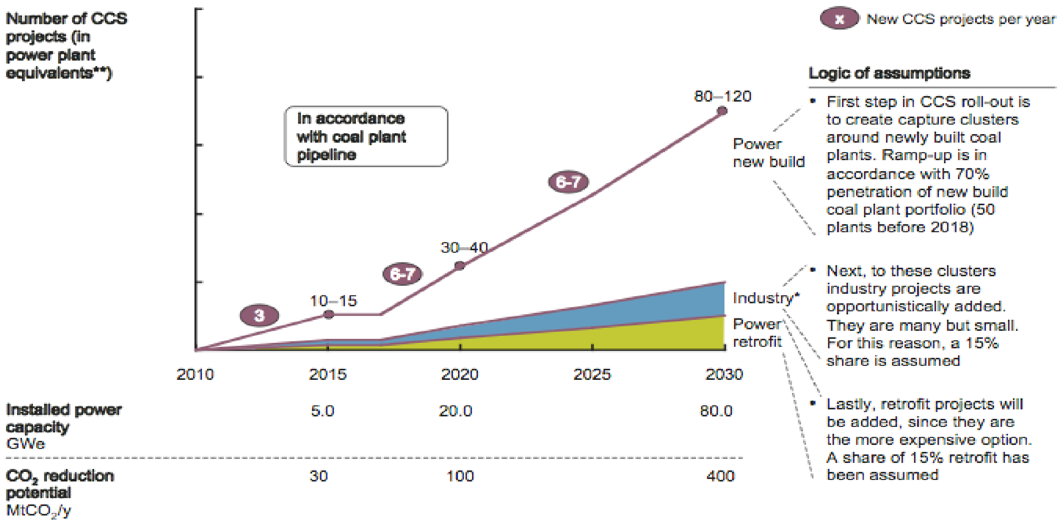
3 Carbon Capture technology routes: Pre-combustion, Post-Combustion, Oxy-combustion (source: ETP ZEP)



The 3 carbon capture routes need dedicated & different power plant definitions (IGCC, CFB, PC, Oxyfiring,…):

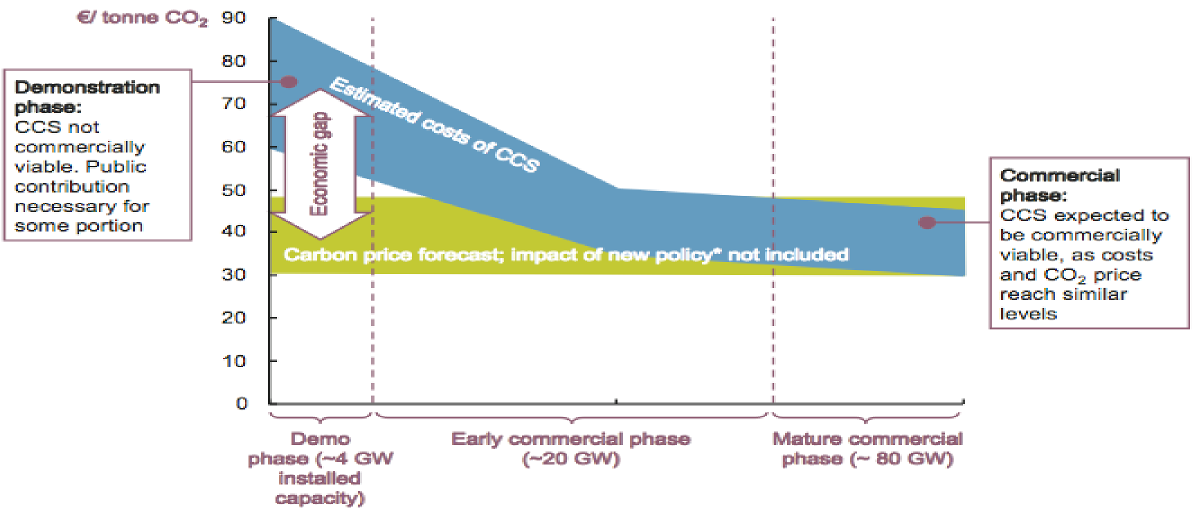
CO_2 capture technologies		CO_2 capture principle	Combustion principle	Power plant definition
Oxyfiring	Coal	High concentration CO_2 stream production	O2 combustion of coal/gas	Oxy-firing plant (Boiler-based)
Post-combustion	Coal	Exhaust gas CO_2 scrubbing	Air combustion of coal/gas	Pulverised Coal (PC) or Circulating Fluidised Bed (CFB)
	Gas			Natural Gas Combined Cycle (NGCC)
Pre-combustion	Coal	Inlet gas CO_2 cleaning	Air combustion of H2	Integrated Gasification Combined Cycle (IGCC)
	Gas			Integrated Reforming Combined Cycle (IRCC)

2 - Avoiding 100 $MtCO_2$/y in 2020 and 400 $MtCO_2$/y in 2030



* CO_2 heavy industrial plants like steel, cement, refineries
** E.g. as industry projects are generally smaller; several of those projects are likely to be equivalent in terms of CO_2 abatement to one power plant project
Source: Platts UDI Database

3 - The targets of the ETP ZEP for the coal-fired power plants: commercial viability of CCS in 2030



* Carbon price band for 2015 from 2008-15 estimates from Deutsche Bank, New Carbon Finance, Soc Gen, UBS, Point Carbo. Impact of the (possible) new ETS directive and the Copenhagen conference are not included in the analysis
Source: McKinsey & Company "CCS – Assessing the Economics" for the cost numbers; policy implications drawn by ZEP

The funding plan of EU's CCS projects is based on the assessment of additional investment & operating costs by the ZEP

On CCS, the EU's target is to have 10-12 demonstration plants up and running by 2015 with an additional cost between € 7 and 12 billion (€ 9,3 billion according to Eurelectric). A projects shortlist is to be published by mid-2010.

The funding engineering planned by the European commission is the following:

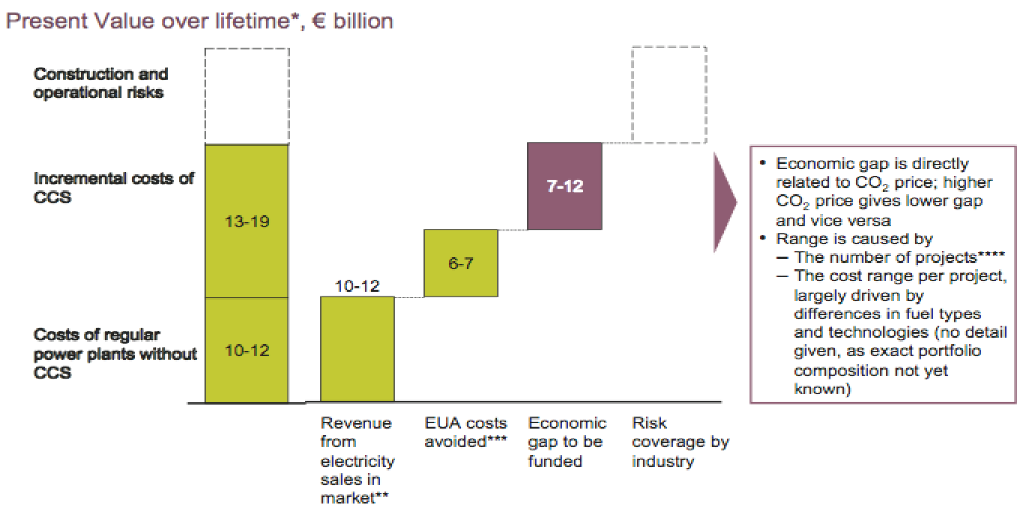
- The revised ETS directive states that the 300 allowances from the New Entrants' Reserve (NER) will only be available until the end of 2015, but these will depend on CO2 price. On 29 June 2009 the European Commission estimated that up to € 7 billion could be made available to fund CCS technology from the EU's Emissions Trading Scheme (EU ETS). Meanwhile, renewables projects would get around € 5 billion.
- Also an investment amounting to € 1 billion will be allocated in the framework of EERP (European Energy Recovery Program).
- A minor part of the funding (not defined to date) should be covered by power utilities (5 approved utilities companies according to Eurelectric), in the framework of a PPP (Public-Private-Partnership).

However some uncertainty remains over the funding of these CCS demonstrations projects, especially given the NER ETS Funds being shared between CCS projects and RES projects.

A voluntary and efficient European industrial policy dedicated to the deployment of CCS routes still remains to be designed and implemented

There is a need to design and implement tools and mechanisms like a « forecast management of jobs and professional skills » dedicated to CCS coal technologies value chain so as to facilitate the social-employment transition.

Another need is to build a governance system to design and implement appropriated tools and mechanisms, in particular to resolve the issues linked with the evolution of workplaces and professional skills dedicated to CCS routes, by



* Assuming 300 MW power plant, lifetime 25 years, 8% WACC, 80% of portfolio offshore
** Assuming electricity revenues equal the costs of regular power plant (incl. capital costs at 8% WACC)
*** ETS Emission Unit Allowances (EUAs), assumed to be at €35/tonne CO_2
**** A portfolio of 11 projects would have a economic gap of €8 – €11 billion
Source: McKinsey & Company "CCS – Assessing the Economics" for the cost numbers; policy implications drawn by ZEP

means of a sectoral social dialogue and dedicated funds at the European level.

The ETP ZEP doesn't integrate any social and employment issues. ETP ZEP aims at coordinating the establishment and implementation of a strategic research agenda and strategic deployment document. However, its governance structure includes representatives of public authorities, professional associations, companies, NGOs, but no representatives of European Trade-Unions in connection with the integration of the social-employment dimension in the deployment of CCS coal-fired power plants in EU.

This integration of the social-employment dimension requires not only a new governance of the ETP ZEP but also to set up a fund dedicated to the deployment of CCS projects.

Issues to be treated for the deployment of CCS

The 3 country cases of Germany, Poland and the UK put in relief some local issues CCS is to face to expect a large scale deployment.

Regulatory framework

CCS operations require a clear regulatory framework, especially for storage or transport operations. Specific laws are to be voted to permit CCS deployment, and for this reason a political support to the technology is requested.

UK is today the more advanced country on this issue, as the law has already been voted.

Germany planned to vote the law on Spring 2009 but it was postponed after elections of September, as the debate between political parties demonstrated the lack of consensus on the technology.

Poland has not yet implemented the EU directive for storage, and there is still no planned schedule. Political parties did not take any firm position in favour or against CCS.

Funding of the projects

If EU is to take part of funding of the projects as described above, local funding will be necessary, from electricity producers and/or by governments.

