Reframing the Problem of Climate Change

From zero sum game to win-win solutions

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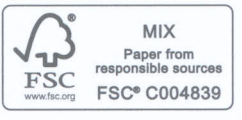

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The case of Europe

Carlo C. Jaeger, Leonidas Paroussos, Diana Mangalagiu, Roland Kupers, Antoine Mandel, and J. David Tàbara

In March 2007 the European Council committed the EU to transforming into a low carbon economy and adopted the so-called 20–20–20 targets. The EU Climate and Energy Package following the mandate commits to: 1) reduce the EU's GHG emissions by 20 per cent below 1990 levels by 2020, 2) increase renewable energy sources to 20 per cent of the EU's overall energy mix by 2020 and 3) improve energy efficiency by 20 per cent by 2020 relative to business-as-usual scenario. At that time, the EU27 also stated that if there would be a comparable international GHG mitigation effort, Europe would adopt a –30 per cent GHG mitigation target.

Meanwhile, the financial crisis of 2007–2008 has reduced the level of the European growth path by several percentage points, and as a consequence the 20 per cent reduction goal is no longer an ambitious challenge. Recently, several member states have proposed to strengthen that goal and aim for a unilateral 30 per cent reduction. In November 2011, the European parliament voted in favour of a resolution stating that a target to reduce CO_2 emissions by 30 per cent by 2020 would be 'in the interest of the future economic growth of the European Union' (European Parliament, 2010).

However, the conventional approach in assessing the impact of GHG mitigation policy on the EU's growth implies that an intensified emission reduction target would jeopardize economic growth. This debate is clearly relevant for the broader question of whether a Green Growth strategy is feasible or illusory. The authors have analysed the 30 per cent goal within this perspective (see www.newgrowthpath.eu for background material). The present contribution gives a condensed version of key findings.

Existing models

A series of climate policy assessments have been produced during the process leading to the EU20–20–20 package. These studies mainly consider two effects: the substitution of fossil fuels by renewables and the reduction of energy use by energy efficiency measures. Both effects are assumed to involve social costs in the

short run. Their only possible justification is seen in the avoidance of long-term costs from climate change. A simple linear dynamics is assumed, by which social costs increase for every additional unit of greenhouse gas avoided. As a result, the reduction of 30 per cent is seen as more costly than a reduction of 20 per cent of the GHG emissions.

The reference study on the 20 per cent target before the financial crisis (Capros et al, 2008) was commissioned by the European Commission and performed using the PRIMES[1] equilibrium model of the European energy system. It analyses the implementation of the EU20–20–20 package under various scenarios of the flexibility mechanisms associated with the emission reductions and renewable energy sources (RES) constraints, as well as the price of fossil fuels.

With this kind of model, the effects on GDP are necessarily negative. In the assessment of Capros et al (2008), they lie below one per cent of GDP.

An independent assessment (Boehringer, Rutherford and Tol, 2009) of the EU20–20–20 package has been performed in the framework of the Stanford energy modelling forum,[2] using a series of computable general equilibrium models (whose taxonomy is presented in Table 5.1).

A comparative analysis of these studies is presented in Tol (2010); key results are reported in Figure 5.1. The implementation of the package comes at a mean cost of 1.3 per cent welfare loss in 2020 through a mean carbon price of €75 per ton. If the package is implemented optimally according to the criteria of these models, the welfare loss goes down to 0.7 per cent and the carbon price to €44.

The economic crisis led to a decrease of 5 per cent of GDP in 2009 compared to 2007 in the EU27 (Eurostat, 2010). As far as GHG emissions are concerned, the fall has been even sharper. With a 9 per cent decrease of emissions, the effect of the economic recession superimposing itself on the sustained trend of decrease in emissions since 2003 (European Environment Agency (EEA), 2010). As a result, total GHG emissions in 2009 were 17 per cent below the 1990 level, almost reaching the 20 per cent target.

These major developments led to a new assessment of the EU20/20/20 package, in the process of elaborating the EU commission communication on options to move beyond 20 per cent greenhouse gas emission reductions (European Commission Staff, 2010a). This new assessment is also based on the PRIMES model (Capros et al, 2008) but uses a new baseline with macro-economic features

Table 5.1 CGE models used in the EMF study for –20% assessment

Model	*M20 impact study references*	*Link to model description*
Pace	Boehringer et al 2009a	www.transust.org/models/pace/
DART	Kretschmer et al 2009	www.narola.ifw-kiel.de/narola-models/dart/
Gemini E3	Bernard and Vielle 2009	www.gemini-e3.epfl.ch/
WorldScan	Boeters and Koornneef 2010	www.cpb.nl/eng/model/worldscan.html

Source: Capros et al (2008).

