Climate change

The Commission's view on shaping future policy

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Introduction

The UN Climate Change Conference held in Montreal in December 2005 has created renewed momentum in international action to combat climate change. The conference agreed upon the "Montreal Action Plan", which marks the start of a new global dialogue on long-term international cooperation to address climate change. This dialogue will follow two tracks. The first track starts the negotiations on the post-2012 targets under the Kyoto Protocol, underlining the European Union's and other countries commitment to the Protocol. This approach, which builds on the international approach agreed so far, will provide more certainty to EU business and the carbon market. The second track engages all Parties to the Convention (including the USA) in a new dialogue on long-term cooperative action to address climate change under the UN Framework Convention on Climate Change (UNFCCC).

The renewed momentum at international level necessarily implies that the European Union will need to define more clearly how it views the international future climate change framework, and define what its role is

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within this framework and how this role can be part of a coherent energy policy that also ensures Europe's security of supply policy, and contributes to the Lisbon agenda.

1. The climate change challenge

In 1968 US ecologist Garrett Hardin sketched the dilemma, well-known as the Tragedy of the Commons. He evoked the case of common land where everyone has the right to graze their cattle. Even if the land becomes overgrazed, people will continue to put their animals on the damaged fields and even add to their herd, said Hardin. Individuals see no point in making a sacrifice if others continue to exploit a common asset. Even if everyone is aware of the risk of abuse, the mix of personal gain, competitiveness and unregulated exploitation eventually makes the land unusable for all. Swap the common land for the Earth's atmosphere and overgrazing for greenhouse gases and you have the greatest environmental challenge of the 21st century: how to tackle climate change.

Over the 20th century, the global average temperature rose by about 0.6°C, and the mean temperature in Europe increased by more than 0.9°C. Globally, the 10 warmest years on record all occurred after 1991. Greenhouse gas concentrations are higher now than at any time in the past 450,000 years and are projected to keep rising. The overwhelming scientific consensus is that the cause is emissions of greenhouse gases from human activity. Because of lags in the climate system, past emissions will lead to an additional rise in the temperature during the 21st century, and emissions are expected to increase further in the coming decades. As a consequence, global temperatures are expected to increase by 1.4 to 5.8°C by the year 2100 (compared to 1990 temperatures) and by 2.0 to 6.3°C in Europe. To put these figures into perspective, the average temperature was only about 5°C lower during the last ice age.

The signs of climate change are already evident today. In the last few years, we have also witnessed a string of natural catastrophes across the globe. These included a continued drought in the Iberian Peninsula and the Amazon rainforest, summer floods in central and South East Europe, and the devastation wrought by Hurricane Katrina and Rita in the south of the US, to give just a few examples.

It is not possible on the basis of current science to directly link individual extreme weather events to climate change, labelling them as being 'human-induced' rather than 'natural' catastrophes. However, the nature and location of each of these catastrophes is consistent with scientific work related to the changing climate. What science does tell us is that the probability and magnitude of these events increases continually as climate change progresses. A recent report from the Association of British Insurers has monetised the direct impacts of extreme weather events such as flooding and hurricanes, demonstrating the economic consequences that such events will bring if no action is taken.

Climate change is therefore much more than just an environmental problem. In a global, long-term perspective, it will lead to major global security problems related to food, water, energy, financial markets, and geopolitical stability.

Climate change and security

FOOD: Various climate scenarios predict 40 to 160 million additional undernourished people.

WATER: With a global temperature increase of 2.5°C, approximately300 million people more will be at risk of water shortage.

ENERGY: Rising global fossil energy use will lead to increased competition for scarce resources. Increased droughts can endanger cooling water supplies for thermal power plants, as well as hydro-electrical output.

FINANCIAL MARKETS: Re-insurance companies are warning about the high economic losses due to climate impacts and the implications for their financial viability.

GEOPOLITICAL STABILITY: Additional risks of conflict due to increased pressures and competition for basic human needs such as water, food and energy.

However, climate change is not a fatality that we have to endure. In the same way that climate change is caused by human activity, mankind can manage climate change. Today, we have the knowledge, the resources, the ingenuity and the technology to tackle the problem.

