

Editorial

The long run

In economics and politics, the long run is no longer than ten years. In the field of climate change, on the other hand, we have to think in terms of centuries or even millennia.

The appropriate means of action are therefore those that will allow us to change our collective behaviours over the very long term. However, this is not yet the case, either for the policies that are being implemented at a global scale (the Kyoto mechanisms) or those developed in Europe (the CO₂ emission trading scheme).

The Kyoto Protocol created an institutional framework that makes it possible to introduce a carbon asset to the international market for projects. This is very significant progress compared to a situation in which there would be no international agreement on the climate. Nevertheless, the incentives that are to be offered to countries over the

period 2008-2012 will remain nothing more than symbolic unless we can quickly come up with a strict post-2012 framework. The example of Bulgaria described in this issue provides a useful illustration of the situation.

This post-2012 context must create more space for technological innovations. As the article on the geological sequestration of CO₂ points out, the wider diffusion of technological innovations is essential to address climate change. In their current configuration, the carbon markets do not provide sufficient incentives for this diffusion because the price signal has not yet been integrated into investment decisions. With a little political daring and greater resistance

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by governments to industrial interests, the European emission trading scheme could play a leading role in the process.

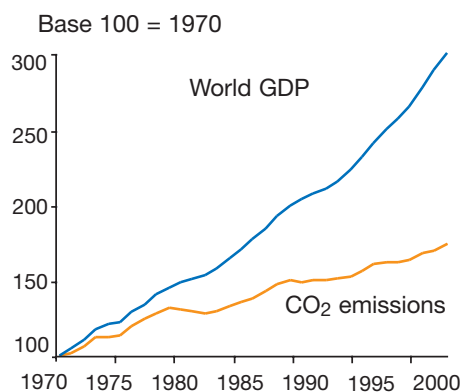
Measurements of growth over the past fifty years in fact show that an increasing number of economies have achieved relative gains by reducing the carbon intensity of their economies. This relative progress is, however, more than offset by the increase in wealth, specifically in the emerging countries. It will therefore take major breakthroughs if we want to both maintain growth and drastically reduce emissions of greenhouse gases in the future as climatologists recommend.

Patrick Criqui and Andrew A. Dessler, the two researchers we interviewed, both call for such breakthroughs. Even more, they seem to agree on the types of measures that will make it possible to reconcile short-term economic efficiency and a long-term view. That such convergent opinions are held even now by experts on both sides of the Atlantic is a very good sign.

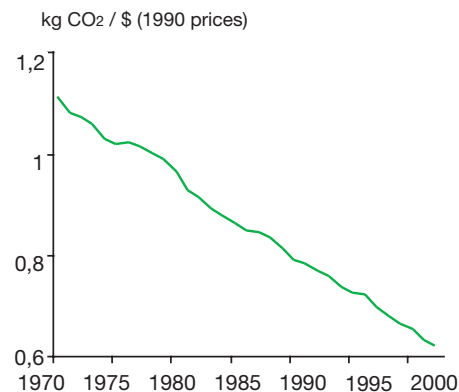
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Link between GDP and CO₂ emissions

Economic growth and emissions



Carbon intensity of the world economy



Since 1970, the wealth created worldwide has increased by a factor of three while CO₂ emissions have increased by 70%. The result is a downward trend in the carbon intensity of the economy that is not nearly sufficient to protect our societies from the risks of climate change.

How can we plan for the long term?

How can we take action today to fight against atmospheric greenhouse gases emissions, the effects of which will become apparent only over the very long term? We asked Andrew E. Dessler of Texas A&M University and Patrick Criqui of the LEPII Research Laboratory (CNRS - University of Grenoble).

Why is it important to engage now a long-term mitigation strategy?

Andrew E. Dessler : Owing to CO₂'s long atmospheric lifetime, the impacts of climate change are the result of emissions integrated over the previous several centuries. Further, the technical and economic changes needed to reduce our vulnerability to climate change are also long-term activities, on the order of several decades for new technology to be fully incorporated into our economy. Together, these two factors mean that if we want to head off possibly serious climate impacts at the end of the 21st century, we need to begin taking actions in the very near future. A good analogy is piloting a supertanker. Because of their immense size, supertankers turn very slowly. To avoid a hazard, the pilot has to begin turning the supertanker well before the hazard is actually reached. By the time the ship is upon the hazard, it's too late to avoid.