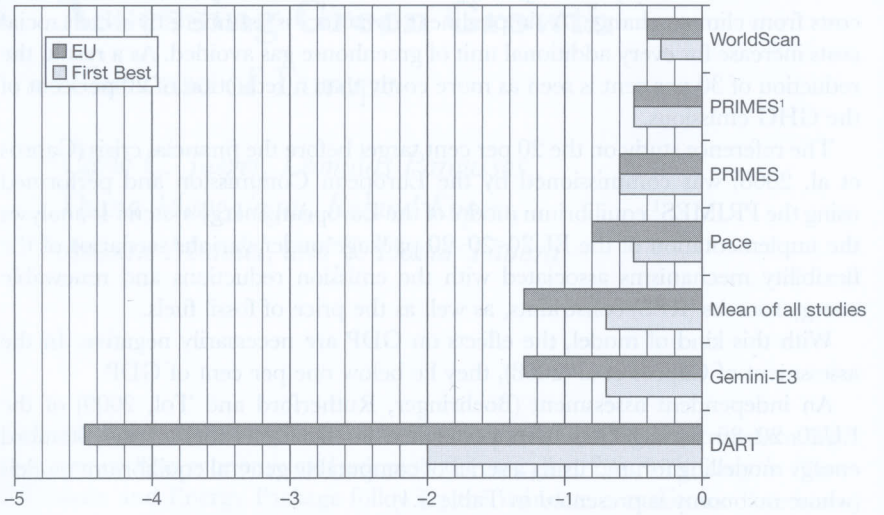

Figure 5.1 The impact of the EU20–20–20 package on welfare in 2020 for the EU27, in per cent.

Source: Tol (2010).

Table 5.2 Comparison of macro assumptions of 2007 and 2009 baselines (PRIMES, Eurosat and EC)

Relevant EU 27 drivers	*2005*	*2020 Baseline 2009*	*2020 Baseline 2007*
Population (millions)	489.2	513.8	496.4
GDP (billion $€_{2008}$)	11687	14963	16572
Crude oil import price $\$_{2008}$/barrel	59.4	88.4	66
Coal import price $\$_{2008}$/boe	14	25.8	16
Gas import price $\$_{2008}$/boe	39.7	62.1	50

Source: European Commission Staff (2010a) [Table 4].

consistent with the 'sluggish recovery' scenario of the Europe 2020 strategy (Communication from the Commission, 2010). It also takes into account up-to-date population projections (EUROPOP2008 convergence scenario from Eurostat (2010)). As Table 5.2 underlines, this new baseline assumes a GDP reduction of 10 per cent in 2020 compared to the pre-financial crisis one.

These macroeconomic developments, as well as the increase in fossil fuel prices, lower considerably the estimates of the costs of the EU20–20–20 package. According to simulations performed using the new baseline, the costs of the package come at €48bn in 2020, or 0.3 per cent of GDP.

This decrease in costs is also reflected in the evolution of the carbon price (Table 5.3), which falls to €16.5 in the ETS sector and €4 in the non-ETS sectors. The interpretation of these results is clear-cut: 'The lower economic growth forecast has made achievement of the GHG reduction targets easier' (European Commission Staff, 2010b).

The roughest estimates of the 30 per cent target can be obtained through a linear extrapolation of the results surveyed in Tol (2010). This leads to an estimate of 2 per cent GDP loss in 2020. However, such an approximation is based only on studies performed before the financial crisis.

Much more detailed results are provided in European Commission Staff (2010b) using the new 2009 baseline. The estimates of macroeconomic outcomes are summarized in Table 5.4. These estimates vary according to the assumptions made about the level at which the COP-15 pledges are implemented in the rest of the world, the access to international carbon credit markets, the modes of allocation of permits in the ETS sectors and the modes of recycling of revenues from the ETS.

The overall picture suggests a relatively mild effect on employment and GDP with a carbon price between €30 and €55. If the revenues from ETS were recycled by reducing labour costs, the 30 per cent target could create up to one million additional jobs (+0.7 per cent). Other potential benefits are the decrease of energy consumption and of imports of fossil fuels.

Table 5.3 Range of energy scenario results EU27, 2020

Internal GHG reduction vs. 1990	–20%
RES share in Gross final energy	20%
Carbon-price EU-ETS €/t CO_2	16.5
Carbon value non-ETS €/t CO_2	4
RES values energy supply €/MWh	50

Source: Capros et al (2008) [Table 7].

Table 5.4 Effects of –30% in EU27

Variable	*Lower bound*	*Upper bound*
GDP (% change from –20%)	–1.5	0.6
Employment (change from –20%)	–0.6	+0.7
Carbon price ETS (€/t CO_2)	30	55
Energy consumption (% change from –20%)	–3.5	–6.5
Renewables share in energy consumption (%)	0	22
Reduced oil and gas imports (billion €)	–9	–14

Source: European Commission Staff (2010a).