Germany and Poland are waiting better understanding of EU funding available, while UK seems more pro-active with a previous mechanism of levy on electricity bills to finance its demonstrators projects.

Stakeholders opinion and social acceptance

Industry manufacturers are very supportive of the technology, as it will offer them business opportunities. European players (like Siemens or Alstom) encourage EU projects with future objective to improve the technology and export it to China, India or USA.

Electricity producers are also in favour of CCS as they want to keep coal in their energy mix, for security of supply, affordability, and their good knowledge of operations.

Trade unions in the UK and in Germany support CCS: wish of preserving their coal mining industry, to save jobs in the electricity sector (as coal plants employ more people than gas or nuclear), confidence in jobs opportunities for national workers in deploying the technology.

Polish unions are very concerned with keeping coal in the energy mix, in order to preserve jobs, and are worried about reduction of the workforce which could come to comply with EU objectives.

But even if stakeholders are predominantly in favour of CCS, no large scale deployment can be considered without social acceptance. From this point, the three countries are very late in regard with EU objectives, and seem very (too much?) cautious with launching public debate. The risk of keeping public opinions out of this debate is to generate oppositions due to the suspicion of an unknown technology, and let the field to opponents.

2. Poland

2.1. Overview of the Polish coal mining and electricity production sectors

Coal mining: a key sector for the Polish economy

The coal mining sector is a key sector for the Polish economy as more than 95% of the country's electricity production is coal based. 58% of total electricity production comes from hard coal, 34% from lignite. In 2008 , the national production of coal was 132 mln t. (83,6 mln t. of hard coal, 55 mln t. of lignite). In the contrary to lignite, only 54% of hard coal production goes to electricity producers as the hard coal industry also supplies district heating companies as well as energy intensive industries. The national production is more or less equal to the domestic needs (exports felt from 19,5 mln t. in 2005 to 7 mln t. in 2008) which ensures the country's energy safety as well as lower energy prices if compared to countries which rely partially or totally on imports.

The hard coal subsector: a strong need for investments

From early 90' until today, the hard coal mining sector has gone through several restructuring processes in order to adapt itself to the market economy and fulfill obligations created by Poland's accession to the EU. In 2003, the sector has been restructurized and 4 major state owned companies had been created. The number of exploited mines has been reduced from 70 to 31 and the national coal production felt from 147,4 mln t. per year to 84. Productivity consistently increased , passing from 380 t. to 725 t./per person per year. The employment level felt from 388 000 workers to a level of 115 000 (average salary ≈ 1200 €). However, the main objective, which was to achieve economic efficiency, was not reached. Moreover restructuring programs focused on adaptation and investment in production capacities were forgotten.

The country's actually exploitable reserves of hard coal are estimated to be 3,7 bln t. which represents 30-40 years of exploitation at a level of 100 mln per year. However, until 2030, 13 mines are expected to close and the national exploitable reserves are expected to fall of 1/3 (to 2,5 bln t.) what means that production is going to be reduced as well. Inorder to maintain the actual production level, huge investments (≈ 5 bln € until 2015) are needed to open new mines or to adapt existing ones. Unexploited reserves of hard coal are evaluated at a level of 5 bln t. (40 to 60 more years of exploitation). In order to finance the needed investments, the government is planning to open the capital of state owned companies to the private sector (by sales of shares on financial markets or negociations with electricity production companies). The entry of private investors may provoke restructuring processes and therefore

Table 1 - Main polish hard coal producers (source: S.Partner)

1 € ≈ 4,15 zł	Annual production (mln t.)	Turnover (mln zł)*	Benefits (mln zł)	employment	Mines
Kompania Węglowa	46,8	10 514	24,7	65 100	16
Jastrzębska Spółka Węglowa	11,8	5 717	567,6	19 586	6
Katowicki Holding Węglowy	16-17	3 205	7,6	20 000	6
Południowy Koncern Węglowy	2	1 000	70	5 500	2

a decrease in the employment level in order to reach a higher level of economic efficiency. Another reduction in the employment level in this subsector may come from the adoption of the Climate energy package. Indeed, the share of electricity produced from hard coal should fall from 58% to 35% by 2030 and power plants efficiency should be increased which will result in a decrease in the energetic hard coal demand level of around 28%.

The lignite subsector

The situation of the lignite subsector is a bit different as it is partially owned by electricity producers and as electricity production sites are situated next to mines. This situation gives to lignite a competitive advantage if compared to hard coal. Electricity production costs from lignite are 30% lower and electricity prices 40% lower. Like it had been the case for hard coal, the sector has been restructurized. Actually, the 5 extracting sites (10 mines) employ 19 000 workers (- 45% if compared to the 80's). Lignite amounts for 34% of total electricity production in Poland. The installed electricity production capacity is 8 917 MW, with half of it coming from the biggest power plant in Europe: Elektrownia Bełchatów (4 360 MW) where a CCS installation is being built.

Present state of the electricity production sector

The annual production of electricity represents 159 TWh, with an installed capacity estimated at 34 GW (average use 24 GW). The annual growth turnover is 211,8 bln zł, which represents an increase of 65% if compared to 2003, mainly due combustible price rises. In 2004, in order to anticipate the opening of the energy market, the Polish State has restructurized state owned electricity production companies and has created 4 public market players in order for them to be able to face enhanced competition and to increase their investment capacities. These are: PGE, Tauron, ENEA and ENERGA. Other main market players are EDF (Elektrownia Rybnik), Vattenfall, Suez and RWE. However market shares of these foreign companies remain relatively low if compared to Polish electricity producers. Actually, the sector employs 88 000 workers. Approximately 1/3 of them are working directly in power plants.

However, even if the profitability of Polish electricity producers has increased in the past years (+275%), benefits remain at a low level and the sector suffers from a lack of investments. Therefore, production installations

Table 2 - Employment in the lignite subsector (2007)

	KWB Adamów	KWB Bełchatów	KWB Konin	KWB Turów	Total
Employment	1853	8193	4688	4150	18884
Mines	3	2	4	1	10

Source: Akademia Górniczo Hutnicza

Table 3 - Major State-owned electricity producers (1 € ≈ 4,15 zl)

	Turnover (mln zł)	% of national electricity distribution	% of national electricity production	employment
PGE	34 000	29%	41%	39 000
Tauron SA	10 000	26%	17%	20 000
ENEA	9 000	15%	8%	10 000
ENERGA	5 700	15%	2%	8 600

Source: S Partner

Table 4 - Power plants to be closed until 2030 by type of fuel (in MW)

	2008-2010	2011-2015	2016-2020	2021-2025	2026-2030
Total	570/1702r	2898/4204	4125	2805	4527
Hard coal	330/222r	1825/444r	2785	2805	4527
Lignite	240/1480r	1073/3760r	1340	-	-

R = to be closed for heavy modernization. Source: Polish Ministry of Economy.

remain highly decapitalized. It is estimated that until 2020 more than 50% of the existing power plants have to be replaced (more than 10 000 MW). This situation is mainly due to energy price regulations which prevents companies from making sufficient profits and thus reinvesting them in new production capacities.

2.2. Expected changes in the electricity production structure by 2030

In the forthcoming years, the Polish electricity production sector will have to face several challenges. Old power plants will have to be replaced and new additional ones will have to be built in order to face expected electricity demand growth (+12,3% by 2020 and +44% by 2030). Moreover, obligations created by the Commission's climate-energy package will have to be fulfilled as well.

Therefore, changes in the structure of energy production are expected. The Polish government forecasts the opening of a nuclear power plant by 2020 (3 x 1600 MW) and an increase of the share of renewables from 2,7% to 18,8% (with wind power accounting for 8,2%). In addition, the development of cogeneration is expected. It's share should increase from 16,2% to 22% (from 24,4 TWh to 49,7 TWh in 2030) thanks to emission rights exemption, state aids and financial incentives.

Polish major market actors may have differentiated strategies. PGE and EDF are planning to develop nuclear energy, Energa's strategy is rather based on renewables. However, even if the proportions are going to change, all companies will keep on producing electricity

Table 5 - Expected electricity demand growth

	2007	2010	2015	2020	2025	2030
Electricity demand (TWh)	150,7	141	152,8	169,3	194,6	217,4

Source: Polish Ministry of Economy

Table 6 -Actual and expected energy production structure by fuel

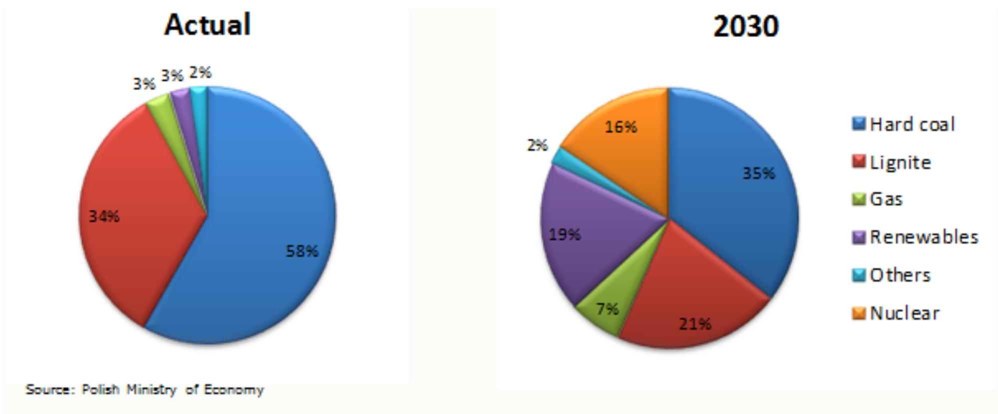


Table 7 - Expected technological evolutions in PKE's new coal fired power plants

	2009	2015	2020	2025
PP efficiency	35%	45%	50%	52%
Process Temp.	535˚c	650˚c	720˚c	780-800˚c
Pression	130b	290b	350b	350b

Source: PKE

from coal. Concerning the choice of the technology, a majority of players plans to build new power plants using super critical cycle and ultra critical cycle technologies.

They are not expected to invest in technologies such as IGCC or Oxyfuel. Investment and exploitation costs appear to be too high. Moreover, those plants efficiency is still at too low level. Finally, the Lack of State financial support and uncertainty concerning financial incentives that may be created by the government or by the EU do not have a positive impact over market players.

What about Carbon Capture and Storage (CCS)?

