Low-carbon economy and industrial jobs: can we have the best of both worlds?

Béla Galgóczi

1. Introduction

Combating irreversible climate change is clearly the major long-term challenge of our century. Although revising the prevailing model of economic growth in the wake of the deepest crisis since the Second World War is currently focused narrowly on financial and economic sustainability, the pre-crisis growth model based on an abundance of liquidity and of material and environmental resources cannot be restored. Any lasting recovery of the real economy will necessarily take the shape of a more resource-efficient production model. This is a declared objective of long-term political strategies, such as the Europe 2020 Strategy, and also features in the broader global-level context in the UNFCCC[1] round of negotiations. Although hard-core policy tools to underpin these targets are still lacking, the process is irrevocably under way.

How the objective of a resource-efficient low-carbon economy is to be reached and how the transition is being managed, however, are crucial issues.

Is the scenario compatible with maintaining a strong industrial base in Europe? While we argue that only a more ambitious and comprehensive European climate policy framework would have a chance of delivering the 2050 climate targets, this does not mean that Europe needs to give up its industrial base and its related competences. In order to manage this, however, a targeted industrial policy is needed.

1. United Nations Framework Convention on Climate Change based on annual intergovernmental conferences of the parties (COP).

This introductory chapter presents a framework for a European climate policy that takes the challenge seriously: Europe cannot return to the resource-wasting carbon- and energy-intensive economy that was the foundation of economic growth in the post-War decades.

Section 1 frames the global context and in Section 2 we argue that, in accordance with current trends and policy tools, a paradigm change in the production model is not yet in sight. We need economic instruments that compel business actors to embark on a strategy of decoupling value generation from resource and energy use. Since without growth Europe will not overcome its debt, employment and social crises, the only way ahead is by enhancing energy efficiency and resource and material productivity.

After briefly reviewing Europe's performance in fulfilling proportional climate targets in Section 3, we point to the potential risks. Decoupling economic growth from resource use on the basis of a neutral climate policy could theoretically be done by turning the broad economic structure towards services: the industrial base would diminish and energy- and resource-intensive activities would be abandoned. The relatively good performance of European industry in reducing greenhouse gas emissions – as we shall show – offers an alternative.

In Section 4 we deal with the performance of European industry in terms of energy efficiency and greenhouse gas reduction, while in Section 5 we address uncertainties attached to the possible employment effects of current climate policy in Europe.

Section 6 stresses the necessity of active transition management on the way towards a low-carbon economy in Europe with the involvement of the social partners.

In the concluding section we argue that the option of attaining a low-carbon economy through 'deindustrialisation' would not allow Europe to preserve its competitiveness and knowledge base, which is also essential for exploiting the potential of the emerging eco-industry. Decoupling is also possible with an industrial base that is more energy- and resource-efficient.

This assumes an active and targeted industrial policy, however, as several chapters of this book will underline.

2. The climate change debate

Despite the dramatic and extraordinary pressures of the ongoing economic crisis, attention will, in the longer term, inevitably have to be devoted to structural processes rather than to temporary crisis-management. The next big restructuring wave will be the transition towards a low-carbon economy, also referred to as the 'green transition' or, by some authors, the 'third industrial revolution' (Jänicke and Klaus 2009).

The International Panel for Climate Change (IPCC 2007) and the Stern Review (Stern 2006) provided convincing evidence that the world is already experiencing global warming and that the human impact on climate has, since the onset of the industrial era, greatly exceeded the impact from natural factors.

As a result, deep and significant cuts in anthropogenic greenhouse gas (ghg) emissions are urgently needed if we are to avoid dramatic, irreversible and self-reinforcing changes in the world's climate. The Cancun Agreements call for countries under the UNFCCC to list their emission reduction targets and actions which they announced in 2010 as a basis 'for the largest mitigation effort the world has ever seen'. The outcome of Cancun is welcome as, for the first time, all the major economies have committed themselves to reducing emissions, but it nonetheless falls far short of meeting the underlying promise to keep the global temperature rise below 2° C. In this way, the Summit drew attention to one of the fundamental questions of climate policy, prompting widely differing interpretations and expressions of concern.

The World Energy Outlook 2010 (IEA 2010), after incorporating these national commitments into its 'new policies scenario' model, reached the conclusion that, on the basis of this scenario, the world climate is on course to warm up by 3.5° C by the end of the present century.

The IEA also calculated what should have been done in order to meet the 2° C target. Its achievement would have required a decarbonisation rate (reduction in carbon emitted per unit of GDP) of 2.8 per cent a year over the coming decade, in other words, double the rate achieved by the world in the past decade. Moreover, in order to retain the 2° C scenario as a realistic objective, worldwide decarbonisation would need to be accelerated at an annual rate of 5.5 per cent during the period 2020–2035 (that is, almost four times the current trend).

In order to set an appropriate policy agenda, an emission target should be agreed, and then, based on the current position, the trajectory for reaching this target can be calculated. The G8 group of nations agreed in 2009 that the increase in global temperatures should be no more than 2°C above pre-industrial levels. To achieve that, according to the models on which the IPCC bases its calculations, global emissions will have to be cut to half their 1990 levels by 2050. For industrialised countries this would mean an 80 per cent cut in their emissions by that date, a reduction to two tonnes of CO_2 equivalent per head per year. In 2008, emissions in the United States were around 24 tonnes per head; in Europe they were 10 tonnes per head (IEA 2010).

According to the 'road map' drawn up at the UNFCCC conference in Bali, developing countries are not required to come up with numerical targets for cuts, but they are required to propose 'nationally appropriate mitigation and adaptation actions'.

The European Union is committed to a 20 per cent cut in greenhouse gas emissions by 2020, rising to 30 per cent if the rest of the world promises significant cuts. Japan's government has promised a reduction of 25 per cent on 1990, but has revealed little about how it might meet such a target. Australia's government struggled to get its legislation through parliament. Canada's emissions continue to grow. The United States would offer a 17 per cent cut in 2005 emissions by 2020 – according to the figure in the Waxman-Markey bill, which is around 4 per cent below 1990 levels – well below the figure of 25–40 per cent that is expected of developed countries. China has offered a 40–45 per cent cut in the carbon intensity of its economy by 2020, which still reckons with further emission growth.

Developing a globally applied and binding strategy for mitigating the effects of climate change poses an unprecedented governance challenge. This is what we saw with the failure of the Copenhagen COP15 Summit in December 2009, while the relative success of the Cancun Summit was merely due to the correspondingly diminished expectations. However, it is important that the commitment to the 2°C limit for global temperature increase was confirmed by the fact that the basic framework of climate policy ambitions for developed economies (80 per cent decrease in greenhouse gas emissions by 2050) still applies. The UN Climate Conference in Durban managed to adopt a universal legal agree-

ment on climate change to be struck as soon as possible but no later than 2015.

Past performance at a global level is alarming. CO_2 emissions from developed countries did not decrease in the period 1990–2008, while those of developing countries showed a substantial increase. The overall global balance is thus a 41 per cent increase in emissions between 1990 and 2008 (IGBP 2008). The development of CO_2 emissions by the major emitter regions in the world shows that while the EU has a relatively stable track record, emissions in the United States keep growing and the increase is gaining momentum in China.