The need for enhanced models

The differences between the studies considered so far are relatively small (Kretschmer, Narita and Peterson, 2009). If the assumptions made in these studies are incorporated in the enhanced GEM-E3 model used for the present study, very similar results are obtained (check the simulation tab at www.newgrowthpath.eu for details).

However, these assumptions neglect two major economic effects and their interaction: the effect of investment on learning-by-doing, and the effect of expectations on investment. These effects are well-established on both empirical and theoretical grounds. Yet, they have been only partially implemented in existing models due to both computational and data restrictions, hence the majority of the studies focusing on the effects of GHG mitigation policies neglects these effects.

The financial crisis has shown that such neglect can no longer be justified in view of the actual dynamics of the global economy. More precisely, in the global financial crisis of 2007–2008, it became apparent that the economic models currently used to assess the course of economic systems are not good enough for situations where basic patterns of how an economy functions are modified. Such situations arise in financial crises, but also in accelerations of economic growth in emerging economies, or in the transformation of the energy system that climate policy aims to achieve.

This insight has led to an intense debate about how to further improve the modelling tools presently available for describing and understanding economic developments and policy measures. Key reference points for this debate are the various single equilibrium models that have become the standard in macroeconomic modelling. They share the assumption that the economy is characterized by a single stable equilibrium – a defining assumption for climate policy.

The resulting models perform quite well as long as only small changes over limited time spans are analysed. What the financial crisis has shown is that these models become misleading when major changes in the functioning of the economy arise.

The fundamental structure of single equilibrium models in economics is well understood. This is how it works: imagine a large number of households with identical preferences between different goods and between obtaining these goods at different moments in time. Households don't like to work but like to consume more rather than less. They can buy goods or some kind of financial asset that yields a revenue from interest. Households then decide how much to work, what goods to consume now, and how much of their income to save for future consumption. This decision is made for every point in the time span considered. At no moment in time do households regret a previous decision. They may, however, react to new events such as a change in prices induced by a carbon tax. Their preferences are such that there is only one optimal decision for any given actual and expected prices.

The savings decisions of households depend on their expectations of the future. In a single equilibrium model, these expectations must identify the relevant equilibrium. Otherwise, the modeller must assume that he or she is smarter than the people investing at Wall Street and might have a hard time answering the well-known question: 'If you're so smart, why are you not rich?', and indeed richer than any of the investors that in the model are represented as being less smart than the modeller.

Next, there is a large number of firms grouped into one or several industries. In each industry and at each moment in time, firms have some given production technology and are faced with a price for their product that they cannot change without losing their market. Under these quantities of output at which they maximize profits, the technologies are such that there is only one such quantity for any given set of prices.

The decisions of each agent can only be optimal if they are consistent with the decisions of all other agents. Otherwise a mismatch of supply and demand would arise somewhere, and at least one agent would be unable to realize his supposedly optimal decision.

This basic framework has been implemented in computer models for climate policy assessment as well as for all sorts of policy assessments, and economic analyses. The assumptions listed above have been modified in many ways, but always so as to maintain the single equilibrium property. As much data as could be obtained and used in the overall framework has been incorporated into those models, and the parameters have been chosen so as to fit that data as well as possible.

What is needed now is to stepwise improve existing models so that they represent the fact that the actual economy can and does from time to time switch from the environment of a given equilibrium to another one.

In the present study, we have undertaken three steps in this direction, starting precisely with the GEM-E3 model used by the EU for its climate policy assessments. The steps are:

- *Take into account learning-by-doing.* For this purpose, technical progress, which is exogenous in the original model, has been made dependent on the speed at which the capital stock is expanded. Because of lack of sufficiently robust data, we have not varied the learning rate to take into account the higher learning effect of new technology.
- *Take into account the effect of expectations on investment.* In the original model, the expectations of investors are calibrated on the past dynamics of the European economy. This is certainly appropriate for the business-as-usual case, and in a single equilibrium world there would be no other equilibrium to be considered. For the new growth path, we have let investors expect a higher growth than under business-as-usual.
- *Take into account the interaction of the previous effects across the economy as a whole.* With learning-by-doing and the effect of expectations on investment, the behaviour of the economy as a whole is modified. In particular, the split between insiders and outsiders on the labour market is much less serious

along the new growth path than in business-as-usual. Therefore, as a final enhancement, for the new growth path we have modified the parameter representing that split in the original model.

Developing enriched models along these lines is a major research programme that will keep many researchers busy for many years. Much more work will be needed to provide the modelling tools required to handle both the risks involved in global financial markets and the risks of climate change. The present study shows that this is a promising route. It is possible to take the mentioned critical effects into account in order to reach a more realistic assessment for Europe after the financial crisis.

