European Climate Platform (ECP)

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LOW-CARBON TECHNOLOGIES IN THE POST-BALI PERIOD:

ACCELERATING THEIR DEVELOPMENT AND DEPLOYMENT

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Based on discussions at the ECP seminar on
Strategic Aspects of Technology for the UNFCCC and
Climate Change Debate: The Post-Bali Technology Agenda
3 October 2007, Brussels.

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About this report

This report is based on a background study and seminar on Strategic Aspects of Technology for the UNFCCC and Climate Change Debate: The Post-Bali Technology Agenda, organised under the auspices of the European Climate Platform (ECP), which is a joint initiative of CLIPORE (Climate Policy Research Programme) and CEPS. The seminar was co-chaired by Frank Convery, Heritage Trust Professor of Environmental Policy at University College Dublin, and Bo Kjellén, Senior Research Fellow at the Stockholm Environment Institute and former Swedish Chief Climate Change Negotiator. For further information on the ECP, please see the back cover of this report or visit: http://www.ceps.be/Article.php?article_id=484.

The report will be presented at the thirteenth session of the Conference of the Parties to the Climate Change Convention and the third Meeting of the Parties to the Kyoto Protocol (COP13/MOP 3) in Bali on 7 December 2007. It examines how the global climate regime might move forward on cooperative action on technology.

A list of the participants in the seminar can be found in the Annex.

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Executive Summary and Recommendations

This report analyses the very broad issue of technology development, demonstration and diffusion with a view to identifying the key elements of a complementary global technology track in the post-2012 framework to be discussed at the 13th session of the Conference of the Parties to the Climate Change Convention and the 3rd Meeting of the Parties to the Kyoto Protocol (COP13/MOP 3) in Bali in December 2007 and beyond. It identifies a number of immediate and concrete steps that could be taken to provide content and a structure for such a track.

After three introductory sections dealing with innovation and technology, investment in developing countries and investment and finance, the report briefly describes and analyses the various initiatives being taken on technology both within and outside the United Nations Framework Convention on Climate Change (UNFCCC). Section 8 presents ideas for the way forward followed by brief concluding remarks. This Executive Summary highlights the key messages and recommendations.

I. Key Messages

1. Domestic responses will remain the backbone of technology policy for addressing climate change. More and more countries are interested in creating a framework where innovation for climate change technologies flourishes, as this offers the best prospect of a competitive edge, technological leadership, export markets and employment opportunities. International collaboration will be crucial, however, in order to achieve the necessary scale, to pool resources, provide financing, encourage investment and speed-up knowledge-sharing.
2. Although technology development and diffusion are basically matters for companies, government help is needed in support of: i) basic research, mostly done by academic institutions; ii) component testing in test facilities and laboratories; and iii) full-scale demonstration, which is an important prerequisite for market push. Other forms of government support include: i) the deployment of energy-efficient technologies in the domestic and transport sectors (e.g. buildings and cars) and ii) consumer behaviour (i.e. lifestyle changes). Government policies in such areas as emissions trading, taxation, regulation or negotiated agreements are central to ensure that carbon has a value and that hitherto ‘unprofitable’ technologies become ‘profitable’.
3. Technology plays a fundamental role in advancing efforts to address climate change on three fronts:
   - accelerating the deployment of existing low-carbon technologies, both to bring down the costs of technologies and to reduce emissions, which requires more ambitious government policies;
   - developing and deploying new breakthrough technologies for the longer-term (beyond 2030), which requires stepping up the speed and scale of innovation; and

- avoiding, at the same time, the locking-in of high-carbon technologies in developing countries, i.e. estimating the incremental costs of making future (energy) investments in developing countries and emerging economies low carbon and paying for them, which require dealing with equity issues, and among other, financial transfers.

This report mainly deals with the second front.

4. To accelerate innovation strategies and finance mechanisms that support the *rapid* development and deployment of promising technologies – such as CO_2 capture and storage, biomass and biotechnology, renewables and end-use energy technologies or hydrogen systems – may require separate and cooperative, technology-specific research, development and deployment at a global level. The reason for such a complementary track, as recognised in studies such as the Stern report, is that pricing strategies through cap and trade *alone* will not be sufficient to provide long-term incentives for all the breakthrough technology development and deployment needed for stabilisation of emissions. Therefore, these additional technology activities are needed to focus on increasing the scale, the removal of barriers, finance and policy responses for key climate change technologies. Such a global effort could be accomplished through the creation of a 'Consultative Group on Climate Innovation', a concept that has proven to be successful in other fields, for example agriculture and health. Donors such as the Gates Foundation, the World Bank and national governments have pioneered the application of these bottom-up 'distributed innovation' strategies to product development. A Consultative Group on Climate Innovation could possibly facilitate international collaboration on the development of low-cost, zero-carbon technologies and the exchange of information about clean energy technologies. The proposals for an International Energy Efficiency Platform or a Sustainable Buildings Network point in this direction. Many countries have already undertaken long-term technology mapping, illustrated most recently by the EU's Strategic Energy Technology Plan.

5. While there are initiatives within the UNFCCC, such as the Expert Group on Technology Transfer (EGTT), the Clean Development Mechanism (CDM) or various initiatives on capacity-building, many additional and promising initiatives for the rapid development and deployment of technology have developed more recently outside the UN framework, such as the G8+5 process (involving the G8 countries plus the five emerging economies of China, Brazil, India, Mexico and South Africa), the Asia-Pacific Partnership on Clean Development and Climate (APP) and bilateral partnerships. Since the codification of these initiatives in the UNFCCC would take time, it may be better to improve cooperation and coordination between the initiatives, possibly within the UNFCCC secretariat. These additional technology measures seem especially important if developing countries such as China and India remain outside the cap and trade framework – more creative technology transfer and deployment measures will be essential if they are to reduce their emissions.

6. Lessons for climate change from the Montreal Protocol on the phase-out of ozone-depleting substances should not be forgotten. These include: i) the fact that national governments assumed a central role in coordinating and facilitating effective national responses, ii) the benefits of developing a basket of technologies able to replace ozone-depleting substances, iii) the need for funding and iv) the importance of capacity-building in developing countries. Moreover, the UNFCCC and its Parties could make use of existing expertise and focal points on technology set up under the Montreal Protocol. This report did not address the issue of funding in detail but it recognises that funding will constitute a major issue. Funding will only follow if the structures are properly in place to make efficient use of finances.

7. There are a number of promising and profitable technologies, mainly but not only end-use energy efficiency technologies. Their diffusion would appear to be a natural priority. This could be done either within the UNFCCC or outside, as is currently mostly the case. The CDM or possible new post-2012 mechanisms could also be a vehicle for sector-based projects for technology transfer in developing countries, particularly if the terms of project eligibility and administrative efficiency are improved.
8. In parallel, existing measures and mechanisms – such as the Expert Group on Technology Transfer, the Global Environmental Facility (GEF), the Clean Development Mechanism (CDM) and Joint Implementation (JI) within the UNFCCC and the Kyoto Protocol – should continue to be improved. There is special merit to practical initiatives such as data collection, the setting up of monitoring, reporting and verification, developing technology benchmarks and best-practices or generally assessing abatement potentials and costs or long-term technology roadmaps, whether they are taken in the context of sectoral approaches for industry, the APP or national initiatives. Such initiatives can form the backbone for the complementary technology track, since there is at present no international forum or structure for the discussion and deployment of cooperative climate technology innovation strategies and policies. However, a post-2012 agreement, it will be critical to set firm reduction commitments in order to give carbon a value. Without such a value, market signals will remain insufficient to provide incentives to trigger the massive investment in low-carbon technologies. But even with such signals, additional technology-specific approaches and policies will be needed to stabilise emissions through massive technology innovation and deployment over the longer term.