What are the principal energy stakes in the next few decades?

Patrick Criqui : Sometimes I say that to achieve sustainable energy growth, like Ulysses, we have to sail between Scylla and Charybdis. The first risk is a scarcity of cheap oil and gas resources, as evidenced these days by the threat of peak oil (and peak gas). The second risk is climate change.

But we can't count on a scarcity of oil and gas resources to solve the problem of climate change. We have abundant coal resources, and the "dash for coal" has already started. If we let this massive use of coal continue

without taking adequate precautions - i.e. without retaining the CO₂ - we are heading for a climatic catastrophe.

How would such a strategy impact the energy system?

Andrew E. Dessler : Because the energy business makes up such a large fraction of our greenhouse gas emissions, any significant emissions reductions will necessarily require a wholesale reconfiguration of how we generate and use energy. In particular, it is likely that some combination of renewable energy (solar, wind, biomass, etc.), nuclear, and carbon sequestration will have to be implemented on a large scale to meet our growing energy needs.

Note that this will occur even in the absence of any policies to address global warming — the impending exhaustion of low-cost oil and gas will in any event force us to redesign our energy systems..

Will the European CO₂ emission trading scheme change the energy equation?

Patrick Criqui: It can change the equation if it lasts, is consolidated, and most of all if it expands. The ideal would be for it to become the basis of an international system that would extend to other countries, which is why some states in the US are considering the question of "Euro-compatible" systems.

An expansion to other sectors would also be desirable. In any case, we have to find the best way to articulate the European

Union Emission Trading Scheme with other mechanisms, which are taxes and standards, either by superimposing them or by finding complementarities.

The merit of the European system is that it covers 50% of European emissions but involves a limited number of players.

I don't think there is any major flaw in the design of this system, although it needs to be refined to be more efficient. We are in fact in a transitional phase, and we have to identify the distorting effects introduced by the system to try to improve it. For example, I think we cannot get around the use of a benchmarking process for the allocation of allowances, especially in the energy sector.

Are cap and trade systems such as the European Trading System appropriate tools to favour the emergence of a low carbon emission economy over the long term?

Andrew E. Dessler: We can all agree that we need the best policy to promote the development of new low-emission, high-efficiency technology. And equally important, once a new technology is developed, the policy needs to encourage adoption of the new technology.

This latter point, often ignored, is not as easy as it sounds. It is virtually certain that new, non-emitting technologies will provide energy at costs higher than today's emissive technology (exactly how much higher, we do not yet know). It is not at all clear that publicly-trade, profit-oriented companies will adopt more expensive but socially beneficial technology on their own, particularly if their competitors do not.

A binding cap-and-trade system can play an important role in solving both of these problems. By providing a clear signal to the market that emissions reductions will occur with a well-defined schedule, cap-and-trade systems provide incentives for companies to invest the necessary large sums in research and development. In the 1980s, for example, the clear signal that regulations were inevitable provided the private sector the incen-

tives needed to develop the replacements for chlorofluorocarbons that today are helping solve the ozone-depletion problem.

Further, a cap-and-trade system also provides the necessary motivation for actors to adopt the new technology. A cap-and-trade system also allows us to achieve emissions reductions at the minimum cost by using market forces to make emissions reductions where they are cheapest.

What other mechanisms could promote the emergence of an economy that reduces its CO₂ emissions in the long term?

Patrick Criqui: Structurally, we have to establish an effective combination of two strategies: the “technology push” and the “demand pull.”

A technology push is a state-sponsored campaign to promote the emergence of new technologies: definition of priorities,

financing of research and development. It is in fact a very state-controlled solution which paradoxically corresponds to the current strategy in the United States. It is indeed “painless” for the economy and its major players (although of course it has an impact on the State finances). After controlling demand and promoting “Very Low Emissions” equipment, the three major technological options left in the fight against climate change are renewable energies, nuclear power and geological sequestration. We probably can’t rule out any of these three options.