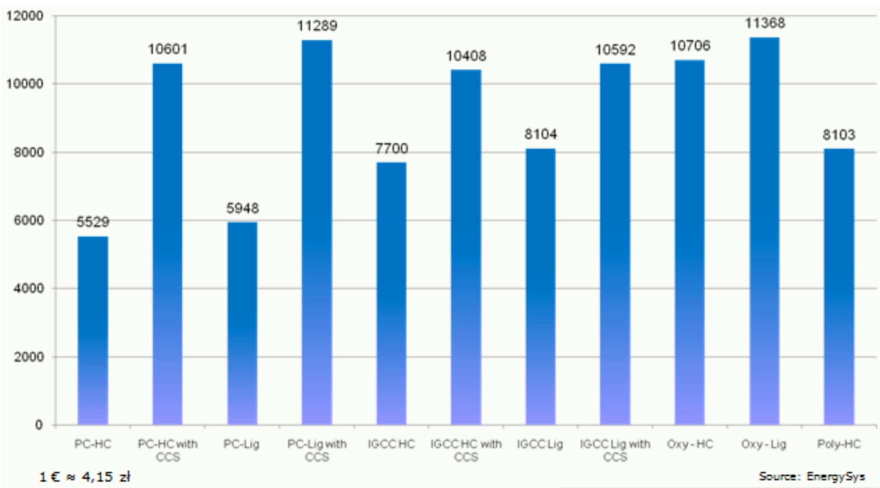
Actually, two demonstration power plants are about to be built in Poland: one lignite unit on supercritical parameters with CCS ready in Elektrownia Bełchatów (858 MW post combustion demo plant - 266 bar/554°C, Net generation efficiency ~ 42%, annual CO2 capture: 2,1 mln t./y, costs: 1-3 bln €) and one energy – carbochemical demo plant in Kędzierzyn (PKE & ZAK, 250 MW for electricity generation, 125 MW thermal power, investment costs = 5,1 bln zł). The polish geological storage capacity is evaluated at a level of 3,8 bln tones (saline aquifers). However, electricity companies are not willing to invest in such installations for the moment. They appear as too expensive (costs +50-70%) and reduce power plants' efficiency from 10 to 12% (this ratio should be reduced to 4-5% by 2020). Moreover, there is a lack of legislative framework, of financial incentives and still some uncertainty about this technology's economic viability.

2.3. Expected impact of forecasted changes in the electricity production model over employment in the coal and energy sectors

Impact over employment in Polish power plants

Presently, the energy production sector suffers from a very low level of productivity if compared to West European countries. The sector employs 88 500 workers (-15,8% if compared to 2003) which are divided as follows: 31 544 workers in Electricity production, 47 206 workers in Distribution & trade and 8574 workers in Transmission. The average salary amounts for 950 €. However, the average age of electricity company workers is 48 years. Seniority within companies reaches 20 years in most of the cases. Therefore, this workforce cannot be considered as flexible. Moreover, productivity (0,9 workers/MW) remains at low level if compared to West European countries such as France

Table 8 – total investment costs of chosen clean coal technologies (mln zl/2007)



or Germany (≈ 0,31 workers/MW). This is mainly due to the lack of externalisation of certain functions (administrative staff for example) and to a low level of production process automatization if compared to the European average. In addition, this productivity level may differ a lot from power plant to power plant.

After the modernization of Polish power plants, it is expected that the employment level is going to be lowered by 50%. Indeed, according to the interviews that were made during the study and taking into account forecasted technological choices, it is expected that labour intensity in Polish power plants will reach the levels of its West European neighbours. This improvement in productivity will be mainly due to a higher automatisation of production processes and to the externalisation of several functions like maintenance or administration for example.

This added to the changes in the energy production structure which will result in a partial switch from thermal power plants to other less labour intensive technologies such as gas and renewables, it is expected that employment in Polish power plants is going to fall by 50% and is going to pass from 31 544 workers to around 14 000 (analysis based on International agency benchmarks), with more than 50% of them still working in coal based power plants. As a consequence of the increased automatization of production processes, qualification levels of workers are expected to be higher.

Expected direct impact over employment in the energy production sector

The modernization of the Polish energy sector should create 579 115 FTE jobs by 2030, which represents a yearly average of 23 165 FTEs. Thermal and nuclear power plants, as well as the wind power subsector, appear as the most labour intensive.

Table 9 - Employment structure in choosen Polish power plants in 2009

	Installed capacity (in MW)	Total number of workers	Labour intensity / MW	Production staff	Maintenance	Administrative staff
Elektrownia Rybnik (EDF)	1775	1022	0,58	506	276	240
Elektrownia Jaworzno III (PGE)	1465	1466	1	513	356	597
Elektrownia Ostrołęka	700	1021	1,46	-	-	-

Source: S Partner

Table 10 – expected labour intensity in Polish power plants in 2030

	Coal fired PP	Gas PP	Nuclear PP	hydro	Solar	Biomass	Wind power
Production	0,25	0,14	0,28	0,12	0,06	0,12	0,12
Maintenance	0,06	0,09	0,05	0,06	0,06	0,09	0,09
Total	0,31	0,23	0,34	0,18	0,12	0,21	0,21

Source: IEA

Table 11 - expected structure of employment in polish power plants in 2030

	Lignite PC/F	HC PC/F	HC - CHP	Gas - CHP	IGCC	Hydro	Nuclear	Local Gas PP	Wind power	Biomas – CHP	Biogas – CHP	Total
Production	2682	2637	1431	148	823	316	1361	33	1180	146	165	10925
Maintenance	697	685	372	103	266	153	264	25	787	110	124	3587
Total	3378	3322	1802	251	1089	469	1625	58	1967	256	290	14512

Source: S Partner

Table 12 - Expected direct impact over employment of the modernization of the energy sector by 2030

	thermal	ccs	HC - CHP	Natural Gas - CHP	IGCC	Hydro	Nuclear	Local Gas PP	Wind power	Biomas – CHP	Biogas – CHP	Solar	total
Mechanical equipments	10244	1587	895	189	4144	169	7104	567	11387	2434	2746	228	**41694**
Electric equipments	3635	575	317	69	1501	62	2544	203	4078	871	983	82	**14920**
Steel industry	1652	257	144	31	672	27	1104	92	1847	394	444	37	**6701**
Non ferrous	661	94	58	12	246	11	432	33	692	143	162	14	**2559**
Mill industry	551	77	48	8	202	9	336	28	539	119	135	12	**2062**
Chemicals	1212	197	106	23	515	21	864	70	1385	298	337	28	**5055**
Total Indirect jobs	17954	278	1568	336	7280	298	12480	992	20004	4271	4819	400	**73191**

Source: S.Partner

Table 13 - Expected indirect impact over employment of the modernization of the energy sector by 2030

	Coal fired PP	HC - CHP	Natural Gas - CHP	IGCC	Hydro	Nuclear	Local Gas PP	Wind power	Biomas – CHP	Biogas – CHP	Solar	total
Civil engineering	35956	2742	587	12790	5228	34272	2538	29279	7158	8076	0	**138 626**
engineering	31411	2395	513	11155	1014	31872	592	17004	3579	4038	309	**103 883**
Equipments	71025	5419	1158	25245	1033	43248	5513	69323	14316	16152	1385	**253 817**
Assembling	25104	1915	409	8915	1216	19104	1771	13618	4772	5384	387	**82 595**
Total	163636	12506	2671	58106	8489	128496	10397	129259	29825	33650	2081	**579 115**
Yearly average	6545	500	107	2324	340	5140	416	5170	1193	1346	83	**23165**

Source: S.Partner

Expected indirect impact over employment in the energy production sector

In addition, 73 191 FTEs should be indirectly created in the equipment sector by 2030, which represents a yearly average of 2928 FTE's.

Impact over employment in the Polish coal mining sectors

Changes in the electricity production structure as well as improved power plant efficiency will negatively impact the demand for energetic coal. By 2030, the share of hard coal in electricity production is going to be reduced from 58% to 35%. The installed production capacity is going to be reduced from 20,7 GW to 18,7 GW (-10%).

The share of lignite is going to be lowered as well, passing from 34% to 21% (from 8,9 GW to 10,8 GW). Because of this and also because of the expected improvement of power plant efficiency, the use of hard coal and lignite for production of electricity and heat is going to be reduced respectively by 27% and 23%.

As a direct consequence, employment in these subsectors should be proportionally reduced. It is estimated that by 2030, job losses in the hard coal subsector will amount to 22 000 and to 4000 in the lignite subsector.

However, it must be underlined that job losses may be more important in the forthcoming years because of probable restructuring programs in Polish mining companies. Indeed, the Polish hard coal sector has the lowest productivity/ worker in Europe (0,3 Ktoe/worker). The expected entry of private investors in this subsector should therefore engender cuts in employment. The lignite subsector appears to be in a more favourable situation (0,65 Ktoe/w) and has already been partially privatized.

Demand for hard coal and lignite in electricity and heat production in Polish PP & CHPs by 2030 (in Ktoe)

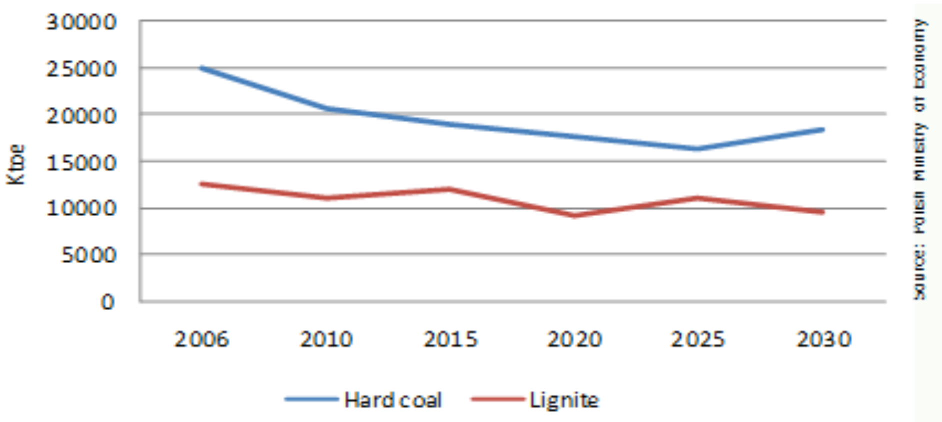


Table 14 - Expected evolution of employment in the hard coal and lignite subsectors

	2006	2010	2015	2020	2025	2030
Hard coal	81650	67266	61511	57686	53145	59669
Lignite	19000	16835	18270	14065	16841	14595

Source: S.Partner

Table 15 - Compared labour intensity in energetic coal extraction

	Polish hard coal subsector	Polish lignite subsector	European average	European average without Poland
Ktoe / worker	0,30	0,66	0,96	1,31

Source: S.Partner

Impact over electricity prices and GHG emissions

Table 16 -Expected evolution of electricity prices (for 60€ /CO2)

	2006	2010	2015	2020	2025	2030
Industry	233,5	300,9	364,4	474,2	485,4	483,3
Households	344,5	422,7	490,9	605,1	615,1	611,5

1 € = 4,15 zl

Source: Polish ministry of economy

Table 17 -Expected GHG emissions of electricity and heat producers in Poland until 2030

	2006	2010	2015	2020	2025	2030
CO_2 (mint.)	164,1	145,4	143,8	123,5	128,1	130,5
SO_2 (th.t.)	786,1	390	303	217,8	205,6	205,9
NOx (th. t.)	281,2	234,7	301,8	151,6	150,6	148,5
Dust (th.t.)	47	37	32,8	27,8	24	22,1

Source: Polish ministry of economy

2.4. Findings and final remarks

Impact over employment

The construction and modernization of coal fired plants with super critical cycle technologies will have a negative impact over employment in coal fired power plants as process automatization and externalization are going to be higher. Moreover, Poland is going to partially switch from coal fired power plants to less labour intensive sources of energy. As a result , it is expected that the total amount of workers in power plants will fall from 31 000 to 14 000. As demand for coal is going to be reduced, 22 000 job losses are expected in the energetic hard coal subsector and 4000 in the lignite subsector.