II. Recommendations

Based on the above key messages and analysis in the principal report, we propose the following recommendations:

1. Parties to the UNFCCC and the Kyoto Protocol must provide or continue to provide leadership in developing effective *domestic* responses to climate change technology challenge, including an efficient business environment in which investment can flourish.
2. As new technologies will be rapidly needed on an unprecedented scale, there should be more focus on technology-specific research, development and deployment both domestically and internationally to drive development, finance and necessary policy frameworks to facilitate low-carbon technologies.
3. The COP/MOP in Bali should consider in a complementary technology track the need for a global initiative on technology-specific research, development and deployment through the establishment of a body such as a Consultative Group on Climate Innovation to facilitate international collaboration on the development of low-cost, zero-carbon technologies and the exchange of information about clean energy technologies.
4. At the same time, the global community must continue to address the issue of estimating the incremental costs of making future (energy) investments in developing countries and emerging economies low carbon – to avoid lock-in – and most importantly, to identify strategies for financing these investments.
5. Among others, the following elements should be included in the complementary technology track:
    - rapid agreement within the UN negotiations or another framework (e.g. G8+5) on measures to speed up diffusion of existing ‘profitable’ technologies, such as in buildings or appliances;

- bundling the UNFCCC initiatives on technology, namely the Expert Group on Technology Transfer (EGTT), the Clean Development Mechanism (CDM) and capacity building;
- applying technology innovation lessons from other fields to climate technology innovation and acceleration through global cooperation, product development and cooperative policy development and the adoption of joint standards for specific technologies in the power and transportation sectors;
- accelerating capacity-building measures for developing countries, while using the existing infrastructure on technology needs and technology transfer under the Montreal Protocol;
- developing the creation of a sectoral and/or programmatic CDM, or additional post-2012 mechanisms, with a technology-transfer component;
- improving the coordination and cooperation between UNFCCC measures and those undertaken in other fora such as the G8+5, Asia-Pacific Partnership (APP) on Clean Development and Climate and the Major Emitters Meetings;
- setting up a process to remove trade and investment barriers to climate change technology transfer; and
- facilitating actions that will improve data and information that are relevant for technology development and diffusion, such as data collection, monitoring, reporting and verification; technology benchmarks and best-practices; further work to assess abatement potentials and costs or long-term technology roadmaps, whether within sectoral industry approaches, the APP, the Ad Hoc Working Group on Further Commitments (AWG) or national initiatives.

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1. Introduction

While there are different opinions on whether the stabilisation of GHG (greenhouse gas) emissions in accordance with the UNFCCC's objective can be reached with technically proven technology,[1] the assertion that there is a need to develop new and technically unproven (i.e. breakthrough) technologies in the long term, and certainly beyond 2050, is uncontroversial. Unless a silver-bullet solution for reducing emissions can be found, a portfolio of different promising technologies will be needed. Among these, wind, solar and biofuels are growing rapidly, albeit from a small base. Other technologies, such as hydrogen, are thought to hold promise, but they face substantial challenges in terms of cost and large-scale implementation. As fossil fuels are expected to dominate the world's energy supply portfolio for several decades, carbon capture and storage (CCS) may become an important bridge before we enter into a low-carbon future. Over and above technical hurdles, the scale of the task means that widespread global deployment of technologies, however promising, will take decades before the cumulative effect of investments makes a substantive contribution to combating climate change. Such massive technological change depends on the right combination of public R&D investments ('technology push') and policies to provide economic incentives for private-sector innovation and widespread technology deployment ('market pull').

A global climate change agreement can have a strong bearing on the full spectrum of the process of technological change. For example, commitments to GHG abatement policies are the source of market-pull signals that encourage innovation and deployment of low- and near-zero carbon technologies. Commitments to R&D efforts represent an option for enhancing and coordinating technology-push policies, basically on three levels: i) support for basic research, mostly done by academic institutions; ii) component-testing in test facilities and laboratories and iii) full-scale demonstration, which is an important pre-requisite for market push. Given the primacy of technological progress in tackling climate problems, a principal question for negotiators is how a global agreement would affect technology development and diffusion.

2. Accelerating innovation[2]

In the case of climate change, twin market failures are at play, inhibiting the emergence of sufficient incentive to produce technological solutions on their own.[3] The most immediately relevant market failure is the fact that the cost of global warming is not borne directly by GHG emitters, which leads to fossil-fuel prices that are 'too cheap' and a level of GHG emissions that is too high from a societal perspective. The economist's policy prescription is to 'put a price' on

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[1] Pacala & Socolow (2004) and IPCC (2001) argue that the climate problem for the next 50 years could be solved with current technologies whereas Hoffert et al. (2002) hold that new and revolutionary technologies would be needed.

[2] This section is a slightly revised version of Fischer and Egenhofer (2007), while also drawing on Brewer (2007a).

[3] This section draws on the summary in de Coninck et al. (2007).

GHG emissions – for example through a GHG tax or cap-and-trade system – thereby forcing individuals and firms to internalise the cost that they are placing on everyone else when they emit GHGs. Second, there also are market deficiencies related to the development and adoption of new technologies. These technology market problems are not as relevant for environmental problems addressed over the course of years as they are for climate policy developing over decades or centuries and requiring much more dramatic changes in technology. Jaffe et al. (2005) identify relevant types of technology market imperfections, as summarised below.[4]

- First, due to 'knowledge spillovers', innovating firms cannot keep other firms from also benefiting from their new knowledge and, therefore, cannot capture for themselves all the benefits of innovation. In addition, the process of competition typically will drive a firm to sell a new device at a price that captures only a portion of its full value. While patents and other institutions are employed to protect firms' investments in innovation, such protection is inherently imperfect.[5]
- Second, 'adoption spillovers' may be relevant in the adoption and diffusion of new technology. For a number of reasons, the cost or value of a new technology to one user may depend on how many other users have adopted the technology. In general, users will be better off the more other people use the same technology, so there is a benefit associated with the overall scale of technology adoption ('network externalities'). The supply-side counterpart, learning-by-doing, describes how production costs tend to fall as manufacturers gain production experience. If this learning spills over to benefit other manufacturers without compensation, it can represent an additional adoption externality. Finally, network externalities exist if a product becomes technologically more valuable to an individual user as other users adopt a compatible product (as with telephone and computer networks). These phenomena can be critical to understanding the existing technological system, forecasting how that system might evolve and predicting the potential effect of some policy or event.
- Third, market shortcomings arise through incomplete information. While all investment is accompanied by uncertainty, the uncertainty associated with the return on investment in innovation is often particularly large. Potential returns are also asymmetrically distributed, and the developer of new technology typically is in a better position to assess its potential than others and may find investors sceptical about promised returns. In the context of environmental problems such as climate change, the huge uncertainties surrounding the future effects of climate change and the magnitude of the policy response and, thus, the likely returns to R&D investment, exacerbates this problem. Another type of information problem relates to the inability of current policy-makers to credibly commit to a long-term emissions path. As a result, the long-term price signal associated with GHG reductions is likely to be significantly diminished relative to what it would need to be in order to achieve significant future reductions.
- Finally, incomplete information lies at the source of principal-agent problems, as when a builder or landlord chooses the level of investment in energy efficiency in a building but the energy bills are paid by a later purchaser or a tenant.

The fact that markets under-invest in new technology (Jaffe et al., 2005) strengthens the case for making sure that environmental policy is designed to foster, rather than inhibit innovation. In

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[4] See Jaffe et al. (2003) for an overview of issues at the interface of environmental policy and technological change.

[5] An opposing incentive of conferring monopoly rights to an innovator may induce over-investment in redundant research efforts, as firms race to get the patent.

cases where environmental costs have not been fully priced, it also is likely that the rate of investment in such technology is significantly below the socially desirable level. And it is unlikely that environmental policy alone can create sufficient incentives.