The big picture can be discerned in the unequal distribution of global material and resource use and in its corresponding impact on environmental degradation and climate change. While developed economies (Kyoto Annex I countries), with 15 per cent of the global population, use about half of the global resources and are still mainly responsible for environmental degradation (45 per cent of greenhouse gas emissions in 2004), the impact of this overwhelmingly affects the rest of the world and particularly the poor and vulnerable in Asian, African and South American societies (Shah 2011). Even though the emergence of China is shifting this distribution, it only means that a small share of the world population (developed economies together with the industrialised regions of China make up around 20 per cent) is responsible for two-thirds of the emitted greenhouse gases. The emergence of China also demonstrates the absolute limits of this resource-intensive development model. If the rest of the developing world also embarks on implementing the Western production model, ten planets the size of Earth would not be enough to provide the necessary resources (Bleischwitz 2010).

The total volume of material resources extracted or harvested worldwide reached nearly 60 billion metric tonnes (Gt) per year in 2007, a 65 per cent increase from 1980 and an estimated eight-fold increase over the past century when material extraction was less than 7 Gt per year (including a 49 per cent increase in the extraction of fossil fuels and a 96 per cent increase in metals) (Krausmann *et al.* 2009). Limited progress has been made in terms of decoupling resource extraction and material consumption from economic growth. From 1980 to 2007 the material intensity of the global economy decreased from around 1.3 kg per USD (constant 2005 PPP) to just over 0.9 kg/USD (OECD 2011).

This global inequality in the use of material and environmental resources also has a historical dimension and points to the most fundamental market failure of the capitalist economy. The use of environmental resources (including also the atmosphere) appeared to be a free public good for economic production. The external cost of the environmental degradation that is manifesting itself in climate change, however, involves a huge shift in terms of space and time. Most affected will be the future poor and vulnerable.

When talking about European climate and industrial policy in this publication we need to be aware that the golden era of post-war economic growth and the welfare gains in the developed industrialised world rested on these global imbalances, resulting from a resource-wasting production and consumption model with huge negative externalities for the future of the planet. We also need to see that labour – in the developed world – achieved a fairer redistribution of income within that unsustainable economic model. We also know that once the current crisis is over there will be no way back to the pre-crisis growth model but not to the broader economic model of Western industrial civilisation either. Enduring recovery will be possible only through a fundamental shift towards a resource and material efficiency-based low-carbon economy.

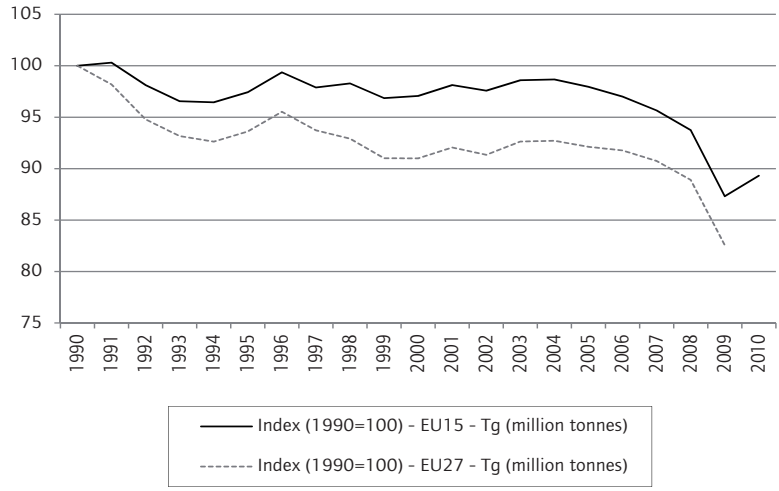
3. European objectives and performance in mitigating climate change

Although Europe has registered a better performance in meeting climate targets than the rest of the world, it is also behind its own targets and the contours of a paradigm change are not yet visible.

The EU 2020 Strategy, with its threefold priority of 'smart, sustainable and inclusive growth', has formulated its 2020 headline targets as a 20 per cent reduction of greenhouse gas emissions (rising to 30 per cent if the rest of the world promises significant cuts), increasing the share of renewable energy to 20 per cent of all energy generation and a 20 per cent increase in energy efficiency compared to the base year 1990. It has devoted one of its flagship initiatives to 'resource efficient Europe'.

Whereas by 2008 greenhouse gas emissions from developed countries (subject to the Kyoto Protocol) showed no decrease, the EU succeeded in significantly cutting its emissions during this period. However, the rate

Figure 1 **Reduction of greenhouse gas emissions in the EU15 and EU27, compared to 1990 levels (%)**



Source: EEA data service.

of reduction is much more due to cyclical economic downturns than to a decoupling of emissions from economic growth as a result of climate policy. The 2020 targets seem to be within reach, however, especially if economic growth remains sluggish in Europe, as recent forecasts predict. Taking the base-year 1990 into account, EU15 greenhouse gas emissions in 2009 were down by 12.6 per cent, while EU27 emissions were down by 17.4 per cent (Figure 1).

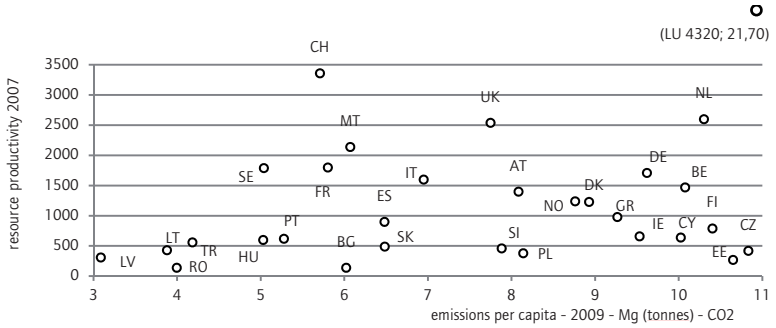
Out of the EU27's total 17.3 per cent reduction in emissions between 1990 and 2009, 7.3 per cent had already been achieved in 1994 (at the lowest point of the transformation crisis in Central and Eastern Europe), and a further 8.2 per cent reduction was due to the economic crisis in 2008–2009. Data for 2010 (only available for the EU15) also show the cyclical nature of greenhouse gas emissions: with a recovering economy, emissions grew by 2 percentage points. This shows clearly that the bulk of the so-called emission cuts was actually attributable to a contraction in output and economic crisis.

European data reveal piecemeal progress. Resource productivity[2] – in terms of which economic growth is decoupled from resource use – shows only marginal improvement. While labour productivity in the EU27 grew by 14.2 per cent during the 1999–2007 period, resource productivity improved by just 7 per cent (Eurostat 2010). Resource efficiency has not yet become a driver of economic decision-making.

It should be noted that these increases in resource productivity were more driven by GDP growth rates than by growth rates in domestic material consumption (DMC). Absolute decoupling between resource use and economic growth – in other words, producing more (in terms of GDP) with less resource input (in terms of DMC) – has therefore not taken place.