As consequence, additional job losses may appear in the coal mining equipment sector.

As a great part of Polish power plants are going to be replaced by 2030, this loss of jobs could be compensated by the creation of direct and indirect jobs in the construction and equipment sectors. In this study we evaluated that direct and indirect new jobs will amount respectively to 23 100 and 2900 FTEs per year until 2030. Part of these jobs (in civil engineering, engineering and assembling) are going to be created in Poland. If it comes to the equipment sector and to indirect jobs, the situation is different. Where these jobs are going to be created will depend of the Polish government's capacity of creating incentives through legislation and financial schemes. Without a strong industrial policy in this field, Poland may lose the opportunities created by the necessity of modernizing the electricity production sector. Finally, construction of CCS installations is not expected to have a noticeable impact over employment in coal fired power plants. After all, it can be concluded that changes directly linked to the modernization of the energy sector and to the climate energy package recommendations implementation might have a positive or negative impact over employment depending of the political will of future Polish governments.

Last but not least, the study does not take into account job losses that might occur because of the negative impact over GDP Growth of expected electricity price rises which are directly linked to investment costs and to the setup of the EU ETS.

Position of social actors

From interviews that were made with trade unionists in electricity production companies, 2 things may be underlined. No one of them had a clear vision of the Polish energy sector's future. Moreover, changes linked to the modernization of the energy sector and/or to the implementation of the EC climate energy package are not known by them. However, when told about forecasted cuts in employment, we have been told that the transition should go smoothly as a part of workers are reaching the age of retirement (seniority reaches an average of 48 years in Polish power plants).

Position of Solidarność

According to K. Grajcarek, head of Solidarność's Mines and energy section, Polish workers are going to pay a high price for the implementation of the Climate energy package. According to him, the European Union should ensure a smooth implementation of the Climate energy package. This should be done by the set up of a climate energy package implementation program (including a road map of social transition's financement) involving the European Commission (or the European Council), employers associations and sectoral trade unions (top down approach). In this context, obtaining a guarantee of the creation of a sufficient number of jobs should be the first priority of European trade unions. However, in order to prepare the forthcoming negociations, trade unions need a more precise knowledge of the exact consequences of the climate package implementation what could be achieved by the realization of a broader study that would cover all carbon intensive sectors.

Possible doubts about the reality of forecasted nuclear and renewables' shares in the electricity production structure

According to interviewed market actors, the impact of these energy sources may be lower than expected. The renewables ' share may not represent more than 10% and the construction of 3 nuclear blocs may be delayed. If the shares of renewables and nuclear energy do not increase as expected by the Polish government, the share of coal based electricity production will not be as lowered as it is forecasted. Taking into account recent developments in the energy sector, it appears that the share of wind power in the renewable energy production structure may not be as high as indicated here. On the contrary, the share of biogas and biomass installations may be higher. However, this uncertainty should not have a noticeable impact over the results of the present study. Finally, the authors want to underline the growing risk of carbon leakage. In July 2009, the Russian government announced the construction of a nuclear power plant in Kaliningrad (2000 MW) by 2015 in order to supply Poland, Lithuania and Latvia with cheaper energy (non EU ETS). The impact of possible carbon leakage has not been taken into account in this study.

3. United-Kingdom

3.1. Coal in UK's energy mix

Coal production decreased but could stabilise

Indigenous production of coal has sharply decreased over the last ten years, with production halved (from 41 MT to 18 MT/year) while imports more than doubled (21 to 50 MT/year). Supply is thus mainly assured by imports, from Russia for 46% (five-fold increase in volume since 2001), South Africa, Australia, Colombia and the USA.

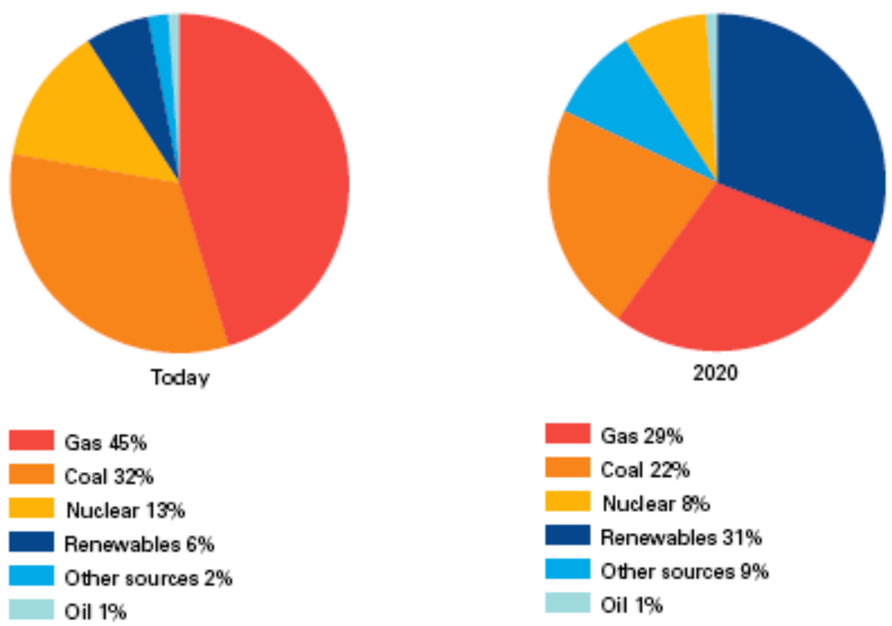
Anyway, the coal industry believes the reserve base of UK coal is capable of maintaining an output of 20 MT a year at internationally competitive costs. The TUC is supporting this objective, as is the Government's coal consultative body, the Coal Forum.

Consumption is likely to decrease in the future as a large majority is used for generation, and that coal-fired electricity's part of the generation mix could reduce (see below). The proportion of indigenous coal in the domestic consumption could therefore increase, generating better security of supply.

Coal production employs around 6 000 people in the UK.

32% of UK's electricity is currently produced from coal-fired plants, while main source of fuel is gas with 45%. Nuclear makes up 13% of the total, while Renewables only 6%, but growing fast.

Coal weights 32% in today's UK generation mix, and would fall to 22% by 2020



Source: UK Transition Plan, Department of Energy and Climate Change

Plan for 2020 is to reach 31% of electricity generation from renewables, mostly from wind. This target is the translation of the EU's binding target of 15% of final energy consumption from renewables. To support it, the UK government has introduced a Renewables Obligation (RO) for electricity producers to have a minimum share of renewables in their mix. This obligation is only for renewables, other fuels are not submitted to any constraint.

Coal's part of the mix is likely to fall to 22% in 2020, as older plants are to be closed after 2016. In a longer term, as UK coal plants are quite old (all built between the 60's and the 70's), they should all be closed (or retrofitted) by 2025.

Government's vision for coal

UK Government considers coal an important element of UK security of energy supply: UK is still a coal producer, with objectives of stabilising production, and imports can be easily secured from non-sensitive countries.

Decline of oil and gas fields of the North Sea in the next 20 years poses a threat to national energy security, as alternatives are imports from Russia or Middle East.

Government wants to keep a balanced generation mix for the electricity, as large development of nuclear (as in France) is not at the agenda, and there are limits on the s[peed of the development of renewable energy supplies. RES won't be able to assume all the generation by 2020 or even 2030, maybe 2050 ?). Furthermore, they need back up from other baseload energy sources because of their intermittency.

Coal is also an important element regarding energy affordability.

However, existing coal power stations in the UK emit an average 940 kg/MWh, and even retrofitted with supercritical technology still emit around 750 kg/MWh (existing gas plant are emitting 400 and new gas CCGT around 350 kg/MWh). Co-firing with biomass could only reduce by another 10 to 15% in a maximum, which would still leave unacceptably high CO2 emissions from these installations.

Coal should play a major role regarding energy security and affordability issues… but unabated coal is not acceptable for UK Government in respect with the target of 80% emissions cut. If CCS is not to prove its feasibility, coal should be abandoned before 2030. But it is worth noting than, in this case, gas couldn't be considered as a long term alternative, being a consistent, even if smaller than coal, emitter of CO2.

3.2. Low Carbon technologies will play a major role in UK industrial policy

Substantial investments are required to secure the energy supply in the coming years

UK's electricity generation mix will be strongly affected by planned closures of nearly 20 GW of generation capacity by around 2020 (from 78 GW in total):

- 7 nuclear plants should close by 2018 as they reach their licensed lifetimes
- 6 coal plants by 2016 as a result of EU legislation on emissions of SO2 and NOx.

Deployment of renewables requires a high level of fossil fuel capacity for a back up (because of intermittent availability to the grid).

20 GW of generation are already under construction (10 GW) or are planned with agreement to connect to grid (10.5 GW), of which 13.7 GW are gas and 3.5 GW from wind. No nuclear is under construction at this stage, even though a re-launch of this technology is

supported by Government policy, with players like EDF or E.On interested.

With a further 7,5 GW to be built, the next decade should have sufficient capacity. The global recession could modify this scenario: on one hand, UK electricity demand has decreased strongly in 2008; on the other hand, some investments plans could be delayed or cancelled by lack of funding.

Nevertheless, all these projects will require a lot of funding and also available workforce.

