The Impacts of Climate Change on European Employment and Skills in the Short to Medium-Term: A Review of the Literature

Final Report (Volume 2)

May 2009

The Impacts of Climate Change on European Employment and Skills in the Short to Medium-Term: A Review of the Literature

Final Report (Volume 2)

Date: 29th May 2009

526 Fulham Road, London SW6 5NR

Tel: 020 7471 8000; Fax: 020 7736 0784

www.ghkint.com

GHK

Document Control

Document Title	The Impacts of Climate Change on European Employment in the Medium-Term
Job No.	J6074
Prepared by	James Medhurst
Checked by	Adarsh Varma
Date	29/05/09

CONTENTS

1 INTRODUCTION

1.1 Purpose of the Report

GHK Consulting was commissioned to produce material for the Restructuring Forum to be held on 22 and 23 June on the impact of climate change on EU employment in the medium term (to 2020). In particular the material comprises:

- Fifteen company cases studies across a range of sectors examining how businesses are being influenced by, and responding to climate change and related polices, with a summary report pulling out the main lessons (Volume 1); and
- A literature review in the field of climate change and its impact on employment (Volume 2).

This report is Volume 2 and summarise the main conclusions from the existing literature on the nature of climate change and related polices, their impact on the EU economy and on economic sectors, examining in particular the effects on employment and skills (differentiating short-term to long term impacts). This sets the context for the debate concerning the drivers for restructuring, the types of sector affected, the need for businesses to anticipate the need for adjustment and the types of adjustments likely to be required. It also provides the basis for the selection of sectors from which the case studies were drawn.

1.2 Economic Restructuring

As described in the European Commission Communication[1], the prosperity and well-being of European citizens depends on economic players and workers adapting rapidly to the current far-reaching socio-economic changes, which are translating into the creation and development of new economic activities, but also into the contraction, or even disappearance, of existing activities and the related jobs.

The restructuring of enterprises often entails costs that can be very high, not only for the workers concerned but also for the local or regional economy. The preservation of social cohesion, which is a distinctive characteristic of the European social model, requires the introduction of accompanying policies designed to reduce the social costs to a minimum and to promote the search for alternative sources of jobs and income.

It is therefore essential to ensure that restructuring is well-managed, so that the competitiveness of enterprises is maintained, preserving employment or facilitating the transition of workers to other jobs of equivalent quality. Restructuring must form part of a long-term vision of the development and direction of the European economy in order to ensure that the changes really are a way of strengthening its competitiveness.

The work of anticipating and accompanying these operations is fully in keeping with the Lisbon strategy and is the collective responsibility of the public authorities, enterprises and social partners.

1.3 Stages in Restructuring Policy

Key stages in restructuring policy can be identified as follows:

1) **Anticipation of Change** – initiatives that promote a proactive and forward-looking approach to the management of restructuring in order to prepare for the changes ahead and minimise any negative social and economic consequences. The typical activities that fit

[1] Restructuring and employment: Anticipating and accompanying restructuring in order to develop employment:, the role of the European Union, COM(2005) 120 final

within this stage revolve around those that focus on the observation, research and analysis of the restructuring phenomenon;

2) **Planning and Preparation for Change** – more „hands-on" measures, primarily focusing on the development and institutionalisation of initiatives that help to deal with restructuring. It may include the provision of training, human resource planning and support in the field of finances, technology and innovation - in other words, effective and practical measures to manage change;

3) **Social Support Measures** – more „reactive" or „remedial" approaches with the aim of eliminating or mitigating the social fall-out of restructuring. This stage can be executed via reclassification measures, reconversion units, regional redevelopment and mobility groups, active labour market measures and other similar interventions.

These stages should not be viewed as cyclical or sequential in nature. Rather, they should be seen as parallel efforts to address multi-faceted and ongoing transformations - ideally in a more proactive or efficient way than simply responding to an immediate „crisis situation."

These stages form part of the European Commission"s conceptual model of restructuring, have been used as a structure for organising the work of previous Restructuring Fora and are cited in various European Commission publications. A similar distinction (into four stages) of restructuring was established in Bernard Brunhes International"s thematic report "Evaluation of European Social Fund Support to the Anticipation and Management of Economic Change and Restructuring."

1.4 Climate Change and Restructuring

It is becoming clear that the significance of climate change is becoming such that companies will have to adapt to changing regulatory frameworks, such as constraints on CO2 emissions for car manufacturers and the proposed CO2 Emissions Trading Scheme (ETS), which is likely to lead to restructuring, at least in some sectors and for some businesses.

The changes needed to respond to climate change polices to reduce CO2 emissions provide a clear example of a restructuring process. There are many opportunities - for example through the early adoption of innovative new technology - to place European companies ahead of global competitors that are slower to anticipate change. Conversely, a failure to anticipate by European firms may lead to hasty, reactive and forced later adjustment, which could damage companies and, leave their employees inadequately prepared, or trained, for alternative employment. Climate change will act as a key driver of evolution for the economic actors involved. The Commission has an important role to play in spreading awareness, to enable both employers and employees to anticipate the changes and meet the challenges. To do so, companies will need to adapt their current products, processes and technology and to develop new innovative solutions and workers will also need to acquire new skills

1.5 Climate Change and the Restructuring Forum

To support workers, companies and their representatives in their efforts to anticipate and cope with climate change implications DG EMPL plans to hold a one-off Restructuring Forum, in mid 2009, to examine the effect on European employment of policies designed to mitigate and adapt to climate change. The Forum will go beyond the usual scope of Restructuring Forums to raise awareness of these questions in general and to specifically consider the impacts on employment and skills requirements of measures to mitigate and adapt to climate change, particularly those linked to the reduction of CO2 emissions.

The Forum will be aimed at a wide audience throughout the European Union, including the current participants in the Restructuring Forums (social partners, representatives of public

authorities at different levels, experts) but also a wider audience among European citizens (consumers, those in education and workers making future career choices).

This report is intended to inform and catalyse discussion at the Forum.

2 CLIMATE CHANGE POLICY AS A DRIVER OF RESTRUCURING

2.1 Impact of Climate Change

The physical impacts of climate change are already being experienced in most parts of the world. Europe has seen an increase in the number of adverse weather related events in the past decade. The EU's climate policy is in keeping with the target of limiting the global temperature rise to 2°C in relation to its pre-industrial level. This level is considered sufficient to reduce the probability of irreversible and extremely damaging effects but will not suffice to avoid a change in the climatic conditions we currently experience. However, the scenario of a temperature rise greater than 2°C cannot be excluded.

Slowly but steadily, a consensus is emerging that addressing climate change will require a cut in global greenhouse gas emissions of at least 50% by the middle of the century – considerably more in developed countries – which will have to bear the brunt of the abatement effort (see Stern, 2007).

This review mainly examines work to assess the impact of climate change policies on jobs. These policies are in response to existing and potential effects of climate change, which are diverse, and which will potentially alter access to basic elements of life, such as food, water, health, use of land and the environment.

The direct physical effects of climate change on employment have not yet been studied systematically. However, it is very probable that the phenomena induced – changes in temperatures and precipitation levels, rising sea levels and changes to the frequency of extreme climatic events – will have implications for economic activity and employment in Europe. In April 2009 the European Commission presented a policy White Paper[2] which presents the framework for adaptation measures and policies to reduce the European Union's vulnerability to the impacts of climate change. The White Paper also presented an economic case for a strategic approach to adaptation, since the response of individuals or businesses (e.g. in agricultural and tourism sectors) to market signals or environmental changes brought about by climate change ('autonomous adaptation') is unlikely to be optimal because of uncertainty, imperfect information and financial constraints.

The main sectors affected directly by climate change and related risk due to changing resource, land and weather patterns are:

- Agriculture, Forestry, Fisheries
- Tourism
- Finance-Insurance
- Health
- Energy

The most extensive amount of work has been focused on agriculture, forestry and fisheries due to its climate sensitivity. Although the contribution to Europe's GDP from agriculture represents only 2.6%, the sector employs about 5% of all workers. ETUC (2008) has estimated the direct physical impact of climate change on jobs in the agricultural sector in Europe. The study found negative employment impacts on the agricultural sectors in southern European countries and balanced or slightly positive effects on agriculture due to potential gains in arable land and new types of crops in the Nordic countries. Forestry might suffer from forest fires and storms with decreasing revenues and employment. Table 2.1 summaries the potential effects of climate change on economic activity and employment in the agricultural, forestry, and fisheries sectors.

[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

Table 2.1: Potential Effects of Climate Change on Economic Activity and Employment in the Agricultural, Forestry and Fisheries Sector

Geographical location	Main climatic drivers	Expected potential effects on				Level of confidence	Remark
		Economic activity		Employment			
Mid- and high latitude regions	Rising temperature, high atmospheric CO_2 concentration	Positive	Agricultural productivity	Positive	Employment overall	Medium-high	The warming level must remain moderate. The increased in productivity could be hindered by other limiting factors (water, nutrients, etc). High uncertainty about the fertilisation effect due to high CO_2
Low altitude mountain resorts	Rising temperature, changes in precipitations	**Negative**	**Winter tourism activities**	**Negative**	**Seasonal employment**	Medium-high	
High altitude mountain resorts	Rising temperature, changes in precipitations	Possible positive	Snow related activities	Positive	Seasonal employment	Medium	Benefiting from a redistribution effect due to the loss of attractiveness of low altitude resorts.
Nordic regions	Rising temperature, changes in precipitations	Positive	Tourism demand	Positive	Sector employment	Medium	
Eastern Europe							
Southern Europe	Rising temperature, droughts	**Negative**	**Agricultural productivity**	**Negative**	**Local level employment**	Medium	
Mediterranean region	Higher fire risk due to above	**Negative**	**Forestry productivity**	**Negative**	**Local level employment**	Medium	
	Rising temperature, droughts	**Negative**	**Agricultural productivity**	**Negative**	**Local level employment**	Medium	
Mediterranean regions, coastal resorts	Changes in precipitations, sea level rise	**Negative**	**Summer tourism demand**	Possible negative	Seasonal employment	Medium	
	Rising temperature in summer	**Negative**	**Summer tourism demand**	Possible positive	Tourism	Medium-low	Qualitative impact on employment in the sector with more stable conditions through longer contract periods.
		Positive	Spring/autumn tourism demand				
General	Increase in frequency and intensity of extreme weather events	**Negative**	**Agricultural/forestry productivity**	**Negative**	**Sector employment**	Medium-low	
Southern Europe	Rising temperature	**Negative**	**Livestock productivity**	**Negative**	**Local level employment**	Low	Heat stress could cause physiological changes.
Fisheries communities (Iceland, Baltic Sea, Spanish and Portuguese coast notably)	Changes in: sea surface temperature, wind regime, water runoff, ice melt, or marine currents	**Negative**	**Fisheries productivity**	**Negative**	**Sector employment**	Low	Employment impacts will possibly be significant at local level.

Note: Negative impacts are highlighted in grey.

Tourism is also a major sector affected by climate change, either due to worsening conditions for winter tourism in the lower mountainous regions or from less demand for vacations in warmer regions due to excess heat. Tourism is an important economic activity for Europe, generating turnover of €263 billion in 2004 according to the World Tourism Organisation (WTO 2005). The industry is responsible for 4% of total EU-25 employment,. The variation of tourist flows will affect regional economies, although the macroeconomic effects might be fairly neutral (Berrittella et al. 2006). The local or regional effects may indeed be stronger than the actual overall impact.

Climate change related physical impacts will also affect the insurance industry. The insurance sector may lose some jobs in general but jobs for certain areas of expertise will increase. According to ACACIA (Parry 2000), the insurance industry turnover is about €600 billion, its assets are around €4,000 billion and the sector as a whole employs some 1 million people. The potential effects of climate change on economic activity and employment in the finance/insurance sector in Europe is given in Table 2.2 below.

Table 2.2: Potential Effects of Climate Change on Economic Activity and Employment in the Finance/Insurance Sector

Geographical location	Main climate drivers	Expected potential effects on economic activity and *employment*	Level of confidence
General	Increase in frequency and intensity of extreme weather events	Economic pressure, especially on small businesses. *Negative impact on employment*	Medium
General	Increase in frequency and intensity of extreme weather events	Devaluation of assets owned by actors in the sector. *Negative impact on employment.*	Medium
General	Increase in frequency and intensity of extreme weather events	Additional demand for experts in risk assessment damage evaluation, awareness campaign, etc. *Positive impact on employment for specific professions.*	Medium

Source: ETUC (2007)

There is some evidence in the literature arguing that climate change is likely to increase heat-related health issues and decrease cold-related ones in Europe. As heat waves are projected to increase in terms of both frequency and duration, mortality and diseases due to heat stress will increase accordingly. The potential effects of climate change on economic activity and employment in the health sector is shown in Table 2.3 below.

Table 2.3: Potential Effects of Climate Change on Economic Activity and Employment in the Health Sector

Geographical location	Main climate drivers	Expected potential effects on economic activity and *employment*	Level of confidence	Remark
General, northern countries especially	Rising temperature	Overall decrease in mortality and morbidity. *Negative impact on employment in health sector due to decreased demand for health services.*	Medium	
General, northern countries especially	Rising temperature	Decrease in mortality and morbidity. *Positive impact on employment through increase in labour productivity.*	Medium-low	Economy-wide
General, southern countries especially	Extreme weather	Negative impact on labour's productivity for activities carried out outdoor. *Negative impact on workers health and safety*.	Medium	Economy-wide

Source: ETUC (2007)

Climate change will change quantities and patterns of energy demand and also alter the conditions and potential for electricity production. The energy demand for space heating in winter is likely to decrease due to the warming. On the other hand, hotter summers could result in an increasing demand for air conditioning (EC, 2006). On the production side, for example, the effect of climate change on hydropower production is mainly twofold. First, variations in rainfall affect hydropower generation potential. Secondly, increased temperatures enhance water evaporation. The potential effects of climate change on economic activity and employment in the energy sector is shown in Table 2.4 below.