Triggering investment

The starting point for a revitalization of the European economy is a substantial increase of investment. This is why an ambitious climate policy is actually a major opportunity for economic policy, too. Building wind turbines, implementing cogeneration of heat and electricity, insulating houses, modernizing the power grid, etc., all require substantial investment. If this green investment would simply displace investment in other sectors – health, education tool-making, etc. – growth would not speed up and employment would only be re-allocated between sectors, without reducing the number of unemployed. However, in the coming years green investment can be part of a broader surge of investment.

Model results show that it is possible to increase the EU climate target to 30 per cent while increasing the share of investment in GDP, which under business-as-usual would be 18 per cent, by up to 4 percentage points. This is mainly, but not only, due to investment in the built environment, which makes up the largest part of the European capital stock.

To realize the opportunity that comes with the 30 per cent reduction target requires: i) consistent policies and measures that reframe expectations in a broader framework of low-carbon growth; and ii) ensuring that the savings rate on property income – the main source of net investment – is high enough to sustain the new growth path. Mainstreaming climate concerns into the next decade of institutional reforms can decisively help the EU to enter a path of low-carbon growth in line with its broader aspirations of sustainable development (EU Sustainable Development Strategy: Commission of European Communities (CEC) (2005), European Commission (EC) (2010)).

No single measure can deliver the type of reductions that are needed to meet the 30 per cent target by 2020, therefore a combined approach is required. At present, however, there is a bewildering multitude of climate policies and measures in place. In order to get on a new growth path, it will be essential to greatly increase the coherence of, and synergies between those measures. There may well be quite a bit of red tape to be eliminated as well.

The European Environmental Agency (2010) currently cites a total of 860 policies and measures that EU countries (EU15) have officially reported to the UNFCCC as part of their effort to reduce GHG emissions. A simple analysis of this database yields the picture shown in Table 5.5.

The problem, then, is not a lack of measures, but rather the lack of an overarching thrust of those measures. This needs to be provided at the European level. However, here again the variety of policies and measures leaves room for improvement.

In order to turn this profusion of policies and measures into an effective thrust towards a new growth path, two steps will be essential. First, to declare explicitly that entering this growth path is indeed the goal of the EU. Moving from the meanwhile redundant target of 20 per cent greenhouse gas emissions reduction towards a schedule aiming at 30 per cent and at a much later stage at a virtually zero emissions economy (the 2°C target, e.g., implies that in the long run global emissions must be reduced by 85–90 per cent as compared to 1990 levels), should be an integral component of this goal setting. Simultaneously, a target of increasing European economic growth by about 0.5 per cent and decreasing the unemployment rate in Europe by at least 2 per cent should be managed as forcefully and artfully as the ECB target of an inflation rate slightly below 2 per cent.

Second, the EU needs to walk the talk, i.e. to implement measures that do establish the thrust towards the new growth path. They include both macro- and micro-economic measures:

- Macro-economic measures, e.g.:
  - using part of the ETS auctioning revenue and resources from the structural funds to support mitigation efforts in Eastern European countries;
  - incentivizing entrepreneurial investment by tax relief balanced with marginal tax increases on capital incomes used for other purposes;
  - building in low-carbon growth expectations in public procurement;
  - managing growth expectations along the lines central banks manage inflation expectations.

Table 5.5 Main focus of climate policy making

Type of measure	*Number of citations*
Economic	371
Regulatory	342
Information	182
Fiscal	119
Voluntary	80
Planning	76
Education	49
Research	39

Source: European Environmental Agency (2010).

- Micro-economic measures e.g.:
  - enhancing building codes to foster investment in energy efficiency; enhancing standards for energy efficiency in transport;
  - using part of the ETS auctioning revenue to foster energy efficiency and renewable energies;
  - standardizing smart grid infrastructures and smart household appliances;
  - creating learning networks of businesses developing innovative solutions across Europe.

Learning-by-doing

If the EU announces and implements a new growth strategy including an ambitious target for emissions reduction, it can trigger additional investments that significantly increase the share of gross investment in GDP. This additional investment induces learning-by-doing across the economy as a whole, and at an even higher rate when it comes to new technologies such as advanced construction materials, renewable energy and others.

From Wright's classical study of factors affecting the costs of airplanes (Wright, 1936) to current work on technological progress in information technology (Koh and Magee, 2006), a huge literature documents the importance of learning-by-doing. Three elements are essential here. First, even for familiar products with a long technological history such as shoes, chairs or windows, learning-by-doing is an ongoing process leading to increased labour productivity in their production. Second, for new technologies that succeed in entering a competitive market, learning rates are much higher than for well-established technologies. And third, there is no way of telling in advance whether a new technology that looks plausible at first sight will actually succeed in the market place, nor is there a way of telling how long it will take for a 'new' technology to become a 'familiar' one.