The UK Low Carbon Transition Plan is a clear political framework for the low carbon technologies

The Energy Act 2008 transposed an EU directive, opening route to implement capture, transport and store of CO2. The Government has published in July 2009 "The UK Low Carbon Transition Plan", which presents the national strategy for climate and energy. The objectives of this Transition Plan are very ambitious:

- 80% emissions cut by 2050 as a binding target;
- 100% electricity generation in UK should be decarbonised by 2030. This is to be achieved with renewables, nuclear, energy efficiency and CCS for coal and gas;
- 40% of the electricity generation should be from non emitting sources by 2020: renewables or nuclear.
- Other objectives concern low carbon vehicles and home (domestic heat and energy efficiency).

Efforts to reduce carbon emissions should also be achieved by an increasing part of the electricity in domestic heat and transports, which will make even more important decarbonising electricity generation. This will increase the need for electricity supply, and by so the use of fossil fuels, as renewables won't be able to cover all the anticipated increased demand for elelctricity.

Total decarbonisation of electricity generation by 2030 can't be achieved without CCS, on coal-fired plants but also on oil or gas power plants.

UK objectives for CCS

The British Government decided in 2007 to launch a competition for the construction of a CCS demonstrator (post combustion). The two main objectives of this competition were: 1) to demonstrate the full chain of CCS technologies to be developed at commercial scale, and 2) it is transferable to key global markets, providing future opportunities for UK industry.

In 2009, it decided to increase to up to 4 demonstration projects (still for coal plants only) with commercial scale: 300 MW CCS by minimum, and minimum storage of 20Mt over 10 to 15 years. This could permit to test different technologies: one would be an oxyfuel, another pre-combustion.

The objective is to have the demonstration plants in operation from 2014 to 2018. ACCAT (UK Advisory Committee on Carbon Abatement Technologies) estimates that if these four projects were to be achieved, 10% of UK power generation capability in 2020 (around 40 TWh) would be provided by coal plants operating with CCS.

The Government is proposing that funding for these demonstrators would be based on a levy on electricity suppliers. This could generate a 2% increase in the price of electricity (less if EU funding contributes for a part), on a total of a previous 15% increase, mainly because of the higher price of renewables than fossil fuel. This mechanism was preferred to an obligation (as for renewables), both because of the difficulty of adjusting the level as the technology's speed of deployment is unknown; and there were too few actors to implement a market of certificates.

As a first step, Budget 2009 announced £ 90 million from Government to fund detailed design and development work (FEED studies). These studies are to provide greater clarity on costs and ensure that preparation for construction can start at the earliest possible date.

In addition to the demonstrators, UK would require:

- Any new coal power station to demonstrate CCS on a defined part of its capacity (the rest of the capacity being capture ready[33]).
- New coal power stations to retrofit CCS to their full capacity within 5 years "of CCS being independently judged technically and economically proven", being planned that it could be in 2020. Independent body proposed is the Environment Agency (non-departmental public body in charge of protecting and enhancing environment in England and Wales).

TUC are in favour of these four demonstrators but would prefer full size scale of CCS, so that the plants would deliver 6.4 GW of clean electricity.

3.3. UK's ambition is to take the leadership for CCS technologies

UK has significant advantages for CCS

Industrials and government point out that the UK's advantages **include skills in the whole chain** of CCS from coal mining, coal-firing plants, equipments for capture, transport and storage; financial and legal advisors; and natural advantages in terms of undersea geological storage sites, and clusters of potential CCS capture plant.

[33] Capture ready understood as sufficient area reserved on site, suitable area of storage proposed with an assessment of the feasibility of transport between the plant and the storage).

Government plans are to take the leadership with the 4 demonstrators, giving a first move advantage to UK developers involved in these projects.

Scheduled North Sea oil and gas fields' end of life offers a window opportunity with skills for transport and storage of CO2 available: CCS could preserve part of these jobs that would otherwise move to other offshore areas.

But organising the transition will not be simple, as timescales may not coincide.

Transport issues

Technology is not considered as a major issue as CO2 transportation by pipeline has been experienced safely for more than 20 years in the USA, or more recently in Europe (project Sleipner).

Transport would probably require the construction of a specific network, as existing pipelines would probably not be available or correctly fitted to transport CO2 (difference of pressure in particular). Creating this network will probably require Government support, both for financial and regulatory reasons.

Government would encourage the creation of clusters of different emitters to share the transport network, keeping in mind that CCS should in a second stage be deployed on gas plants and on industrial emitters (Iron&Steel, Cement, Pulp&Paper, Refining, Chemicals). In the Aire Valley, the Yorkshire Forward project includes a cluster of 13 large emitters (coal, steel, chemical plants and other) to build a new high-pressure pipeline through the valley to transport and store it in depleted North Sea gas reservoirs.

For the Kingsnorth project, E.On plans to build an oversized pipeline (bigger than requested for the only power station), in the perspective of a future cluster.

Storage issues

The North Sea's depleted fields and saline aquifers offers a huge potential: British Geological Survey made an assessment of theoretical storage capacity of 24.7 billion tons of CO2 in 22 sites:

- Gas and condensate fields: 6 Bt (75 fields)
- Oilfields: 4.2 Bt (74 fields)
- Saline aquifers: 14.5 Bt (32 sites)

This theoretical capacity is very speculative as saline aquifers are very little known (they were not studied as they have no economic interests) and that gas or oilfields should not be used at their maximum to prevent any risk. Nevertheless, according to the ACCAT, the study does give grounds for optimism that it will be possible to qualify sufficient storage capacity to reduce UK emissions by up to 20% for 50 years, which would require 5 Bt of storage capacity.

Social acceptance will be easier to reach with subsea reservoirs than with onshore (no fears of leakage).

Estimated costs of CCS technologies

Our interlocutors were very cautious with costs evaluation, as the technologies have never been tested at a commercial scale.

For demonstration projects (from now to 2015), most of them refer to the McKinsey study "Pathways to a Low-Carbon Economy" which indicates a range of 60 to 90 €/tonne for the first demonstration project.

At the stage of an industrial deployment (between 2020 and 2030), assessment of costs are around 40 €/tonne, with an intermediate of 50 €/tonne in 2015 for Doosan Babcock.

These assessments would set the technology close from an economic viability (of course depending on carbon price at this timeline).

Investment for post combustion equipment should represent half the cost of a coal plant without CCS, so that CCS would be a third of the total cost.

Investment and extra operating costs represent an important amount of funding, but it is emphasised that Coal + CCS is less expensive than Offshore Wind…

Employment impact

CCS represents a huge employment potential…

CCS employs very few people today, only in R&D and small scale demonstration projects, as the technology is still at a pilot scale (For example in Doosan Babcock around 50 people).

Syndex designed a spreadsheet model to evaluate the impact of low carbon technologies in industry (refer to the methodology described in the Polish Country study). These estimates are based on the Low Carbon Transition Plan, published in July.

Directs FTE average/year (thousands)

	2010-2020	2020-2030
Coal CCS	8 136	17 290
Oil	0	0
Nuclear	5 814	12 660
Gas	3 900	9 103
RES	36 929	11 940
Total	**54 779**	**50 993**

Source: Syndex

Our estimate is about 55 000 direct jobs per year for the period 2010-2020, mainly in renewables. During the period 2020-2030, direct jobs would amount 51 000 per year.

For CCS, the construction of 4 demonstrators as planned by Government's Plan would generate 1 780 direct jobs in the first period. Large scale deployment post-2020 and about 24 000 jobs for the period 2020-2030. These figures do not include employment impact of the construction of a pipeline network (see below).

The option supported by TUC, NGO and the industry of accelerated deployment, with 4 full scale plants (generating 6.4 GW) would increase employment to 8 136 FTE on 2010-2020 period and 17 290 on 2020-2030.

A study from AEA Group for the DECC estimates that low carbon coal technologies could represent a potential market of 2 to 4 £Bn by 2030, sustaining 30 000 to 60 000 jobs: half from CCS technologies and half for other clean coal technologies (equipments and retrofit). This estimation is based on IEA's perspectives of deployment of clean coal technologies in the world, with hypothesis of UK's manufacturers of around 35% on their domestic market and 3% worldwide. Given the size of the respective markets, most of the value would be created abroad, UK market representing only 17% of the total.

FTE by sectors (thousands)

	2010-2020	2020-2030
Civil engineering	24 454	22 864
Engineering	4 885	4 187
Equipments	8 949	7 350
Assembly	16 491	16 592
Total	54 779	50 993

Source: Syndex

Civil engineering and assembly are the sectors where UK jobs will be more numerous, as major employment potential is in the construction or retrofit of plants (for example Kingsnorth: construction of CCS facility would employ around 2000 workers FTE during 2 years, according to Doosan Babcok).

For the power generation sector, according to our interviews, operations and maintenance of CCS could add 20% workforce to the present workforce in power plants.

Transport and Storage job potential will depend on the size of the network to deploy and the timescale at which it would be built (most of the jobs in the construction of this network, while monitoring is less job intensive). In the example of the pipeline to be built in the Yorkshire Forward project, construction phase of the project is expected to produce £1.8 Bn in value added, corresponding to 55,000 jobs; operations would produce £126 M in value added and support 2,400 jobs a year.

As the Low Carbon Industrial Strategy (LCIS) identifies five areas where CCS could be deployed (The Humber, Teesside, Thames Gateway, the Firth of Forth, Merseyside), employment impact of transport pipeline of CO2 could be estimated to 200,000 to 250,000 jobs in building (which could represent an average of 20,000 to 25,000 jobs a year assuming a time of ten years to build all networks) and around 10,000 jobs a year for operations. Construction of the pipeline network could therefore add 30,000 jobs per year.

Impact on British economy will be important and go further than industry as many sectors will be involved in development of CCS:

- Power plant operators
- Large combustion plants operators (Iron&Steel, cement, refineries…)
- Original Equipment Manufacturers (OEM)
- Process Engineering companies and consultants
- Project developers
- Oil & Gas companies
- Oil services companies and consultants (geological, offshore)
- Pipeline contractors
- Electricity and gas suppliers
- Banks, financial advisors and legal.

… But a skills gap could slow down its deployment

UK energy sector is facing big challenges in the years to come:

- Closure of old coal plants and retrofits
- Deployment on very large scale of renewables (offshore wind)
- Decommissioning of nuclear by 2018 and construction of new nuclear plants
- Renewal of the grid and adapting to new decentralised generation
- Energy efficiency

These challenges will require a large number of workers and skills to be achieved, with a risk of bottlenecks.