Table 2.4: Potential Effects of Climate Change on Economic Activity and Employment in the Energy Sector

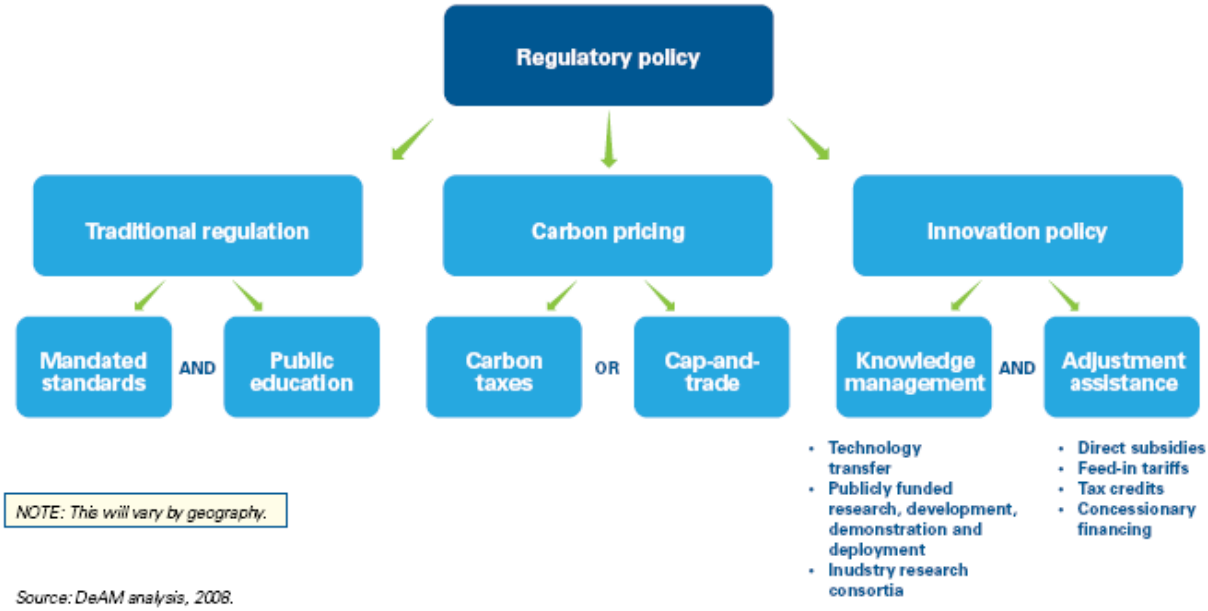
Geographical location	Main climate drivers	Expected potential effects on economic activity and *employment*	Level of confidence
General, northern Europe, especially	Rising temperature	Reduced energy demand for space heating in winter, increased energy demand for space cooling in summer. *Mixed impact on employment in energy production and distribution.*	Medium
Nordic countries	Increased precipitations	Possible increase in hydropower generation potential. *Possible positive impact on employment*	Medium

Source: ETUC (2007)

2.2 An Overview of Climate Change Policies

There are three main forms of climate change regulation: traditional regulation (standards, etc), carbon pricing, and innovation policy, (Figure 2.1).

Figure 2.1: Overview of Climate Change Policies



Source: DeAM analysis, 2008.

Currently most climate change policies are concentrated either in traditional regulation (energy standards, energy efficiency standards, building codes and emissions standards) or in innovation policy (feed-in tariffs, tax credits, direct subsidies and funding for research and development and innovation). Regulation has long been a stimulus for newer environmental technologies (Box 2.1), but there is now an increasing emphasis placed on innovation support (see Section 2.2) A number of mitigation opportunities, such as biofuels in the US or wind in Europe, are influenced both by traditional regulation and innovation policy (shown by the policy overlap section in Figure 2.2 below).

Box 2.1: Regulation as Stimulus to New Technology

Regulations have had significant impacts on establishing markets for green technologies, for example:

- Denmark's 1979 wind turbine standards are credited with making the country the world's leading turbine manufacturer.
- Germany's 1991 turbine standards and certification requirements prevented quality control problems such as those experienced in California and India.
- Spain, for instance, instituted a new building code in 2006 requiring all new large non-residential buildings to generate a portion of their electricity with solar PV.
- The Chinese government issued its first compulsory standards for controlling vehicle Fuel Consumption for Passenger Cars(on September 2, 2004, and the policy became effective on July 1, 2005.) to phase out inefficient vehicles manufactured in the 1980's

Source: UNEP, 2008

Traditional regulation and innovation policy will continue to have an important role to play, but carbon pricing is seen as an instrument of growing importance (see Stern, 2006; McKinsey, 2009). Carbon pricing is a relatively new form of climate policy. By internalising

the price of carbon and given that energy prices fluctuates, carbon pricing would provide a continuous incentive to innovate. In the future, we can expect carbon pricing to be the main climate policy driver because it should enable the market to generate the most cost-effective greenhouse gas reduction measures. As a driver of restructuring this policy is reflected in higher energy costs for producers, and the need for producers to invest in alternative technologies and product development to reduce energy use, and/or to reduce carbon emissions.

The cap and trade mechanism (as reflected in the use of carbon emission permits under the EU Emissions Trading Scheme (ETS), Box 2.1)) has, however, received significant criticism: the cap (or total allowable emissions) is seen by some to be set too high, and the trade (in permits) is not functioning well because of the free allocation of permits based on past emissions levels and because the recession has led to surplus of permits (allowing their sale without any pressure on emissions, and a stock piling by large emitters especially the energy companies). Because of this there has been a call for a move to a simpler system of carbon taxes, although this measure is also difficult to operate and (unlike a cap and trade mechanism) does not fix the level of allowable emissions.

Box 2.2: Overview of the EU Emission Trading Scheme

The EU ETS is the world's first trans-national emission trading scheme and came into effect in January 2005, with the first phase running from 2005 to 2007, followed by a second phase from 2008-2012. It is a cap and trade system aimed at putting EU member states on course to meet their targets under the Kyoto Protocol. The cap covers only carbon dioxide (CO2), although other greenhouse gases (GHGs) may be added in the future. In its first phase, the EU emissions trading scheme (EU ETS) covered CO2 emissions from power generation, oil refineries, coke ovens, iron and steel, cement, lime, glass, ceramics, and pulp and paper, as well as from all combustion plants with a rated thermal input of more than 20MW of capacity.

The first phase included some 15,000 installations in EU-10 and 10 Accession countries, representing approximately half of EU CO2 emissions that fall under the activities specified in Annex I of the Directive. Each installation obtains emission allowances for the whole period and allowances are allocated to installations covered by the scheme by the Member States of the EU by means of a national allocation plan (NAP) and according to defined criteria. For the first period emission allowances are free of charge and allocation is based on grandfathering. In the second phase (2008-2012) Member States can auction up to 10% of their total emission allowances. The allowance price on average has been around €20-25 per tonne of carbon.

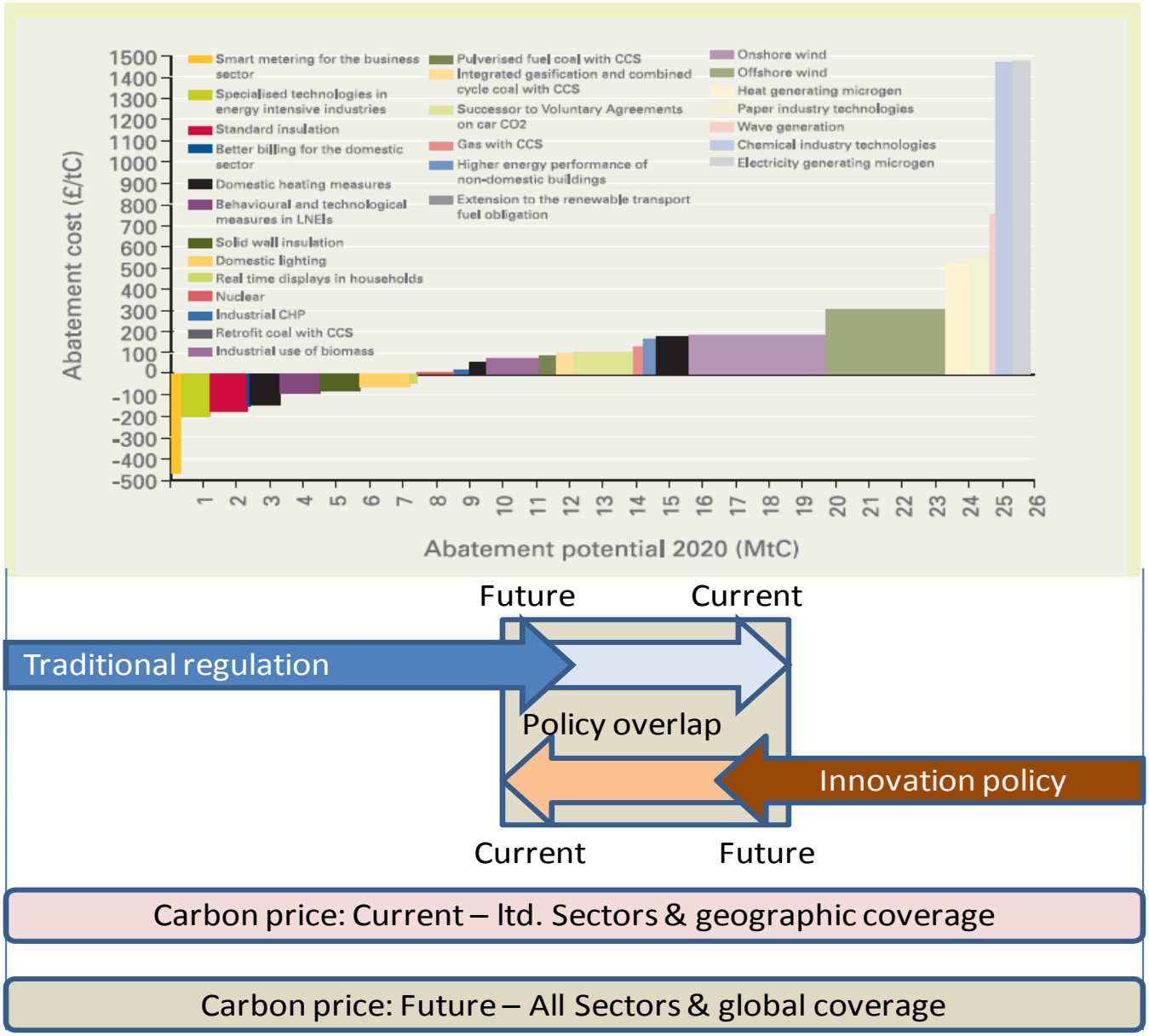
If a company fails to surrender sufficient allowances to its Government at the end of each yearly reconciliation period, it faces a fine of €40/tonne in Phase 1 and €100/tonne in Phase 2, in addition to having to purchase the equivalent shortfall for retirement the following year.

These measures are global in nature, although their relative use and specific design will vary by country and by sector.

2.3 Policy Drivers and Carbon Reduction Measures

Figure 2.2 sets out a range of carbon emission reduction measures and their relative costs and hence significance as a driver of restructuring.

Figure 2.2: Measures to Reduce CO2 Emissions and Related Abatement Costs



Source: UK Energy White paper (2008)

The two policy drivers of regulation and innovation support are theoretically best-suited to the extreme ends of the greenhouse gas mitigation policy curve, with regulation securing little or no compliance cost where costs are negative or small, and innovation required in order to find solutions where current responses have high costs. However these drivers operate throughout the range of responses and overlap.

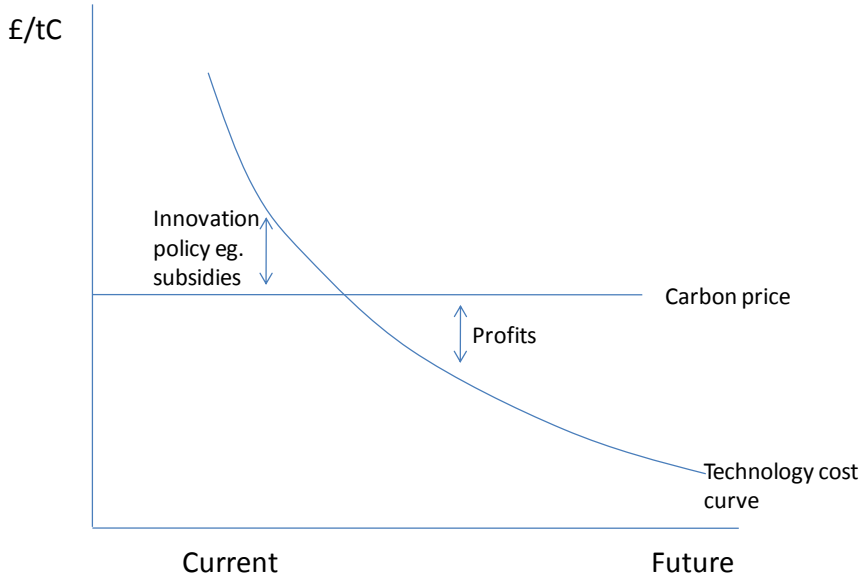
As carbon pricing becomes established there is potential scope to reduce the reliance on regulation and innovation policy in the areas where responses are not overly costly or where regulation is a more effective driver. For expensive technology solutions, innovation policy would improve learning rates and lower mitigation costs (see Figure 2.3 below).

Furthermore, some of the technologies to the right of the MAC curve in Figure 2.2 have a greater quantity of annual emissions that can be eliminated by that method[3] (such as wind

[3] The horizontal width of a bar represents the total quantity of annual emissions that can be eliminated by that method, and bar heights show the economic cost of the method that makes it cost-effective, measured in cost of CO2e per ton. The height of each bar also takes into account the learning rate of the technology – which is vital

power) so a technology breakthrough in these technologies can lead to significant cost reductions for the economy. However, selecting the right measure to be subsidised is complicated as it is difficult to foresee promising technology of the future today, but the principle is described in Figure 2.3

Figure 2.3: The Economic Case for Innovation with Carbon Pricing.



2.4 Future Policy Drivers

The three main types of policy driver are likely to continue. In the most recent analysis of abatement measures, McKinsey (2009) conclude that four types of regulation are required:

1. Traditional regulation, to respond where imperfect markets prevent the full effect of carbon pricing, specifying standards and norms;
2. Carbon pricing (using taxes or tradable permits) to establish stable long-term incentives and encourage energy producers and industrial companies to invest in more efficient GHG reduction technologies;
3. Innovation support and incentives to invest in emerging technologies that promise greater cost-effectiveness in carbon reduction
4. Measures to ensure the potential of forestry and agriculture is effectively addressed, mainly in developing countries.