What can be confidently expected, then, is that an increase in European investment will accelerate learning-by-doing and therefore increase labour productivity and decrease unit production costs. This will happen across the whole economy, but at higher speed in sectors using new technologies that have begun to show their competitiveness. Such technologies include the use of wind energy, as well as advanced medical technology, new construction materials and information technology.

With new technologies, however, there is a danger of overconfidence: it is easy to claim that amazing cost reductions will make expensive new production processes competitive in a few decades, but it is nearly impossible to find empirical evidence for such a claim as soon as one talks about a particular technology. In the present study, therefore, we have only assumed learning rates that hold even for well-established technologies. This means that our results may well be too conservative, which we consider a virtue in the present context.

An even greater virtue, however, is to break out of the mental straightjacket that takes the modest rate of productivity increase displayed by the European economy in the recent past as the upper limit of what that economy is capable

of. If such were the case, increased investments would only lead to higher production costs and therefore to lower returns or higher inflation or both. In reality, a new growth path is possible because of a virtuous cycle that moves from higher investment to higher learning-by-doing, from there to improved expectations, and from there again to higher investment.

Clearly, there are limits to the extent to which additional investment can trigger learning-by-doing, and this in turn limits the amount of emission reductions that can be achieved in a given time span by a Green Growth strategy. Our simulations confirm that a reduction of 30 per cent in 2020 compared to 1990 levels is certainly feasible along a higher growth path than business-as-usual.

Expectation management

Additional investment induces learning-by-doing, which enables the economy to grow faster than it would have done otherwise. The faster growth in turn leads to more positive expectations for the future, which lead to further investment. This is the virtuous cycle leading to the new growth path.

However, investors are no fools: they try to correct their expectations whenever there may be a reason to do so – after all, their fortunes are at stake. This leads to the danger of volatile expectations, a major challenge for monetary policy. Indeed, monetary policy has important lessons to offer for a policy aiming at a new growth path. The first lesson is that the expectations of investors must indeed be consciously managed. If this had not been done in 2007–2008, the world would have experienced a global economic breakdown that would have dwarfed even the global crisis of 1929.

A next lesson is that expectation management starts with explicitly stating goals, loud and clear. In the case of the ECB, the main goal is an inflation rate slightly below 2 per cent. To be effective, the goal declaration must be credible. An inflation rate of 0 per cent would not be credible, because experience has shown that seriously pursuing such a goal would throw the economy into a deep depression. Nor would a rate of 6 per cent or more be credible, because again experience has shown that inflation at that rate would pose a continuous danger of turning into a runaway inflation and into major social unrest. If the EU would announce a growth target of 5 per cent for the coming years, this would not be credible, despite the fact that many countries, including European ones, at times achieve growth rates of 5 per cent and more. But for Europe as a whole, such a growth target would simply be too far away from the experience of the past decades. At the same time, if the EU were to stick to the 20 per cent emissions reduction target, it would lose credibility both as a leader and as an expression of its will to assume global responsibility. This target simply does not express a will to tackle global environmental problems.

The problem of credibility is also essential to assess the possible effects of other conceivable targets. The key problem is not to find some magic number, but to show that the EU is determined to get beyond business-as-usual. Otherwise the expectations of investors will stay focused on this perspective and neglect the

possibility of a new growth path. As a result, no additional investment would occur, and the investment needed to achieve a given target would crowd out other, economically more promising investments. There would then indeed be an additional cost to the economy as a whole rather than a win-win strategy. The growth rate would not be slightly higher than in business-as-usual, but indeed slightly lower. Of course there is no sharp threshold at which the expectations of investors would mechanically switch towards the new growth path. Much depends on how the EU will communicate its target for 2020, especially how that target will be embedded in a broader view of the growth path and the emissions trajectory the EU wants to realize.

Credibility, however, is not only a matter of announcing targets, but also of implementing them. Central banks have learned over decades that only by consistently pursuing their announced targets through a long series of decisions, can they establish a solid credibility. The same is true with a new growth path. Sticking to the target of increasing growth and investment while reducing unemployment and emissions will be essential. Public procurement, reviewing the common agricultural policy, building complex European infrastructures, research and development, etc., these are all areas where the credibility of the new growth path can be established.

The last lesson from monetary policy to be considered here concerns the global context in which European targets must be met. A credible inflation target is one that does not depend on what the US, China or global markets do. The appropriate way to pursue the target will vary greatly depending on global circumstances, but not the target itself. The same holds for the new growth path. The economic opportunities of a European 30 per cent scenario are available independently of an international post-2012 climate agreement. The simulations performed for the present study assume no international climate agreement. As a reference frame, we have taken the modest pledges made in the Copenhagen Agreement of 2009. If more ambitious goals would be pursued in the future by major economies, the positive impacts for Europe would be even larger.