The differences in resource productivity displayed by individual member states are frequently overlooked (Figure 2). The gaps are enormous: for example, the level of resource productivity in Luxembourg is thirty times

Figure 2 **Resource productivity (EUR/tonne) and per capita CO_2 emissions in the EU by member state**



Source: EEA (2011) for CO2/capita, Eurostat (2011) for resource productivity.

2. Resource productivity (GDP/DMC) is defined as the ratio between gross domestic product (GDP) and domestic material consumption (DMC).

what it is in Bulgaria. This gap is thus far wider than corresponding gaps in GDP/capita or wages. Even if Europe, as a whole, is currently profiting from the huge 'emission drops' in Central and Eastern Europe's new member states, caused by the collapse of their traditional industrial base in the early 1990s, these countries face particularly severe challenges when it comes to increasing resource productivity in the future.

If we also look at CO_2 emission intensity of EU member states per capita (Figure 2), we get quite a different picture. Luxembourg, which leads in terms of resource productivity, is the worst performer in terms of per capita CO_2 emissions (in 2009 it was 21.7 tonnes). For Bulgaria, the country with the lowest resource productivity, it was 6 tonnes, while for Latvia it was a mere 3 tonnes (the lowest in the EU).

At the same time, it is important to note that it is not production alone that determines the resource efficiency – in a wider but more relevant sense – of a given country or region. What matters above all is consumption. A country might, after all, specialise in economic activities with low-resource use and emissions, while importing resource-intensive products.

One study conducted using consumption-based CO_2 accounting finds that Europe should add net imports of 4 tonnes CO_2 equivalent per person to its per capita production-based CO_2 emissions. The latter were 10 tonnes CO_2 equivalent in 2008, so this would mean 40 per cent additional emissions (Steven J. Davis and J. Caldeira 2010)! This is also an important policy implication for the future.

The European Environment Agency (EEA) report tracking European performance in meeting the Kyoto targets (EEA, 2010) reckons with a possible fulfilment of the EU Kyoto targets by 2020. However, this envisaged meeting of the greenhouse gas reduction target, even if achieved, will be predominantly due to one-off events associated with economic crises and is not based on a sustainable implementation of measures aimed at achieving policy targets.

Even if Europe is performing better than the rest of the world, it is not on a sustainable track towards fulfilment of the ambitious 2050 targets. The target of an 80 per cent cut in emissions for the industrialised economies by 2050 means a cut in emissions to two tonnes of CO_2 equivalent per head per year. In 2008, emissions in Europe were 10 tonnes, with an

extra 4 tonnes CO_2 equivalent of imports. There is thus a long way to go to meet this long-term objective.

Gap between performance and long-term objectives

The challenge is not simply to raise current efforts to a quantitatively higher level – in other words, quadrupling current decarbonisation levels in coming decades – but to raise policy implementation to a qualitatively new level (Galgóczi 2010). A paradigm change entailing a comprehensive reorientation of how production, consumption and overall economic activity are organised still lies in the future (Degryse and Pochet 2009).

This does not mean, however, that actions have ensued, even if we consider the pre-crisis period.

The piecemeal approach characterising the efforts to combat climate change has contributed, alongside the lack of any genuine paradigm shift, to an emerging critical stance – mainly by environmental NGOs – in relation to the current mainstream climate policy discourse.

In the words of Crist (2007), 'industrial-consumer civilization has entrenched a form of life that admits virtually no limits to its expansiveness within, and perceived entitlement to, the entire planet'. But any questioning of this civilisation is by and large sidestepped in the mainstream climate-change discourse, with its single-minded quest for a 'global-warming techno-fix'. The dominant frame of the climate change discourse is focused on pragmatic work designed to address global warming specifically, while failing to address the foundations of the civilisational pattern.

4. Economic instruments and the issue of policy implementation

In order for a paradigm shift to take place, tools and instruments should be created that realise policy objectives at the level of business and consumer decision-making. It would also require the implementation of a new type of supranational governance with multi-actor involvement.

Implementation is thus a cornerstone of achieving climate policy targets. What we have now at European level are mostly declared objectives, without a concrete roadmap or instruments of implementation. While economic actors are becoming aware that the costs of using environmental resources will be increasingly important in their business operations, they are unable, in the absence of a concrete policy framework, to plan any necessary adjustments.

Before taking account of the economic tools and instruments necessary for achieving climate targets, it is worth looking at the main lines of economic theory.

4.1 Economic theory and sustainable development

Neoclassical economic theory is not able to address the crucial issues of sustainable development. With the assumption of the substitutability of economic and natural capital (Solow 1974) with the help of technology and a properly working price mechanism, Solow maintains the view that man-made capital can, in principle, replace all types of natural capital. This is known as the weak sustainability view: essentially, every technology can be improved upon or replaced by innovation, and there is a substitute for any scarce resource or material. This view seriously overlooks the limited character of natural resources and the external effects of their wasteful use. From the perspective of sustainable development, the natural capital stock is to be preserved and no substitution between economic and natural capital should take place.

Another theoretical approach put forward from a non-orthodox perspective aims to resolve the economic-ecological conflict with the imposition of zero-growth or 'steady state economy', as Herman Daly (2005) has put it, arguing for 'stopping growth, but not development'. Prosperity without growth was Tim Jackson's central thesis in his influential report for the UK Sustainable Development Commission (Jackson 2009). More radical critiques of the resource-intensive growth model, such as the French '*decroissance*' ('degrowth') movement, poses fundamental questions about growth itself and seeks alternatives to growth (Gadrey 2010).

Although these authors have made a huge contribution by putting the issue of sustainable development at the centre of economic debates and their perspective might also be a long-term reality for the developed

world, it has been not clarified how monetary and fiscal policy would function without growth in a high-debt environment that is a determining characteristic of all major economies for the coming decades.

There is another way in which the resource-wasting economic model can be turned around, however. Zero-growth or even decreasing resource use does not mean that economic growth would not be possible.

Decoupling economic growth from natural resource inputs – also called the 'strong sustainability concept' – is not only possible in relative but also in absolute terms, as several authors show (see also Schepelmann in this volume). An important paper by Bleischwitz (2010) argues that resource productivity – that is, the efficiency of using natural resources to produce goods and services in the economy – will become one of the key determinants of economic success and human well-being. The author introduces the empirical tool of material flow analysis to measure the use of natural resources and gives evidence of resource productivity increases across a number of economies. Introducing the notion of 'material flow innovation', the paper also discusses innovation dynamics and issues of competitiveness. However, he concludes that market barriers make a case for effective resource policies that should provide incentives for knowledge generation and get the prices right (see also UNEP 2011).

Increasing resource productivity is indeed a viable option: as the Lindau group calculated, a resource productivity increase of about 4 per cent per annum would be needed in order to achieve absolute decoupling (www.worldresourcesforum.org).

Munoz and his colleagues claim that in industrialised countries current resource productivity must be increased by an average of a factor of 10 during the next 30 to 50 years. This is technically feasible if we mobilise our know-how to generate new products, services, as well as new manufacturing methods and modes of consumption (Munoz *et al.* 2009).