According to basic economic principles, sound policy-making requires at least as many types of policy instruments as there are market problems to be addressed (Tinbergen, 1956). Hence, the optimal set of climate policies also likely includes instruments explicitly designed to foster innovation, and possibly technology diffusion, in addition to GHG emissions policies that stimulate new technology as a side effect of internalising the GHG externality. Likewise, long-term technology R&D alone is not sufficient because it provides no direct incentives for the adoption of new technologies and because it focuses on the longer term, missing near-term opportunities for cost-effective emissions reductions (Philibert, 2003; Sandén & Azar, 2005; Fischer & Newell, 2004).[6]

3. Technology and developing countries

Arguably, the producers of new technologies are in most cases industrialised countries, although more and more developing countries, especially emerging economies, are developing advanced technologies (Brewer, 2007b). Long-term success requires that effective R&D and emissions policies are in place. In developed countries, that policy strategy will most effectively be a mix of largely market-based measures to overcome the market failures and smart public investments. However, the consumers of climate-friendly technologies will be all countries, including developing and transition economies. In these countries, poverty, limited institutional capacity, governance problems and other issues loom larger as barriers than the preceding market failures. Under these circumstances, it is naïve to expect the aforementioned market-based strategies for emissions reductions and innovation to generate the same results. There is a particular value of information exchange systems: not only do they contribute to accelerated technology deployment, but also in their ability to increase awareness of climate change and low-carbon technology solutions. They may also contribute to the enhancement of endogenous capacities and technologies in developing countries. For LDCs, access to technologies is a key issue, while for some fast-growing developing countries, concessional finance is needed for wider technology cooperation.

4. Investment and finance

In a strategy to stabilise CO_2 at about 450 ppm in the low-carbon scenario, the World Bank has identified an investment need for non-OECD countries of around \$165 billion p.a. for electricity generation with current private and public sector resources funding each around half.[7] To fill that gap, three sources of funding for mitigation are available: i) voluntary actions, ii) international grants, e.g. GEF and iii) carbon trading. Carbon trade is likely to confer the biggest flow of funds to developing countries – between \$20 billion and \$120 billion per year, but

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[6] In addition to setting the proper stage for private investment, governments also have their own investments to manage. Public infrastructure is particularly important, as it has a long life span and predetermines people's choices of where to live and work, what to consume, what sort of economic activities to carry out, and whom to communicate with. Infrastructure development will be a critical factor for both costs and overall effectiveness of climate policies. Moreover, history matters. Past infrastructure investment determines the present, although economists disagree on how widespread this path-dependency is.

[7] See the World Bank's reports to the Development Committee in the spring and fall of 2006 on the Clean Energy Investment Framework – which is now developed into an action plan.

requires a long-term global regulatory framework (i.e. a 2050 target) with differentiated responsibilities – with intermediate targets. New financial instruments are required, especially to ensure market continuity in the post-2012 period.

International financial institutions can be an important source of finance, policy and technical advice regarding the financing of investments needed for clean energy for development. Also the creation of new financing instruments could support this effort in several possible ways (World Bank, 2006 and 2007):

- *Clean Energy Financing Vehicle (CEFV)*. This could provide a mechanism to transfer high-efficiency technology by blending grants and carbon finance.
- *Power rehabilitation financing facility*. Failures of supply can cause high costs. This facility could enable developing countries to rehabilitate inefficient plants without loss of power
- *Project Development Fund*. 'Bankable' projects seem to be needed. Such projects with participation of the public and the private sector could be addressed with this fund.
- *Venture capital funds for technology adoption*. These funds could finance the development, adoption and penetration in the market of promising, new and clean technologies.

Without changes in policy frameworks and appropriate instruments to facilitate investments in new technologies, developing countries would follow a carbon-intensive development path. There are strong pressures in emerging economies for quick expansion of energy supply, notably for power generation and transport fuels. These economies scramble for energy supply to meet growing demand generation capacity very quickly often by using existing capital stock and technology, and making use of domestic reserves of coal wherever possible, regardless of higher recurrent costs later through efficiency losses and local or regional environmental damage. There is a major risk that the power sector could become locked into coal. The investment taking place in the next 10 to 20 years could lock in very high emissions for the next half-century (World Bank, 2006).

5. Technology and the UNFCCC: Is there sufficient action?

Under Article 4(5) of the UNFCCC, industrialised countries have a special obligation to promote, facilitate and finance the transfer of technology to developing countries. The focus in the UNFCCC has thus primarily been the transfer of technology to developing countries for energy efficiency, and lately for adaptation. Various processes have been introduced. The Expert Group on Technology Transfer (EGTT) is the main instrument. It addresses technology needs assessments, information exchange, enabling activities and capacity-building. In addition, two finance mechanisms that encourage technological diffusion through financial assistance and cooperation should be mentioned: the Global Environmental Facility (GEF) and the Clean Development Mechanism (CDM).

5.1 The Expert Group on Technology Transfer[8]

The Expert Group on Technology Transfer (EGTT) was established by the Marrakech Accords, with the objective of enhancing the implementation of Article 4(5) of the Convention, by analysing and identifying ways to facilitate and advance technology transfer activities and making recommendations to the Subsidiary Body for Scientific and Technological Advice.

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[8] The authors would like to acknowledge the comments and information provided by Bernard Mazijn for this section.

In collaboration with other agencies such as the UN Industrial Development Organisation (UNIDO), UN Environment Programme (UNEP), UN Development Programme (UNDP), Global Environmental Facility (GEF) and the Climate Technology Initiative (CTI), the Expert Group on Technology Transfer (EGTT) has worked for six years on the key elements for the development and transfer of technology: Technology information (clearing house[9] and networking with regional technology information centres), technology needs assessments, enabling environments and mechanisms.

During the last years, two new areas of work have been added: Technologies for adaptation and innovative options for financing.

A review of the progress of the work and terms of reference of the expert group had been conducted at COP12 in Nairobi. During the negotiations, it has been proposed that a second phase of the EGTT could build on the knowledge and expertise acquired during the first period and act as a think tank for the building block 'technology' in 2008-09.

5.2 The Global Environmental Facility

The UNFCCC central financial tool for technology transfer is the GEF. It is the main provider of grants for environmental projects in developing countries, of which climate change claims 40% of the current yearly budget. The Marrakech Accords in 2001 clarified the role of the fund and created three specific new funds to generate the conditions and leverage for private financing, including technology transfer for adaptation and mitigation purposes: The Trust Fund, the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF). An adaptation fund is in preparation, which may also cover adaptation technology, but its size and rules of implementation have yet to be agreed.

The Trust Fund is accessible to all countries, while the SCCF is only accessible to non-Annex 1 countries and the LDCF is exclusively dedicated to least developed countries. The GEF has supported projects in over 130 countries to modernise over two dozen technologies. Most of the assistance is aimed at developing countries and thus the GEF fund is mainly absorbed by agriculture, food, water and disaster prevention measures. Its effectiveness globally has been often called into question, due to the modest budget of $275 million a year, even if the total expenditure with co-financing is nearly five times that sum.

5.3 The Clean Development Mechanism

Although the CDM does not have an explicit technology transfer mandate, it partly contributes to technology transfer by financing a number of emissions reduction projects that use technologies not yet available in the host country.[10] Based on a survey of participants in CDM projects, Haites et al. (2006) find that 33% of project developers claim that technology was actually transferred; meaning in this definition mostly transfer of equipment, but with some involvement of knowledge transfer. CDM project participants also claim that technology transfer represent 66% of the estimated annual emissions reductions. Interestingly, projects claiming technology transfer are often substantially larger projects, often involving more than one country. Four countries – Brazil, China, India and South Korea – account for 67% of the projects claiming technology transfer, and for 75% of the annual emission reductions. Haites also points out that the governments of China, India and South Korea mention technology

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[9] TT:CLEAR (http://ttclear.unfccc.int/ttclear/jsp/index.jsp)

[10] Decision 17 CP 17/CP.7 of the Marrakech Accords, however, already reflected the intention of the Parties to make the CDM a tool for technology transfer to developing countries.

transfer as a key eligibility criterion for CDM projects, implying that the CDM can be an important vehicle for technology transfer if the terms of project eligibility (i.e. explicitly including technology transfer) and administrative efficiency are guaranteed.