Even if each type of generation requires specific skills (for example nuclear), many jobs are common: R&D, engineers, project managers, which could generate competition between the technologies. Companies could have difficulties to recruit or train as much people as required.

In this case, all technologies would face delays to slow down, and CCS could be specifically impacted if it appears to be less attractive than industries like nuclear or renewables.

The LCIS says that Government will also publish a National Skills Strategy later in the year to put in place an approach to skills policy which prepares Britain for the upturn. Low carbon skills will be a critical component of this approach.

In May 2009 the Government tasked a **High Level Forum** on skills for a low carbon resource efficient economy, including industry and TU representatives, with suggesting how Government can boost demand for the skills required for the transition to a low carbon economy. A key recommendation was that there is significant potential for collaboration among employers within supply chains, supported by Sector Skills Councils.

An important DEFRA skills study in 2008 highlighted the lack of a strategic approach on LCREE skills. A key conclusion was that leaving this to employer demand is futile:

- There was evidence of a latent demand for LCREE skills – demand is not currently being articulated by many employers and as a result the current "demand led" skills delivery framework is ill equipped to anticipate and respond. LCREE system.
- Organisations do not have the right levels of understanding of the skills requirements and implications of a LCREE and consequently of the importance and potential benefits of integration of LCREE skills into their businesses.
- Only when these links and a clear business case are made will businesses demand LCREE training. This leaves us in a 'Catch 22' situation – understanding and awareness are the key to stimulating demand for skills but in a demand led skills delivery system, an expression of demand is required from the organisations for the skills delivery sector (especially SSCs) to respond to.

In May 2009 the Government tasked a Strategic Advisory Group of leading employers, including some of the country's largest companies as well as smaller companies, with suggesting how Government can boost demand for the skills required for the transition to a low carbon economy. Members of this group, reflecting on the experience of their companies, identified two key sets of skills:

First, the core skills required by industry to produce the low carbon goods and services increasingly demanded by the market. A significant shortage was identified in many essential skill areas related to Science, Technology, Engineering and Mathematics (STEM). This shortage is holding back business development, particularly where skills need to be transferred to new contexts. These skill shortages have been reported widely across the British economy, but are particularly acute in their application to specific low carbon technologies;

Second, the more general skills that help a company or other organisation make and maintain the transition to low carbon operation. These skills include the communication, leadership and management skills to drive culture change, or overhaul existing business practices. Other necessary skills include sustainable procurement, environmental management systems, risk management, monitoring and measuring.

Initiatives are developed like the National Skills Academy for Nuclear, launched by the end of 2008, and a project of NSA for Power. The aim of the Skills Academy would be to help tackle skills shortages in areas from electricity generation (including renewables and fossil fuels) through to power transmission, distribution and metering, by developing and maintaining a network of high-quality, employer-responsive training providers, offering bespoke training and support where it is required.

For the TUC, the main issue is urgency: for the Government to deliver its LCREE strategy including through consultation with industry and trade unions.

Other issues for full deployment of CCS

Social acceptance could still be a major issue

CCS process is divided in three distinct operations, which could generate public oppositions: capture, transport and storage.

Capture is not seen problematic by actors as it only consists in adding another unit on existing coal plants, already generating pollution. Local communities should be in favour of a process that could allow coal plants to continue operating, reduce pollution and so save many jobs locally.

Transport is seen to be the major issue, as building a pipeline network in a dense country like UK is always difficult, but this is not really a CCS issue, as it would be the same for a gas pipeline, an high voltage grid, a railway. However, the public may become concerned over the transport of a new, unfamiliar gas at high pressure.

Storage would be only made in offshore, by decision of the UK Government (both for geological and political reasons), which would not generate local oppositions as onshore storage would probably.

In fact, the main difficulty for CCS deployment is linked with the bad image of unabated coal in the public (old-fashioned and dirty way of producing electricity), which generates opposition to new constructions or retrofits. E.On is experiencing this opposition on their Kingsnorth Project: retrofit an old coal plant to a new supercritical (2 x 800 MW) with 300 MW CCS. However, it is important to mention that Kingsnorth is a stand alone plant, located in the Kent, which is no longer a mining area for more than twenty years.

Anyway, most players (producers, manufacturers, DECC) do recognize there's still a lot to do in terms of public information about these technologies.

Technology transfer is a key issue, still to discuss

Biggest potential for CCS is in the deployment of the technologies in emerging countries, in particular China and India. Industrials are in favour of "knowledge sharing" for developing countries, but not in favour of free access to intellectual property rights. Trade unions support the open transfer of this technology.

Knowledge sharing is required to help costumers making the choices of the right equipments and then using them in a proper way.

DECC is a member of the Global CCS Institute, launched by the Australian Government in order to support the development of the 20 large-scale demonstration projects and share the knowledge and experiences from these projects.

Conclusion: CCS is seen as very positive by most of the actors

British government is dedicated to tackling climate change (Stern report), has high ambitions to create a low carbon economy in UK, to mitigate carbon emissions and develop CCS, making UK-based industry a leader in CCS technology.

Electricity producers are involved in the demonstration projects, as they want to keep a diversified generation mix: E.On, RWE and Scottish Power have project proposals.

Industrials are in favour: manufacturers, oil companies are strongly in favour of CCS and see business opportunities. Steel or cement companies are watching, as they are not concerned by the demonstration stage, but are looking to further implementation. They participate to Yorkshire Forward project.

TUC and the mining and energy unions are supporting carbon abatement technologies, especially CCS, for reasons of energy security and affordability, future of coal mining industry, and opportunities for UK workers, while, of course, putting UK on the path to a low carbon economy. Recently, TUC's Clean Coal Task Group (which is a joint trade union / industry body formed to promote clean coal technologies within the UK) published answers to the consultation launched by the Government. TUC are in favour of four demonstration plant, but would prefer full size scale of CCS, so that the plants would deliver 6.4 GW of clean electricity by 2020.

NGO consider coal without CCS unacceptable, and thus are opposed to demonstrator projects providing CCS on a limited part of the plant. Option proposed by TUC's CCTG of full scale demonstrators could be acceptable for them. It is also to consider that the alternative to zero coal would be more nuclear (as renewables will be limited to 2030) which is no more acceptable for them.

4. Germany

Introduction

According to the Federal Statistics Office, the total amount of German CO_2 emissions in 2008 was 832 million tonnes[34], which is a slight decrease compared to 2007. In Germany the share of energy production in these emissions was 45% in 2008.

We will focus on the particular situation of Clean Coal technologies in the energy sector in Germany, where almost 47% of energy production in 2007 was based on energy generation from lignite and hard coal.[35] According to forecasts until 2030 the energy mix in Germany will be substantially composed of fossil fuels with coal holding a share of 48%.[36]

4.1. Energy sector in Germany

The energy mix

Energy mix Germany 2007 (gross electricity production)

Energy source	Percentage
Lignite	23,8%
Hard coal	22,8%
Nuclear	22,1%
Natural gas	12%
Renewable	14%
Others	6,3%

Source: Own illustration based on Umweltbrundesamt 2009.

[34] Website German Federal Environmental Agency www.umweltbundesamt-umwelt-deutschland.de/umweltdaten/public/theme.do?nodeIdent=2842.

[35] German energy mix in 2007: 23,8% lignite, 22,8% hard coal, 22,1% nuclear, 12% natural gas, 14% renewable energies and 6.3% other energy sources.

[36] See IEA: World Energy Outlook 2008.

Since 1990, overall CO_2 emissions have decreased in Germany by 20% from 1036 to 832 million tonnes in 2008. Here, hard coal and lignite are major sources of CO_2 emissions and are significantly contributing to the total amount with 135,9 and 174,5 million tonnes per year. In Germany the nuclear phase out will lead to a shift in energy production, with coal and renewable energies as potentially important sources to fill in the gap.

Forecast on Energy mix Germany 2030 (Total production)

Energy source	Percentage
Coal	48,1%
Oil	0,7%
Gas	13,1%
Combustible renewable and waste	19,8%
Nuclear	-
Hydro	2,4%
Geothermal	4,9%
Solar, wind, etc.	10,9%

Source: own illustration based on IEA 2007. Energy policies of IEA countries, Germany Rewiew.

Main Energy providers

The German energy market shows a high concentration on four major energy providers, each of them operating with a regional focus. Additionally there are independent public utility companies ("Stadtwerke) in Germany in several local markets. It is typical for the German situation that each of the four leading energy providers operates nuclear power plants and fossil fuel fired power plants and is at the same time active in renewable energy generation.

Vattenfall and RWE, as well as E.ON operate lignite coal mining districts and are also major operators of lignite-fired power plants. Particularly Vattenfall, but also RWE, are leading actors in the early development stage of the CCS-technology with one pilot-power plant in

Overview on four main energy providers of Germany

Energy Provider in Germany	Employees in Germany	Energy mix 2008	Capacity of power plants	
			Power plants - all types	Coal power plants
E.ON	43,500	45% nuclear 39% coal 7% gas & oil 6% renewable energy 3% others	23560 MW (installed capacity)	
			47	14
EnBW	19,500	47% nuclear 32% fossil energy + others 21% renewable energy	9119 MW (installed capacity)	
			11	6
RWE	40,000	33% lignite 29% hard coal 19% nuclear 12% gas 7% renewable energy + ohers	33,033 MW	
			24	13
Vattenfall	19,670	60% coal 22% water power 12% nuclear 7% gas	13,378 MW	
			23	11

Source: wmp consult 2009.

operation and CCS-demonstration power plants in planning.

Fossil energy resources in Germany: hard coal and lignite

In Germany, lignite and hard coal compose a significant fossil energy resource. Almost 47% of the country's energy generation is based on coal. Whereas lignite originates to 100% from national coal production, nearly two-third of the German hard coal demand is now-a-days imported.

The role of German hard coal mining industry is decreasing for decades from over 490.000 employees and 146 mining sites in operation in 1960 to about 30.000 employees in 2008.[37]

Today, the company RAG AG is the main coal mining company. One economic problem is that the costs for hard coal production in Germany exceed the price on the world market.

The local coal mining industry is not competitive. In the so-called "coal compromise" of 1997, the trade union IG BCE, the coal mining company RAG AG agreed on a gradual decrease of subsidies for mining activities until 2005. The aim was to reach a socially acceptable end of subsidised coal mining in Germany by the end of 2018. However, this agreement will be reviewed and again discussed in 2012.[38]

[37] Employment figures according to Kohlewirtschaft e.V. and IG BCE.

[38] According to the revision clause, all responsible actors will check, review and discuss the possibility of a future hard coal production in 2012.