Although the European Union has committed itself to the 'strong sustainability' concept of a resource-efficient economy, as we show below, this concept largely remains a declarative objective without the tools needed to enforce it.

4.2 The fragmented framework of economic tools and instruments in European climate policy

The central issue is how to achieve appropriate resource price signals. Within the European context economic policy instruments determining the effective carbon price include 'cap and trade' policies (such as emissions trading), a variety of carbon-related taxes and the direct involvement of the state through steering mechanisms (for example, emission standards, levies on carbon-based energy generation and use, while providing subsidies for environmental innovation). These instruments, taken on their own, would be incapable of translating policy targets into business reality. What is needed is a coordinated policy mix of these instruments, with a clear implementation agenda at European level, but this is largely missing.

As regards carbon-related taxes, Cottrell (2010) gives a critical overview of scattered practices by EU member states. Although green taxation is a constant element of climate policy discourses in Europe, green taxation, as a percentage of GDP, is now lower than it was ten years ago (Le Cacheux 2010; Eurostat 2010). Jänicke and Zieschank lay down a framework for environmental tax reform and draw consequences for shifting competitive advantages in industry and green growth (Jänicke and Zieschank 2011).

While a carbon tax is still a theoretical option at the European level, Europe has launched an Emission Trading System.

The European Commission is currently finalising the design of the third trading phase of the ETS, which will begin in January 2013 and last until 2020. The Commission's stated objective is to increase the share of emission permits that are auctioned rather than allocated for free to installations covered by the ETS.

The European Emission Trading System clearly demonstrates the uncertainties and distortions of policy instruments that are not integrated into a comprehensive policy framework (see also Laurent in this volume). The current form of the EU ETS has been criticised in several respects, as it fails to give proper incentives to economic actors to reduce CO_2 intensity (Le Cacheux 2010). It has been also subject to wide manipulation and fraud and has thus become a source of uncertainty for economic actors (cf. ETUC 2010).

Generally speaking, the potential exposure level of industries or sectors to EU ETS can be assessed through three major factors: the CO_2 intensity of production, the opportunity to abate carbon within the sector and the ability to pass along carbon cost increases to output prices. The economic impact of the EU ETS scheme hinges to a certain extent on whether carbon costs are reflected in output prices, while the overall emission cap is of greatest importance in achieving lower emissions.

A key concern is the potentially negative impact of the next phase of the ETS on the competitiveness of affected businesses. Evidence from interviews with almost 800 managers in Europe shows that most industry sectors that will still be entitled to free emission permits would not face an increased risk of closure or relocation outside the EU if they had to pay for permits (CEP 2010). Another study on the potential effects of the EU ETS for industrial branches, carried out by the ZEW Institute, concludes that some of the sectors analysed have the ability to pass through a portion of their carbon costs to consumers. However, the results also indicate that sectors cannot achieve a complete pass-through of their costs into output prices, with the exception of ceramic goods. Moreover, although generally accepted as an important indicator for the competitiveness implications of EU ETS, the ability of sectors to pass on costs also has its limits. The longer term impacts – in particular, of sectors and firms attempting to passing through carbon costs, and the consequences for leakage – remain uncertain (Oberndorfer 2010).

The CEP paper argues that European governments should improve the design of the ETS by limiting existing exemptions and raising additional income of up to 7 billion euros annually. Rather than providing an unspecific subsidy for industry, this money could be earmarked to finance investments and R&D crucial for the transition to a low-carbon economy. It could equally be used to mitigate the possibly regressive effects of higher carbon prices on low-income groups.

There is substantial uncertainty about the third phase of EU ETS, with a hardly calculable increase in EU ETS costs driven by an assumed increase in the price of allowances. Capital intensive industries need time to plan investments and to respond to policies. According to a study by the WWA consultancy group, commissioned by the EIUG and the TUC, the forecast increase in the total energy bill, taking electricity, gas and emissions reductions schemes together, is projected to be between 18 per cent and 141 per cent by 2020. These figures include the costs of EU

ETS phase III and show an incredibly wide range (EIUG-TUC 2010). Companies participating in this study reported an increasing reluctance on the part of their owners to commit to any investment, given not only the scale of climate change costs, but the ongoing uncertainty surrounding the climate change regime and its impact on energy prices.

Improving resource efficiency is a key issue and the European Commission has presented its Roadmap for a resource-efficient Europe (European Commission 2011). This document closely follows the Flagship Initiative on a Resource Efficient Europe under the EU2020 Strategy and calls for a decoupling of economic growth and the use of resources. How realistically can this be achieved in a context of sluggish growth? How determined is the EU to impose serious binding targets on member states and the different industrial sectors, and will it be ready to implement sanction mechanisms to ensure compliance with such targets? These questions remain open. Are binding targets sufficient, or should other devices – such as price mechanisms comparable to the European Emissions Trading Scheme (ETS) – also be contemplated in the field of resource efficiency?

Europe thus has a controversial emission trading system covering a fraction of economic activities, no carbon tax at European level and a number of sector-related policies at national level. This policy framework does not provide a sound foundation for achieving Europe's announced climate policy targets.

5. The role of European industry in decoupling resource and energy use from growth

A decoupling of energy and resource use from economic growth can theoretically be made in two main ways: broad restructuring of a national or a regional economy, where energy and resource intensive activities are downscaled or abandoned and other activities of value generation are developed (for example, services, finance and so on). Luxembourg and the United Kingdom are examples of this in Europe as their high resource efficiency and economic structure shows. What works on the scale of national economies would not work on the level of the 500 million EU27, however. Deindustrialisation is not a way for Europe to meet climate targets, not just because the magnitude of that restructuring would have a high price in terms of employment and human resources. Indus-

try is the foundation of Europe's competitiveness and without industrial competences neither business-related services nor an eco-industry can function. If industrial goods were imported from other parts of the world where lower climate standards apply, global emissions and resource use would not benefit either. The only way ahead is through eco-innovation and higher resource and energy efficiency on the part of an industrial base maintained and continuously upgraded in Europe. In this regard, industrial policy is a key element of a climate policy framework (several chapters of this book are devoted to industrial policy, see Rondinella, Wilke and Nelissen).