These conclusions echo the earlier recommendations of the Stern Review to develop carbon pricing and innovation support and the continuing need for traditional regulation that address the barriers to behavioural change especially with respect to energy efficiency,

2.5 European Policy Support for Restructuring - Current and Emerging Initiatives to Aid Restructuring in Responses to Climate Change Polices

There are a number of existing and planned financing instruments and other innovation support initiatives that are potentially available to assist with businesses and sectors having to restructure in response to climate change polices. These include the Competitiveness and Innovation Programme (CIP), Joint Technology Initiatives (FP7), European Technology

for projecting the future cost of emerging technologies on the mitigation curve, as many of them are coming down the learning curve at 5-10% a year. This means that within a decade, the cost of many of the technologies on the curve halve.

Platforms (ETPs), lead market initiatives and international sectoral agreements. Finally we note the recent agreement to a 'Green Stimulus Package. In summary these comprise:

The Competitiveness and Innovation Framework Programme (CIP), has been designed to contribute to the "enhancement of competitiveness and innovation capacity in the Community, the advancement of knowledge society and sustainable development based on balanced economic growth". CIP brings together the specific Community support programmes (Multi Annual Programme for Enterprise and Entrepreneurship (MAP)) and parts of other Community programmes (7th Framework Programme for Research and Technological Development FP6, LIFE+) in fields critical to boosting productivity, innovation and sustainable growth into one specific Community support programme. CIP has three main pillars: the Entrepreneurship and Innovation Programme, the ICT Policy Support programme and the Intelligent Energy - Europe programme. Running from 2007 to 2013 CIP has a budget of approximately EUR 3.6 billion. It represents a 60% increase in annual spending on actions related to competitiveness and innovation by 2013 compared to 2006.

Joint Technology Initiatives (JTIs): were introduced in May 2007 by the European Commission. This is the first time that public-private partnerships, involving industry, the research community and public authorities, were proposed at European level to pursue ambitious common research objectives. JTIs will support large-scale multinational research activities in areas of major interest to European industrial competitiveness and issues of high societal relevance.

European Technology Platforms (ETPs): Provide a framework for stakeholders to define a Strategic Research Agenda on a number of important issues with high societal relevance where achieving Europe's future growth, competitiveness and sustainable objectives is dependent upon major research and technological advances in the medium to long term. The tasks include the timely development and deployment of new technologies, technology development with a view to sustainable development, new technology-based public goods and services, technological breakthroughs necessary to remain at the leading edge in high technology sectors and the restructuring of traditional industrial sectors. ETPs are proving to be powerful actors in the development of European research policy, in particular in orienting the Seventh Research Framework Programme (FP7) to better meet the needs of industry.

Lead Market Initiatives (LMIs): there are currently six Lead Market Initiatives (LMIs) designed to influence the demand for new innovation and technological development, based on an integrated mix of policy initiatives. These include a combination of measures around revising or extending legislation, the use of public procurement, the review or extension of certification and standardisation of process or product and extensions or revisions in state-aid (R&D&I and Environmental) Guidelines).

International Sectoral Agreements: DG Enterprise is currently funding a project to examine the possibility of international sectoral agreements in four selected energy intensive industries (EIIs) with three countries (Brazil, China, Mexico). The work in this project will identify specific proposals for specific agreements for each of the selected EIIs and in particular the use of one or more of the following approaches:

Transnational Sectoral Approach

- Single international standard/benchmark for similar facilities in a sector
- Differentiation lies in timing and level of financing provided

Sectoral Bottom-up Approach

- Developing countries would adopt voluntary "no-lose" GHG intensity targets in key sectors
- Technology and financial assistance to encourage more aggressive targets

Sectoral Carbon Finance Approach

- Applies CDM approach to all plants in a given sector or subsector in a given country
- Simplifies baselines and additionality

EU Green Stimulus Package: The EU fiscal stimulus plan agreed by Member States on the 12th of December 2008 sets out a framework for how funds should be used to stimulate investment, to "green" Europe's economy and boost energy efficiency. The Plan also includes proposals to stimulate labour markets and increase demand for energy efficient goods and services through innovative use of taxation. Under the innovation and investment priority a number of actions were announced:

- a 'European green cars initiative' (€5bn), for low carbon transport, funded by the Community, the EIB, industry and Member States'.
- a 'European energy-efficient buildings' initiative (€1bn), in the construction sector to promote green technologies and the development of energy-efficient systems and materials in new and renovated buildings to reduce energy and emissions
- a 'factories of the future initiative' (€1.2bn), to increase the use of technology in manufacturing to help EU manufacturers across sectors, in particular SMEs, to adapt to global competitive pressures by increasing the technological base of EU manufacturing through the development and integration of the enabling technologies of the future, such as engineering technologies for adaptable machines and industrial processes, ICT, and advanced materials.

3 ECONOMIC CONTEXT FOR ASSESSING RESTRUCTURING PRESSURES AND RESPONSES TO CLIMATE CHANGE POLICIES

3.1 Economic Context for Restructuring Pressures of Climate Change Polices

Climate change will lead to restructuring by impacting on both the supply-side and the demand side of businesses:

- Costs – climate change mitigation and adaptation policy leading to higher compliance costs (especially in the form of higher energy prices), exacerbated for businesses subject to strong international competition and where climate change policies differ significantly from the EU; and
- Changing demands – responding to changing customer demands that reflect climate change policies through measures to reduce barriers and promote innovation in response to market threats and opportunities.

All businesses are therefore likely to be impacted on in some way because of climate change policies. Many will choose to ignore the impacts (at least in the short term), others will simply absorb the impacts (such as higher energy prices) in their normal business model. However, some sectors are more susceptible to these polices, and the associated businesses will need to formulate more explicit business strategies to respond.

3.2 Overall Economic Impact of Climate Change Policies

The economic impact of climate change polices in the EU has been the subject of a range of studies. To date, there appear to only be a few estimates of what the macroeconomic impact might be of meeting carbon reduction targets in terms of the net effect on GDP levels (global, European or national level) and the potential level of investment required to attain these levels of reductions. The greater focus has been on where the potential benefits and market opportunities of low-carbon business and resource-efficiency might be (Box 3.1).

These suggest (Box 3.1) that in aggregate the overall level of impact is modest and that costs will also be associated with the opportunity to take competitive advantage from the structural changes triggered by climate change policies.

Box 3.1: Estimates of Overall Economic Impact

Key Points from the literature:

- Globally, market growth in the environmental sectors is driven primarily by legislation, whether at the international or national level, particularly in the more mature markets of the US, EU and Japan (Ernst and Young, 2008)
- In a one of the more detailed assessments, the economic impact of implementing CC policies was estimated at 1% of annual global GDP to 2050 to stabilise emissions at 550ppm CO2-e (Stern, 2006)
- Costs will increase if the most efficient carbon reduction technologies are not used. Delays in implementing climate change polices will increase costs to achieve given reductions or fail to achieve target reductions (Stern Review, 2006; McKinsey, 2009)
- Overall climate change policy will have a modest aggregate economic impact on job growth in the US (CERES, 2008) and in the EU (EUTC, 2008). Climate change policies are more likely to lead to a redistribution of jobs within and across sectors than to changes in absolute employment levels (ETUC, 2008), (IEEP, 2008), (CERES, 2008).
- Markets for low-carbon energy products are likely to be worth at least $500bn per year by 2050, and perhaps much more (Stern, 2006)

- US and EU support for the renewable energy industry will benefit sectors of the economy and states that currently suffer from high unemployment (Apollo Alliance , 2008), (CERES, 2008), (EUTC, 2008), (Fankhauser, 2008), (Kammen, . Kapadia, & Fripp, 2004), (OEDC, 2008), (WWF, 2001)
- All models estimate that overall, the renewable energy industry generates more jobs per MWa than the fossil fuel based industries (mining, refining and utilities)" (CES, 2007), (Deutsche Bank , 2008), (ETUC, 2008) (Kammen, . Kapadia, & Fripp, 2004), (Kammen D. M., 2007), (US Conference of Mayors , 2008), (UNEP, 2008) (WWF, 2001)

The employment impact of climate change policy and the transition to a low-carbon economy is examined in a recent report on 'Green Jobs' by the United Nations Environment Programme (UNEP). The analysis states that the 'greening' of an economy will affect employment in four ways:

Effect	Example
Additional employment created	Additional insulation fitters for retrofitting homes
Employment substituted	Manufacturing hybrid cars instead of inefficient cars
Eliminated jobs	Reduction in packaging of products
Transformation of existing jobs	Gas-fitters installing gas CHP instead of traditional systems

Note: Adapted from UNEP/ILO report, 'Green Jobs: Towards decent work in a sustainable, low-carbon world', 2008

Climate change policies will affect all sectors differently. Each sector and business will face its own set of challenges and opportunities. A study by the OECD/IEA (2008) concludes that the required expenditure to meet carbon reduction targets reflects a re-direction of economic activity and employment and not necessarily a reduction of GDP.

The degree to which net employment is expanded as a result of climate change policy will be in part affected by the size of the pool of unemployed labour and the natural rate of unemployment in the economy. This natural rate can be reduced through improving the skills of the workforce (which reduces occupational immobility). However, some workers may still be hurt by restructuring due to climate change policy, and there may be geographical differences across MSs in the EU.

In summary the conclusion is not dissimilar to that for environmental policies as a whole, that '…environmental policy just contributes to a process of structural change. The main (macro) economic impacts of climate change policy are:

- Comparative advantage for some industries - marginal reallocation of resources from those sectors financing a policy (paying its costs) to sectors that benefit from the intervention. More bluntly, its main impact is to just shift resources from polluting sectors to more environmentally-friendly sectors;
- Increase in value added - a transfer of demand to higher-value 'green' industries - this could finance an expansion in net employment;
- Increase in investment - this could come from the Government or from the private sector (eg. Clean tech venture capital); and
- First mover or fast follower advantage - A firm or sector may gain a first mover advantage under certain market conditions – for example, where significant barriers to entry exist, such as strong intellectual property rights or large economies of scale. In other situations, it may be more efficient to be a fast-follower, taking advantage of the work done by the first mover. This may be the case where there are much lower R&D

costs for followers, and where there are high initial marketing costs for the first mover in order to educate the public.

3.3 Quantitative Estimates of Employment Effects

Climate change policies and their impact on employment has become an important policy issue. Governments across the world are investing in green jobs (low carbon economy) as part of their fiscal stimulus package.

Each climate change policy measure has different effects on prices, international trade, and the economies of the Member States, and therefore on employment. These effects have been the subject of a number of studies that have sought to quantify employment effects at the level of the EU, Member States and also in the US. Any review of the results of these studies has to carefully categorize the different indicators used and the underlying assumptions of the different approaches. In particular rit is important to distinguish:

Gross employment – Increase in investment in, say renewables, leads to higher turnover creating ***direct*** jobs. This leads to increase in ***indirect*** jobs due to increased demand for inputs from intermediate sectors, such as metal industries and mechanical engineering. The sum of direct and indirect employment is called ***gross employment*** in the literature.

Net employment – Any increase in employment has to be balanced with jobs being displaced elsewhere or jobs being substituted. When the investment has to be paid for from private or public budgets, it causes negative effects from foregone demand and consumption in other sectors. However, new markets and technologies can also attract international capital and yield positive or non-negative impacts. Furthermore, changes in the price of the green good or service (eg. electricity from renewable sources) also affects the entire price structure of the economy, influencing intermediate and final demand, production and imports. Increased production can lead to more value added, but also to more imports and more use of intermediate inputs. Developments in prices, wages, and productivity play an important role in this distribution and the question of whether or not additional value added also leads to more employment. The balance of all these positive and negative effects on the job market is referred to as ***net employment***, which generally requires more complex modelling work.

The estimate of jobs as a result of climate change policy differs by type of policy package and definition of jobs attributed to the policy packages. The most common terms are:

- Green Jobs
- Jobs in the Environment Goods and Service sector (EGS)
- Jobs in the Eco-Industry
- Jobs in the low carbon economy
- Jobs attributed to climate change package
- Jobs attributed to renewable energy targets or renewable energy sources (RES)
- Jobs attributed to energy efficiency measures
- Jobs attributed to green fiscal stimulus

There is no consistent definition for the above in the literature. Existing sources tend to talk about green jobs as jobs associated with Environmental Goods and Services (EGS).

One of the most recent pieces of work[4] identifying green jobs has been undertaken by the United Nations Environment Programme (UNEP). The extract below is taken from their recent report in this area and states their views on what should be characterised as a "green job" and how employment could change over the wider economy:

[4] UNEP,2008, "Green Jobs: Towards decent work in a sustainable, low-carbon world" (p.3 ex. summary),

*"[UNEP] define green jobs as work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies**;** de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution.*

Many European studies[5] have followed the OECD/Eurostat (1998) eco-industries classification. According to this definition, the eco-industry accounts for 1.7% of total paid employment in Europe or about 3.4 million full-time job equivalents[6]. This is substantially more than prominent sectors such as car manufacturing or pharmaceuticals. Employment in the sector grew at around 5% per year in the 1990s. Since 2000, growth has originated from the smaller but more dynamic sub-sectors

Given the inherent difficulties in assessing what could constitute climate change policy related jobs or green jobs, it is unsurprising that a variety of figures have been used to show the impact of climate change policy on the economy and employment. For example, estimates of jobs related to renewable energy published in the literature have considerable differences depending on definition. This can range from the number of employees in the companies that produce windmills, photovoltaic systems, turbines to indicators measuring jobs in production of the systems and operation and maintenance per mega-watt installed capacity to estimates of gross employment of the whole value chain. Also the scope of renewable energy can differ, For example bio-fuels are included in the 20% EU Renewable target by 2020 but other Member State studies exclude bio-fuels from renewable sources.