By declaring its will to achieve a new growth path and then by increasing growth while reducing emissions and unemployment, Europe can find a new and influential role in the global arena of the twenty-first century. It should not be forgotten that after the global crisis of 1929, a surge of investment in Europe and elsewhere was initiated by the perspective of military armament. This successfully restarted the European economies, but with an obviously nefarious ending.

Boosting the European economy

Before the financial crisis of 2007–2008, GDP per capita was growing in Europe at a rate of slightly more than 2 per cent per year. The crisis has reduced European GDP by about 4 per cent, and there is no sign that this loss will be fully compensated anytime soon. It is likely that if Europe follows business-as-usual regional disparities in Europe will increase and average unemployment will stay high. In fact, decision-makers, investors, and the general public begin to expect

such a future. This is a dangerous development: such expectations can turn into self-fulfilling prophecies.

However, post-crisis Europe can revitalize its economy by developing a credible vision of additional investment leading to higher growth and more jobs. The challenge of building a low-carbon economy can provide that vision. In line with OECD terminology[3] we label the result as *Green Growth*. What will make the difference against business-as-usual is not simply investment in wind farms and the like, but the shared understanding that developing the quality of life that comes with a sustainable future provides plenty of avenues for mutually reinforcing investments – in education, health, entertainment, housing, transport, and much more. In this perspective, raising the European climate target from 20 per cent to 30 per cent emission reduction can open the way towards higher growth and increased employment (Figure 5.2).

The financial crisis has led to reduced emissions. However this emission reduction is not 'sustainable', since it was not the result of an economy-wide restructuring (including changes in the power mix and energy efficiency measures), but rather the result of a shrinkage of overall activity. Now the target of reducing greenhouse gas emissions by 20 per cent in 2020 as compared to 1990 is no longer challenging. It has become too weak to mobilize innovations and to stabilize political will. Sticking to that target is the equivalent of digging deeper while being stuck in a hole.

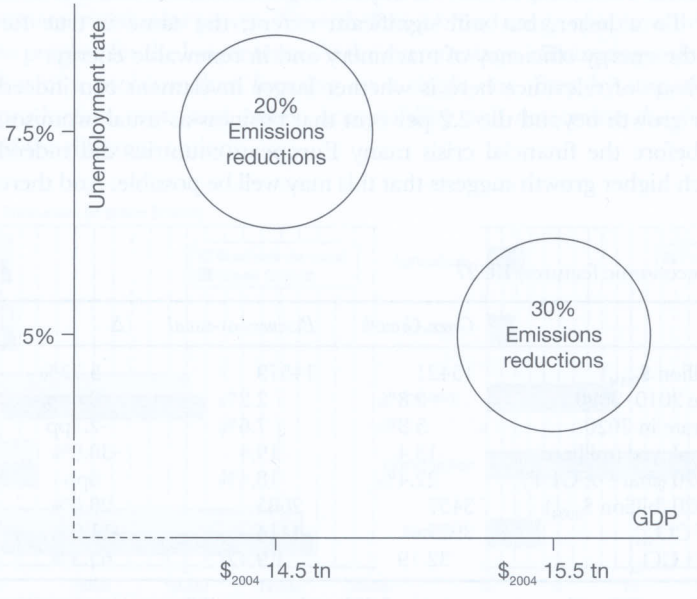

Figure 5.2 Two scenarios for Europe in 2020.

Source: Own analysis based on GEM-E3 simulations.

The question is whether in the coming decade Europe will accept the challenge of increasing economic growth while reducing both unemployment and greenhouse gas emissions. The simulations performed for the present study assume domestic reductions of 30 per cent and no international climate agreement that would go beyond the modest pledges made in the Copenhagen Agreement of 2009. If more ambitious goals would be pursued in the future by major economies, the positive impacts for Europe would be larger. Under the given assumptions, over the coming decade raising the EU's climate target from 20 per cent to 30 per cent can foster the following outcomes (Table 5.6):

- increase the growth rate of the European economy by up to 0.6 per cent per year;
- create up to 6 million additional jobs Europe-wide;
- boost European investments from 18 per cent to up to 22 per cent of GDP in 2020;
- increase European GDP in 2020 by $\$_{2009}$842bn.

There are two reasons why this may seem too good to be true. First, it is often taken for granted that GDP can only be increased with increased emissions. There are, no doubt, situations where this is true, but in Europe in the years to come, serious emission reductions imply higher growth than business-as-usual. The reason is straightforward: such reductions require a renewal of the built environment, and the built environment is by far the largest component of the overall capital stock. Therefore, its renewal implies larger investment and therefore larger growth. To a lesser, but still significant extent, the same is true for investments in the energy efficiency of machinery and in renewable energy.