Demand pull corresponds to the economic mechanisms of environmental policies that modify the market signals and thus behaviors. For example, even if we develop methods for carbon capture and sequestration, this technology will only be used if the players have an incentive to do so. This second line of action is particularly visible in current European policy. But we can’t forget that such a program is very ambitious from an economic and social point

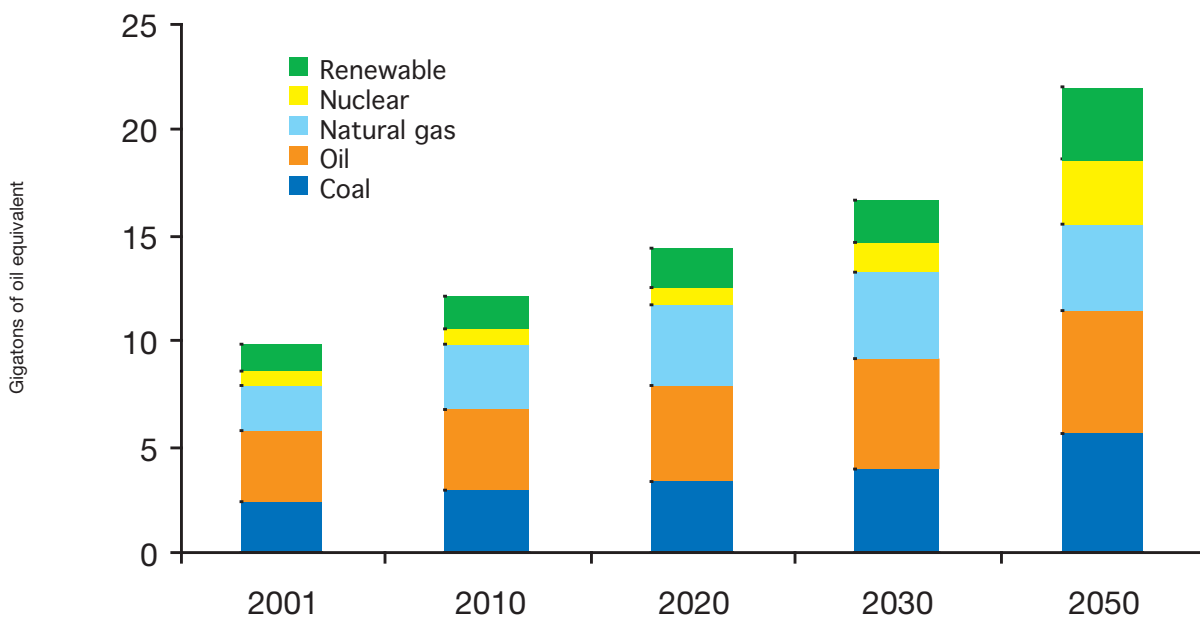
of view. When setting climatic objectives, we are confronted with a basic contradiction: what is desirable, when it comes to greenhouse gases concentrations in the atmosphere, appears difficult to attain, while what is reasonably attainable is unacceptable from the point of view of climate.

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World energy supply in a “business-as-usual” scenario



Source : POLES Model, LEPII-EPE, 2006

In 2001, 80% of world energy supplies came from primary fossil energy sources. In 2050, 70% of this supply could still be based on fossil energy, with a lower proportion from oil but a higher proportion from coal.

The carbon efficiency of the major economies

Since 1950, CO₂ emissions have increased at a slower pace than wealth creation in the industrialized economies. On the contrary, in the developing economies, emissions have increased more rapidly than wealth creation.

The carbon intensity of the economy measures the quantity of CO₂ emitted on average to produce one GDP unit. If an economy's CO₂ emissions increase at a rate slower than the GDP, this intensity decreases over time, which translates into a gain in carbon efficiency, and vice-versa.

European and US parallels, Japanese distinctiveness

In 1950, the Japanese economy had the lowest carbon intensity among the industrialized countries with discharges of 0.64 kg per dollar produced (at 1990 prices and purchasing parities). Its carbon intensity has since been reduced by 28%, thanks to progress in energy efficiency following the first oil shock. Between 1950 and 2003, reductions of carbon intensities have run in parallel in the European Union and in the United States and have fallen twice as fast as in Japan (63% and 61% respectively). As in Japan, progress was more consistent during the decade following the first oil shock, but has since flattened out. At the end of the period, the carbon intensity of the US

economy remains 50% higher than that of Japan and 60% higher than the EU of 15.

Since 1990, the reference year to which the objectives of the Kyoto Protocol are pegged, Japanese growth has stalled as the fallout of the speculative bubble bursting. Its recent revival will make it more difficult for the country to comply with its Kyoto commitments due to its relative lack of progress in the area of carbon efficiency. Over the same period, US economic growth has outpaced that of the European Union by one-third. This difference accounts for the sharper increase in the US CO₂ emissions.