Included in Table 3.2 below are examples of estimates of the numbers of jobs (current or potential) in relation to a low carbon economy. The estimates are not comparable due to:

- Geographical differences – EU, US, Member State, global;
- Sectoral differences – often focussing solely on individual sectors or sub-sectors.
- Gross and net effects
- Inclusion / exclusion of whole value chain effects
- Differing assumptions concerning economic growth and the effect of existing business as usual policies

[5] DG Environment Environmental Publications - http://ec.europa.eu/environment/enveco/industry_employment/index.htm#labor

[6] http://ec.europa.eu/environment/enveco/industry_employment/pdf/facts_and_figures.pdf

Table 3.2: Summary of Findings from the Literature on Estimated Employment Effects of Climate Change Related Policy Measures

Study	Country	Job estimates	Method	Remarks
ETUC (2005) Impact on employment in the European Union-25 of climate change and CO2 emission reduction measures by 2030	EU	Sectoral impacts on gross employment of measures to reduce CO2 emissions: * Transport - 20% more jobs in 2030 compared to 1990 * Iron & steel - loss of 50,000 jobs * Building & Construction - upto 200,000 man years	Various: Literature review, stakeholder interviews and modelling	Includes estimates on the economic effects of climate change in the agriculture, tourist, insurance sector
Impact of EU Climate Change Policy on Economic Competitiveness, by Margo Thorning of the International Council for Capital Formation. In Climate Change Policy and Economic Growth: A Way Forward to Ensure Both. 2003	EU	-1% in Germany, -0.4% in UK, -0.07% in NL and -0.7% in Spain (from baseline by 2010)	Review of existing studies	* Reviews studies by the ICCF - negative impact of carbon emissions trading under Kyoto and more stringent targets on jobs. * Mandatory targets and timetables not working in the EU, have significantly negative effects on GDP and employment because of the cost of carbon permits. US voluntary approach is better as it balances multiple policy objectives
Kyoto Protocol and Beyond: Economic Impacts on EU Countries, International Council for Capital Formation, 2002.	EU	* Germany: employment decreases by 1 million jobs annually during 2008-2012. By 2020, employment could fall by 780,000 - 1.2 million jobs annually. * Netherlands: decrease of 110,000 jobs annually during 2008-2012. By 2020 employment falls by 80,000 - 150,000 annually. * UK: employment falls by 410,000 jobs annually during 2008-2012. By 2020, could fall by 390,00-650,000 annually. * Spain: decrease of 850,000 jobs annually during 2008-2012 and decrease of 600,000-800,000 jobs annually in 2020.	Modelling	Employment decrease based on increase in energy prices. 2020 estimate of job losses depends on the stringency of targets set. Doesn't consider CDM or JI mechanisms. When all greenhouse gases are included, the negative impact could be less in the UK than predicted. Assumes intra-country trading.

Study	Country	Job estimates	Method	Remarks
Challenges and opportunities facing public utilities, ILO 2003	EU / Global	* Renewable energy: create 60 person years of employment. * California: 28,000 construction & 3,000 permanent jobs over 30 yrs / 120,000 person years of employment	Review	*15-19 jobs created for each megawatt of wind capacity. 27% more jobs developed per kW hour of wind power vs. coal, and 66% more than natural gas plant.
European Renewable Energy Council "New renewable energy target for 2020 – a Renewable Energy Roadmap for the EU". Impact Assessment, SEC(2006) 1719	Europe	Renewable technologies: turnover of €20 billion and employment 300,000 people in 2008	Using the energy system model POLES and the extended version of the general equilibrium model PACE	
20% renewable energy target for 2020 - Impact Assessment, Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020, SEC(2008) 85	Europe	GDP 0.5% higher than BAU and employment would grow by around 0.3%, which amounts to about 650,000 additional jobs	The ASTRA employment and GDP model, quantifying the direct and indirect impacts of a given policy	
Links between the environment, economy and jobs. GHK, 2007	Europe	* 2.3 million directly employed in 'green jobs', 1% of EU workforce. 4.6 million direct & indirect jobs * Core environmental activities linked to 4.4 million jobs, 21 million broader direct jobs.	Modelling	* First estimate based on traditional definition of eco-industries * Second estimate using broader definition
EU Joint impact assessment – Climate and Energy package, (2008), SEC(2008) 85/3	Europe	-0.5% change in employment in 2020	Number of models – PRIMES, GAINS, GEM-E3, POLES and PACE.	Macro economic Impact at Member State level of auctioning in the EU ETS and of distribution of auctioning rights and GHG reduction commitments for the sectors not covered by the EU ETS
Meeting the Targets & Putting Renewables to Work, MITRE 2004	EU-15	Continuation of current RES policies leads to an overall net employment of 1.4 million in the EU-15 by 2020, an advanced policy scenario results in 2.5 million jobs, including all indirect effects.	Uses an I/O approach where the RES sector has been integrated as an own vector in the input-output tables	

Study	Country	Job estimates	Method	Remarks
German environment ministry (BMU) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BUNR), Erneuerbare Energien: Arbeitsplatzefektex, Kurzfassung (Berlin: June 2006)	Germany	260,000 in 2006 in Renewable Energy	Data include direct and indirect jobs, based on an input-output analysis	
BUNR, "Renewable Energy Sources Act. Progress Report 2007," Summary (Berlin: 5 July 2007)	Germany	400,000 in renewables by 2020 (Gross estimate) 70,000 - 80,000 net jobs by 2020	Direct and Indirect job, Input-output models and expected growth rates	
Roland Berger business consultants, Theo Bühler, Herbert Klemisch, and Krischan Ostenrath, Ausbildung und Arbeit für Erneuerbare Energien. Statusbericht, 2007	Germany	500,000 in renewables by 2020 and 710,000 by 2030	Not available	
Article: Global Green New Deal - Environmentally focused investment historic opportunity for 21st Century Prosperity and Jobs. UNEP, 2008	Global	* UK: 160,000 new jobs from wind turbines by 2020 ; * CURRENT Globally 300,000 people employed in wind power, 170,000 in solar, 600,000 in solar thermal, 1.2 million in biomass energy, 2.3 million in RE. * CURRENT Germany: 250,000 employed in renewable energy. * Mexico: 150,000 new jobs by 2020. * EU/USA: 2 - 3.5 million green jobs	Review	* UK estimate based on $100 billion investment in wind turbines by 2020 * Global marine protected area network (20% of fishing grounds) could conserve an estimated 27 million jobs and generate 1 million new ones. * EU/USA estimate based on investments in energy efficiency in buildings

Study	Country	Job estimates	Method	Remarks
Global Green New Deal, UNEP 2009	Global	Energy: * USA: 30,000 job years for every $1 billion in government spending on green energy initiatives in the US would lead to 30,000 job-years * China: 1 million jobs in renewable energy. * EU: 1-2 million jobs with immediate/large scale energy programme. * South Korea: 515,000 new jobs. Transport: * Globally: 3.8 million jobs and 19 million ancillary jobs with production of environmental vehicles. 1.2 million jobs in biofuels, 10 million more with expansion. * US: 250,000 new jobs over next 10 years. * South Korea: 138,000 jobs over next 3 years. South Koreas Green New Deal * 960,000 jobs by 2012 * 149,000 in 2009 due to construction	Review / Case studies / Modelling: T21 model policy simulations (Threshold 21), integrated planning model	
Into the black: Growth of the low carbon economy. Climate Group 2007	Global	* UK: 100,000 jobs in the UK by 2015 in environmental industries sector. * Germany: 100,000 new RE jobs by 2020 (13,000 in 2004). * US: 355,000 jobs in RE by 2020. * EU: A 20% reduction in energy consumption in Europe by 2020 would bring €60 billion per year in savings, improve economic competitiveness and create one million jobs in the EU. * EU: 45,000-75,000 new rural jobs to be created per 1% inclusion level of biofuels * UK: 20,000-30,000 new jobs with 5% biofuel inclusion.	Case Study / Review	

Study	Country	Job estimates	Method	Remarks
Carbon Down, Profits Up: Third Edition. The Climate Group, 2007	Global	* CURRENT - Spain: 3,600 employed in Navarre region's RE sector * FUTURE - Manitoba, Canada: 700 jobs per year (wind industry)	Case Study / Review / Empirical: profiled 84 corporations, 36 city and 17 regional governments. BUT - based mostly on secondary research from 2006 Carbon Disclosure Project, but some own research (surveys etc)	
Kyoto Protocol and Beyond: Economic Cost Italy, ICCF Global, 2005	Italy Spain UK	Annual job losses at 221,000 by 2010. By 2025, job losses will be between 295,000 - 433,000 depending on target level Annual job losses at 611,000 by 2010. By 2025, job losses will be between 626,000 - 708,000 depending on target level Annual job losses at 336,000 by 2010. By 2025, job losses will be between 394,000 - 673,000 depending on target level	Modelling	Assume that an international carbon dioxide trading mechanisms is established and that companies can purchase emissions credits in the international market.
Economic Impact on Italy of Implementing Kyoto Protocol and additional greenhouse gas reductions planned for post-2012 period. 2003, Global Insight	Italy	Annual job losses at 51,000 by 2010. By 2025, job losses will be 280,000.	Modelling	
Borrowing Green: economic and environmental effects of a green fiscal policy in the Netherlands. Scholtens, B., 2001	NL	Increase in total employment of 21,500 labour years	Empirical: analyses effects on the basis of existing information	* Analyses impact of deductability of interest returns/dividend yields from 'specified' green projects during 1995-1999 * makes a number of (conservative) assumptions based on experience with other projects (i.e. a multiplier of 2 and that production value of projects equals the funds invested)
Commission on Environmental Markets and Economic performance, BERR/DEFRA 2007 report	UK	* UK: 400,000 employed in environmental goods and services. * Germany: jobs increased from 160,000 to 235,000 between 2004 and 2006 in RE sector. Predicted to increase to 400,000 by 2020.	Review	Skills gap is a big barrier to UK success in environmental markets.

Study	Country	Job estimates	Method	Remarks
Comparative advantage and green business, 2008 Ernst & Young/BERR	UK	* 14,000 new jobs in manufacturing * 6,000 over 10 years in chemical sector	Empirical/Case Studies/Modelling. Identify sectors of comparative advantage by analysing trade data and FDI flows; use of the Oxford Economic model/Oxford Energy Industry Model to show impact on UK economy of different modes of developing green processes/products in different sectors. OEIM is an input-output model of the UK which analyses sectoral impacts of different policies	* Only looks at 4 specific sectors using different transmission modes / policies for each, very specific. * Discontinuities not considered. * 14,000 job estimate is based on additional annual GDP from £1billion green R&D spend in manufacturing yielding greener products * 6,000 job estimate based on a shift to greener production processes in the chemical sector
Kyoto Protocol and Beyond: Economic Cost to UK, 2005. ICCF Global	UK	Annual job losses at 336,000 by 2010. By 2025, job losses will be between 394,000 - 673,000 depending on target level	Modelling	Assume that an international carbon dioxide trading mechanisms is established and that companies can purchase emissions credits in the international market.
Manufacturing: new challenges, new opportunities, 2008. BERR, DIUS	UK	1 million jobs by 2030 in low carbon economy	Empirical	Environmental goods/services sector
Emerging markets in the environmental sector, UK CEED, 2006	UK	UK * environmental industry employs 400,000 people * 6,370 employed in RE UK industry in 2004 * between 69,000 and 160,000 employed in waste management industry in 2004/2005 International * US: 1.6 million jobs (environmental markets) * France: 34,701 employed in waste and wastewater treatment and 27,780 in waste management in 2006	Review / Empirical: desk research and interviews with industry and government agency and use of workshops. Also uses previous reports / existing studies	

Study	Country	Job estimates	Method	Remarks
Today's investment, tomorrow's asset: skills and employment in the wind, wave and tidal sectors. SQW Energy report to British Wind Energy Association, 2008	UK	* CURRENT: 4,800 full time employees (wind, wave, tidal sector) * FUTURE: projected total full time employment for 2014 between 12,000 and 18,000 (depending on scenario, wind wave and tidal) * FUTURE: projected between 23,100 - 56,900 full time employees in wind sector alone by 2020 (depending on growth scenario) * FUTURE new employees between 7,170 and 12,895 by 2014 and 18,710 and 54,210 by 2020 (depending on growth scenario)	Empirical / Modelling: Qualitative analysis of skills policy and quantitative assessment of employment issue - analysed employment by sector and occupational category to identify employment needs by various scenarios. 3 scenarios are modelled of sector growth	* Sectors need 149,000 additional professionals and technicians by 2014 to satisfy growth and replace demand * Wave and tidal show less projected growth: between 350 and 2,100 FTEs by 2020 depending on scenario * increase in wind, wave and tidal sector by 2020 represents a 500-120% increase compared to 2008
Current and Potential Green Jobs in the U.S. Economy, U.S. Metro Economies Green Jobs in U.S. Metro Areas, October 2008	USA	750,000 Green Jobs in 2006 and potential to create 2.5 million new green jobs by 2018	Data is from the National Establishment Time Series (NETS) database by Walls & Associates	Potential new jobs in Renewable Power Generation (407,200), Residential & Commercial Retrofitting (81,000), Renewable Transportation Fuels 1.2m and Engineering, Legal, Research & Consulting (850,000)
Energy Efficiency, Innovation, and Job Creation in California, Centre for Energy, Resources, and Economic Sustainability (Uni. California Berkeley), October 2008	USA	Energy efficiency measures between 1972-2006 created 1.5 m FTE jobs (might not all be in 'green' sector)	Using a series of input-output tables, comprising inter-industry flows, value added, and final demand for about 500 activity and commodity categories over the period 1972-2006. Detailed employment wage data were obtained by California Regional Economies Employment (CREE) Series	For every new job foregone in energy supply chains, including oil, gas, and electric power sectors, more than 50 new jobs have been created across the state's diverse economy.
Energy Efficiency, Innovation, and Job Creation in California, Centre for Energy, Resources, and Economic Sustainability (Uni. California Berkeley), 2008	USA	403,000 jobs created by proposed policies to reduce Californian emissions to 1990 levels by 2020	State level Berkeley Energy and Resources (BEAR) model. Model captures innovation, economic adjustments to climate action and can model cap and trade systems	

Study	Country	Job estimates	Method	Remarks
Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy, Centre for American Progress, September 2008	USA	Total Job Creation through $100 Billion Green Stimulus Program 935,000 million direct jobs, 586,000 indirect jobs, and 496,000 induced jobs, for a total of about 2 million total jobs created.	Using the U.S. input-output model to generate direct and indirect employment effects.	The allocation of total investment funds that we are working with is: 40 percent retrofits; 20 percent mass transit/freight rail; and 10 percent each for smart grid, wind power, solar power, and biomass fuels. Adjusting the budgetary allocations would affect the job total estimates, but not by a dramatic extent.
Economic Stimulus: Case of green infrastructure, energy security and green jobs. Deutsche Bank 2008	USA	5 million new jobs over 10 years	Review: paper by UNEP, University of California, US Metro Economics, Political Economy Research, Obama's policies and Gordon Brown's Renewable Programme.	Jobs estimate based on Obama's aim to invest $150billion over next 10 years in clean infrastructure
Green Recovery: Program to create good jobs and start building a low-carbon economy. PERI and Centre for American Progress, 2008	USA	2 million jobs over 2 years.	Empirical	Based on $100 billion green energy stimulus package spent in 6 areas
The new Apollo Program: Clean Energy, Good Jobs. Apollo Alliance, (2008)	USA	Overall 5 million new jobs over 10 years	Case Study / Review	* Based on economic investment strategy, involving $500 billion over the next 10 years * 100,000 on site jobs with $10 billion dollars of investment into efficiency upgrades and retrofits * 100,000-200,000 for every 10 billion gallons of ethanol produced in the US (projections of US Department of Energy * 85,000 permanent jobs with an aggressive program to promote domestic manufacturing of RE products

3.3.1 Conclusions from Other Relevant Studies

A number of other studies have also been reviewed that provide some quantitative results:

- The European Renewable Energy Council (EREC) calculates gross employment in the renewable energy industry, in the related agricultural production and in operation and maintenance of 2 million jobs by 2020 if the 20% target is to be reached.
- In addition to the German studies in the Table above, the German Environmental Ministry has launched a series of studies on the employment effects of renewable energy (Staiß et al. 2006, and Lehr et al. 2007 and 2008). These studies have used extended I/O tables in combination with the macro-econometric model PANTA RHEI. These are one of the few studies that have calculated net employment effects of the policies that increase the share of renewable energy in Germany.
- Study by Babiker and Eckhaus (2006) shows Kyoto commitments could result in 4% decrease in US GNP within 10 years because of increased unemployment.
- Another study (Kuster 2007) models the effects globally, of subsidies on the application of RE technologies and emissions cap and trade and shows unemployment rises as subsidies for RE results in negative growth effects.
- Moreno and Lopez (2006) analyzed the regional effects of a fuel switch for a fossil fuel based industrial region in Asturias, Spain. They considered gross employment and counterbalanced it with employment losses in the fossil fuel industries of the region. The balance turned out to be slightly positive, i.e. the additional employment outweighed the losses.
- Stocker et al. (2008) found for Austria net employment gains of between 10,000 and 20,000 by 2020 for three different scenarios, including an enforced increase of biomass applications and a photovoltaic and solar oriented scenario.