Trends of energy intensity by country and economic sector in Europe

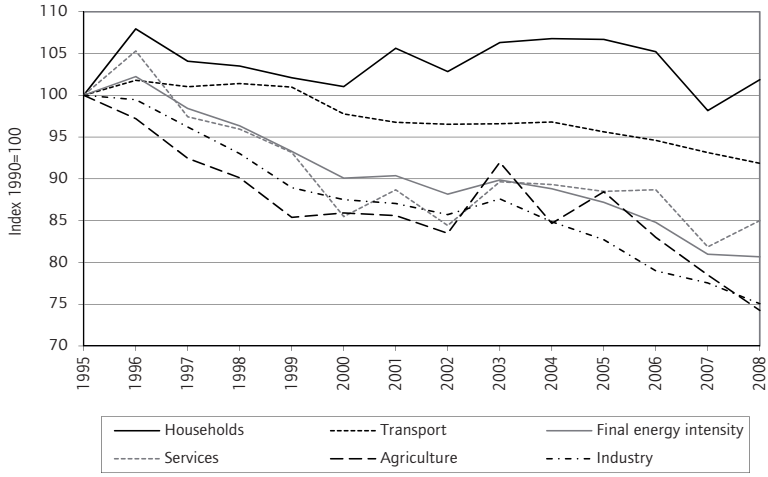
Over the period 1990–2008, the total GDP of the EU27 grew at an annual average rate of 2.1 per cent, while the final energy consumption grew by only 0.5 per cent annually. Consequently, over the period, final energy intensity decreased at an average annual rate of 1.6 per cent. In 2007, the decrease even reached 4.5 per cent compared to 2006. In 2008, final energy intensity remained at the same level as in 2007.

Trends differed significantly among EU member states: final energy intensity decreased very rapidly in Estonia (by around 8 per cent a year) and also to a lesser extent in Slovakia, Lithuania and Bulgaria (around 5 per cent a year); in contrast, it increased in Portugal and Spain.

Improvements in final energy intensity were influenced both by structural changes in the economy (such as a shift from industry towards services) and, within industry, to less energy-intensive processes, and by energy efficiency improvements.

Figure 3 shows the changes in energy intensity by sector in the EU27. Since 1995, decoupling of growth from final energy consumption was most successful in the agricultural and industrial sectors, where energy intensity has decreased by 25.7 per cent and 24.9 per cent, respectively. In the tertiary and transport sectors final energy consumption intensities have decreased by 15 per cent and 8 per cent, respectively, compared to 1995. In households, final energy consumption per capita has increased by 1.9 per cent since 1995 due to larger and more numerous dwellings and more ownership of electrical appliances.

Figure 3 **Index of final energy intensity by sector, EU27 (1995=100)**



Source: Eurostat.

The development of CO_2 emissions showed a similar trend. For the period 1990–2008 emissions decreased by 9.4 per cent in the energy industry, 25.1 per cent in manufacturing and construction and 12.1 per cent in the residential, tertiary and agriculture sectors, but grew by 23.8 per cent in the transport sector.

Data thus show that industry had a major share in the improvement of energy intensity and in the reduction of CO_2 emissions in Europe in the past decade, while households and the transport sector saw no or only minor improvement.

6. Possible employment effects

Under circumstances of major uncertainty with regard to the concrete tools of European climate policy, it is difficult to discuss their expected employment effects. We make an attempt here only in order to highlight the main contradictions between targets, intentions, implementation and reality (for more on employment effects see the chapters by Mestre and Morvannou, Torregrossa and Wilke in this volume).

It is important, at the outset, to distinguish between the expected effects of *intended* climate policies (that is, those formulated in terms of promises and targets) and climate policy that is actually being *implemented* by means of effective and binding policy instruments. The same inconsistency affects employment forecasts. Most of the literature assumes the fulfilment of declared climate policy targets when calculating positive employment effects, but tends to downplay employment risks, because it does not (or cannot) fully take into account the effects of measures that have not (yet) been implemented but would be required for the achievement of long-term targets.

With all the uncertainties of policy tools and the implementation of climate change mitigation policies, it is important to examine the potential effects of these developments on industrial activity and employment in Europe, both in quantitative and qualitative terms. If we look at the possible social consequences of a climate mitigation policy that is indeed being implemented, and where the assigned economic instruments are actually applied (not the case up to now), we can identify two major impacts: one is the effect on employment, the other is the way in which a higher carbon price affects different income groups in society and influences equity.

One thing is sure: with the implementation of climate targets, industry and industrial jobs will be significantly transformed, in both quantitative and qualitative terms. Theoretically, the connection between climate policy and employment is ambiguous and depends on the sign of cross-elasticity of labour demand with respect to energy prices.

However, there is a broad consensus in the European literature (for example, Cedefop 2010 and further studies cited in this section) that although climate policies would have no major aggregate impact on the number of jobs, a massive redistribution of jobs is to be expected:

– new jobs are being created;
– existing jobs will be transformed ('greened' jobs in existing industries);
– jobs will also disappear.

There will be huge differences between regions, branches and sections of the labour market.

There is also a clear consensus that jobs identified as 'green jobs' will be net beneficiaries of the process, although the contours of this category are not clearly defined (green jobs are often referred to as jobs that contribute to preserving or restoring environmental quality; jobs that reduce energy, materials and water consumption; jobs that contribute to decarbonising the economy and minimising all forms of waste and pollution). It matters a lot, however, if we restrict this classification to single products or take the whole value chain into account (producing steel might not be seen as a green activity but if this as an input for a windmill, the perspective changes). Bearing this in mind, high energy intensity and carbon emission activities are, in general, expected to suffer a decline and substantial employment losses. This might affect regions, countries and industries unevenly and the resulting tensions need to be addressed.

In most of the existing literature on possible employment effects, there is too much focus on the positive side of the green restructuring process ('green jobs'), and too little on employment risks and negative impacts involving a potential reduction in some activities. This is typically true of the European Commission's Communication 'Seven measures for 2 million new EU jobs' (European Commission 2009a), which calculates the employment creation effect of the measures contained in the European Energy Efficiency Action Plan. For energy efficiency measures in the housing sector there is indeed huge job creation potential, provided the projected magnitude of retrofitting buildings can be realised (and envisaged programmes do not fall victim to austerity measures). The 'Employment in Europe 2009' report takes a more nuanced approach but puts green job creation in the foreground (European Commission 2009b). A study by the UNEP and the ILO (UNEP 2009) takes into account the job creation potential of the green economy, branch by branch. It draws an important distinction, saying that jobs that are 'green' in terms of the end product are not always green in terms of procedure because of the environmental damage caused by inappropriate practices (for example, in the recycling industry). The report also addresses the issue of job quality in the context of green jobs.

A discussion paper by the King Baudouin Foundation goes further, as it addresses the implication of individual climate change mitigation measures on social justice and employment (Schiellerup *et al.* 2009).

A recent paper based on US data on electricity prices and labour market indicators for the period 1976–2007 estimates that in the short run, an

increase in electricity prices of 4 per cent would lead to a reduction in aggregate FTE employment of about 460,000 or 0.6 per cent (Deschenes 2010).

Branch-level employment effects

When examining the branch-level employment effects of applied and planned climate policy measures, the uncertainty is even greater than for higher level economic activities. One key question concerning climate policy is how it aims to achieve emissions cuts; whether by reducing activities that are energy intensive or by increasing the efficiency of these energy intensive activities.

Government policies often do not explicitly target energy inefficiency, but rather the amount of energy used. By doing so, they do not recognise that many energy-intensive products have a low lifecycle carbon footprint, mainly due to their durability and recyclability. Energy-intensive sectors, such as steel, chemicals and ceramics, provide many of the materials and products that are essential for the transition to a low-carbon economy (wind farms, for example, need steel, cement, carbon fibre and aluminium). These materials and industrial products may also help to reduce energy use by providing homes with energy efficient glass and insulation.