The CDM could in particular become a vehicle for sector-based projects for technology transfer in developing countries. There are good arguments in favour of an extension towards a broader range of forestry and bio-energy projects and the development of the CDM into a more programmatic or sectoral crediting mechanism although many open questions, such as permanence, remain. More importantly, massive expansion of the CDM or other credits needs to be matched by *demand*, most of which is currently provided by the EU ETS or other Kyoto Protocol signatories.

There are a number of design flaws in the CDM, which limit its scope and which have been highlighted, among others, by a previous ECP report on CDM. "As a market-based instrument, the CDM tends to favour projects that are cheapest and most secure. This has put countries with weak economies and a lack of adequate institutional infrastructure in a disadvantageous position to benefit from the CDM" – as confirmed by the Haites et al. (2006) study: "This limitation is a barrier to avoid fossil-fuel based development in countries in earlier stages of economic development." To reduce the imbalances, complementary actions may be needed such as the use of different finance instruments (e.g. ODA and financing from international finance institutions). Another limitation of the CDM is the focus on limited types of gases, which excludes opportunities for a range of technologies to be developed and transferred.

6. A marriage of convenience with non-UNFCCC processes?

In addition to the technology transfer to developing countries, there have been pull approaches to technological change within industrialised countries. The oldest of such initiatives emerged in 1995: The Climate Technology Initiative (CTI), which has been implemented through the International Energy Agency. The IEA has also been tasked by the Gleneagles G8+5 process[11] with analysis, planning and knowledge dissemination during the implementation of the Gleneagles Plan of Action. Within the Gleneagles process, the focus has enlarged from technology transfer to all stages of the deployment of new technologies, from RD&D to commercial deployment.

6.1 The G8+5 process

The G8+5 emphasise the need to stop and reverse the increase of greenhouse gas emissions, focusing on three actors: the Ministerial Dialogue, cooperation with the International Energy Agency (IEA) and with the World Bank. A major commitment of the G8 Summit in Gleneagles was to "take forward a Dialogue on Climate Change, Clean Energy and Sustainable Development, and to invite other interested countries with significant energy needs to join". As an informal forum for discussion, it is meant to complement and reinforce the formal negotiations within the UNFCCC by trying to create the conditions necessary for successful agreement. This Ministerial Dialogue encompasses 20 countries (G8+5 together with Australia, Indonesia, Nigeria, Poland, South Korea and Spain), the European Commission and key international organisations including the World Bank, the IEA and the UNFCCC Secretariat. Having run throughout the UK, Russian and German Presidencies, the Japanese Presidency will conclude the G8 process on climate change with a final report on previous work under the dialogue being submitted for the consideration of G8+5 leaders in Japan. An accompanying

[11] Involving the G8 member countries plus five developing countries – Brazil, China, India, Mexico and South Africa.

process, the GLOBE[12] G8+5 Climate Change Dialogue, launched to shadow the G8 process, is expected to ensure input from stakeholders including business (e.g. the World Business Council for Sustainable Development) and environmental NGOs.

6.2 The Asia-Pacific Partnership on Clean Development and Climate

The Asia-Pacific Partnership on Development and Climate Change (the APP) was created in 2006 by Australia, China, India, Japan, South Korea and the US, and is now joined by Canada. Its modus operandi can be characterised as a sectoral approach combining cooperation on the development and deployment of technologies with reforms for removing barriers to mitigation potential (Fujiwara, 2007a).

It is a public-private partnership on a regional scale, encouraging interaction of business, government and researchers from partner countries. Through eight Task Forces, it focuses on specific key sectors to address clean development: three energy supply sectors (cleaner fossil energy, renewable energy and distributed generation, power generation and transmission); and five energy-intensive sectors (steel, aluminium, cement, coal mining, buildings and appliances). The Task Forces are designed to facilitate the development, diffusion, deployment and transfer of cost-effective, cleaner and more efficient technologies and practices among the partners through concrete and substantial cooperation so as to achieve practical results.

These Task Forces formulated Action Plans together with a portfolio of 110 projects ranging from technology development and deployment to information exchange and technical cooperation. Most Task Forces put a special effort into exchange of information, especially about best practice. Another focus aims to assess technology options and estimate their potential to reduce GHG emissions.

6.3 Major Economies' Meetings

Following the Japanese 'Cool Earth 50' proposal of May 2007, the US launched on 31 May 2007 the idea of a 'major emitters' initiative' – later to become major economies' meetings (MEE), crucially composed of all large emitters of GHGs in both developed and developing countries, with the aim of agreeing on emissions reductions. The objective of the initiative is to develop and contribute to a post-Kyoto framework on energy security and climate change by the end of 2008. This effort is meant to complement existing national, bilateral, regional and international programmes to address the long-term challenge of global climate change as well as highlight the US intention to take action on climate change at home and abroad.[13] Importantly, all participants, although reflecting a diversity of perspectives, agreed on the central role of the UNFCCC as the global forum for addressing climate change.

The discussion focused on five key areas: i) low-carbon fossil power generation, ii) transport, iii) land use, iv) market penetration of technologies and v) energy efficiency and finance. Hence, the MEE initiative takes a similar approach as the Gleneagles Plan of Action. There were proposals to broaden the agenda to include a long-term global goal for greenhouse gas reduction, incentives and finance for clean technology investments, adaptation, deforestation,

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[12] GLOBE, which stands for the Global Legislators Organisation for a Balanced Environment, is an organisation comprising legislators from around the world, including the G8+5 countries.

[13] The first Major Economies Meeting on Energy Security and Climate Change was held on 27-28 September in Washington, D.C. and was attended by senior representatives of 17 Major Economies, as well as the UN and the EC (Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Korea, South Africa, United Kingdom and the EU).

reforestation and afforestation, among others. Further meetings are scheduled to take place after the COP/MOP in Bali.

6.4 Global sectoral industry approaches

There is an increasing political momentum behind 'global sectoral approaches'. Some industries are concentrated in such a way that a small number of companies represent a large share of the world market and a significant share of the global GHG emissions. The examples of such industries include aluminium, cement, steel, float glass and a few heavy chemical industries. At the same time, these industries produce and trade goods that are globally priced. In some cases, they are also easily transportable. While there are very different models of approaches across sectors, they all attempt to combine two objectives:

- Induce changes to technologies through either development of new and breakthrough technologies or accelerated deployment of existing technologies, essentially by means of cooperation between the firms.
- Engage developing countries in reducing emissions and taking on emissions reduction commitments.

As an intended side-effect, sectoral approaches can reduce unevenness of distributional impacts between firms within the same sector that arise as a result of uncoordinated local, national or regional climate change policies.

While global industry sectoral approaches (e.g. initiatives by the Cement Sustainability Initiative, International Aluminium Institute, International Iron and Steel Institute) are only emerging, it is yet unclear in which direction they will develop. However, global sectoral industry approaches may potentially improve:

- data collection on the state of the sector, e.g. emissions (actual and projected), applied technologies, technology benchmarks and best-practice,
- identification and spread of best-practice and the
- development and diffusion of technology.

7. Technology-oriented agreements and their limitations

Most of these initiatives can be described as so-called 'technology-oriented agreements' (TOAs) or at least have elements of them. Technology-oriented agreements stress the need for a portfolio of R&D investments across a spectrum of technology classes, and integration of energy technology development as part of a larger comprehensive strategy.

Technology-oriented agreements are expected to address important failures in the market for technological innovation. Still, they will operate best in conjunction with appropriate emissions-reduction policies, particularly market-based ones. This complementarity could be mutually reinforcing: as emissions-reduction policies spur the uptake of new technologies and increase the profitability of innovation, TOAs spur additional innovation to lower the costs of mitigation and improve the social and political acceptability of emissions targets. TOAs could be negotiated separately, linked together or incorporated into the climate policy framework in a Policies and Measures approach. More modest TOAs have the advantage of being able to be negotiated and implemented by a smaller set of countries, potentially outside of the UNFCCC.