Overview on companies involved in the CCS-technology (Table: wmp consult)

Carbon Capture and Storage Technologies		
Post Combustion	**Oxy-fuel**	**Pre Combustion**
Power Plant Operators	**Power Plant Operators**	**Power Plant Operators**
- E.ON AG - RWE AG - Vattenfall Europe AG	- Vattenfall Europe AG	- RWE Power AG
Power Plant Engineers	**Power Plant Engineers Chemical industries**	**Power Plant Engineers / Chemical Industries**
- Hitachi Power Europe GmbH - FISIA BABCOCK ENVIRONMENT GmbH - Babcock Noell GmbH - Siemens Energy - Alstom Deutschland AG	- Alstom Deutschland AG - Hitachi Power Europe GmbH - Linde AG	- BASF AG - Linde AG - Siemens Energy

The lignite industry of Germany is mainly carried out by 6 companies with a total number of 22.263 employees in June 2009.[39]

Perspectives of lignite and hard coal production

It is important to mention that there is no direct link between the production of hard coal and the introduction of CCS to power plants in Germany, since 67% of the national hard coaldemand is now-a-days imported. Whereas lignite presents a competitive fossil energy resource in Germany, the production of hard coal is highly subsidised and will probably end in 2018. The future use of lignite and in this regard the perspectives of this particular employment group are closely linked to an introduction of CCS.

4.2. Carbon Capture technologies and their adaptability to Germany

There are three general processes of capturing CO_2: the post-combustion technology, the pre-combustion technology and the oxyfuel technology. The German energy providers and power plant engineers have chosen only one or two of the three CCS-technologies for pilot- or planed demonstration projects in Germany. Especially the ability to retrofit existing power plants has gained attention. In September 2008, Vattenfall Europe launched the world's first pilot system called "Schwarze Pumpe" in the eastern parts of Germany, in Spremberg. This pilot system, with an investment volume of approximately 70 million €, applies the oxyfuel

[39] Inclusive of 5.864 employees in general supply units of companies and in lignite power plants. Source: DEBRIV, June 2009.

technology and reaches a capacity of 30 MW. Vattenfall also plans to equip the demonstration plant in Jaenschwalde with both technologies oxyfuel and post-combustion, providing an estimated investment volume of 1 billion €. RWE plans to compete and go on steam with the first pre-combustion demonstration power plant by the end of 2014 in Huerth (area of Cologne) inclusive of pipelines and storage facilities for CO_2. This IGCC demonstration plant with a capture rate of over 100.000 t CO_2 per year is based on a preceding overall investment volume of 1,6 billion €.

CCS-technology projects in Germany

CCS-technology projects in Germany have been financed by the ministries BMU and BMWi, the Federal Ministry of Education and Research (BMBF) and the energy companies who have contributed to the ongoing development of CCS.

Vattenfall, RWE and E.ON are the main industrial actors involved in CCS-technology projects. Their activities vary according to development stages, technologies, cooperation partners and investment volume. In addition, equipment producing companies and chemical companies are bound in the construction phases of CSS-power plants.

The role of German hard coal mining industry is decreasing for decades from over 490.000 employees and 146 mining sites in operation in 1960 to about 30.000 employees in 2008.[40] Today, the company RAG AG is the main coal mining company. One economic problem is that the costs for hard coal production in Germany exceed the price on the world market.

Economic costs and perspectives for employment resulting from the introduction of CCS

The data base

All studies imply that the development of the CCS technology and the corresponding infrastructure are supported by public funds. Another precondition is that appropriately equipped large-scale power plants are going on steam from 2020 onwards. For the following 10 years, strong "learning effects" are expected with analogous positive impacts on abatement potentials and abatement costs.

Abatement costs

With the deployment of CCS technology there will be additional costs for CO_2 capture and compression, for transport as well as for storage (abatement costs) compared to electricity generation in conventional power plants. At the moment, the abatement costs in the German project plants are said to be around 60-90 € /t CO2e altogether. McKinsey comes to the conclusion that the abatement costs in newly built large-scale power plants will be 31 € in the case of lignite and 52 € in the case of hard coal and could then, primarily through technology specific learning processes, drop to 30 € and accordingly 48 € / t CO_2 by 2030.

The biggest part of the CCS-induced additional costs accounts for capture and compression of CO_2,. The abatement costs for the retrofit of power plants with CCS-technology tend to be higher than for newly established CCS power plants due to higher costs of capital and lower capture rates.

[40] Employment figures according to Kohlewirtschaft e.V. and IG BCE.

To estimate the abatement potential and abatement costs in the range of conventional power plants, it is assumed that all plants established after 2020 are fit with CCS. In view of the age structure of the plants it is further implied that from an economic aspect half of the coal-fired power plants built between 2005 and 2020 can be retrofit and that this will indeed happen by 2030.

Under these ambitious assumptions, the abatement potential of the coal-fired power plants Germany will soar between 2020 and 2030 and will reach in the final year of the projection 66 Mt CO_2, this is equivalent to nearly two thirds of the total CO_2 induced abatement potential. The abatement costs will then be 2.7 billion €.

With the only minor CO_2 emission of the CCS power plants, the competitiveness of CCS compared to conventional power plants is given if the CO_2 prices correspond approximately to the abatement costs. The CCS technology can thus become profitable, but only provided that other alternatives (renewable energy sources) will not be available in sufficient number or will only be available for a higher price.

Electricity generation costs and electricity tariff

According to prognos, additional conventional power plant capacities between 14,000 MW (with a decline in power consumption by 15 per cent) and 21,000 MW (with a constant power consumption) will be needed in Germany between 2020 and 2030. If these capacities are built as CCS coal-fired power plants, the following changes of the cost structure will arise compared to gas and steam plants (which would otherwise be built):

From its model for the year 2030, prognos deduces a decline of the wholesale prices for electricity compared to the reference scenario without CCS by 17 per cent (version 1) or 22 per cent (version 2).

Abatement costs* with employment of CCS in conventional power plants in Germany (EUR / t CO2e)

Process step	Lignite	Hard coal	(natural gas)
Newly built power plants in 2020**			
Capture	20	41	84
Transport	5	5	5
Storage	6	6	6
Total	31	52	84
Newly built power plants in 2030			
Total	30	48	87
Retrofit between 2005 and 2020 built power plants in 2030			
Total	33	52	> 100

** Difference compared to the energy source specific costs of the corresponding reference technology assessed on the basis of full costing; **Pilot- and demonstration plants* ***Source: own compilation according to McKinsey (2007).***

Abatement potential and costs with employment of CCS in conventional coal-fired power plants* in Germany

	2020	2030
Abatement potential		
Mt CO_2e	5,8	66,1
In% of all potentials*		
Abatement costs		
Million €	253	2.676
€ per Mt CO_2e	44	41

** In the range of gas-fired power plants the potential abatement costs in 2030 will be comparatively low with 113 million €. ** through CO_2 capture.* ***Source: Own calculations on the basis of McKinsey (2007).***

With employment of the CCS technology in Germany induced additional and reduced costs in the period of 2020 to 2030 (billion €)

	Version 1 power consumption minus 15%	Version 2 Power consumption constant
Additional investments in power plants	+21,6	+33,3
Reduction of expenses for imported fuels*	-28,6	-37,4

** substitution of natural gas with hard coal, where upon it is assumed that the border crossing prices for crude oil and natural gas rise by 16% between 2008 and 2030, whereas those for import coal fall by 21%.* ***Source: prognos 2009.***

Macroeconomic and sector effects

According to the prognos model, the increase in the value added is due to the implementation of CCS technology in power plants – examined over the whole period 2016 to 2030 – twice as high as the primary impulse consisting of additional investments and little fuel imports: in version 1 (power consumption falls by 15 per cent) the gross domestic product is by about 100 billion € higher, in version 2 (power consumption is constant) by about 148 billion € higher than the reference model. The lion's share of this increased efficiency is provided by the outfit investments; but also the demand for construction work and private consumption are significantly higher in the CCS models than in the reference model.

This difference shows in the particular employment curves: in version 1 the number of additional employees reaches its peak with 76,000 in about 2025. Afterwards it drops significantly. In version 2, CCS-induced employment rises to 102,000 people and remains on a comparatively high level until the end of the decade. Due to this development, the number of employees is on the average of the years 2025 until 2030 significantly higher than in the five years before.

CCS-induced employment in Germany
(Number of additional employees in the average of the period, rounded values)

Industrial sector	2016-2020	2021-2025	2026-2030
Version 1 (power consumption 2030/2005: -15%			
Coal mining/energy supply	100	400	400
Manufacturing industry	3.800	13.700	9.400
Construction industry	1.300	8.200	7.400
Trade, hotel/restaurant industry, transport	2.800	13.400	10.800
Financing enterprise services	2.400	14.300	12.900
Public and private services	1.200	11.300	12.900
Others	300	1.600	1.500
Total	**11.900**	**62.900**	**55.200**
Version 2 (power consumption 2030/2005: constant)			
Coal mining/energy supply	100	500	600
Manufacturing industry	7.000	16.200	15.700
Construction industry	2.700	10.400	11.600
Trade, hotel/restaurant industry, transport	5.200	15.800	17.900
Financing enterprise services	4.600	17.000	21.100
Public and private services	2.400	13.500	19.700
Others	400	1.900	2.300
Total	**22.400**	**75.300**	**88.900**

Sources: prognos and own calculations.

All in all, the service industry can, however, provide many more jobs – between 2020 and 2030 even twice as many – as the production industry.

With the CCS induced industrial added value, growth in performance with enterprise services is on the other hand associated from which above all the data processing profits and expands its level of employment above average accordingly. When interpreting this data it is to be considered that the macroeconomic employment effects of several impulses connected to the employment of CCS in coal-fired power plants are not or only partly enclosed in the prognos model:

CCS possibly enables further operating of coal mining businesses, which would have to be closed within the period under consideration. In Germany this applies for lignite in particular. In coal mining there was a total of about 46.000 employees in 2007, 29.600 of them in hard coal mining and 16.400 in lignite mining. As 90 per cent of domestic coal output is purchased by power plants, it is assumed that these jobs will be completely lost with a renunciation of CCS; thus they cannot be included in the prognos reference scenario in which solely gas-gas and steam plants are built. Which part of the domestic capacities will be able to survive after the introduction of CCS depends ultimately on the development of the costs of hard coal on the world market and therewith on the development of coal imports. At least in the lignite mining sector a significant number of the around 16.000 jobs will be saved in the medium term. By calculation they are to be considered as a CCS induced growth in employment.