3.4 Identifying Sectors Subject to the Greatest Impacts

Given the focus of the study on the effects on business in the short to medium term (to 2020), the emphasis is on sectors and businesses subject to or indirectly effected by climate change policies rather than climate change itself.

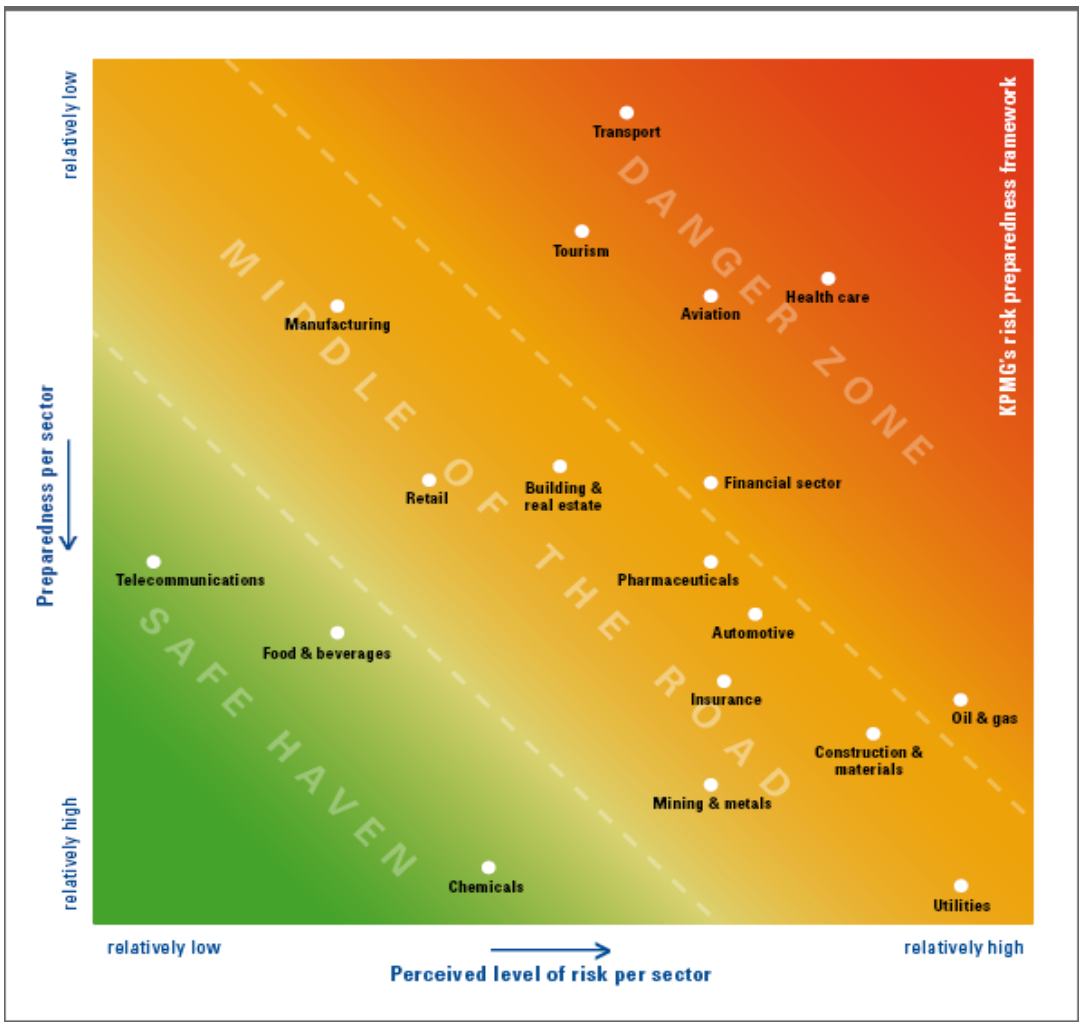
The literature on sectoral impacts identifies those sectors that produce carbon emissions from the generation of energy (the energy and utilities sector) and those sectors that use energy intensively in their production process, or which produce products that are significant energy users (mainly manufacturing industries and transport).

Analysis by KPMG used this standard typology based on a view of the risk to sectors from climate change polices and combined it with their own assessment of the extent to which sectors were developing effective responses to these risks. Figure 3.1 provides an initial overview of the relevant sectors, at risk form climate change and related polices.

Based on the literature and the KPMG overview a more detailed analysis to identify the relevant sectors can be based on:

- The energy (carbon) generating sectors (likely to be the direct subject of climate change polices);
- The employment intensity of sectors (where changes in polices might trigger significant employment change);
- The competition intensity of sectors (where small changes in energy costs or products translate into significant market impacts); and
- The vulnerability of sectors (where the scope for major revisions to cost base or service offers in response to climate change polices is limited).

Figure 3.1: Identification of Sectors at Risk from Climate Change



Source: KPMG: Risk Preparedness Framework: Climate Changes Your Business (2008)

3.4.1 Energy Generating and Supply Sectors

The major energy generating and supply sectors in the EU comprise the electricity, coal and gas sectors. The renewable energy sector is included. In addition one could include the supply of transport fuels. Key points to note are:

- Conventional energy generation is a relatively low labour-intensive sector with 1.6% of EU employment. A 16% reduction in electricity consumption could reduce direct employment by up to 20% (ETUC, 2008)
- Coal mining employment will decline concentrated in the 12 new Member where 26% of EU coal sector jobs are located (IEEP, 2008). Globally actions taken to mitigate CC will reduce the demand for coal by up to 30% resulting in at least an 8% fall in production/employment (Polidano, 2000). (EUTC, 2008) estimates that employment in the coal sector could fall by up to 50%, although it is difficult to directly attributable this to Climate Change policies given past and current trends in the sector.
- Renewables are considered to be more labour intensive and to have high employment multipliers due to the nature of their value chain. GHK (2007) found that a 10% shift in of output from non-renewable (conventional) electricity sector to renewables would increase EU indirect employment by 58,000 jobs. Meeting the UK's 2020 target for off shore wind power generation is projected to create between

85,000 and 133,000 jobs (Douglas Westwood, 2008), up to 66% of which would be located outside the UK (Harvey, 2008).

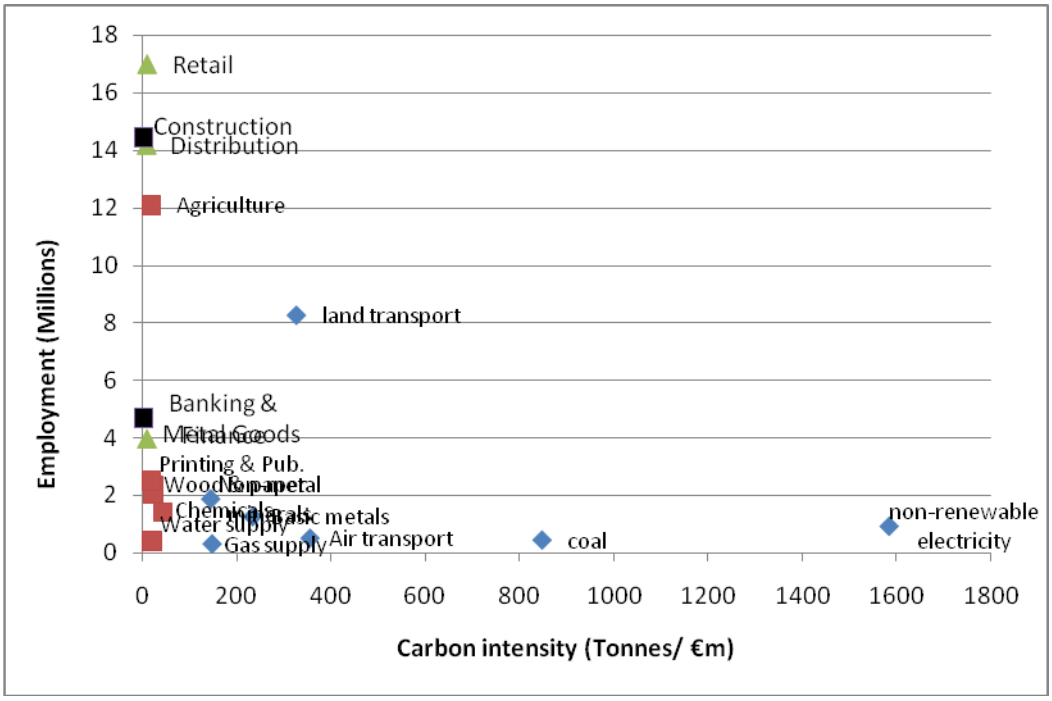
3.4.2 *Employment Intensity*

There is not a strong correlation between those sectors with a relatively high carbon intensity and those with a high total level of employment (Figure 3.2). Employment intensive sectors (especially retail, distribution, food) are likely to be particularly sensitive to consumer responses to climate change polices, and restructuring is these sectors is therefore likely to be triggered by changes in consumer preferences.

In the case of construction, impacts are more likely to be generated through changes in regulation and in particular increases in standards for energy efficiency in buildings. While complying with the EU mandatory energy efficiency standards will increase building costs, several studies have found that policies that encourage energy efficiency will increase overall employment in EU and MS economies.

ETUC (2008) found that extending the scope of the directive on energy performance of buildings would create between 30,000 to 90,000 additional man-years in the EU 15, and 90,000 man-years in the new Member States. If the EPBD directive was extended to all dwellings in the EU there would be an additional 285,000 jobs in the construction sector compared to business as usual. If a: long term reduction in residential sector emissions of 75% was achieved then by 2050 between 146,000 and 456,250 jobs would be created. The sector is also likely to benefit from policies that encourage the take up of renewable energy generation.

Figure 3.2: Carbon intensity and employment in EU-27 (2000)



Source: GHK: Linkages between Environment, Economy and Jobs (2007), DG Environment

3.4.3 *Competition Intensity*

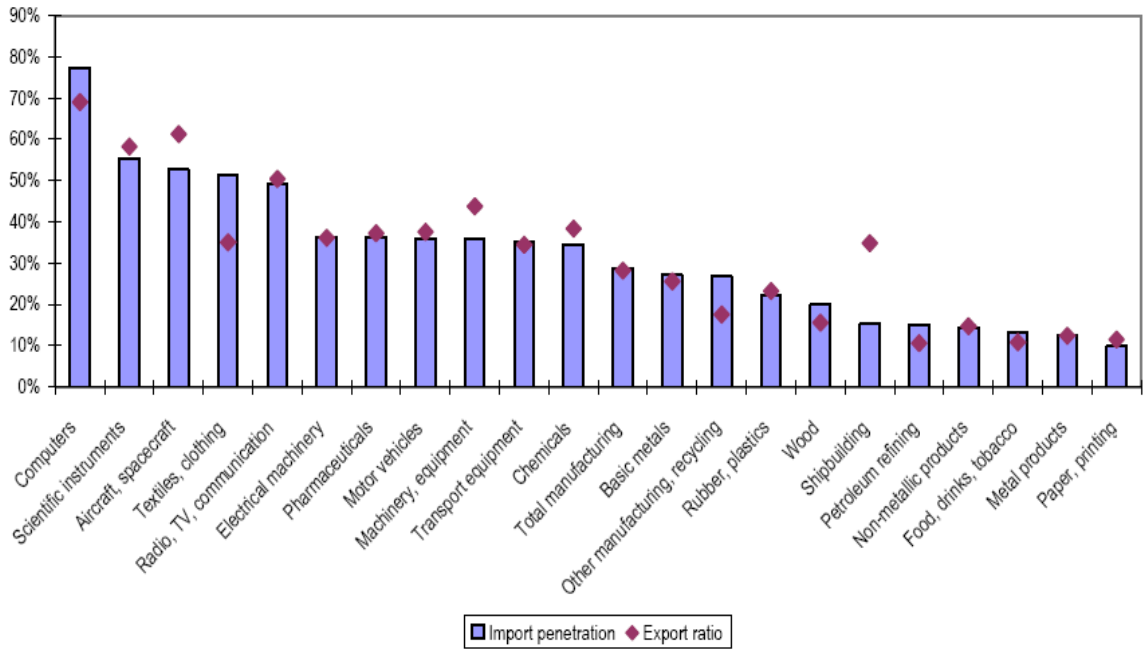
Climate change policies are likely to have an especially strong impact on the need for restructuring in those sectors especially sensitive to international competition. A number of EU industries are losing their market share over time due to the growth in global competition. Stringent product and quality standards and environmental policies, such as the EU ETS, further increase the burden of competing in international markets.