Box 1. Technology-oriented agreements

A Global Energy Technology Strategy in international cooperation with public and private sectors has been proposed (Humphreys, 2001; Edmonds, 2003). The proposal has been further developed to address the lack of incentives for short-term action and the deployment of advanced technologies. Barrett (2002, 2003) has proposed a new R&D protocol based on collective funding of basic research into the development of new technologies and on standard protocols for the adoption and diffusion of new technologies around the world. He also suggests that the long-term focused proposal needs to be combined with further protocols for the short-term options such as domestic measures or emissions trading.

De Conink et al. (2007) survey the range of existing TOAs and identify four broad types:

1) knowledge sharing and coordination;
2) research, development and demonstration (RD&D);
3) technology transfer and
4) technology deployment mandates, standards and incentives.

To date, most existing TOAs related to climate change fall into the first category of knowledge sharing. These initiatives include the Carbon Sequestration Leadership Forum (CSLF), Methane to Markets Partnership or the International Partnership for the Hydrogen Economy, and most recently, the Asia-Pacific Partnership on Development and Climate (APP) or the existing global sectoral industry approaches. Agreements of this type provide relatively low-cost means to exchange information, promote common standards and facilitate innovation; however, their effectiveness is limited by the voluntary, non-binding nature of their framework.

To date, RD&D agreements, i.e. category 2, have primarily focused on fundamental research and demonstration projects, where expenses may be high and where the technology is too far from commercialisation for intellectual property rights to be a concern. Examples of these cost-sharing arrangements include the ITER fusion reactor, the Solvent Refined Coal II Demonstration Project (SRC-II) and some IEA research programmes. Technology cooperation and RD&D agreements will most likely find their limits, however, when the technology moves from the pre-competitive to the post-competitive stage.

Technology transfer, i.e. category 3, has been attempted within the UNFCCC. One of the shortcomings is that most advanced technologies consist of integrated products, which depend to large extent on know-how. Thus, simply transferring patents does not help.

Category 4 of technology mandates is best exemplified by the International Convention for the Prevention of Pollution from Ships (MARPOL). In the climate arena, one could imagine (and some have proposed) harmonised standards for renewable energy, building codes and energy efficiency, or requirements for carbon capture and sequestration. These kinds of agreements fall more into market-pull strategies. While they have bigger potential for generating emissions reductions by virtue of their sector-by-sector nature, they raise cost-effectiveness questions in comparison to broad-based methods. On the other hand, in an international framework with incomplete participation, performance-based standards can have less effect on competitiveness than emissions price policies, since standards do not impose the additional direct cost of emissions, resulting in smaller product-price increases (Bernard et al., 2007; Fischer & Fox, forthcoming).

The use of TOAs as an effective substitute for an emissions-based approach is limited to the category of standards, mandates, or substantial incentives, i.e. category 4, as they would need to be applied on a sector-by-sector, if not technology-by-technology, basis. This approach may make the most sense in certain specific settings: for highly trade-sensitive sectors, in which agreement upon targets and timetables is difficult; for sectors not otherwise covered by emissions trading programmes; for sectors that can benefit from international coordination; and for situations where significant ancillary benefits are foreseen. For a comprehensive programme of reducing global emissions, TOAs are best viewed as playing a strong supporting role, with a well-designed emissions-reduction policy with long-term targets as the main instrument and driver.

8. Which way forward?

Most TOAs focus on 'knowledge sharing and co-ordination'. They are relatively low cost, simple and politically uncontroversial. On the other hand, their impact will be limited. There are few examples of R&D cooperation at international level. Technology transfer, the third category has been largely confined to the UNFCCC. The fourth category, technology mandates has been tried within the G8+5 process as well as outside, but it has not yet been applied in a major way.

8.1 More focus on technologies rather than on policies?

In applying the wedges-approach, the WRI report entitled "Scaling up" (Wellington et al., 2007; 7) makes the case that a necessary precondition for the development and deployment of new technologies is a massive amount of information. Policy-makers' and business executives' decisions are only as good as the information allows. In order to make "the wedges reality", the report proposes research to initially focus on providing the necessary information in *three* areas and to engage decision-makers in policy and business (Wellington, et al., 2007; 7):

Technology	The scope, scale and availability of the technologies in question, as well as the risks and other impacts associated with them.
Investment	How domestic and international investors respond to the incentives created by policy? In turn, how the combination of policy and commercial opportunity affect capital flows from the private sector and development assistance.
Policy	Agreements, trade conditions and other factors that affect international deployment of the technology. The successful realisation of any wedges depends on understanding decision-making processes in the country of region in which it is to be implemented.

Although not entirely technology-specific, this nevertheless constitutes a somewhat different approach than a more horizontal technology approach as for example proposed by Stern (2006; chapter 16). Although ultimately, when technologies move closer to demonstration and deployment, we can expect that market conditions combined with smart government policy, such as removing institutional and other non-market barriers, will be the key drivers for deployment of new technologies. While technology-neutral policies are strongly preferred as they leave decisions for resource allocation in the hands of market participants, the market fails in three areas: i) long-term technology development, demonstration and deployment of breakthrough energy technologies; ii) energy efficiency in domestic sector and iii) consumer behaviour. Price signals may only emerge gradually or not provide necessary incentives to bring technologies to the point of deployment. There is a good understanding of the key technologies, capable of addressing climate change and typically include technologies for energy efficiency and conservation, fuels switching, CO_2 Capture and Storage (CCS), nuclear fission, renewable electricity and fuels and forests and agricultural sinks and hydrogen technologies (e.g. Pacala & Socolow, 2004; Edmonds, 2007 and Wellington, 2007).

8.2 Establishing a Consultative Group on Climate Innovation?

The proposal for the Consultative Group on Climate Innovation is a somewhat more concrete version of the above strategy. The starting point is the need for a complementary technology track including innovation strategies, and finance mechanisms that support the rapid development and deployment of low-carbon technologies, all within new forms of global infrastructure.[14]

The consultative group concept has its origins in the 1960s. While it started as a 'big science' effort, it has evolved considerably. It now relies increasingly on a more distributed and decentralised approach among donors in areas such as agricultural productivity and natural resource protection.[15] This new approach goes beyond research; the evolving distributed innovation approaches focus on product development, targeted analysis, finance and cooperative policy development. An international framework and strategy supports the work on the complex global public goods involved in these fields, whereas no such cooperative architecture exists today for innovation in climate technology. The EU's proposal for an International Energy Efficiency Platform or suggestions for a Sustainable Buildings Network point to a similar direction. The new Strategic Energy Technology Plan (SET-Pan) proposed by the European Commission (European Commission, 2007c) can be seen as an EU variation of the same approach. Many countries have undertaken technology-mapping exercises.

Box 2. What is distributed innovation?

Public interventions in the low-carbon energy sector often have focused only on supporting information-sharing networks that lack the incentives or infrastructure to drive massive innovation and then product development and deployment. To the extent that public investments have extended beyond information-sharing, they have largely supported long-term demonstration projects or prototype development. The current surge in venture capital is largely directed towards a relatively small number of sectors (e.g. solar); these investments are helpful but are insufficient to drive large-scale technology development in multiple energy sectors. A new global climate technology innovation initiative – a 'distributed' model of climate innovation and commercialisation – can overcome these failures. Distributed innovation strategies bring together the international expertise needed to develop and deploy new technologies. Teams include project leaders with business expertise to ensure that research and development are linked to viable commercialisation strategies. Robust information technology tools support these teams, enabling people throughout the globe to collaborate together; the distributed innovation approach assembles the best people for a task regardless of their location. These strategies enable teams to tap innovative thinking from unexpected places; these tools could 'open' the climate innovation process in the same way that a growing number of companies now supplement their own in-house research and development capacity in other areas.

Source: Milford (2007a, 2007b).