Essentially, the international debate boils down to one question: What must we do to avoid a Tragedy of the Commons?

2. The European Union's objective: limit global temperature increase to 2°C

In March 2005, the European Council – the summit of EU Heads of State and Government - reaffirmed its goal that global average temperatures should not exceed 2°C above pre-industrial levels.

This goal is not just a political aspiration but is solidly based on current scientific knowledge. The work of the Intergovernmental Panel on Climate Change has shown that an average temperature rise of more than 2°C will cause a number of impacts to increase rapidly. For instance, the number of additional people at risk of water shortage would increase exponentially, from some 25 million with an increase of 1.5°C to some 300 million people with a rise of 2.5°C.

This goal is also related to analysis of costs and benefits. There is increasing scientific evidence that the benefits of limiting the global temperature increase to 2°C outweigh the costs of abatement policies. If temperatures continue to rise beyond 2°C, a more rapid and unexpected response of the climate becomes more likely, and irreversible catastrophic events may occur with higher resultant costs.

Technically, this goal needs to be translated into more operational and measurable terms, such as greenhouse gas concentrations in the atmosphere, because this can be readily correlated with actual greenhouse gas emissions. Greenhouse gas concentrations and related emissions can therefore be used as a more direct guidance for policy development. Today's greenhouse gas concentration is already over 400ppmv CO_{2eq} and rising at an average rate of 0.5% per year. Research indicates that a level of 550ppmv CO_{2eq}.offers a one in six chance of respecting the 2°C target, while if the concentration were to rise to 650ppmv CO_{2eq}, there is only a one in sixteen chance. All global projections based on a continuation of current trends show increases of the greenhouse gas concentrations above these levels.

Clearly, significant emission reductions will be required. While global emissions are likely to continue to grow in the next few decades, the 2°C

target implies that the rise will need to be slowed down and then reversed to a level in 2050 at least 15% below that of 1990.

The European Council of March 2005 emphasised the European Union's determination to explore options for a post-2012 regime. European Union leaders also stated that "*without prejudging new approaches for differentiation between Parties in a future fair and flexible framework, the EU looks forward to exploring with other Parties strategies for achieving emissions reductions and believes that, in this context reduction pathways for the group of developed countries in the order of 15 to 30% by 2020, compared to the baseline envisaged in the Kyoto Protocol […] should be considered*".

In February 2005 the Commission published its Communication '*Winning the battle against climate change*', in which it outlined the key elements of a strategy for the global Community to address the climate challenge post-2012. These elements are further elaborated in this paper, with an emphasis on how they relate to global and European energy issues.

3. The participation challenge

Firstly, only through broad participation in the global reduction effort - by all major emitters, including the US and rapidly developing countries - can we effectively tackle climate change. Projections show that, in the absence of an international climate policy, absolute emissions from the developing world will continue to increase at a much faster rate than in industrialised countries. If present trends continue, they will exceed those of the developed world within the next decade. From an economic perspective, broader participation is equally important, as many of the low-cost options for emission reductions with respect to the business-as-usual scenario are to be found in developing countries.

The Kyoto Protocol used a 20th century concept of a bipolar "North/rich-South/poor" world. This is no longer the world of the 21st century. Some countries, such as Korea, Singapore and Taiwan, have leapfrogged into highly technological societies over the last few decades, with a GDP per capita higher than some of the 25 EU Member States. Others - China and India are the most pertinent examples - are going through a rapid phase of modernisation and industrialisation. Yet another group of countries, in particular on the African continent, are still struggling to satisfy the most

basic needs of their populations.

However, most developing countries, even those with booming economies, should not – and indeed could not - take on the same commitments as the industrialised countries. Their *per capita* emissions, and their welfare level as expressed for instance in the Human Development Index, are still, in most countries, a fraction of ours. But we could design a system with different types of participation, under which countries would take on commitments that were in line with their level of economic development. This would be in accordance with the UNFCCC principle of 'common but differentiated responsibilities'.