The second issue of relevance here is whether larger investment can indeed generate higher growth beyond the 2.2 per cent that business-as-usual promises. The fact that before the financial crisis many European countries did indeed experience much higher growth suggests that this may well be possible. And there

Table 5.6 Macroeconomic features, EU27

	Green Growth	*Business-as-usual*	Δ
GDP in 2020 (billion $\$_{2004}$)	15421	14579	5.77%
GDP growth-rate 2010–2020	2.8%	2.2%	0.6pp
Unemployment rate in 2020	5.3%	7.6%	–2.3pp
Number of unemployed (millions)	13.4	19.4	–30.9%
Investment in 2020 (share of GDP)	22.4%	18.4%	0pp
Investment in 2020 (billion $\$_{2004}$)	3457	2685	28.8%
Emissions (Mt of CO_{2e})	3927	4414	–11.0%
Carbon Price (€/t CO_2)	32.19	19.47	65.3%

Δ: Difference 20% vs. 30% either as percentage of 20% value or as difference in percentage points (pp).

Source: Own analysis based on GEM-E3 simulations.

is ample evidence to the effect that investment induces productivity gains via learning-by-doing, especially in the case of new technologies such as renewables or new building materials.

Sectoral dynamics

Along the new growth path, all broad economic sectors – agriculture, energy, industry, construction and services – increase production (Figure 5.3). Even the energy sector gains, mainly because of the expansion of renewables. The largest relative increase – although not in absolute terms – happens in construction. The new growth path implies a major effort to retrofit buildings and enhance the built environment. This is advantageous in view of employment because people with very different vocational skills can operate in these sectors after a few months of on-the-job training. In the construction industry, nowadays, the majority of jobs is not centred around manual work – and there too, on-the-job training can be very effective.

Emissions are reduced in all sectors except construction. The emissions reductions achieved by increased energy efficiency of buildings, however, is much larger than the additional emissions from construction. Across the European economy, emissions are reduced by increasing energy efficiency and shifting from coal to renewables and gas. Energy efficiency is mainly, but not only, a matter of buildings. Over the next decade, renewables will be mainly wind, both on- and offshore. Carbon capture, photovoltaics and nuclear cannot make much of a difference over this time span, nor can other options such as geothermal or concentrated solar power. Nevertheless, a broad range of options will be important to prepare for the longer term. At the current stage, eliminating a single one is much less of a problem than focusing on a single one. Step by step, the evolution of production costs and public acceptability will determine the future prospects of the different options.

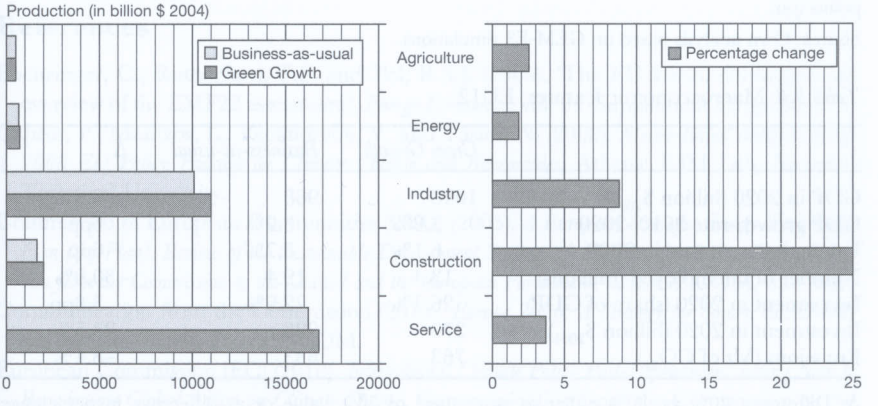

Figure 5.3 Production by sector, EU27.

Source: Own analysis based on GEM-E3 simulations.

The shift towards gas sometimes raises concerns about energy security. European imports of natural gas, however, are reasonably diversified. The largest supplier, i.e. Russia, delivers just one third of total imports. Other major suppliers are Norway, Algeria and Qatar. Moreover, Europe is a vital customer for Russia for two reasons: First, China is determined to limit dependency on energy imports. And second, the increasing extraction of shale gas in the US – with its own environmental problems – has already changed the global gas market and dented Russian market power.

While the shift from coal to gas is hardly a threat to European energy security, Eastern European countries need improved transport opportunities for gas imported into Western Europe in order to diversity their sources of natural gas from Russia. For the same reason, but also in view of the volatility of energy use, gas storage facilities need to be improved across Europe.

Regional dynamics

Not only is the new growth path quite balanced with regard to sectors, it is also remarkably balanced between old and new member states, i.e. EU15 and EU12 countries (Tables 5.7 and 5.8).