Energy intensity is not in itself bad for the environment, while energy inefficiency definitely is. Europe cannot produce low-carbon energy or consume energy more efficiently without energy-intensive products.

Consequently, there is a significant difference between potential adaptation strategies: do we wish to downsize energy- and resource-intensive industrial activities – for example, by concentrating on financial services instead of manufacturing – or to increase energy and resource efficiency while maintaining core industrial activities. These questions remain open.

We need to bear in mind, however, that most manufacturing emissions originate in primary production, while most value added is concentrated in downstream processing and application. According to a 2007 study by the United Kingdom-based Carbon Trust, the impact of carbon costs on these higher value added manufacturing activities is small compared

to differences in labour, energy and other input costs between EU and non-EU countries (Carbon Trust 2007).

Syndex Consultancy has carried out several empirical studies and forecasts on the sectoral employment effect of climate policy measures (for more detail, see Mestre and Morvannou in this volume). One of their studies commissioned by the European Trade Union Confederation (Syndex 2009) took stock of potential employment effects for existing industries, emerging industries and major infrastructure projects in Europe. Accordingly, the renewable energy sector will be a future source of employment growth. Developing, installing, operating and maintaining renewable energy systems will create a vast number of new jobs, which are both local in nature and not subject to relocation. According to the forecast made in the study, the 1.4 million jobs accounted for by the sector in Europe in 2005 are likely to increase by a further 760,000 jobs by 2020. The Commission reckons on 2.3-2.8 million jobs in the renewable energy sector in Europe by 2020 (European Commission 2009b). The UNEP-ILO study on green jobs calculates a potential 20 million new jobs in the renewable energy sector worldwide by 2030 (UNEP 2009).

There is great employment creation potential in reducing emissions in the housing and construction sector, as the operation of buildings accounts for 40 per cent of all energy use. Jobs are to be created mainly in the construction sector and in the industries delivering the necessary technology overhaul. The Commission's Employment in Europe report estimates that the Directive on Energy Performance of Buildings will create between 280,000 and 450,000 new jobs in the medium term. New jobs are linked to activities in the retrofitting of buildings and energy management, including related services (facility management, maintenance and control). Industries delivering domestic appliances, office equipment, air conditioning, lighting and heating systems, as well as related ICT services will also benefit from the programme. It is estimated that every 1 million euros invested in energy efficiency creates 12–16 new jobs. The proportion of stimulus packages spent on such projects has a high rate of return, not only in terms of lowering emissions but also in creating jobs. The only question is how long these public resources will remain available at a time when the overall focus of economic policy is debt consolidation and austerity has become the number one priority.

Manufacturing is responsible for one-third of global energy use and 36 per cent of global CO_2 emissions (International Energy Agency 2007).

Within manufacturing, the steel industry accounts for 30 per cent of industrial CO_2 emissions and employs 550,000 employees in Europe, now that excess capacities have been eliminated through decades of restructuring. The steel industry is also a key innovator and supplier of several products of the green economy (windmills), with lightweight steel solutions contributing to long-lifetime buildings and better energy performance.

Over the past 40 years, the unit CO_2 and energy consumption of the European steel industry have decreased by 50 per cent and 60 per cent, respectively. Almost all the steel from cars is being recycled, and by 2015, 95 per cent of all car materials must be completely recycled.

Even though the steel industry is one of the most energy-intensive industrial activities, the lifecycle CO_2 footprint of its products has decreased dramatically and its energy efficiency has also improved. The industry's contribution to further emission reduction is expected to be made by further energy efficiency improvements and not by further downsizing. The post-2012 EU ETS regime will be crucial for the steel industry in Europe. In the current circumstances, future effects on employment in the industry cannot yet be predicted.

For other energy-intensive sectors besides iron and steel – such as aluminium, cement and lime manufacture, pulp and paper making, basic inorganic chemicals, and nitrogen fertilisers – there is even greater uncertainty. Many of these industries are based in regions of relatively high unemployment, and their continued operations are vital to the economies of these areas.

Transportation is a particularly critical industry in terms of both its climate effect and its key role in the European economy. While efforts are being made to reduce the footprint of cars, public transport systems offer lower emissions and greener jobs.

Railways can generally be regarded as sources of green employment. In many countries, however, the trend over the past few decades has been away from rail, and towards cars, trucks and planes, a trend which takes us further away from achieving a sustainable balance between modes of transport. Employment – both in the operation of railway lines and in the manufacture of locomotives and rolling stock – has fallen accordingly.

In the EU25, a total of 8.2 million people were employed in all transport services combined in 2004. Railway transport accounted for just 11 per cent or 900,000 jobs. Rail employment has fallen in the past few decades: in the short period of time between 2000 and 2004, the number of jobs was cut by 14 per cent. Road passenger and freight transport, in contrast, account for some 4.3 million jobs and air transport jobs number 400,000 (Syndex 2009).

Road transport emissions dominate transport emissions, with light-duty vehicles responsible for the bulk of emissions globally and emissions from transport still growing fast. Global CO_2 emissions from transport grew by 44 per cent from 1990 to 2008. Depending on the assumptions for economic growth, transport emissions might grow by another 40 per cent by 2030. Estimates like this already take account of efficiency improvements.

The automotive industry and its supply industries employ a total of 12 million people in Europe, making it the backbone of European manufacturing industry: 2.3 million employees are directly involved in the production of vehicles, while the supply industry has 10 million employees (ACEA 2010). According to the already cited UNEP report, only some 250,000 jobs are directly involved in the manufacturing of fuel-efficient, low-pollution and low-emission cars and can be considered green jobs within the European automotive industry (UNEP 2009).

The automotive industry faces particularly tough challenges over the next few years, in the course of the transformation to a low-carbon economy. The key process of the next decades will be the restructuring of industry through environmental modernisation. The greening of the automotive industry by low-emission cars and its integration into an all-inclusive mobility system are the decisive elements of this strategy.

There are two key objectives for the automotive industry with regard to lower CO_2 emissions: the reduction in CO_2 emitted by cars and commercial vehicles in operation, and the reduction of CO_2 emissions in the production of vehicles. Overall CO_2 emissions resulting from the manufacture of passenger cars increased between 2005 and 2007 at a rate of 1.4 per cent, due to the growing number of passenger cars produced. Efficiency rates, measured by the amount of CO_2 emitted per vehicle produced, fell by 5 per cent to 0.83 tonnes CO_2 over the same period (Syndex 2009).

The greater challenge for the industry, however, is to meet the binding CO_2 emission limits for passenger cars and light-duty vehicles. The European regulation sets a binding limit for CO_2 emissions from an average new car fleet at 130g CO_2/km by 2012, with premium fees imposed if the average CO_2 emissions exceed the limit value in any year from 2012.

The Commission's long-term target will be 95g/km, specified for 2020.