Let us look at China, the country that, because of its sheer size and economic track record of the last two decades, is attracting most attention. Firstly, China is a country vulnerable to climate change. For example, because of the region's huge population, vanishing glaciers are expected to negatively affect the hydrological situation and water supply over the next few decades. Secondly, China is confronted with major health problems due to air pollution, whose external costs are estimated at 6-7% of its GDP. Thirdly, in terms of their energy situation, the Chinese are acutely aware of the energy security risks they are exposed to. Their energy consumption grew by 15% last year. They realise that unlimited demand growth for fossil fuels cannot be sustained. In addition, their electricity supply is plagued by numerous outages as the development of infrastructure is not able to keep pace with demand. In sum, the Chinese energy system is faced with long-term structural deficiencies that could turn out to be one of the main barriers to sustained, and sustainable, economic growth. Facing up to these multiple challenges will require cooperation with other nations and require them to make use of the most advanced energy technologies. The country has already taken several measures. The government has stated that it aims to provide 15% of its energy needs from renewable energy within 15 years - up from 7% today, and 50% more than its previously stated goal of reaching 10% by 2020.

The on-going international debate on energy, security and climate change shows that there is increasing understanding in the world community that continuing with the energy systems of the past will not be sustainable and that the multiple policy objectives related to energy are interdependent and require international cooperation to be tackled adequately. A future international climate change regime should therefore include a clear focus on creating benefits for all Parties involved. This can be done by

acknowledging efforts to reach domestic policy objectives, increasing cooperation on technological innovation, spurring foreign investment in clean technologies (for instance through the Clean Development Mechanism) and helping countries to adapt to climate change, in particular those most vulnerable to its impacts.

The Commission deemed it necessary to engage first in a real dialogue with key international partners during 2005, in order to listen to the needs of other countries, explore options and prepare the ground for a way forward in international climate negotiations. This dialogue was conducted in various international forums: under the UNFCCC, under the G8 initiative on climate change during the British Presidency, and through various bilateral partnerships on climate change between the European Union and key countries such as China, India and Russia. For instance, the EU-China Partnership on climate change and energy seeks to build the first zero-emissions fossil fuel power plant with carbon capture and storage technology on Chinese soil.

4. The innovation challenge

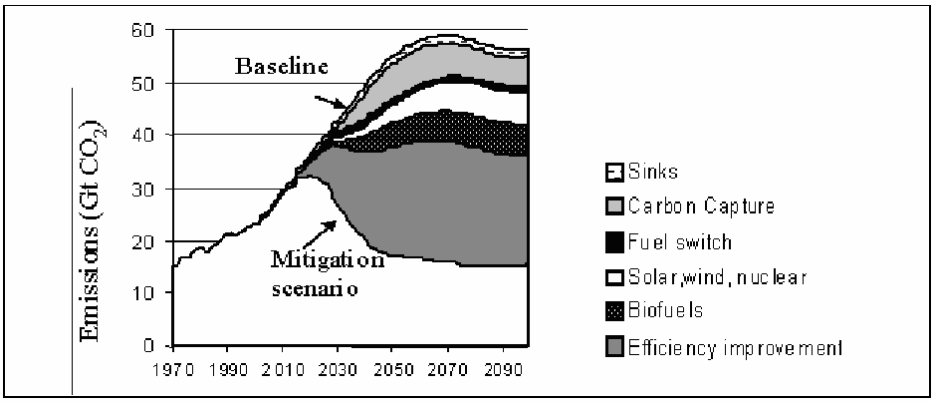
Energy projections from national and international organisations, research institutes and global energy companies forecast a very similar business-as-usual trend for future energy systems for the next decades. For instance, the International Energy Agency's 2004 World Energy Outlook paints a sobering picture of how the global energy system is likely to evolve from now until 2030. In the reference case, world energy demand - and CO2 emissions - will be approximately 60% higher than today. Global primary oil demand is projected to grow by 1.6% per year, reaching 121 mb/day in 2030. Major oil and gas importers, most OECD countries, but also India and China, will become increasingly dependent on imports from distant and often politically unstable parts of the world. Rising oil demand will have to be met by a small group of countries with large reserves.