The Russian case

The carbon intensity of the Russian economy increased until the late 1980s, culminating at around 2 kg per dollar of GDP. When the system of centralized planning was abandoned, this intensity dropped suddenly as many industrial combines were shut down. Since then the gains in carbon efficiency have been rapid, although the carbon intensity of the Russian economy is still much higher than that of the other countries.

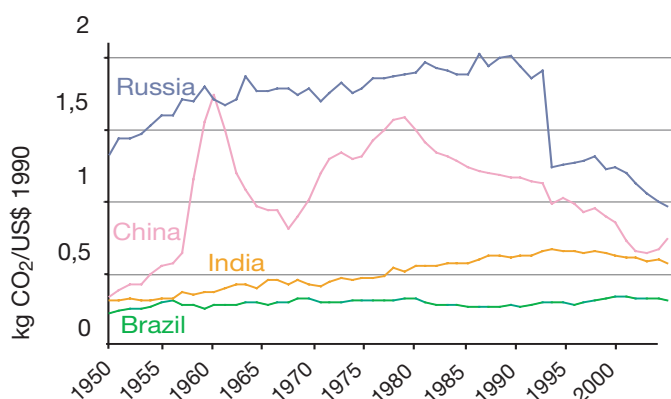
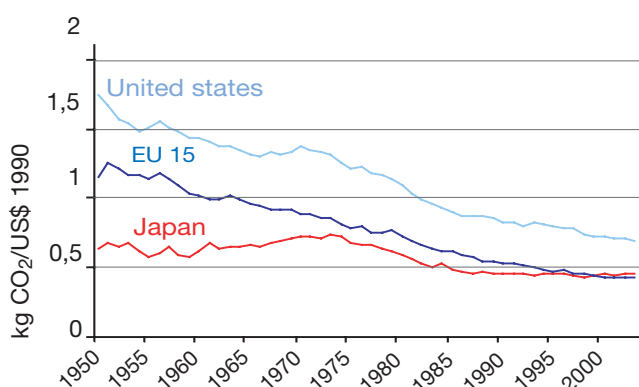
Indian and Chinese turnarounds

In 1950, Brazil, India and China had carbon intensities that were lower than those of the industrialized countries, reflecting their narrow industrial bases and the weakness of their transportation systems. Between 1950 and 2003, their emissions grew more rapidly than their GDP, which translated into increases of their carbon intensity by 36%, 88% and 133% respectively. Their respective share of global emissions also increased as they grew at a much higher rate than industrialised countries.

In Brazil, growth has been slower and kept steady at the end of the period. In India, the acceleration of growth that began in 1995 has been accompanied by a significant reduction of the production carbon intensity. India's recent dynamic growth rests on a diversified economic base that specifically includes many information services activities, which seems compatible with gains in carbon efficiency. In China, a comparable phenomenon of gains in carbon efficiency occurred. The trend started in the late 1970s, at the beginning of economic liberalization. Since 2000, there has been an increase in the carbon intensity of the economy, resulting from the rapid expansion of the country's network of fossil-fuel fired power plants and the sudden increase of automobile traffic. The overheating of the Chinese economy is the principal factor behind the country's carbon fingerprint.

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Curve of the CO₂ intensity of the major economies



In 2003, the production of one dollar of GDP (at 1990 prices and purchasing parities) resulted in the emission of 0.42 kg of CO₂ in the European Union (of 15), compared to 0.69 kg in the United States and almost 1 kg in the Russian Federation.

Burning coal without emitting CO₂?

Coal is the most CO₂-emitting energy source. Will it be possible to overcome this problem through CO₂ capture and storage?

Taking into account current costs and technologies, coal is the Number One candidate to replace oil. Thanks to very large reserves distributed throughout the world, coal can act as a link between the planned reduction in the use of oil and the increased use of renewable energy sources that will ultimately be necessary.

Largely familiar technologies

Unless we can tolerate atmospheric CO₂ concentrations that are much higher than the ceilings recommended by climatologists, coal's return to the good grace in the energy mix will be possible only if technological breakthroughs can drastically reduce its carbon footprint. That is the goal of geological sequestration, which requires the large-scale capture of the CO₂ emitted during combustion, then transporting it for storage in underground reservoirs.