It is worth mentioning that the binding regulation of 2009 was the result of 13 years of discussions on the reduction of CO_2 emissions from passenger cars. In 1995, the European executive body had announced a 120g CO_2/km target for 2005. In the following years, the target was postponed twice, once to 2010 and then to 2012. The automotive industry failed to meet it voluntary targets, hence the binding regulation.

It seems clear that in the future the conflicts between a growth-oriented market strategy of the automotive industry and the goal of reducing CO_2 emissions will become more and more marked. The industry has a strong interest in changes being managed without major cutbacks in the market or financial burdens on the car industry itself. Therefore industry representatives are demanding that policymakers across Europe adopt a comprehensive strategy involving technologies as well as market incentives, infrastructure adjustments and changes in driving habits.

Under these circumstances it is extremely difficult to give a realistic forecast for the likely development of employment in the automotive industry in the coming decade (for a detailed analysis of the automotive sector see Wilke and Wolff in this volume).

In the absence of a European concept for a sustainable balance of modes of transport, this calculation could not take into account possible shifts between modes of transport, whereby, for example, the share of road and individual transport would certainly lose out to rail and public transport, with corresponding consequences for employment.

The uncertainty surrounding potential employment effects of the green transformation applies not only to the automotive industry but to manufacturing industry as a whole. Most available forecasts assume at least a neutral overall employment effect, while putting the creation of new jobs in green industries in the foreground.

A recent Cedefop study estimates a loss of nearly 2 million manufacturing jobs in Europe by 2020: 'although there might be expectations of an increasing share in manufacturing at national level, the total share of jobs in manufacturing and construction in EU27 will decrease from 22.9 per cent in 2010 to 21.3 per cent in 2020' (Cedefop 2010).

7. Sustainable restructuring

As is the case with major restructuring processes, managing the transformation by means of appropriate policy instruments with the involvement of the social partners will be a decisive factor in its final success. One crucial question is how the costs of the transition will be distributed among the various actors and within society.

This restructuring process will also be unique in the sense that it is directly induced and shaped by explicit policy targets to mitigate climate change, implemented by means of a policy mix. This is genuinely different from restructuring processes that were driven by market forces (for example, globalisation) and where the role of policymaking was more indirect, in the form of liberalisation and deregulation practices (without explicit policy targets). This is why 'anticipation' of change attached to this new restructuring wave can be more straightforward and explicit and responses to its challenges (above all related to employment) can even be planned and integrated into the policy framework right at the outset. Above all this would include the design of targeted labour market policies to ease necessary transitions and matching education and training measures. The most urgent step would be a proper assessment of the concrete and planned climate mitigation policy measures for employment.

Another vital question concerns how to manage this process in a socially sustainable way, what role trade unions would have and what strategies they follow.

The critical environmentalist approach vis-à-vis the traditional stance of trade unions was originally based on the assumption that the basis for the social reconciliation between the capitalists and the working class became possible on the basis of the high degree of wealth established through ever increasing material flows and the wastage of natural resources. Growth was considered a way of reconciling opposite inter-

ests (workers/capital) by redistributing (part of) the additional wealth (Maier 1990). From this point of view, in continental Europe the social partnership model was developed between labour and capital in order to minimise strikes and social unrest in general, always provided that there is enough growth for labour to receive a decent share of it.

Labour and capital were thus perceived as two sides of the modern industrial capitalist production model.

Does this mean that trade unions are still 'locked-in within that traditional capital–labour deal' and would be incapable of developing new strategies and moving beyond the established production model?

The supposition of a 'locked-in position' of the labour movement in the resource-wasting capitalist production model might have been applicable to the traditional constellation in the industrial post-Second World War production model. At the same time, labour has always been on the opposing side vis-à-vis capital, to which it has adopted a critical stance, albeit without managing to question – or having failed in its attempts to do so – the foundations of the capitalist production model.

If we look at the role of labour within the 'labour–capital deal' of the industrialised production model, it is not enough to point out that it is part of the system. For capital, labour is one production factor, while natural resources, including the atmosphere, are another. In this respect, labour used to constitute, for capital, a quasi-externality and the acquired rights – in other words, a decent 'price' for labour – were hard won. It is indeed true that internalising the external costs of using environmental resources for business operations requires a paradigm change in the production model and that this process expands the scope of the traditional capital–labour conflict/dialogue. It is also true that the constituency of trade unions (employees) as consumers is an integral part of the capitalist production/consumption model. At the same time, trade unions as longstanding opponents of capital are, precisely, in a position to address issues linked to the other externality (environmental resources).

Another prejudice often applied to trade unions in the past was that they were predominantly interested in preserving the status quo. However, not least because of the structural pressures induced by globalisation in recent decades, trade unions (together with works councils) have now become important agents in the management of change.

A key demand of European trade unions in such an approach is for a 'just transition' (now enshrined in the Cancun declaration). According to the ETUC (2010), the five pillars of a just transition to a low-carbon European economy are as follows:

(i) dialogue between governments and key stakeholders, including the social partners;
(ii) green and decent jobs through investment in (new) low-carbon technologies, R & D and innovation;
(iii) green skills developed by active strategies of government training, allowing a shift towards a low-carbon economy;
(iv) respect for human and labour rights: the democratic decision-making and enforcement of these rights are essential to ensure a fair accommodation of interests of workers and communities at all levels;
(v) strong and effective social protection systems.

Trade unions as major societal actors will have a crucial role in pushing ahead this paradigm change, even if this might increase the pressure of deep structural change with effects on their traditional constituency, namely working people.

8. Conclusions

There is a consensus in Europe that reversing climate change is the overall policy priority of the coming decades and that the transformation towards a resource-efficient and low-carbon economy will be the decisive trend of the future. Even if past performance in fulfilling previous targets is very disappointing, it can be firmly stated that the determination of European policymakers and economic actors to achieve a breakthrough in greenhouse gas emission cuts has undoubtedly become serious in recent years. The concrete economic tools and the economic foundations of this process are largely missing, however. Examples of the existing economic instruments – such as the EU ETS – clearly show this and lead to a situation in which the effective carbon price in the future is still not calculable. On the one hand, we have ambitious targets and promises but it is still uncertain by what means and at what price these objectives could be achieved.

A paradigm shift from a resource-wasting production and consumption model towards a low-carbon and resource-efficient Europe is clearly

necessary and the speed of adaptation should be raised by a magnitude. What we have stressed in this introductory chapter and will be addressed by the individual chapters of this book is that this large-scale restructuring process needs a guiding principle. Sustainable industrial and structural policies are needed in order that this revolutionary process can take place in a socially balanced way and Europe will be able to keep its industrial core competences. A low-carbon European economy without a strong resource and energy-efficient industry would not be able to exploit the opportunities of green growth, would result in massive job losses and would not help the global climate, either.

When addressing the issue of the employment impact of this transition process, the focus is generally put on the job creation effect in the form of green jobs. It is not enough to talk about green jobs only: the challenges of the transformation of existing industrial jobs also need to be addressed. It is clear that the transformation towards a low-carbon economy will encompass a full-scale transformation of the whole economy, with wide-ranging employment impacts. As is the case with major restructuring processes, managing the transformation by appropriate policy instruments with the involvement of the social partners will be a decisive factor in its ultimate success. It is crucial to decide how the costs of the transition will be distributed among the various actors and within society.