Export ratios and import penetration rates for the EU (excluding intra-EU trade), United States and Japan show similar patterns of internationalisation across manufacturing industries (Figure 3.3). Computers, aircraft, scientific instruments and radio and television communication equipment have high exposure to international trade competition, whereas the exposure of paper, printing, metal products and food, drink and tobacco is low.

Over time, import penetration in most of the EU manufacturing industries, especially energy intensive industries, has increased. For example, in 1992, the EU was the world's largest chemicals-producing region, with 32% of world output, but this is projected to fall between 16 – 23% by 2015. These energy intensive industries also face relatively high compliance burden from climate change policies aimed at increasing the price of energy and incentivising energy efficiency. This creates an unlevel playing field for these industries.

The strongest example of sectors subject to both restructuring pressures from globalisation and climate change are the energy intensive industries (EII). The production of cement and lime, steel, aluminium, primary container glass and some basic chemicals were expected be among the activities most hit by climate policies (IEEP, 2008). These sectors are exposed to a high degree of international competition and are responsible for a significant share of EU Gross Value Added (23%) and jobs (18%), as illustrated in Table 3.1. High regulatory burden and energy prices are major factors responsible for reducing the market share of these industries.

Figure 3.3: Import Propensity and Export Ratio1[7] in Selected OECD Countries[8], 2003



Source: OECD Economic Globalisation Indicators, 2005

[7] The export ratio indicates the share of output Y which is exported, i.e. X/Y, and the import penetration rate shows to what degree domestic demand D is satisfied by imports M, i.e. M/D = M/(Y – X + M).

[8] OECD includes Austria, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and the United States.

Table 3.1: Economic Significance of the EU Energy Intensive Industries

	EIIs	Value added, 2003 (EUR million)	Share of industrial value added, 2003 (%)	Number of persons employed, 2003 (thousands)	Share of industrial employment, 2003 (%)	Production mil tonnes (2005)	
1	Manufacture of pulp, paper and paperboard (NACE 21.1)	20,448	1.2	243	0.7	Primary pulp	41.5
						Recovered fibre	41.4
						Total paper & board	99
2	Chemicals and chemical products(1)	241,000	14	3,560	10	436[a]	
3	Glass and glass products	16,000	0.9	375	1.1	35	
4	Ceramic goods and clay products	14,200	0.8	360	1.0	27[a]	
5	Cement and concrete	28,876	1.7	501	1.4	239[b]	
6	Manufacture of first processing of ferrous metals (2)	31,085	1.8	550	1.6	EAF Steel	73
						BOF Steel	114
7	Manufacture of basic precious and non-ferrous metals (3)	13,000	0.8	215	0.6	Primary Aluminium	3[c]
						Recycled Aluminium	5[c]
	Total	**364,609**	**23**	**5,804**	**18**		

Note: the industrial economy comprises of NACE Sections C to E. Source: Eurostat (SBS), Rounded estimates based on non-confidential data. Value added and related share, rounded estimates based on non-confidential data. Production figures: P&P -CEPI, Chemicals-CEFIC, Glass-CPIV, Ceramics-Ceramunie, Steel-World steel report, 2006, Aluminium- International Aluminium Institute. (1) Includes basic chemicals, pharmaceuticals, rubber and plastics. (2) Covers manufacture of basic iron and steel and ferro-alloys, manufacture of ferro alloys and other associated activities (3) Covers manufacture of metals such as aluminium and nickel, including precious metals (e.g. Gold, silver) and common metals (e.g. Zinc, copper). [a] in Billions of €, [b] Cement only, [c] estimates for 2004

3.4.4 Sector Vulnerability

The analysis by KPMG (Figure 3.1) identifies the transport sector including aviation as a sector particularly vulnerable to climate change polices partly because of the limited levels of response to date, itself partly a function of the limited scope for businesses to develop and invest in new service offers and products. This vulnerability is reflected in the emphasis on transport in the green stimulus package.

The transport sector including the automotive sector has a high carbon intensity and is a major GHG emitter. As such it has come under regulations in the EU, MS and in the US. Regulations are likely to seek to shift passenger and freight transport from high carbon (air and road) to low carbon (rail and public transport) sectors. IEEP (2008) found that regulation to limit CO2 emissions from passenger cars would have relatively marginal direct employment effects and had a strong potential to have positive employment impact on upstream component suppliers in Europe, by creating a market for high-value added and innovative technologies. ETUC (2008) found that policies that restricted transport activity while rebalancing transport modes in favour of rail would lead to an overall average annual growth in employment of around 2% for passenger transport and 1.25% for freight transport.

Regulations to increase vehicle efficiency will increase the price of private vehicles by between €600 to €3000 (Standard and Poor, 2007). ETUC (2008) found that the increased added value linked to the spread of clean technologies in the automotive sector would keep employment stable through to 2020.

The inclusion of aviation in the EU ETS will increase the cost of transporting booth goods and people. This will have a negative impact on the sector's growth, although the sector is still anticipated to have high levels of growth until 2020. The net impact on employment in the sector is likely to be minimal, reflecting the fact that demand for aviation is, in general, not very price sensitive (European Commission, 2006).

3.4.5 Other Sectoral Considerations

The approach to the identification of sectors should also have regard to: capital costs of abatement measures; supply chain or multiplier effects where direct sectoral changes trigger significant indirect impacts through the subsequent effects on purchases from sectors supplying the sector directly affected[9]; and the nature of businesses (from international businesses to SMEs).

Capital Costs of Abatement

The recent analysis by McKinsey (2009) distinguishes the overall abatement cost, taking into account the energy savings over the life of a given technology, and the up-front capital costs. This identifies investment in buildings and transport as especially problematic, because the up-front capital costs are high, and the scope for the investor to secure the associated energy savings may be poor. For example, car producers or house builders may be unable to reflect the subsequent user benefits in the price of their products. This means that he theoretical levels of cost-effectiveness may not be achievable.

Supply Chains

The largest multiplier effects at the EU level occur from changes in the fuel manufacturing sector (Table 3.2). Other manufacturing sectors also have large multipliers, with motor vehicles and water transport sectors with large multipliers.

Table 3.2: EU Type I Employment Multipliers by Sector (greater than 3.0)

Sector (NACE)	Multiplier
13 Manuf. Fuels	4.86
23 Motor Vehicles	4.13
9 Food, Drink & Tob.	4.02
15 Chemicals nes	3.34
35 Water Transport	3.3
18 Basic Metals	3.26
21 Electronics	3.2

Source: GHK estimates[10]

It should be noted that the multipliers calculated for the EU27 as a whole are higher than those produced by national multiplier studies. The reason for this is that for EU level multipliers trade between EU countries is not counted as a leakage from the system. As intra-EU trade accounted for something in the region of 60% of total EU imports in 2000, this dramatically reduces leakages from the system and increases the size of the multiplier.

Nature of Businesses and employment

It is worth noting that large companies and SMEs, although subject to the same overall pressures, may be impacted in different ways. The EU ETS, for example, mainly applies to large companies. It should also be noted that in some sectors such as tourism, retail and construction, small companies account for bulk of the employment (Table 3.3).

[9] This is defined as a Type I multiplier effect, and can be measured in terms of the effect of a given change in output in a sector on the output of the rest of the economy, based on supply chains captured in input-output tables

[10] Derived from the study by GHK and CE: Linkages between Environment and Jobs, DG Environment (2007)

Table 3.3: Sectoral Share of Employment by Employment Size-bands (2005) – EU 27

	Total number of Employees				
Sector	**1 to 9**	**10 to 49**	**50 to 249**	**250 +**	**Total**
All sectors	**30%**	**21%**	**17%**	**33%**	**100%**
Mining	0%	0%	12%	70%	100%
Oil And Gas	0%	1%	6%	91%	100%
Automotive	2%	5%	11%	83%	100%
Utilities	2%	5%	14%	80%	100%
Chemical	3%	9%	23%	64%	100%
Telecommunications	4%	3%	5%	88%	100%
Aviation (Transport & Manufacture)	4%	6%	11%	77%	100%
R&D	13%	16%	27%	46%	100%
Manufacturing	14%	21%	25%	41%	100%
Food And Beverage	16%	22%	25%	37%	100%
Transport	19%	14%	13%	53%	100%
Pharmaceuticals	19%	23%	24%	35%	100%
Finance And Insurance	31%	16%	17%	35%	100%
Retail	40%	21%	12%	27%	100%
Construction	42%	30%	15%	12%	100%
Tourism	45%	27%	11%	18%	100%
Real Estate	56%	17%	13%	13%	100%
Health Care	NA	NA	NA	NA	NA

Source: Eurostat

3.4.6 Summary of Proposed Sectors for the Selection of Case Studies (Volume 1)

Based on the criteria discussed above businesses have been selected within the following categories of sector (Table 3.4):

Table 3.4: Categories of Sector from which to Select Individual Businesses

Criteria for Selection	Title and Characteristics of the Category	Exemplar Sectors
Energy (carbon) generating sectors	**Energy Generation and Supply:** Sectors responsible for manufacture and supply of energy, subject to policies that restrict or encourage the types of technologies used and policies that change relative prices between different products	Electricity, gas, coal, transport fuels,
Employment Intensity of Sectors (jobs per unit output)	**Customer Focus**: Sectors employing large numbers of people and supplying goods and services that are likely to be subject to changing demands as a result of climate change policies, including (but not mainly) as a result of income effects due to higher energy costs	Construction, retailing, tourism
Competitive Intensity of Sectors (EU export, import ratios)	**Energy Intensive**: Sectors that are subject to high levels of international competition and using high levels of energy, where 'uneven playing fields' due to EU climate polices may have a significant effect on costs and competitiveness	Cement, chemicals, metals

Vulnerability to Climate Policies (risk assessment)	**Transport**: Transport sectors provide products and services which are likely to be subject to especially focused polices and where the scope for significant changes in service / product offers maybe limited	Airlines, Vehicle and vehicle component producers, Multi-modal providers

Note: A similar typology has also been used recently in a US study (CERES, 2008) to examine the impacts of climate change policies in California, distinguishing, energy generating; employment intensive; competition intensive; and transport categories.

4 IMPACTS OF CLIMATE CHANGE AND RELATED POLICIES ON SKILLS

4.1 Introduction

The greening of the European economy will lead to a redefinition of many jobs across almost all sectors. People in jobs at all levels will experience a change in the content of their jobs, with new performance and skills requirements. The impact of climate change policies and the shift to a low-carbon economy will also require new skills and qualifications, offering potential for the creation of new 'green' jobs but also entailing structural change and the transformation of existing jobs. The International Labour Conference (ILC) of June 2008 stated that skills development should form part of an effective response to changing conditions, including climate change. Identifying the skills required to adapt to climate change and to reduce greenhouse gas emissions therefore has an important role to play in policy development. Meeting skills needs is crucial for productivity, employment growth and development.

The right skills for green jobs are a precondition for the transition to a greener economy. Today, climate change policies have led to certain skill shortages in a number of sectors, such as renewable energy, energy and resource efficiency, building renovation, construction, environmental services and manufacturing. Clean technologies require skills in the application, adaptation and maintenance of technology. Thus, green skills are critical for enabling economies and businesses, and workers and entrepreneurs to adapt rapidly to changes brought about by climate change and related policies.

4.2 Existence of Climate Change (Environment) Related Skills

Before reviewing the results of work examining the impacts of climate change on skills it is important to understand and define skills in relation to changes in new and changing occupational profiles, the greening of existing occupations and the identification of obsolescent skills and occupations.

According to the OECD, environmental job qualifications and skills is the use of traditional qualifications and skills applied to environmental related sectors. In other words, there are no environmental qualifications per se, but recognises that there are for example chemists working in the water and waste sectors[11]. Renewable energy companies require regular engineers and science graduates and their skills are topped up with in-house training programmes.

On the other hand, the recent DG Environment report 'Environment and labour force skills (2008)[12]' states that specific skills are needed for the Green Economy such as knowledge of sustainable materials, "carbon foot-printing" skills and environmental impact assessment skills.

4.3 Skills Data

Data on skills profiles is available for only a handful of sectors. According to the study for DG Environment (2006)[13], little information is available on the skills profiles in nature protection, biodiversity conservation and natural hazards prevention sectors. The majority of information available is on the eco-industry sector.

[11] OECD Seminar Social and Environment Interface Proceedings (1999). http://www.oecd.org/dataoecd/51/15/33848718.pdf

[12] http://ec.europa.eu/environment/enveco/industry_employment/pdf/labor_force.pdf

[13] http://ec.europa.eu/environment/enveco/eco_industry/pdf/ecoindustry2006.pdf

Both the OECD study 'Environment and Employment: an Assessment'[14] and a working document of the EC[15] found that employment in the environmental goods and services sector tends to be polarised into low-skill jobs, in such areas as waste management, and highly qualified labour, such as in the sub-sector of environmental consulting.

UNEP et al. (2008) found that green jobs span a wide array of skills, educational backgrounds, and occupational profiles. This is more apparent with indirect jobs - those in supplier industries. They occur in research and development; professional fields such as engineering and architecture; project planning and management; auditing; administration, marketing, retail, and customer services; and in many traditional blue-collar areas such as plumbing or electrical wiring.

Also, green jobs exist not just in private business, but also in government offices (standard setting, rule-making, permitting, monitoring and enforcement, support programs, etc.), science and academia, professional associations, and civil society organizations (advocacy and watchdog groups, community organizations, etc.).

4.3.1 Skills in Renewables and Energy-efficiency Sectors

As an example the renewables and energy efficiency-related sectors comprise workers of all educational and skill levels. Some occupations in these sectors employ highly educated and specialized personnel such as technicians, engineers, and skilled trades. Jobs in biofuels processing require more technical skills. UNEP states that the majority of technologies used in the renewable energy sector do not necessarily require highly skilled workers to operate them[16]. Higher skills are required in bio-fuels processing than in feedstock production and harvesting[17].

The share of highly educated people in the Spanish renewable energy sector is the highest for enterprises with less than 10 employees and enterprises with between 251 and 1,000 employees (respectively 38.0% and 33.4%). This can be seen from Table 4.1. Firms with more than 1,000 workers have the highest share of graduate workers.

Table 4.1: Distribution of Employees by Qualification (%) in the Spanish Renewable Energy Sector

Qualification	<10	11 - 50	51 - 250	251 - 1,000	> 1,000	Total
University graduates	38	20	25	33	27	32
Technical graduates	21	17	15	17	11	18
Management	9	8	8	8	4	9
Supervisors	22	31	38	32	18	28
Workers	10	14	14	10	39	13

Source: ISTAS (2008), Future skills needed in renewable energies in Spain: "A vision of enterprises".