Capturing carbon dioxide is not an unknown operation. It has been in use since the late 19th century. It is estimated that the current worldwide industrial demand for CO₂ is approximately 15 million tons a year. Carbon dioxide is used for example in the chemical industry, the production of dry ice and in the food industry. To that figure we must add the 30 to 40 million tons that are injected each year into oil wells, in particular in the United States and in Norway, to enhance the oil recovery. Expanding the practice of capturing CO₂ will, however, require major investments to improve processes.

Creating conditions for the widespread adoption of innovations

The injection of CO₂ into underground reservoirs poses multiple questions in terms of technology, safety and social

acceptability. It is the subject of major research programs in the United States, Europe and Japan. Several pilot projects are beginning to see daylight but they all run into the problem of financing. The first operation involving storage on an industrial scale was launched by Statoil in 1996. Each year, one million tons of CO₂ recovered from the Sleipner oil field are stored more than 1000 m under the floor of the North Sea. The operation was triggered by the Norwegian government's decision to extend the tax of 40 euros per ton of CO₂ to emissions from offshore platforms, and shows the importance of economic incentives in the adoption of innovative technologies.

Under the most favourable conditions, the geological storage of carbon dioxide

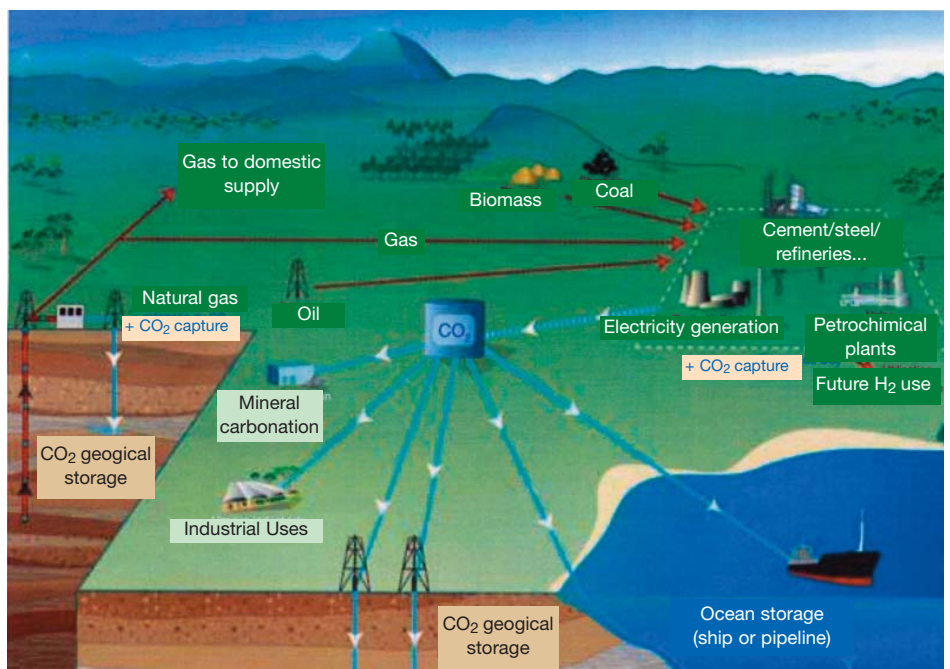
could go into commercial operation within fifteen years. To achieve that, the research programs would have to be stepped up and better coordinated, if possible. This is one of the objectives of the "Zero Emission Platform" established by the European Commission. But the most critical factor may very well be the establishment of attractive economic incentives.

Currently, geological storage cannot be counted as emission reduction, either in the framework of Kyoto Protocol project mechanisms or in the European Union Emission Trading Scheme. Integrating geological storage into future carbon financing mechanisms by issuing credits to industries that use it could be a major lever for the widespread adoption of this technological innovation. But to be efficient and effective, industries would have to be able to assess the project's rate of return and forecast a price far beyond the five-year horizon that currently defines the CO₂ markets.

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Capture and storage of carbon dioxide



Bulgaria in the European climate

On January 1, 2007, Bulgaria will join the European Union. In the matter of the climate, it must comply with the ETS directive by limiting its industrial CO₂ emissions.

A long transition

Bulgaria is representative of countries in transition that have had to revamp the organization of their production sector following the breakup of the USSR. Between 1990 and 1999, the Bulgarian GDP declined by one quarter as the result of the shutdown of a major portion of the country's heavy industry. The resumption of growth in 2000 has been insufficient for the country to catch up with its 1990 level of wealth or even to offset the loss of population. The country's population has declined by 10% since 1990.