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[14] While the idea of a complementary technology track is not new, the essential role of climate-technology-innovation policies has been overshadowed by market-based theory, and the issue of how to structure and implement such a complementary technology-based strategy has received remarkably little attention. The Council of the European Union recently endorsed a proposal that cap and trade be "supplemented" by technology strategies for the upcoming Bali negotiations but offered few details about how the concept could be put in place. (See Council of the European Union, "Council Conclusions on Climate Change," 30 October 2007.)

[15] The GLCA report derives its recommendation for a CGCER from a 2006 Summary Report of the International Task Force on Public Goods, *Meeting Global Challenges: International Cooperation in the National Interest*.

The proposal for a Consultative Group on Climate Innovation (Milford, 2007a, 2007b) builds on the work by the Club of Madrid and the United Nations Foundation, acting through the Global Leadership for Climate Action. It proposes a more expansive new global architecture and strategy for climate technology innovation in the post-2012 framework to cover technology innovation for mitigation (and perhaps adaptation), as well as related finance initiative, create decentralized and cooperative global structure around climate technology innovation ('distributed innovation' – see Box 2 above). In addition, it addresses many issues that go well beyond research such as climate technology product development, finance, business models, policy analysis, and related strategies to scale-up existing technologies and create new breakthrough innovations, linking of developed and developing country technology initiatives as well as the involvement of private and public sectors and civil society.

8.3 Learning from the Montreal Protocol

Technology has also been a focal point of the Montreal Protocol. Although the Montreal Protocol and a potential climate change agreement will necessarily have different features, as they deal with different problems, there may nevertheless be a number of lessons that can apply. First, governments emerged as major stakeholders in the Protocol and assumed a central role in coordinating and facilitating effective national responses, including those on technology. Second, the Montreal Protocol developed a basket of promising technologies able to replace ozone-depleting substances. However, an important difference from climate change is that the technology options were known. A third element of success was funding, although the scale for climate change is different. Less-known is the contribution of the Montreal Protocol to assess the country specific requirements, training in adapting to new technologies and exchange of information on technology options before making the final decision. This element was instrumental in capacity-building in developing countries. In practical terms, the Montreal Protocol has developed an infrastructure for technology assessment and transfer, which could eventually be used by the UNFCCC.

8.4 Effective national/regional technology approaches

In the search for a global response to the technology challenge, it should not be forgotten that the backbone of technology policy will likely be national or in the case of the EU, a regional approach. Incentives for actions are stronger than for abatement policies *per se* as the development and deployment of advanced low-carbon technologies do not only offer the prospect of lower emissions but also hold out the promise of technological leadership, a competitive edge, export markets and employment opportunities. More and more countries are joining the climate technology race.

The EU integrated energy and climate change package, launched on 10 January 2007, is the specific EU response, manifesting the EU's will to broaden its reflection on its future energy systems, taking into account increasing market liberalisation and globalisation, environmental pressures, technological challenges and the growing import dependency from politically unstable regions. Technology was one of the priorities. It includes actions in the energy sector (e.g. cleaner fossil energy, renewable energy, power generation and transmission) as well as cross-cutting issues (e.g. R&D and energy efficiency). To address the choice between technology-neutral and technology-specific approaches, the EU in principle has taken a 'horizontal' approach. On the condition that a global agreement is reached,[16] the EU has

[16] Entailing commitments from other developed countries to 'comparable' reductions and from emerging economies to contributing 'adequately', according to responsibility and capabilities.

proposed to accept a binding absolute emissions reduction commitment of 30% by 2020 based on 1990 levels. Failing that, it has undertaken a ‘firm independent commitment’ to achieve at least a 20% reduction in overall emissions by 2020 and a 20% reduction of primary energy consumption by 2020 and to develop a European Strategic Energy Technology Plan. Nevertheless, the package foresees a number of measures for specific sectors under prioritised themes. For example, EU actions for energy efficiency improvements cover appliances and buildings as well as heat and electricity generation, transmission and distribution. There are two notable areas where a sector-specific approach prevails: renewables and carbon capture and storage. A binding target of 20% of renewable energy in total energy consumption by 2020, should ensure accelerated deployment of renewable energy technologies, essentially to bring down costs. As an example, for wind energy, the IEA estimates that each doubling of capacity can lower the costs by 18-20% , although such ‘learning curves’ differ for different technologies, mainly depending on how mature they are. In addition, the EU has endorsed a carbon capture and sequestration policy, among others, by bringing forward a legal and policy framework for carbon capture and geological storage by the beginning of 2008, as well as an incentive framework, support programmes and external elements such as technology cooperation with key countries on CCS (see Appendix 1). Similar technology packages are put together or are already in operation in other countries.

Domestic approaches should also include removing trade and investment barriers to climate change technology transfer. There are numerous trade barriers in developing countries and industrialised countries that constrain exports of ‘greenhouse gas intensity-reducing technologies’ in all directions but notably North-South, South-North and South-South (Brewer, 2007b). For developing countries, removing ownership restrictions for foreign ownership has been identified as one such measure.

9. Final remarks

Returning to the theme of global responses to technology within the UNFCCC or outside that framework, this report has examined the vexed question of technology in the global climate change negotiations. It has attempted to address the key questions that will remain central to the negotiations, but its answers are only partial. Nevertheless, the preceding section 8 has identified a number of concrete steps for immediate and longer-term action. We recognise that more research will be needed before we can comprehensively answers the questions below.

1. What is necessary to further accelerate deployment of existing commercially available technologies including energy efficiency?
2. How can international technology cooperation be scaled up to promote innovation and development of newer technologies?
3. What are the full incremental costs of making future energy investment in developing countries low carbon? How can these costs be met? By whom?
4. What is the role of the UNFCCC in providing a catalyst for change?
5. How can voluntary initiatives and other multilateral initiatives outside of the UNFCCC contribute towards achieving a stabilisation goal?
6. How can additional support for technology (through UNFCCC or processes outside of the Convention) leverage commitments for actions by the advanced developing countries?
7. Is there a role for technology-type agreements? How could these be taken forward and financed?

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Appendix 1. The EU Energy and Climate Package*

The European Commission has proposed a comprehensive package of measures to combat climate change and boost the EU's energy security and competitiveness. The package sets a series of ambitious targets on greenhouse gas emissions and renewable energy and aim to create a true internal market for energy and strengthen effective regulation. The key elements of the package include the following.

Strategic objectives

- An EU objective in international negotiations of 30% reduction in GHG emissions by developed countries by 2020 compared to 1990. In addition 2050 global GHG emissions must be reduced by up to 50% compared to 1990, implying reductions in industrialised countries of 60-80% by 2050.
- An EU commitment to achieve at least a 20% reduction in GHG emissions by 2020 compared to 1990.

A European Strategic Energy Technology Plan (SET-Plan)

The so-called SET-Plan (European Commission 2007b) is meant to develop a vision towards a low-carbon economy. The European Commission Proposal, published on 22 November (European Commission 2007c), focuses on a number of specific steps to assist implementation of the EU energy package such as the creation of an Energy Technology Information System, public private partnerships in the different technological fields, better coordination of EU research centres through a European Energy Research Alliance grouping together European institutes, and more emphasis on infrastructure developments. It takes into account that

- By 2020 technologies will have to make the 20% renewable target a reality by permitting a sharp increase in the share of lower cost renewables;
- By 2030 electricity and heat will increasingly need to be produced from low carbon sources and extensive near-zero emission fossil fuel power plants with CO_2 capture and storage. Transport will need to increasingly adapt to using second generation biofuels and hydrogen fuel cells.
- For 2050 and beyond, the switch to low carbon in the European energy system should be completed with an overall European energy mix that could include large shares for renewables, sustainable coal and gas, sustainable hydrogen, and, for those member states that want, Generation IV fission power and fusion energy.

The first SET-Plan is foreseen for endorsement by the 2008 Spring European Council.

Sectoral objectives

- More energy efficient buildings, appliances, equipment, industrial processes and transport systems;
- Developing biofuels, in particular second generation biofuels, to become fully competitive alternatives to hydrocarbons;
- Getting large scale offshore wind competitive within the short term and paving the way towards a competitive European offshore supergrid;

* *Source*: Fujiwara, N. (2007), *The Asia-Pacific Partnership on Clean Development and Energy: What it is and what it is not*, CEPS Policy Brief No. 144, Centre for European Policy Studies, Brussels, October.