The model suggests an indication to employment effects which result from newly built CCS power plants and movements in the structure of fuel imports. In contrast, costs and macroeconomic effects for building a subterraneous pipeline system as well as preparation and fitting of suitable storage sites for the captured CO_2 are not quantified. In fact, the investments for this part of the infrastructure – the Wuppertal Institute quantifies the costs for one kilometre of pipeline 1 million €, that would with an inner-German network length of about 2,000 km[41] about 2 billion € – are probably lower altogether than the additional investments for the new building of power plants (according to prognos between 22-33 billion €). That applies all the more to the present context as the costs for the building and operation of this infrastructure are attributed not only to those power plants fired with fossil fuels but also to various branches of the manufacturing industry which capture CO_2.

Finally, the macroeconomic effects which can be expected from the export of CCS technology are not included in these scenarios. A overall quantification of the employment effects based on the mentioned four key factors is not possible here.

Debate on the introduction of Clean Coal technologies in Germany

Milestones of the debate

On the political side, two ministries, the Federal Ministry of Economics and Technology (BMWi) and the Federal Ministry for the Environment (BMU) have appeared as leading actors in the debate and have given important impetus on research and development projects, funding and recently the drafting of the CCS law. It has to be stated that the German government is generally favoring an introduction of the CCS technology in Germany, while at the same time expecting economic growth and employment effects from exporting this new technology.[42]

COORETEC

One early initiative was the COORETEC programme of the BMWi. COORETEC is an abbreviation for CO_2-reduction technologies for fossil-fired power plants. It is the German R&D initiative for clean coal technologies and involves

[41] According to Matthes (2009), this is the basic structure.
[42] See BMU 2006: Ecological Industrial Policy

stakeholders from the industry and academia. Under CORETEC 239 projects have been financially supported between 2004 and 2008 with increasing funds since 2004. All major industrial players working on CCS in Germany have been involved in various projects funded by the COORETEC initiative. Its funding has increased from initially 5 million € per year to over 30 million € per year in 2008.

Political parties

All political parties have developed positions in the debate on CCS. Whereas the SPD and CDU drafted the CCS law, the Green party and the Left Party presented themselves as opponents. The SPD and CDU have drafted the CCS law as governing parties in the grand coalition. Both parties share a positive view on CCS. However, CDU and SPD face an internal and rather critical debate on the need of CCS. With the Federal Ministry of the Environment headed by a SPD politician, the SPD generally supports a fast introduction of CCS. Although the CDU has been involved in the drafting process, leading CDU politicians from northern Germany rejected the CCS-law, which has led to its postponement to the next legislative period.

The Green party (Bündnis 90 / Die Grünen) has a very critical position on the CCS technology and has referred to many unsolved questions. As the environmental party, the Green party supports the use of renewable energies for power generation and criticizes that CCS might prolong the existence of coal-fired power plants or even lead to the construction of new coal-fired power plants, instead of investing in renewable energies.[43]

The liberals (FDP) support a rapid introduction of CCS in Germany. They consider the use of coal as a substantial part of the German future energy mix and CCS as an opportunity to effective reduce CO2 emissions. However, the liberals classify CCS as a transitional technology, which enables the connection of climate protection and affordable energy supply.[44]

The left Party (Die Linke) present a very critical position and reject an introduction of CCS in Germany, because of power plant efficiency loss, lack of safety, high costs and competition for funding with renewable energies. The left party considers CCS as a measure of the energy providers to set positive light on coal-fired power plants by giving them a sustainable image. Another point of criticism tackles the high costs of CCS which will apply on German tax payers.[45]

However, there are also other more critical voices in the debate. Several environmental groups have actively participated in CCS-related discussions and opinion making.

The CCS draft act in Germany

In April 2009 the German government drafted and presented the draft legislation act on capture, transport and permanent storage of carbon dioxide (CCS) in April 2009, corresponding to the EU directive on CCS. As a common draft of the BMWi and BMU, it shall establish a legislative frame to enable exploration and storage of CO_2 in Germany.[46]

The presentation of the draft act has led to an ongoing political debate on the advantages and disadvantages, and necessity of CCS, which ended in the postponement of the draft act. After the German elections in September 2009, the CCS act will be discussed again. The draft act defines responsibilities and liabilities of operators of the CO_2 storage sites and the shifting of responsibilities to the federal states

[43] Bündnis 90/ Die Grünen 2009: Klare Regelungen für CCS-Technik – Vorrang für erneuerbare Energien.
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[44] FDP Fraktion 2009: Rechtliche Grundlagen für die Einführung von CCS-Technologien unverzüglich schaffen.

[45] Die Linke 2009: Technologieversprechen CCS verlängert Kohleära und bremst Energiewende.

[46] For entire document of CCS-draft act; see Deutscher Bundestag 2009: Gesetzentwurf der Bundesregierung: Gesetz zur Regelung von Abscheidung, Transport und dauerhafter Speicherung von Kohlendioxid.

and federal government of Germany after 30 years.

Public acceptance of CCS

The adaptation of the CCS draft act was postponed to the next legislative period. One of the main reasons was the low or non-existent perceived public acceptance of the CCS technology. The lack of acceptance by the general public turned out to be a barrier for the implementation of CCS.

Summary

An introduction of Clean coal technologies in Germany can have an important impact on various economic areas, but is at the same time dependent on still undecided factors.

Firstly, coal will probably hold a respectable share in the future electricity generation in Germany after the nuclear phase out and until renewable energies will have reached a sufficient development stage. CCS may serve as a transitional technology to effectively reduce CO_2 emissions in coal fired power plants in order to make the use of coal "cleaner".

Secondly, costs for constructing new CCS-power plants or retrofitting existing power plants are estimated at 500 million € to 2 billion € per facility. In addition, costs for capture, transport and storage of CO_2 are estimated in this study at 31 €/ t CO_2 for lignite fired power plants and at 52 €/t CO_2 for hard coal fired power plants in pilot- and demonstration facilities. Costs of retrofitted power plants are expected to be higher as efficiency rates decrease. All of these costs indicate that rising costs for electricity generation are possible which might have an effect on electricity tariffs in Germany.

Thirdly, CCS can open economic perspectives for the industry. Mostly the equipment producing industry for power plants and steel producers as well as construction firms for the CO_2 infrastructure might profit from CCS. The future of the lignite mining sector is also closely dependent on CCS, considering that CCS might secure the share of lignite in the future energy mix.

Fourthly, the net employment effect is expected to be positive. Employment effects generated out of CCS have been estimated between 76.000 people and 102.000 employees. These employment estimations do not include a potential impact on the German mining sector and the effects of constructing CO_2 infrastructure. Neither are macroeconomic effects resulting from an export of the CCS-technology part of the estimations.

CCS technologies face a number of uncertainties. One significant problem is the lack of public acceptance of CCS, another one is the unclear political framework in Germany. Also, the risks of CO_2 storage for both environment and people are currently not sufficiently analysed and may not be ignored.

The German government, trade unions and the industry generally favour a rapid introduction of CCS. The German trade unions IG Metal, IG BCE and ver.di commonly support research and development on CCS in Germany and consider CCS as solution to make coal "cleaner". They assume that CCS may prevent the relocation of energy-intensive industries from the production site Germany and forecast a potential positive employment effect resulting from the introduction of this technology.

The introduction of clean coal technologies to Germany might create a change in job profiles and qualifications among employees in the energy providing industry. However, currently there are no studies available on this topic.

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R. VAN SLOTEN: EXECUTIVE DIRECTOR INDUSTRIAL POLICY, CEFIC

Steel industry and aluminium

J.-C. Charbonnier: secrétaire general de l'ESTEP (European Steel Technology Platform)

B. Kohl: directeur Environment d'Eurofer

J.-P. Birat: coordinateur du programme Ulcos (ESTEP)

R. Jeekel: directeur Energy & climate change policy

Clean coal

United Kingdom

J. Shapiro: CCS Association

M. Farley: Doosan Babcock

D. Meredith: E.On

D. Rutland: DECC (Department of Energy and Climate Change)

S. Ferns: Prospect (affiliate of TUC)

M. Clancy: Prospect (affiliate of TUC)

R. Sneddon: Community (affiliate of TUC)

T. Kerr: International Energy Agency

P. Pearson: TUC

Poland

K. Grajcarek: Solidarność

K. Szynol: PKEE

J. Tchórz: directeur du département de Développement de la technologie, PKE

L. Kurczabyński: directeur de la Promotion et des analyses de marché, Coal Holding Katowice Company (KHW)

P. Litwin: directeur du Développement et des investissements, Energa

Germany

Social partners

A. Thomas: Ressortleiterin Technologie et Environnement, IG Metall Frankfurt

Dr. R. Bartels: IG BCE, Hannover

Dr. R. Klopfleisch: Energiereferent Verdi, Berlin

Experts

K. Pietzner, A. Esken et P. Viebahn: Wuppertal Institut

Prof. Dr.-Ing. A. Kather: Technical University Hamburg-Harburg, chairman of Cooretec

Power plants operators

D. Müller, head of project Communications, CCSVattenfall, Berlin

Equipment producers

J. Karg: head of Business development IGCC, Siemens Energy, Erlangen

T. Opderbeck: Energy Communications vice-president, Siemens Energy, Erlangen

A. Schimkat: manager External affairs Germany, Alstom, Mannheim

Europe

A. Hercsuth: projekt officer, DG TREN, Commission européenne

W. Raldow: head of Unit « Energy – Energy conversion and distribution system », DG Research, Commission européenne

J. Lipponen: head of unit « energy policy & generation », Eurelectric

Dr T. Diercks: secrétaire general, Euracoal

D. Bonijoly: coordinateur CO2 projects (Castor, Geonet…), BRGM

F. Kalaydjian: director, Sustainable Development Technologies Division, IFP

P. Paelinck: directeur, CO2 Systems Business Development, Alstom

T. Kerr: senior energy analyst, IEA

B. Beck: Energy Technology Policy Division, IEA

Syndex
27, rue des Petites-Écuries
75010 Paris – France
Tél. : (33) 1 44 79 13 00
Fax : (33) 1 44 79 09 44
www.syndex.fr

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Wilke, Maack und Partner
Unternehmensberatung
Schaarsteinwegsbrücke 2
20459 Hamburg
Tel. +49 40 43 27 87-43
Fax +49 40 43 27 87-44
http://wilke-maack.de

S. Partner Sp. z o.o.
ul. Wspólna 35 lok. 10
00-519 Warszawa
tel. +48 22 380 33 60
fax +48 22 380 33 66
www.syndex.pl