With regard to international and European agreements on climate, Bulgaria's commitments will not be really restrictive until 2012. Under the terms of the Kyoto Protocol, the country must limit its emissions of greenhouse gases to 122 million tons of CO₂ equivalent annually between 2008 and 2012, i.e. a reduction of 8% from the 132 million tons emitted in 1988. However, because much of its heavy industry was shut down during the 1990s, emissions were reduced by one-half to around 67 Mt in 2004. The country will therefore have allowances in excess until 2012, which are colloquially called "hot air". The country will hence join the European Emission Trading Scheme (ETS) without much difficulty.

This integration of Bulgaria in the ETS will take place on January 1, 2007. By coincidence, industrial emissions are likely to increase sharply on that date as a result of the shutdown of the four units of the Kozloduy Nuclear Power Plant, which supply 12% of the country's electricity. This was required by the European Union for safety reasons. The great majority of power

generation will be shifted to thermal power plants that emit large quantities of CO₂, a process which is expected to cause a more than 6% increase in the country's greenhouse gases emissions.

The proper use of the flexibility mechanisms

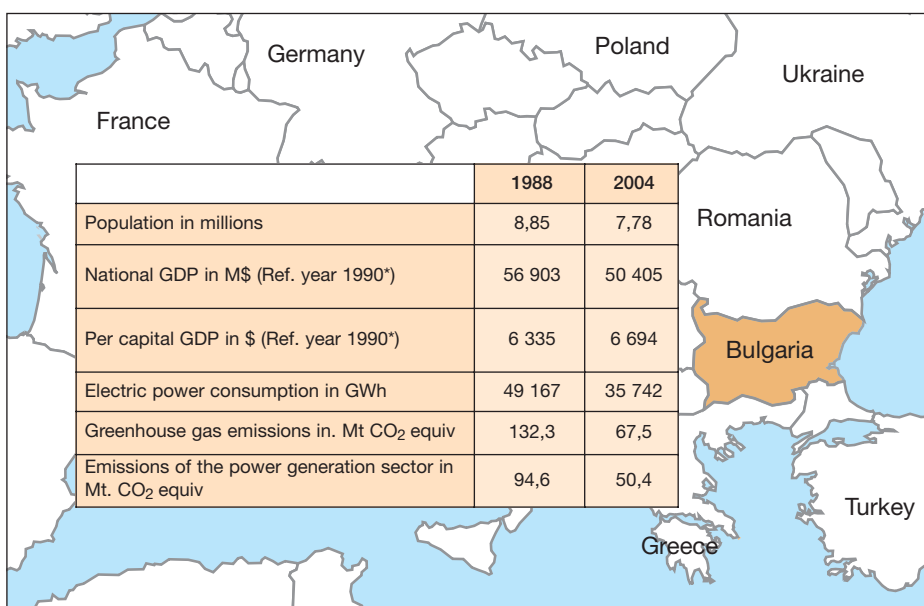
The national allocation plan, which covers 2007 plus the period 2008-2012, is based on an average 5.5% economic growth hypothesis and takes into account the changes that will occur in power generation after the nuclear plant shutdown. The allowances allocated for 2007 should cover all of the expected emissions. For Phase II of the ETS, the government plans on a 13% increase of the annual number of allowances in average compared to 2007.

That would roughly correspond to a 2% effort against a reference scenario for the installations covered by the ETS. This objective can be achieved either by increased effort at rationalizing power generation or by purchases on the market. Considering the potential for low-cost improvements in energy efficiency, it is likely that Bulgarian industries will be net sellers of allowances for the period.

The number of allowances allocated to industry will cause only a slight reduction in the inventory of "hot air", which is expected to exceed 150 Mt between 2008 and 2012. This "hot air" can either be saved for the post-2012 period or sold on the international market. It can also be used to finance emissions-reduction projects as part of the Joint Implementation (JI) mechanism in Bulgaria. The Bulgarian authorities have made a commitment to this last option with the effective registration of 17 JI projects in September 2006 which are expected to reduce emissions by 15 Mt between 2008 and 2012. This is an environmentally and economically responsible way to use some of the income derived from its «hot air» cushion.

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Bulgaria : key figures



Source : Climate Task Force from the INED, GGDC, National Inventory Report 2004
 * corrected by purchasing parities