The International Energy Agency's World Alternative Policy Scenario analyses the global impact of current environmental and energy-security policies, resulting in a faster deployment of clean and efficient technologies. While not requiring increased overall investment - it would require higher investment on the demand side, but this would be balanced out by a reduction of investment costs on the supply side - it would indeed lead to

substantial reductions in energy demand (10%), oil demand (11%), and CO2 emissions. This International Energy Agency (IEA) scenario does not include certain technological options, such as carbon capture and storage, or other major changes in the way energy is produced and used. The IEA's alternative scenario is therefore is only a first, modest attempt to start developing a new approach to energy issues, as it deals only with currently envisaged measures, and it barely takes account of the opportunities provided by alternative energy technologies.

From a technological perspective, there is a wide range of options in operation or at the pilot stage today that can indeed help meet the world's future energy needs, and at the same time follow a climate-compatible emissions pathway. These technologies are not the mainstream technologies that are fuelling today's economy, but many of them are available today. They vary greatly in terms of technological maturity, nature of innovation (incremental improvement of current technologies or 'radical' new technologies), current and projected cost, impact on energy and transport infrastructures, and impact on society. No single technological option can be considered a silver bullet that would solve the climate change problem on its own, nor is it possible to define which technologies will be most successful and what exact mix of these various technologies would work in the most cost-effective way. For this reason it would also be unwise for policy-makers to try to "pick winners", or to bet on any one single potential solution.

The European Commission has already analysed how a carbon constraint would influence the world's energy system. The penetration of new technologies is illustrated through analysis of how emission reductions will be achieved in the 550 ppmv CO2eq stabilisation scenario and for a carbon value associated with this scenario. It shows the contribution of different abatement options to the overall reduction objective. Over the whole simulation period, in particular in the first two decades, most reductions come from energy efficiency improvements. By 2030, other options start to bring major reductions at a global level, e.g. using biomass/biofuels instead of fossil fuels and solar/wind or nuclear power for power generation. Thermal generation with carbon capture and sequestration also plays an important role throughout the century under this scenario. Obviously, the actual contribution of each technological option will depend on how its costs evolve in the future as a result of technological progress, how they compare with each other, and on economic development in general.



A large number of these technologies would also enter the market in a business-as-usual scenario, anticipating the gradual depletion of fossil fuel resources, albeit at a later stage and to a lesser extent. In addition, it is worth noting that from an energy security perspective the vulnerability of the energy system is much reduced, showing that a low-carbon economy is largely synergetic with a more secure energy system. In the long term, a sustained and globally supported climate policy could have an important impact on energy prices. Energy efficiency and alternative technologies reduce demand for fossil fuels, and this in turn would lead to lower prices. In a carbon constrained world, the price of energy would obviously be a combination of an energy component and a carbon component, so the overall cost picture might be less divergent. However, this energy price structure would have some interesting features that make it more attractive, in particular:

- the sensitivity of energy prices to supply/demand imbalances could be reduced
- different distributional effects, since "carbon euros" would be paid either domestically or spread throughout the world, while most "petro-dollars" tend to be channelled towards a limited number of countries.

Energy efficiency

The above confirms the Commission's approach in giving priority to energy efficiency within the context of wider energy policy. By improving energy efficiency the European Union could save at least 20 % of its present energy consumption in a cost-effective manner by 2020, as additional costs are balanced by fuel cost savings. This also results in additional benefits related

to security of energy supply, reduction of import dependence, improvement of balance of payments, and reduced exposure to volatile fossil fuel prices. An effective energy-efficiency policy would also make a major contribution to EU competitiveness and employment.

Investments to harness these potential savings, in terms of new energy-efficient equipment and energy services, will help European business in several ways. First, reduced demand could strengthen much needed competitive forces in electricity markets and lead to lower prices. Secondly, more efficient production would make basic industries more competitive on world markets. Thirdly, it would foster competition in equipment and appliances in terms of energy performance, rather than purely on the basis of cost, where EU production is at a disadvantage due to its high labour costs.