4.4 Skill Requirements Generated by Climate Change

The available evidence from the current literature on the implications of climate change policies for skills beyond the sectoral changes discussed in Section 3, is very limited. However, policies at the community, national and international level to mitigate and adapt to climate change will directly affect the level and structure of employment and skill needs

[14] OECD (2004). Environment and Employment: An Assessment

[15] EC (2005). Commission Staff Working Document on the links between employment policies and environment policies. http://ec.europa.eu/environment/integration/pdf/sec_2005_1530_en.pdf

[16] UNEP (2007). Labour and the Environment: A Natural Synergy.

[17] Website of Worldwatch Institute. Renner. M. (2008): http://www.worldwatch.org/node/5821

worldwide[18]. Unfortunately, there is little information on the exact magnitude of the changes that are likely to occur. Nevertheless, it is clear that skills development will be important if mitigation and adaptation policies are to be effective and efficient. According to the UK government, building a low carbon economy is only possible by unlocking the skills, creativity, entrepreneurialism and capacity to innovate firms, the workforce and communities[19].

According to stakeholders[20] in the sectors believed to be most influenced by climate change (agriculture/forestry/fisheries, tourism, and finance/insurance), climate policies should contribute to an increase in the demand for better educated and skilled workers and a decrease in the demand for lower skilled workers.

The requirements for green skills will change as climate change related jobs change. This could happen in three ways:

- **Some skills will become obsolete** due to structural changes in the labour market and employment shifts both within and across sectors due to demands for a greener economy (e.g. as utility meter reading services are rendered obsolete by introduction of 'smart' household meters that automatically relay data to utility companies);
- **Demand for some new skills will be created** as new 'green-collar' occupations emerge to support adaptation to and mitigation of climate change (e.g. support and servicing of solar, wind and other renewable energy technologies);
- The **skills required for existing jobs will have a stronger green element** as existing occupational profiles change (e.g. bottle manufacturers learning new technical skills to reduce carbon emissions from production).

New jobs in 'green' sectors can lead to increased investment in the skills of these workers. There are examples where demand for employees with environmental skills has involved (re)training schemes for workers, for example in the case of installing energy-efficient insulation in the UK housing sector that has involved re-training and up-skilling. The DG Environment (2008) report also showed that, since green jobs are created at the local level, it is important to tie green skills to sustainable local economic development strategies.

However, several sectors are already facing skill shortages[21] and there are signs that these skill shortages could hamper the greening of the economy (UNEP et. al 2008). The Directive on Energy Efficiency of Buildings promotes practices that combine environmental and training measures. However, according to several national trade unions, a shortage of skilled people exists and as a consequence there will not be enough qualified workers to implement the Directive (ETUC, 2006). In many OECD countries, firms in the growing green economy struggle to find workers with the required skills. Reasons for this include deindustrialization and the off-shoring of manufacturing firms (UNEP et. al, 2008).

OECD (2008) identified particular skill shortages generated by the sectoral changes stimulated by climate change polices. In particular the work reported specific examples of skill shortages associated with the shift to lower carbon technologies:

- Germany's renewables industry companies are suffering from a shortage of qualified employees, especially in knowledge-intensive positions;

[18] World Resources Institute et al. (2005). from http://www.ilo.org/public/english/employment/skills/download/ilcreport.pdf

[19] HM Government (2007). Building a low Carbon economy, Unlocking Innovation and Skills.

[20] ETUC (2007) interviews with stakeholders.

[21] Cedefop (2008). Future Skill needs in Europe. Focus on 2020. http://www.trainingvillage.gr/etv/Upload/Information_resources/Bookshop/498/4080_en.pdf

- In the UK, the Confederation of British Industry had expressed concern that sectors going green are struggling to find technical specialists, designers, engineers and electricians; and
- In the United States, the National Renewable Energy Laboratory has identified a shortage of skills and training as a leading barrier to renewable energy and energy-efficiency growth.

A lack of the skills required in a low-carbon economy could reduce the capacity of the economy to respond to Government and EU incentives, and increase the likelihood of painful transition costs for EU MSs. The case is exemplified in material reported in the UK in relation to the energy and utilities sector reported in CEMEP (2007), Box 4.1.

Box 4.1: Skills gaps in energy and utilities

In the energy and utility sectors 28 per cent of firms reported a skills gap, as opposed to 20 per cent in England as a whole. The electricity industry is experiencing the most difficulty, with approximately one in two organisations reporting a skills gap of some sort.

A recent research report by the Energy & Utility Sector Skills Council highlighted a significant shortfall in the number of overhead lines workers to deliver the up-coming phase of infrastructure renewal and repair. Senior authorised engineers and project supervisors have to undertake five to seven years of training to become competent.

Work by the London Energy Partnership showed there was a shortage of trainers skilled in renewable energy. Moreover, as there is a large gap between the skills and training available and the needs of the sector, the skills gap is forecast to get worse as the sector expands.

Cogent, the Sector Skills Council for the chemicals, nuclear, oil and gas, petroleum and polymer industries, estimates that the UK will need an additional 8,500 workers with skills in nuclear decommissioning and waste management by 2015, even if there is no new nuclear build.

The Energy Savings Trust has reported that a key barrier to increasing the uptake of new micro-generation devices is the shortage of appropriate skills and training courses for the emerging micro-generation technologies.

Source: TUC presentation to CEMEP

4.5 Future Skill Trends

In summary, the conclusion is that transition to a low carbon economy will create demand for workers, many of them in skilled trades or professions. Adequate training programmes will be needed to fill these new positions.

A number of sources suggest there will be a shift towards integrated technology and away from end-of-pipe through natural market changes but also though policies such as the Sustainable Production and Consumption policy and the Environmental Technology Action Plan. As a consequence, high-skill jobs are promoted at the expense of low-quality jobs[22]. This is also argued by the AK Wien study, a survey on the impacts of introducing cleaner technologies (in Germany, the Netherlands, Austria, Sweden and Spain), by stating that step-wise upgrades of existing processes and machinery regularly go together with in-firm training and an increase in the skills of employees and job quality[23]. A German study

[22] EC (2005). Commission Staff Working Document on the links between employment policies and environment policies. http://ec.europa.eu/environment/integration/pdf/sec_2005_1530_en.pdf

[23] EC (2005). Commission Staff Working Document on the links between employment policies and environment policies. http://ec.europa.eu/environment/integration/pdf/sec_2005_1530_en.pdf

(Schleich J. et al., 2006) focusing on energy-intensive industries also states that more jobs will shift towards highest and medium levels of education. This study argues that climate policies will not have a significant effect on jobs requiring lower qualifications.

The impact of climate change and environmental policies on future skills in the environment related sectors is summarised in Table 4.2 below.

Table 4.2: Future Skills in Environment-related Sectors

Carbon capture and storage (CCS)	▪ Technically more complex operations will involve workers with a very different skill set
Buildings	▪ Higher-skilled, higher-paying employment will arise due to energy-efficient equipment. ▪ Jobs are likely to be performed by workers who already work in the building sector. However, these jobs will be redefined in terms of new skills, training, and certification requirements. ▪ Potential will arise for highly skilled researchers and engineers. Extensive training needs in four main areas: diagnostic techniques, knowledge of renewable energy, installation, organizational skills (i.e. town planning).
Cement	▪ Jobs in this industry are expected to require higher levels of skills.
Wind Power Industry (renewables)	▪ Many of the positions will require highly skilled people. ▪ Universities need to consider offering entirely new study fields and majors due to technology development.
Climate Change	▪ Climate information and forecasting as well as R&D into crops adapted to new weather patterns have the potential to create specialized and high-skill employment.
Agriculture	▪ Jobs for agricultural skilled workers, for clerks and for craft and related trades workers will decrease. ▪ The requirement for skilled agricultural and fishery workers will be about 2.2 million in 2015.
Electricity	▪ It is probable that together with technical competences management skills will be required.
Rail sector	▪ It appears that a dangerous shortage of skilled workers is emerging. This shortage of skilled workforce might take place by 2030.
Waste treatment and recovery/recycling	▪ The quick technological changes in these sectors are creating an increasing demand for new skills.

Source: Taken from DG Environment report 'Environment and labour force skills (2008)

Original sources: UNEP et al (2008). Green Jobs: Towards decent work in a sustainable low-carbon world, ETUC (2007). Climate Change and employment. Impact on employment in the European Union-25 of climate change and CO2 emission reduction measures by 2030, ECOTEC (2002). Analysis of the EU Eco-Industries: their Employment and Export Potential, Dupressoir (2008), ETUC, Impact of climate change mitigation policies on employment in the EU, Cedefop (2008). Future Skill needs in Europe. Focus on 2020.

4.6 Strategic Labour Market Issues

ETUC (2008) have suggested that the transition from high carbon to low carbon employment is not without its difficulties. They argue the potential cost of the transition for employees in "losing" sectors is not appreciated, nor is the vulnerability of some categories of workers in relation to the opportunities for re-skilling. Because of this, irreversibility effects are underestimated: the unemployment of displaced workers could become structural if developments are not correctly anticipated and followed up. Finally, the

potential obstacles to the development of new jobs in the "winning" activities are not identified.

UNEP (2008) note that along with the skills gap can be placed the "management challenge," which will consist in the development of new perspectives, awareness, and managerial capacities. New capacities will also require new styles of management. Developing new production systems "is not just a matter of sending some blue collar workers to be trained. Managers must be willing and able to learn new skills as well, and to make use of the skills their subordinates have obtained. Supervisors must be retrained from being disciplinarians to being coaches."[24]

UNEP (2008) also observe that employers' organizations and other business groups can facilitate the transition process by encouraging their affiliates and partners to engage in social dialogue and to take practical action within the workplace on these issues. In some developed countries, the level of deindustrialization has become so advanced that efforts will need to be made to ensure that the green manufacturing sector is capable of functioning without crippling bottlenecks and skills gaps in the workforce. Investment in workforce development is therefore critical.

In the case of the renewable industry (Douglas-Westwood Limited, 2008), (DEFRA, 2006), (Centre for American Progress, 2008) (UK CEED, 2006) (Deloitte and EFF, 2008), responses have included a number of proposals including programmes to provide:

- Free or low-cost training and certification courses in installation and maintenance of renewable energy systems
- Financial/tax incentives for renewable energy companies which absorb and train unemployed workers
- Support for community colleges and schools that offer training and certification programs in renewables and energy efficiency

[24] Susan Helper, Renewing U.S. Manufacturing: Promoting a High-Road Strategy, Economic Policy Institute Briefing Paper 212, (Washington, DC: Agenda for a Shared Prosperity, 2008), p. 20. Quoted in UNEP, 2008

5 IMPACTS OF CLIMATE CHANGE AND RELATED POLICIES ON BUSINESSES

5.1 Risks to Businesses

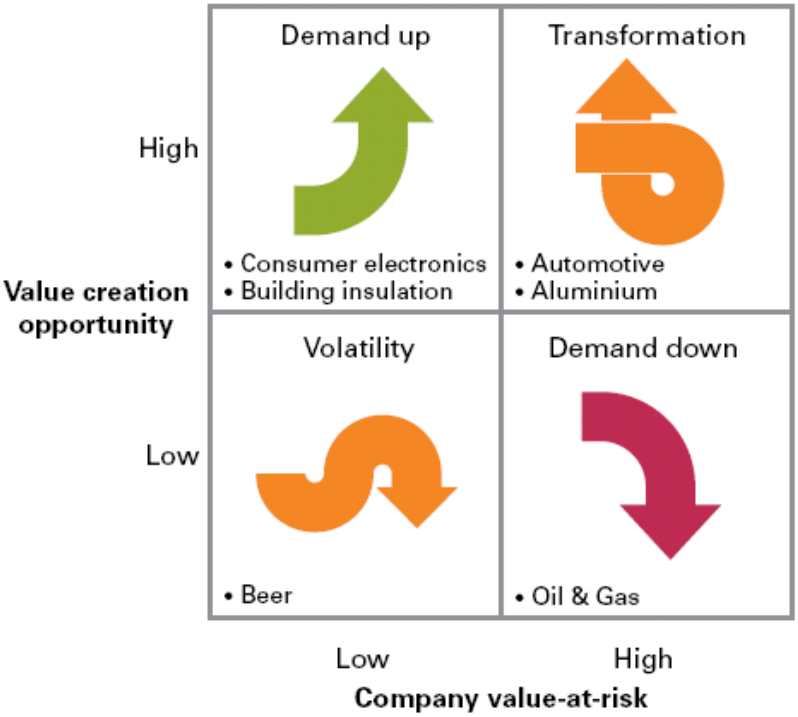
The most extensive review of the particular risks to businesses within the most affected sectors has been the work by KPMG (2008) based on reviews of company business plans and reports. This study examined planned business responses to climate change policies and found that in general the risks were being under-estimated with low levels of preparedness. They identified a number of particular risks including:

- Regulatory risk – the failure to adjust to new and changing laws and regulations leading to competitive disadvantages, and to adjust to the greater levels of uncertainty associated with a changing policy environment;
- Reputational and litigation risks – the failure to recognise the threats posed to business reputations by ineffective (even if compliant) responses; and the threat of litigation from non-compliant behaviour.

Whilst the majority of businesses were aware of regulatory risks, fewer were aware of the risks of to reputation and of litigation. However, awareness was not always reflected in preparedness.

Thus, complying with climate policies could create or destroy company value, which, by implication could have a significant effect on the distribution of jobs across the economy. A recent report by the Carbon Trust (2008) emphasised the different nature of impacts that could be felt by different sectors of the economy by looking at how tackling climate change could affect company value. The analysis identifies four ways in which company value could be created or destroyed – upward demand shift, sector transformation, downward demand shift and increased volatility – as shown in Figure 5.1 below:

Figure 5.1: How Climate Change Could Create and Destroy Company Value



Source: Carbon Trust, 2008, Climate Change – a business revolution? How tackling climate change could create or destroy company value

This categorisation suggests that strategic investors should be able to discriminate between sectors and companies on the basis of their opportunities and risks. Assuming investors are able to discriminate in this way would lead to a shift in resources to those sectors or companies perceived to be a 'good' investment in terms of climate change polices, and implies that the distribution of employment could follow.