- Getting photovoltaic electricity competitive to harness solar energy;
- Using full cell and hydrogen technologies to exploit their benefits in decentralised generation and transport;
- Sustainable coal and gas technologies, particularly carbon capture and storage;
- Leading in fourth generation fission nuclear reactors and future fusion technology to boost the competitiveness, safety and security of nuclear electricity, as well as reduce the level of waste.

Sectoral targets

- A target of 10% minimum interconnection levels
- A binding target of 20% of its overall energy mix will be sourced from renewable energy by 2020
- A minimum target for biofuels of 10%
- An increase in its annual spending on energy research for the next seven years by at least 50%
- Saving 20% of total primary energy consumption by 2020
- Construction of 12 large-scale demonstration plants in Europe by 2015

Appendix 2. Major global partnerships on energy and climate change*

Table 1. Major multilateral global partnerships on energy and climate change

Partnerships	Description
Global Gas Flaring Reduction (GGFR), (2002-)	The GGFR is the World Bank-led initiative launched at the *2002 World Summit on Sustainable Development (WSSD)*. It is a *public-private partnership* that facilitates and supports national efforts to use currently flared gas by promoting effective regulatory frameworks and tackling the constraints on gas utilization. Poverty reduction is also an integral part of the programme.
Partnership for Clean Fuels and Vehicles (PCFV)(2002-)	The PCFV was also launched at the *2002 WSSD* as a *public-private partnership*. It will help reduce vehicular air pollution in developing countries through the promotion of clean fuels and vehicles, and will focus initially on the elimination of lead in gasoline and the phase down of sulphur in diesel and gasoline fuels concurrent with the adoption of cleaner vehicle technologies.
The Johannesburg Renewable Energy Coalition (JREC) (2002-)	The JREC was launched following the Johannesburg Plan of Implementation agreed at the *2002 WSSD*. Ministers and senior officials identified a large range of policy objectives that can be addressed through increased renewable energy policies and measures including objectives related to environment, energy, and development.
Carbon Sequestration Leadership Forum (CSLF), (2003-)	The CSLF focuses on development of improved cost-effective technologies for the separation and capture of CO2 for its transport and long-term safe storage. Its purpose is to make these technologies broadly available internationally and to identify and address wider issues relating to carbon capture and storage.
International Partnership for the Hydrogen Economy (IPHE), (2003-)	The IPHE aims to accelerate the transition to a hydrogen economy. It serves as a mechanism to organize and improvement effective, efficient and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies.
Methane to Markets Partnership, (2004-)	The Partnership is an initiative that advances cost-effective, near-term methane recovery and use as a clean energy source. Its goal is to reduce global methane emissions in order to enhance economic growth, strengthen energy security, improve air quality, improve industrial safety, and reduce GHG emissions.
FutureGen, (2005-)	FutureGen is a *public-private partnership* to build a first-of-its-kind coal-fuelled, near-zero emissions power plant.
Renewable Energy and Energy Efficiency Partnership (REEEP)(2004-)	The REEEP was conceived at the *2002 WSSD* and established in 2004. It is a *public-private partnership* that structures policy and regulatory initiatives for clean energy and facilitates financing for energy projects. Its aim is to accelerate the integration of renewables into the energy mix and to advocate energy efficiency as a path to improved energy security and reduced carbon emissions, ensuring socio-economic benefits.
Generation-IV International Forum (GIF)	Countries work together to lay the groundwork for the 4th generation nuclear reactor, Generation IV.
Global Nuclear Energy Partnership (GNEP)	GNEP was first announced in 2006. GNEP seeks to develop worldwide consensus on enabling expanded use of clean, safe and affordable nuclear energy to meet growing electricity demand. It proposes a nuclear fuel cycle that enhances energy security.

Sources: http://www.cslforum.org/; www.methanetomarkets.org/; www.iphe.net/; www.worldbank.org/; www.futuregenalliance.org/about.stm; /www.reeep.org/; www.unep.org/pcfv/; ec.europa.eu/environment/jrec/index_en.htm; gif.inel.gov/; http://www.gnep.gov/

* *Source*: Fujiwara, N. (2007), *The Asia-Pacific Partnership on Clean Development and Energy: What it is and what it is not*, CEPS Policy Brief No. 144, Centre for European Policy Studies, Brussels, October.

Table 2. Major bilateral global partnerships on energy and climate change

Partnership	Description
US Fossil Energy Bilateral Agreements	The formats and goals are set bilaterally.
US ENERGY STAR agreements	There are international agreements to promote certain ENERGY STAR qualified products. They aim to unify voluntary energy-efficiency labelling programmes in major global markets and make it easier for partners to participate by providing a single set of energy-efficiency qualifications.
International Nuclear Energy Research Initiative (I-NERI)	The I-NERI is a US programme designed to foster collaborative research and development with international partners in advanced nuclear energy systems. It has implemented bilateral collaborative agreements.
EU bilateral cooperation initiatives	The formats and goals are set bilaterally.

Sources: http://www.fossil.energy.gov/international/International_Partners/International_Partners.html
http://www.energystar.gov/index.cfm?c=partners.intl_implementation;
http://www.energetics.com/ineri_client/index.aspx;
http://ec.europa.eu/dgs/energy_transport/international/index_en.htm

Table 3. Multilateral global partnerships and their main participants

	APP	APP	APP	APP	APP	APP	APP	EU	EU	EU	EU	
	Au	Ca	Ch	In	Ja	Ko	US	Fr	Ge	It	UK	EU
GGFR		○					○	○			○	○
PCFV	●	●	●			●						
JREC								●	●	●	●	●
CSLF	●	●	●	●	●	●	●	●	●	●	●	●
IPHE	●	●	●	●	●	●	●	●	●	●	●	●
MMP	●	●	●	●	●	●	●		●	●	●	
REEEP	○	○			●	●	○	●	○	○	○	○
GIF		●			●	●	●	●			●	
GNEP	●		●		●		●	●			◘	

Legend: ○: member and donor; ●: member; ◘: observer

Note: The EU is a donor to GGFR, and led the launch of JREC. The European Commission is a member of CSLF, IPHE, and REEEP. EURATOM is a member of GIF.

Table 4. Bilateral global partnerships and their main participants

	Au	Ca	Ch	In	Ja	Ko	US	Fr	Ge	It	UK	EU
Fossil Fuel	●	●	●a	●b			○			●	●	
ENERGY STAR	●	●			●		○					●
I-NERI		●			●	●	○	●				
Cooperation			●c	●d			●					○

Legend: ○: Host country; ●: Its partners.

[a] A bilateral Fossil Energy Protocol has been extended to 2010. There is a public-private partnership, US-China Oil and Gas Industry Forum.

[b] An US-India Energy Dialogue was launched in May 2005.

[c] An EU-China Partnership on Climate Change was agreed in September 2005.

[d] An EU-India Initiative on Clean Development and Climate Change was agreed in September 2005.

Appendix 3. Agenda of the ECP meeting on 3 October and List of Participants

Fourth ECP Seminar

STRATEGIC ASPECTS OF TECHNOLOGY FOR THE UNFCCC AND CLIMATE CHANGE DEBATE:

THE POST-BALI TECHNOLOGY AGENDA

CEPS, Brussels

Agenda

3 October 2007

09:00 Registration and coffee

09:30 Welcome by **Christian Egenhofer**, CEPS

09:35 Introduction by ECP co-chairs: **Frank Convery,** Heritage Trust Professor of Environmental Policy at University College Dublin & President of the European Association of Environmental and Resource Economists (EAERE); **Bo Kjellén,** Senior Fellow Stockholm Environment Institute and Former Chief Climate Negotiator of Sweden

SESSION I. Setting the scene

- What are the full incremental costs of making future energy investment in developing countries low carbon? How can these costs be met? By whom?
- How to further accelerate deployment of existing commercially available technologies including energy efficiency?