Considerable efficiency gains can be achieved through energy conversion and end-use technologies in all sectors, i.e. the domestic, industrial and services sectors, as well as in the transport sector. While many of the technologies are commercially available, they are still niche markets. There are also market barriers that prevent their more rapid use in the end-use sector, such as lack of awareness and information, and the nature of the market in which they operate. In terms of energy conversion, alternative technologies increase the thermal efficiencies of the conversion process or make use of the waste heat. Examples of appropriate technologies in the end-use sector are abundantly available in building design (e.g. low- or zero-emission buildings, energy management systems), domestic equipment (e.g. reduction of stand-by losses, more efficient boilers, efficient light-bulbs), industrial equipment (e.g. electric motor systems), and the various transport modes.

The possibilities for further improvement of current technologies are by no means exhausted. For instance, notwithstanding the improvements in the fuel economy of passenger cars in the past 30 years, the large-scale introduction of hybrid cars (with a CO_2 emission performance per km up to 40% to 50% lower than today's conventional engines) could become reality within a decade.

Renewable energy technologies

The resource base of renewable energy (covering wind, hydro, solar, biomass, tidal, wave, and geothermal energy) is very large for each of the

resources, and exceeds by far world energy demand. Most of the technologies that use a renewable resource base are technologically viable and many are technically well proven. Some, such as hydro, wind, and some forms of biomass, have reached or are reaching the stage of competitiveness with conventional energy sources. For these technologies, commercial and market barriers are the main obstacles. For others the cost is high relative to conventional energy sources, but still offers significant potential for technological improvement and cost reduction through R&D, investment and operating experience. Extensive scientific literature on learning curves indicates that cost-effectiveness will improve over time with sufficient penetration. A major effort will be required by industry and the research community over the next 25 years to turn more renewable resources into mainstream technology. Europe's track record and leading position (for instance number one in wind turbines and number two in solar photovoltaic after Japan) must be maintained at a time when the potential of renewable energy is starting to be acknowledged across the globe.

Carbon capture and storage

Carbon capture and storage technologies should allow fossil fuels to be used in a way that makes them virtually carbon-free. This would allow considerable CO2 savings and 'buy time' if alternative solutions prove to be less effective, or more costly. It could prolong the life time of fossil-fuel-based technologies and smooth the transition to low-carbon technologies. In Europe, several private sector initiatives applying this technology are now on the drawing board.

The Commission recently established a Technology Platform on zero-emission fossil-fuel power plants so as to bring together key industrial players and foster a coordinated approach. In addition it is setting up a specific Working Group with stakeholders from industry, academia, NGOs and Member States under the Second European Climate Change Programme. Its objective is to explore the options for creating an enabling regulatory framework for the safe and secure application of this technology.

Although there is considerable uncertainty concerning the potential of a number of carbon storage media, storage capacity available worldwide is certainly very substantial. This provides a new option for those countries, such as China, the US, Poland, South Africa and Australia, that view domestic coal as providing strategic energy security or as an important local industrial activity. It would also widen the low-carbon options for

producing hydrogen through pre-combustion processes of fossil fuels. The basic technology is already in use for other purposes, such as enhanced oil recovery. Cost estimates range from only a few €/tonne CO2 for 'early opportunity' applications (e.g. involving enhanced oil recovery, pure CO2 streams in upstream oil and gas) up to €80/tonne of CO2. Cost estimates vary widely depending mainly on transport distance, the purity of the gas stream (e.g. pre- or post-combustion) and the location and nature of the storage medium.

5. A policy to induce technological change towards a low-carbon economy

The Commission sees no contradiction between promoting technological solutions to climate change and the need for a strong policy framework. In fact both approaches are fully complementary. To give an example, a technology like carbon capture and storage can be developed and demonstrated through an R&D policy, but it is highly unlikely that the technology would become mainstream unless the investor is rewarded for the emissions reductions, since its only advantage is the avoidance of CO_2 emissions. The cheapest and most flexible way to do this is to implement market mechanisms, such as emissions trading, which pull new technologies onto the market by allowing companies to profit from such investment. Another example is the wind turbine industry. It would not have produced its current state of the art multi-MW machines if a number of pro-active countries in the European Union, such as Denmark, Germany and Spain, had not implemented ambitious support schemes to accelerate the deployment of wind energy.

The Commission is therefore determined to continue developing this twin-track 'technology push/market pull' approach.