Bibliography

ACEA (2010) Available at: http://www.acea.be/index.php/news/news_detail/employment/

Bleischwitz, R. (2010) International economics of resource productivity – Relevance, measurement, empirical trends, innovation, resource policies, *International Economics and Economic Policy*, 7 (2–3): 227–244

Carbon Trust (2007) *EU ETS Phase II allocation: implications and lessons*, London, UK. Available at: www.carbontrust.co.uk/publications/pages/publicationdetail.aspx?id

Cedefop (2010) *Skills supply and demand in Europe*. Available at: http://www.cedefop.europa.eu/EN/Files/3052_en.pdf

CEP (2010) *Europe's emission trading system: how European taxpayers are losing out to the industry lobby*, Centre for Economic Performance, London.

Cottrell, J., R. Mander, S. Schmidt and K. Schlegelmilch (2010) *Environmental fiscal reform in Europe: research, experience and best practice*, European Economic and Employment Policy Brief, Issue 5/2010, Brussels: ETUI. Available at: http://www.etui.org/research/Media/Files/EEEPB/2010/5-2010-EEEP

Crist, E. (2007) Beyond the climate crisis: a critique of climate change discourse. *Telos* 4 (winter): 29–55. Available at: www.telospress.com

Daly, H.E. (2005) Economics in a full world, *Scientific American*, 293 (3) (September).

Degryse, C. and P. Pochet (2009) *Changer de paradigme: la justice sociale comme prérequis au développement durable*, Working Paper 2009.02, Brussels: ETUI.

Deschenes, O. (2010) *Climate policy and labor markets*, NBER Working Paper 16111, Cambridge, MA.

Economist (2009) Special report on climate change and the carbon economy (3 December), London.

EEA data service (2011) Available at: http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475

EIUG-TUC (2010) *The cumulative impact of climate change policies on UK energy intensive industries – are policies effectively focussed?* A summary report for the Energy Intensive Users Group and the Trades Union Congress, prepared by Waters Wye Associates, London. Available at: http://www.eiug.org.uk/publics/WWA%20Impact%20of%20Climate%20Change%20Policies%20EIUG%20TUC%202010723.pdf

ETUC (2010) Resolution on a Sustainable New Deal for Europe and towards Cancun. Available at: http://www.etuc.org/a/7743

European Commission (2009a) Seven measures for 2 million new EU jobs, Communication of the Commission, Brussels. Available at: http://www.euractiv.com/pdf/Draft_COM_IS_Oct2009-1%5B1%5D.pdf

European Commission (2009b) *Employment in Europe 2009*, European Commission Brussels. Available at: http://ec.europa.eu/social/main.jsp?catId=119&langId=en

European Commission (2011) *Roadmap for a resource-efficient Europe*, Brussels.

European Parliament (2009) Regulation (EC) No. 443/2009 of the European Parliament and of the Council of 23 April 2009. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0001:0015:EN:PDF

Eurostat (2010) *Sustainable development – Consumption and produc-*

tion. Available at: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Sustainable_development_-_Consumption_and_production#Resource_productivity

Gadrey, J. (2010) Adieu à la croissance: bien vivre dans un monde solidaire, les Petits matins, Alternatives économiques, Paris.

Galgóczi, B. (2010) *The harsher employment effects of a necessary paradigm shift in climate policy will need active transition management*, European Economic and Employment Policy Brief, 7/2010, Brussels: ETUI. Available at: http://www.etui.org/index.php/research/Media/Files/EEEPB/2010/7-2010

Grossman, G. and A. Krueger (1995) Economic growth and the environment, *Quarterly Journal of Economics* 110: 353–77.

IGBP (2008) *Global Carbon Project*. Available at: http://www.igbp.net/page.php?pid=500

International Energy Agency (2007) *Tracking Industrial Energy Efficiency and CO2 Emissions*.

IPCC (2007) *Climate Change 2007: Synthesis Report*. Available at: http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

Jackson, T. (2010) *Prosperity without growth*, report, Sustainable Development Commission, London.

Jänicke, M. and J. Klaus (2009) *A third industrial revolution? Solutions to the crisis of resource-intensive growth*, Berlin. Available at: http://www.polsoz.fu-berlin.de/polwiss/forschung/systeme/ffu/publikationen/2009/jaenicke_martin_jacob_klaus_2009/index.html

Jänicke, M. and R. Zieschank (2011) ETR and the environmental industry, in P. Ekins and S. Speck (eds), *Environmental tax reform (ETR). A policy for green growth*, pp. 313–339, Oxford University Press.

Krausmann, F. *et al.* (2009) Growth in global material use, GDP and population during the 20th century, *Ecological Economics*, 68: 2696–2705.

Le Cacheux, J. (2010) Towards a low carbon economy? European coordination of carbon taxation is crucial, in A. Watt and A. Botsch (eds), *After the crisis: towards a sustainable growth model*, Brussels: ETUI. Available at: http://www.etui.org/research/content/download/7604/36053/file/Jacques%20Le%20Cacheux%20After%20the%20crisis.pdf

Maier, J. (1990) *The green parties in Western Europe. A brief history, their successes and their problems*, Global Greens.

Munoz, P., S. Giljum and J. Roca (2009) The raw material equivalents of international trade, *Journal of Industrial Ecology*, 13 (6): 881–898.

Oberndorfer, U. *et al.* (2010) *Understanding the competitiveness implications of future phases of EU ETS on the industrial sectors*, ZEW, Mannheim. Available at: ftp://ftp.zew.de/pub/zew-docs/dp/dp10044.pdf

OECD (2011) *Resource productivity in the G8 and the OECD – A Report within the framework of the Kobe 3R Action Plan*, Paris.

Schepelmann, P. (2009) *A green New Deal for Europe*, Wuppertal Institute for Climate, Environment and Energy. Available at: http://www.greens-efa.org/cms/default/dokbin/302/302250.pdf

Shah, A. (2010) *Climate justice and equity*. Available at: http://www.globalissues.org/article/231/climate-justice-and-equity

Solow, R. (1974) The Economics Of Resources Or The Resources Of Economics, *The American Economic Review* (American Economic Association), 64 (2): 1–14.

Stern, N. (2006) *Review on the Economics of Climate Change*, report for the British government, London.

Steven, J., J. Davis and K. Caldeira (2010) *Consumption-based accounting of CO2 emissions*, Department of Global Ecology, Carnegie Institution of Washington, Stanford, USA.

Syndex (2009) *Climate disturbances, the new industrial policies and ways out of the crisis*, Brussels.

UNEP (2009) *Green jobs: towards decent work in a sustainable, low-carbon world*, UNEP, ILO, Geneva. Available at: www.unep.org/labour_environment/features/greenjobs.asp

UNEP (2011) *Decoupling natural resource use and environmental impacts from economic growth*, Geneva. Available at: http://www.unep.org/resourcepanel/decoupling/files/pdf/decoupling_report_english.pdf