09:45 **The critical role of technology for international climate change policy: a taxonomy of climate change and technology**

Introduction to Background Paper No. 1 and No. 2 by **Thomas Brewer**, Georgetown University, Washington, D.C.

09:55 Comments by **Anders Wijkman,** Member of European Parliament & Chair, Technology working group, GLOBE G8+5 Climate Change Dialogue

10:05 Comments by **Chris Dodwell**, Head of UK climate change delegation

10:20 **Open Discussion**

11:10 Coffee Break

SESSION II. Scaling up

- How can international technology cooperation be scaled up to promote innovation and development of newer technologies?
- How can voluntary initiatives and other multilateral initiatives outside of the UNFCCC contribute towards achieving a stabilisation goal?

11:25 Scaling-up

Hilary McMahon, World Resource Institute (WRI), Washington

11:40 Scaling up the CDM

Ulrika Raab, Member of the CDM Executive Board

11:55 Open discussion

12:50 Light lunch at CEPS

13:50 Can AP6 be scaled up to global level? Presentation of Background Paper No. 3 by Noriko Fujiwara, CEPS

13:55 Comments by **Christian Josis**, ArcelorMittal

14:05 Comments by **Koichi Akaishi**, Executive Director, Brussels Office, Japan Machinery Center for Trade and Investment [17]

14:15 Open discussion

SESSION III. Next steps towards a technology strategy

- The role of the UNFCCC in providing a catalyst for change
- How can additional support for technology (through UNFCCC or processes outside of the Convention) leverage commitments for actions by the advanced developing countries?
- Is there a role for technology-type agreements? How could these be taken forward and financed?

15:10 Kick-off by **Lew Milford**, President, Clean Energy Group, US

15:35 Responses by **Nick Campbell**, Chairman Climate Change Working Group, Business Europe and **Francois Dassa,** EDF

15:50 Open discussion

16:50 Conclusions and wrap-up by the Chair and further information by **Christian Egenhofer** on the presentation of the final ECP report and its presentation at the COP in Bali

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[17] The Japan Machinery Center for Trade and Investment (JMC) is a non-profit organization that was established, under the authorization by the Japanese government (Ministry of Economy, Trade and Industry) to promote sound development of foreign trade and direct investment.

List of Participants

Sara Aagesen
Senior Adviser
Ministery of Environment, Spain

Koichi Akaishi
Executive Director, Brussels Office
Japan Machinery Center for Trade and Investment

Monica Alessi
Research Fellow
CEPS

Richard Armand
General Secretary
Entreprises pour L'Environnement

Stefan Bakker
Climate Policy Researcher
Energy Research Centre of the Netherlands (ECN)

Arno Behrens
Research Fellow
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Thomas T. Brewer
Associate Professor
Georgetown University

Nick Campbell
Environment Manager
ARKEMA SA

Gonçalo Cavalheiro
Consultant
Ministry of Environment, Portugal

Tomas Chmelik
Environmental Products Manager
CEZ Group

Michel Colombier
Deputy Director
Institut pour le Développement Durable et Relations Internationales (IDDRI), France

Frank Convery
Head of Environmental Studies
University College Dublin

François Dassa
Senior Adviser
Electricité de France

Chris Dodwell
Head of International Negotiations
DEFRA

Daniel D. Dutcher
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Romain Duval
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Senior Fellow
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Ministry of Trade & Industry, Finland

Noriko Fujiwara
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Peringe Grennfelt
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Clipore

Fredrik Hannerz
Office of Anders Wijkman
European Parliament

Magnus Hennlock
Assistant Professor
Gothenborg University

Inge Horkeby
Director Environmental Affairs
Volvo

Christian Josis
Environment & Global CO2 Strategy
Arcelor Mittal

Bo Kjellen
Senior Research Fellow
Stockholm Environment Institute

Anja Köhne
WWF

Atanas Kolev
Economist
European Investment Bank

Aneta Kukwa
Junior Specialist
The National Administration of the Emission Trading Scheme

Astrid Ladefoged
DG Environment, Climate Change Negotiations Unit
European Commission

Corneel Lambregts
Policy Adviser
Ministry of Environment, The Netherlands

Hilary MacMahon
Senior Associate
World Resources Institute (WRI)

Bernard Mazijn
Visiting Professor at Ghent University – Chair of Centre for Sustainable Development
Member of the UNFCCC EGTT (Vice-Chair in 2005, Chair in 2006)
Member of the Belgian delegation to the UNFCCC
EU Lead Negotiator on the Development and Transfer of Technology

Lewis Milford
President
Clean Energy Group, USA

Hidehiro Muramatsu
Counsellor
Mission of Japan to the EU

Charlotte Nilsson
Communications Officer
Swedish Environmental Research Institute (IVL)

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Ulrika Raab
Senior Adviser & Member of the CDM Executive Board
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Ministry of Environment, Portugal

Allison Saunders
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Stephan Singer
Head of Unit
WWF European Policy Office

Yoshinori Tanaka
First Secretary
Mision of Japan to the European Union

Anders Turesson
Head of Climate Change Delegation
Ministry of Environment of Sweden

Hans JH Verolme
WWF

Henning Von Stein
Head of Brussels Office
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Ilka Wagner
Federal Ministry for the Environment, Germany

Katherine Watts
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Katrine Wied Christensen
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Anders Wijkman
MEP
European Parliament

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Professor at University College Dublin

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Michel Colombier
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Christian Egenhofer
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Christopher Dodwell,
Head, EU Emissions Trading Scheme Team, Department for Environment, Food and Rural Affairs (Defra), UK

Mike Hulme
Executive Director, Tyndall Centre for Climate Change Research

Bert Metz
Netherlands Environmental Assessment Agency, Global Sustainability and Climate Unit (MNP/RIVM), co-chairman of IPCC Working Group III

Artur Runge-Metzger
Head of Unit, Climate Strategy, international negotiation and monitoring of EU action, DG Environment European Commission

Teresa Ribera
Head of the Spanish Climate Delegation

Anders Turesson
Head of Climate Change Delegation, Swedish Ministry of the Environment

Anders Wijkman
Member of the European Parliament

Nicole Wilke
Head of the German Climate Delegation

About the European Climate Platform (ECP)

The ECP is a joint initiative of the Climate Policy Research Programme (Clipore) of the Swedish Foundation for Strategic Environmental Research (Mistra) in Stockholm and the Centre for European Policy Studies (CEPS) in Brussels. Established in 2005, the ECP aims to facilitate interaction within the policy research community, mainly but not exclusively in Europe. Its working methods consist of bringing together a select number of policy-makers, negotiators and experts to vigorously debate key topics in the area of international climate change policy and to widely disseminate its conclusions. The ECP actively seeks dialogue with policy-makers and other stakeholders while being dedicated to academic excellence, unqualified independence and policy relevance. The ECP is governed by a steering group, drawn from government and academia. For further information, see: http://www.ceps.be/Article.php?article_id=484 .

About the Climate Policy Research Programme (CLIPORE)

Clipore is an international research programme that aims to stimulate policy-oriented research that contributes to moving forward global efforts to combat climate change. A steady and integrated process of research and dialogue with stakeholders lies at the foundation of the Clipore programme: spawning, developing, sharing, scrutinizing and refining ideas. The programme is comprised of two large climate policy research projects, independent university positions and the Clipore Policy Forum. For more information see: http://www.clipore.org

About the Centre for European Policy Studies (CEPS)

Situated in the nexus between academia, business and policy-making, CEPS performs a unique role as an independent analyst and critic of European policy. CEPS' core expertise is the conduct of policy research on European affairs including climate change and the broad dissemination of its findings through a regular flow of publications and events. (See: www.ceps.be on CEPS in general and for a description of its energy, climate change and sustainable development programme: http://www.ceps.be/Article.php?article_id=12).

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