Pushing technological change

Currently, the challenge that energy systems are facing is not reflected in the level of R&D resources deployed by governments or the private sector. Since the first and second oil shocks (1973 and 1979-80), government R&D efforts have been steadily declining in this area. While the first EU Framework Programme for R&D spent approximately 50% of its budget on energy and transport R&D, this was reduced to less than 18% in the current

Sixth Framework Programme. This trend needs to be reversed if the European Union wants to lead in low-carbon technologies and improve its competitiveness in these key markets.

The current budgetary constraints at European level will require us to be more imaginative and creative to find more effective, cost-effective and innovative ways to spur R&D and demonstration projects. This can also include stronger private sector involvement. Technology platforms and Joint Technology Initiatives are new instruments emerging in the planned Seventh Framework Programme that should be exploited. It should also be investigated whether venture capital for low-carbon technology investments could be supported through public-private partnerships.

International cooperation on R&D and deployment of new technologies can also enhance the effectiveness of technological innovation policies. The European Union is participating in the International Partnership for a Hydrogen Economy and the Carbon Sequestration Leadership Forum, both initiated by the US. The Gleneagles Plan of Action, the Asia Pacific Partnership on Clean Development and Climate, as well as the EU-China Partnership on Climate Change and the EU-India Initiative on Clean Development and Climate Change, are further examples of international and bilateral cooperation to foster more climate-friendly technologies.

Pulling technological change through market instruments

Establishing a market value for greenhouse gases, for instance through emissions trading or taxation, provides a financial incentive for curbing demand, promoting the widespread use of such technologies and encouraging further technological development. The European Union Emissions Trading Scheme (ETS) represents a departure from traditional environmental legislation. Governments set the environmental goal but then stand back and let business decide through its daily operations where emissions will be reduced and how. The ETS has broken new ground as the first international emissions trading system and the largest ever in economic coverage. With the scheme, the European Union has also created a new currency: emission allowances. It is still early days but the financial potential of the market in the future could be significant: the estimated 260 million allowances traded in 2005 have a value of about €5.4 billion.

The Kyoto Protocol's project-based flexible mechanisms - the Clean Development Mechanism (CDM) and Joint Implementation (JI) - represent

a second important type of market-based instrument. On the basis of current data, EU Member States are expected to purchase over 500 million emission credits over the five years of the 2008-2012 Kyoto commitment period, representing a market value of some €2.5 billion at current prices. The total investments in clean technology that are generating these credits are much higher.

The Commission is convinced that such market mechanisms, while still limited in size today, must be at the core of a successful long-term response to climate change. In implementing the emissions trading scheme, the European Union has created the nucleus from which an international carbon market can grow over time.

In addition, policies need to encourage the adoption of new technologies and promote their early deployment. Such policies are particularly suited to helping overcome the barriers to market penetration that new technologies encounter at an early stage of commercialisation. The European experience shows that active support policies helped radically to reduce unit costs of producing electricity from renewable energy sources in the years 1980-1995: by -65 % for photovoltaics, -82 % for wind power and -85 % for electricity from biomass. Such efforts must continue at accelerated speed for these sources to become fully competitive. In addition, policies should exploit possible co-benefits, for instance in terms of air quality or urban transport.

These policies should take advantage of normal capital replacement cycles. Gradual transformation will require a stable, long-term policy framework. Given the need for the renewal and expansion of the global capital stock in the electricity industry in the coming three decades, such a framework needs to be established as early as possible. Such opportunities cannot be missed as investments in the power sector, industry, transport infrastructure or buildings will determine CO2 emissions for several decades ahead. In Europe alone around 700 GW of electricity generation (equivalent to the currently installed capacity) needs to be installed. Planning for these decisions is being done some 5 to 10 years ahead and must be based on the necessities of long-term climate policies.

6. Conclusion

Over the past decade, and following the Kyoto Protocol negotiations in 1997, the European Union has established a coherent framework for tackling climate change. The policy challenges ahead are twofold. First, we need to build on the most successful elements, in particular the ETS and the energy efficiency improvements achieved in industry and transport. Second, we have to undertake intensive efforts to broaden the number of nations around the world that are developing effective climate change policies. Only then can the global problem of climate change get a global policy solution.