Table 5.7 Macroeconomic features, EU15

	Green Growth	*Business-as-usual*	Δ
GDP in 2020 (billion $\$_{2004}$)	14373	13594	5.7%
GDP growth-rate 2010–2020	2.7%	2.1%	6pp
Unemployment rate in 2020	5.1%	7.4%	–2.3pp
Number of unemployed (millions)	13.4	19.4	–30.9%
Investment in 2020 (share of GDP)	22.1%	18.1%	4.0pp
Investment in 2020 (billion $\$_{2004}$)	3178	2459	29.2%
Emissions (Mt of CO_{2e})	3164	3581	–11.6%

Δ: Difference 20% vs. 30% either as percentage of 20% value or as difference in percentage points (pp).

Source: Own analysis based on GEM-E3 simulations.

Table 5.8 Macroeconomic features, EU12

	Green Growth	*Business-as-usual*	Δ
GDP in 2020 (billion $\$_{2004}$)	1048	968	6.3%
GDP growth-rate 2010–2020	3.8%	3.2%	6pp
Unemployment rate in 2020	6.1%	8.7%	6pp
Number of unemployed (millions)	13.4	19.4	–30.9%
Investment in 2020 (share of GDP)	26.7%	22.9%	3.8pp
Investment in 2020 (billion $\$_{2004}$)	279	226	23.5%
Emissions (Mt of CO_{2e})	763	833	–8.4%

Δ: Difference 20% vs. 30% either as percentage of 20% value or as difference in percentage points (pp).

Source: Own analysis based on GEM-E3 simulations.

In both groups of countries, average growth rates are about 0.5 per cent larger on the new growth path than for business-as-usual. This also means that the catch-up process of the EU12 is maintained. The unemployment rate, which is somewhat higher in the EU12, decreases slightly more in this group of countries. Emissions, which are much larger in the EU15, decrease more there. Overall, it is clear that none of the two groups of countries is at a disadvantage with the new growth path.

Conclusion

With a well-designed Green Growth strategy, Europe currently has an opportunity to combine emissions reduction, economic growth and additional jobs. From a negotiation point of view, this means that there is a win-win strategy available where the key question is not how to nudge as great a burden as possible onto others while trying to keep one's own burden as small as possible, but rather how to seize and share the opportunity at hand.

Under these conditions, Europe can become a laboratory of Green Growth. In particular, if Europe reduces emissions in such a way that the new member states actually grow stronger, this will be quite important for developing countries who believe that emissions reductions inevitably are a growth impediment.

By showing that in the decade up to 2020 the vision of sustainable development can be turned into high economic growth with decreasing greenhouse gas emissions, Europe can offer a perspective for organizing the expectations of investors worldwide. This may end up being the most significant contribution of Europe to global emissions reductions.

Notes

1 See www.e3mlab.ntua.gr/manuals/PRIMsd.pdf.
2 See 3 See www.oecd.org/greengrowth.

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6 Putting people at the heart of the climate debate

Jeremy Hobbs[1]

> Now we are really confused. When the birds come we know when to plant our crops, and when to harvest. But the weather has changed and the birds are late. We have had too much rain at once and it was at the wrong time. And the last year was too hot for an extra month . . . it has ruined our crops.

The speaker, a careworn woman maybe in her thirties, lives on a farm income of less than US$2.00 per day. She was speaking at a climate hearing we had organized in Patna, Bihar, India's poorest state, in the lead up to Copenhagen, one of five hundred hearings held around the developing world, attended by one and a half million people.

They have heard testimonies of people affected by the dramatic changes in weather that are happening now; not some unknown catastrophe in the distant future, but the real impact of increased flooding, extended droughts and erratic weather patterns that destroy the livelihoods of vulnerable people. Local and national officials have been invited to hear the testimonies; in this case, it was the State Minister for Emergency Services, who deals on a regular basis with the impact of changed weather patterns in Bihar.

Another farmer spoke of how they had three years of heavy flooding in a row, and had decided reluctantly that they had to move their village to higher ground. He also explained, that local NGOs had informed them of how the climate was changing due to air pollution caused by rich countries.

Some of these farmers, amazingly, are already adapting and mitigating. Despite their poverty they are learning new farming techniques, trying different varieties or planting extra crops. They even feel they need to reduce their carbon footprint, reduce the amount of forest they cut for fuel, and move away from oil-based fertilizers. Necessity is forcing people to adapt to changes in the weather in their daily lives in order to survive.

This picture is repeated over and over in the developing world; poor communities doing their best to adapt and survive, even though their governments lack the capacity and resources to adapt to the changes on a macro level. At its worst, climate change is affecting huge numbers of people in large-scale emergencies, floods and droughts.