5.2 Organising Business Responses – Identifying Risks and Developing Strategies

The Carbon Trust report (2008) repeats the oft cited view that impacts will vary by sector and depend on company responses to the challenge – whether they are proactive and seek out new commercial opportunities or whether they fail to adapt to the challenges of operating in a low-carbon business environment.

In the face of these widespread climate impacts, all companies should prepare, at a minimum, by gaining a better understanding of the risks and opportunities from climate change including regulatory changes that may affect energy prices and reputational and competitive risks that may affect companies that lag their peers in understanding and managing the impacts of this issue, (Ceres and Calvert (2007)).

In addition to assessing these risks, companies should disclose their climate risk to investors using the three most important disclosure mechanisms: securities filings, sustainability reports using the Global Reporting Initiative (GRI) guidelines, and CDP responses. Companies should also engage with investors and governments to address climate risks and opportunities. This kind of engagement with investors is critical to developing an effective, tangible response to climate change before further dangerous warming occurs.

The assessment of risk sits at the heart of corporate responses (IPS, 2008), Table 5.1.

Table 5.1: Principles of Corporate Sustainability Strategies

Internal	Internal / External	External
Secure CEO leadership Define organisational responsibility Define tangible targets Identify financial value / Build and refine business case Build Infrastructure to manage and track progress	Develop knowledge base and external networks Assess carbon footprint and drivers Assess regulatory and environmental risks broadly Seek to explore cost reduction opportunities	Pursue market and product opportunities Substantiate green communication to stakeholders – no 'greenwashing' Seek to influence policy – early action

Source: IPS (2008)

IPS (2008) also set out an approach to developing a sustainability strategy (Table 5.2).

Table 5.2: Choice and Approach Framework to Develop Sustainability Strategy

Diagnostic	Strategy Development	Capacity Building and Implementation
Assess carbon footprint Regulatory, location and environmental risk assessment High level assessment of 'green' product and service opportunities Assess opportunities for differentiation (supply chain) Initial action plan economics and business case (carbon shadow pricing) Business and impact scenarios	Strategic goal and aspiration choice (eco-compliance, cf, eco-efficiency, cf eco-advantage Target setting Prioritisation choices (Review initiatives, market research) Partnership choices Business case finalisation	Initiative implementation plan Metrics and monitoring Carbon trading capability (if required) Policy management and influencing capabilities External positioning and communication

Source: IPS (2008)

6 CONCLUSIONS

6.1 Climate Change Polices and Restructuring

It is becoming clear that the significance of the risks of climate change is becoming such that climate change polices have now become, after a long gestation period, a high priority for governments around the world. This is despite the global economic recession and the constraints on finance to invest in the move to a low carbon economy. Rather, the move to a low carbon economy is seen as a means of stimulating economic demand and employment (new 'Green Deals') as announced in the US and in the EU.

Climate change policies comprise a mix of traditional regulation (such as efficiency and emission standards) and support for new technologies, with carbon pricing an increasingly important element in the policy mix. These policies are, in some industries at least, supported by initiatives aimed at safeguarding industries through the recession (such as the vehicle manufacturing sector), where the initiatives are in part designed to stimulate new lower carbon technologies and products.

The industry and business changes needed to respond to climate change polices provide a clear example of a restructuring process. There are likely to be many opportunities - for example through the early adoption of innovative new technology - to place European companies ahead of global competitors that are slower to anticipate change. Conversely, a failure to anticipate by European firms may lead to hasty, reactive and forced adjustment, which could damage companies and, leave their employees inadequately prepared, or trained, for alternative employment. Climate change policies will act as a key driver of evolution for the economic actors involved.

6.2 Economic and Sectoral Impacts

The global macro-economic impact of climate change polices has been estimated to be in the region of 1% of annual GDP, but rising with delays in implementing policies and where more inefficient policy responses are made. The impact is arguably less about the overall economic impact but the differential impact the policies have on sectors of the economy. Some sectors (such as coal mining for example) are likely to be adversely affected (unless clean coal technologies develop rapidly). Other sectors are likely to see demand increase (such as renewables), whilst others have to transform products to maintain competitiveness (such as vehicles).

The impact on different groups of sectors depends on the extent to which they are exposed to higher energy costs, international competition and the scope to transform. In some cases the driver for change will be the need for cost reduction, in others it will be the need to respond to different market preferences. In either case significant changes in processes and products are likely to be required. Moreover, the impacts at sectoral and business level are, as with the economy as a whole, likely to increase, the later industry responses are developed and implemented.

Based on this analysis we have identified a typology of sectors to organise Stage 2 of the work (Table 3.4 above).

6.3 Labour Market Impacts

The employment impacts mirror the economic and sectoral impacts, with perhaps only modest effects on total employment, but significant changes in employment by sector, partly influenced by supply chains as well as direct impacts. In terms of the labour market there is not a significant correlation between sectors that have a high carbon intensity (use of energy per unit of output) and those with a high employment intensity (jobs per unit of output). However, sectors with large workforces (such as retailing and construction) will be

affected, for example through changes in consumer preferences, or the need to adapt distribution systems.

The effects of climate change polices on skills is less well defined. However, the move to a low carbon economy will place a premium on creativity and innovation and will echo the general economic pressure for better management and higher level skills. At the present time, there is already some concern that the lack of managerial awareness and of skills is inhibiting the shifts in production methods and products required for a low carbon economy, requiring bespoke training programmes and related initiatives.

6.4 Business Responses

At the level of the business, there are two main issues to consider: the degree of risk that the business is potentially exposed to because of its markets and production methods; and the degree of preparedness that the business has developed.

The risks are largely a function of the sector in which the business is located. The level of business response is clearly determined on a business by business basis, although some measure of collective response through social dialogue may assist businesses to identify and secure appropriate responses.

A starting point for businesses is the assessment of risk and the identification of feasible commercial responses based on strategic management choices as to the level of compliance and advantage sought from the responses developed.

The case studies of business responses (Volume 1) have explored with individual businesses the nature of risks, the need for change and the types of responses being developed.

REFERENCES

Apollo Alliance . (2008). *The new Apollo programme clean energy, good jobs: an economic strategy for American prosperity.*

ASC. (2007). *Mind the Skills gap: The skills we need forsustainable communities.* http://image.guardian.co.uk/sys-files/Society/documents/2007/10/08/Final_full.pdf.

Babiker, M., Eckhaus, R.S., 2006, Unemployment Effects of Climate Policy, Report No. 137, MIT Joint Program on the Science and Policy of Global Change, Cambridge, MA [available at http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt137.pdf].

Berrittella M., Bigano A., Roson R., Tol R.S.J., « A General Equilibrium Analysis of Climate Change Impacts on Tourism » , Tourism Management, 27, 2006, pp.913-924.

Carbon Trust, (2008). *Climate Change – a business revolution? How tackling climate change could create or destroy company value.*

Centre for American Progress. (2008). *Green recovery a program to create good jobs and start building a low-carbon economy.* http://www.americanprogress.org/issues/2008/09/pdf/green_recovery.pdf.

CERES. (2008). *"Energy efficiency policies Efficiency, Innovation, and Job Creation in California.".* http://are.berkeley.edu/~dwrh/CERES_Web/Docs/UCB%20Energy%20Innovation%20and%20Job%20Creation%2010-20-08.pdf.

Ceres and Calvert. (2007). *Climate Risk Disclosure by the S&P 500.*

CES. (2007). *Changement climatique et emploi Cas de la Finlande.* http://www.etuc.org/IMG/pdf/Finland_CountryReport_Final-2.pdf: Confédération européenne des syndicats (CES.

CES. (2007). *Changement climatique et emploi Cas de la France.* http://www.etuc.org/IMG/pdf/France_CountryReport_final-2.pdf.

DEFRA. (2006). *Environmental innovation bridging the gap between environmental necessity and economic opportunity.* http://www.berr.gov.uk/files/file34987.pdf.

Deloitte and EFF. (2008). *Delivering the low-carbon economy – Business opportunities for UK manufacturers.* http://www.deloitte.com/dtt/cda/doc/content/UK_Manu_Delivering_LowCarbon_Economy.pdf.

Deutsche Bank . (2008). *Economic Stimulus: The Case for"Green" Infrastructure, Energy Security and "Green" Jobs.* http://static.twoday.net/rauch/files/Economic-Stimulus-and-Green-Infrastructure.pdf.

DG Environment (December 2008) 'Environment and labour force skills: Overview of the links between the skills profile of the labour force and environmental factors'. EcorysDouglas-Westwood Limited. (2008). *Supply Chain Constraints on the Deployment of Renewable Electricity Technologies.* http://www.berr.gov.uk/files/file46792.pdf: BERR.

Ernst and Young. (2008). *Comparative Advantage and Green Business.* http://www.berr.gov.uk/files/file46793.pdf.

ETUC (2007). *Climate change and employment impact on employment in the European Union-25 of climate change and CO_2 emission reduction measures by 2030.*

Commission européenne (EU), "Vulnerability Assessment, Climate Change Impacts and Adaptation Measures", chapitre 5, in Fourth National Communication from the European Community under the UN Framework Convention on Climate Change (UNFCCC), 2006, disponible sur Internet à l'adresse: http://unfccc.int/resource/docs/natc/eunce4add.pdf, consulté le 3 avril 2006.

Fankhauser. (2008). Climate change, innovation and jobs. *climate policy* , 421-429.

GHK Consulting (2007). *Links between the Environment, Economy and Jobs, DG Environment, European Commission, 2007.*

Goodwin Procter, Environmental & Energy Advisory. (2007). *Climate Change Strategies for the Financial Services Industry, 2007.* http://www.goodwinprocter.com/~/media/4606DBA0701441E8A324FC51F99886F2.ashx.

IEEP. (2008). *Burden Sharing – impact of climate change mitigation policies on growth and jobs.* Committee on Climate Change under contract IP/A/ENVI/FWC/2006-172/LOT1/C1/SC14.

ILO. (2007). *Green jobs facing up "an inconvenient truth".* World of Work .

Institute of Policy Studies (IPS), (2008). *Responding to Climate Cgange – What Can Business Do? IPS Roundtable Handout, 25th July 2008, Monitor Group*

Kammen, D. M. (2007). *Green jobs created by global warming initiatives.* http://www.unep.org/civil_society/GCSF9/pdfs/karmen-senate.pdf: US Senate Committee on Environment and Public Works.

Kammen, D. M., . Kapadia, K., & Fripp, a. M. (2004). *Putting renewable to work: how many jobs can the clean energy industry generate?* http://rael.berkeley.edu/old-site/renewables.jobs.2006.pdf: Energy and Resources Group Goldman School of Public Policy.

Küster, R., Ellersdorfer, I.R., Fahl, U., 2007, A CGE-Analysis of Energy Policies Considering Labor Market Imperfections and Technology Specifications, FEEM Working Paper 7.2007, Fondazione Eni Enrico Mattei, Milan.

Lehr, U., Wolter, M. I., Großmann, A., Lutz, C. (2008), Gesamtwirtschaftliche Effekte der Umsetzung der EU Ziele im Bereich Erneuerbare und Gebäudeeffizienz in Österreich bis 2020, Study commissioned by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management.

Lehr, U.; Nitsch, J., Kratzat, M.; Lutz, C.; Edler, D. (2007): Renewable energy and employment in Germany. Energy Policy, 36 (1), Elsevier Ltd., 108 -117. Makie Bunse. (2006). *Final country report .* http://www.etuc.org/IMG/pdf/CZ_CountryReport_Final_061117-2.pdf: Wuppertal.

McKinsey & Company (2009). *Pathways to a Low Carbon Economy, Version 2 of the Global Greenhouse Gas Abatement Cost Curve http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp*

Moreno, B., Lopez, A. (2008), The effect of renewable energy on employment. The case of Asturias (Spain). Renewable and Sustainable Energy Reviews, 12, 3, 732-751.

OECD/IEA, (2008). *Energy Technology Perspectives*

OECD (2008). *Green jobs: towards decent work in a sustainable, low-carbon world.* http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_098503.pdf

Parry M.L. (ed.), Assessment of Potential Effects and Adaptations for Climate Change in Europe. The Europe Acacia Project, Jackson Environment Institute, University of East Anglia, Norwich, 2000.

Patrick Nussbaumer and, A. B. (2006). *Climate Change and Employment in Europe country report Spain .* http://www.etuc.org/IMG/pdf/Spain_CountryReport_Final-2.pdf: ISTAS.

Polidano, C. (2000). *The impact of climate change policies on employment in the coalmining industry.* http://www.ilo.org/public/english/dialogue/sector/papers/impact/index.htm: ILO.

Potsd AM. (2008). *Investments for a Climate-Friendly Germany.* http://www.bmu.de/files/pdfs/allgemein/application/pdf/studie_klimadeutschland_en.pdf.

Schleich J. et al., Endogenoous Technological Change and CO2 Emissions, the Case of Energy-intensive Industries in Germany, Stuttgart, 2006.

Scholtens. (2001). *Borrowing green: economic and environmental effects of green fiscal policy in The Netherlands.* http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VDY-44HYJ31-9&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=8dacf30b92d92952a25eeaea6aa0b1bc.

Standard and Poor. (2007). *Can Global auto automakers meet emision limits without steering off the road?*

Stern Review (2006). *The Economics of Climate Change, UK Government, 2006*

Stocker, A., Hinterberger, F. Kowalski, K., Bohunowski, L., Wolter, M.I., Grossmann, A., Madlener, R. (2008), Erneuerbare Energien in Österreich: Modellierung möglicher Entwicklungsszenarien bis 2020, Study commissioned by the Austrian Ministery of Agriculture, Forestry, Environment and Water Management.

Thorning, M. (2002). *Kyoto Protocol and Beyond:Economic Impacts on EU Countries.* http://www.iccfglobal.org/pdf/economic-impact2002.pdf: ICCF.

UK CEED. (2006). *Emerging Markets In the Environmental Sector.*

UNEP et al. (2008). *Green Jobs: towards decent work in a sustainable, low-carbon world.* http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_098503.pdf: OEDC.

US Conference of Mayors . (2008). *Current and potential green jobs in the US. Economy.*

Welsh Assembly Government. (2008). *Green jobs for Wales.* http://wales.gov.uk/consultation/det/2008/buseconomy/greenjobs/consultationen.pdf?lang=en.

Wuppertal . (2006). *Final country report Hungary .*

WWF. (2001). *CLEAN ENERGY: Jobs for America's Future.* http://www.tellus.org/energy/publications/clean_energy_jobs.pdf http://www.worldwildlife.org/climate/Publications/WWFBinaryitem4931.pdf.