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Index

Executive Summary 2

The Need for a Paradigm Shift 4

Carbon Pricing 8

Command and Control Instruments 12

Supporting Low Carbon Technology Development and Deployment 15

The Need for Effective International Collaboration 20

What Next? 23

Executive Summary

The need for a paradigm shift: The world's GHG emissions are increasing rapidly and it will be very difficult to achieve the substantial, long-term reductions required to avoid an increase of more than 2^0C, which is the level likely to trigger dangerous climate change. We urgently need an internationally agreed paradigm shift that simultaneously restrains growth in energy demand and provides sufficient, secure energy supply for global economic growth. This will require:

- Creating markets for low carbon technologies by putting a price on carbon emissions and by enacting different forms of 'command and control' regulations and standards.
- Government support for research, development and deployment to stimulate new low carbon technologies.
- Education and information for consumers and stakeholders to help produce substantial behavioural change.
- International collaboration on technology transfer and financing assistance to help developing countries take up low carbon energy supply options.

Carbon pricing: Carbon pricing can provide strong economic incentives for boosting energy efficiency and the deployment of low carbon energy technologies.

Command and control instruments. Price incentives have not by themselves led to the required efficiency gains. Command and control instruments must therefore also be used. These include building codes, appliance standards, portfolio standards and feed-in tariffs.

Supporting Low Carbon Technology Development and Deployment: Governments must spend substantial amounts to accelerate the introduction of new technology. Widespread use of carbon capture and storage (CCS) as well as bio-fuels awaits resolution of key technical and commercialisation issues.

The Need for Effective International Collaboration: Reducing carbon emissions to prevent dangerous climate change requires international exchange of information on 'best practices', R&D co-ordination and technology transfer to the developing world. A post Koto international framework for this is essential. Japan has proposed three principles to guide its creation:

- all major emitters must participate,
- the framework must be flexible and diverse in order to take into consideration the circumstances of each country, and,
- it must achieve compatibility between environmental protection and economic growth by utilising energy conservation and other technologies.

What Next? We do not have an answer to how the developing world can alleviate poverty while global carbon emissions are reduced to avoid dangerous climate change. It will help if:

- Priority is given to low carbon energy supply over other environmental concerns.
- There is a strong focus on energy efficiency and establishing the viability of CCS technology as rapidly as possible.

There is a very large gap between the level of effort that countries are currently willing to make to stabilise the climate and what is needed, with no clear way ahead to bridge this gap. The new energy paradigm requires a 'rewiring' of the global economy. There is considerable optimism about achieving progress towards this paradigm, but pessimism about meeting the ambitious goals needed to develop enough energy supply for global economic growth while stabilising the climate at less than a 2^{0} C temperature increase.

The Need for a Paradigm Shift

1. Current trend lines in global energy use project large increases in the consumption of fossil fuels due to population and economic growth, leading to steadily rising levels of greenhouse gas (GHG) emissions. Thus, the International Energy Agency's (IEA) baseline scenario for global CO_2 emissions shows annual emissions increasing from 25,000 million tonnes (Mt) in 2003 to almost 60,000 Mt in 2050. Scenario A2 from the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC), based on a 'business as usual' (BAU) approach, contains a significant relative probability of temperature increases greater than 3^0 C by the end of the century.

2. Yet, climate change analysis predicts that if global warming increases to more than 2^0 C above the temperature in pre-industrial times, there will be a substantially increased risk of major, irreversible change to the global climate system, resulting in much greater physical damage and economic cost. In order to minimise the risk that global warming will exceed 2^0 C, the concentration of atmospheric CO_2 should remain below 550 parts per million (ppm) CO_2 equivalent, and ideally be stabilised at around 450 ppm. Atmospheric CO_2 concentrations are already at 400 ppm and so would need to peak by 2010 to stabilise at less than 450 ppm. A reduction of up to 50% in global GHG emissions compared to 1990 levels is required by 2050 in order to stabilise atmospheric concentrations below 550 ppm.

3. Consequently, the European Union (EU) as well as individual European countries have begun setting long-term targets for reducing GHG emissions. Within these overall targets there are other agreed upon objectives for energy efficiency gains and low carbon technology deployment. The EU has agreed to a 20% reduction in its GHG emissions by 2020 from 1990 levels, and to a 30%

reduction if there is also an international commitment to do so. The UK's 2007 Energy White Paper has the goal of reducing 2020 emissions by more than a quarter relative to 1990, and 2050 emissions by 60%. Germany has already reduced its national emissions by 18% compared with their 1990 level. However, major issues related to national burden sharing in meeting EU targets await resolution.

4. Beyond Europe, Japan's "Cool Earth 50" initiative of May 2007 has proposed a 50% cut in global GHG emissions by 2050 as an agreed upon target for the entire world. The United States has to date emphasised voluntary initiatives to help achieve emissions reductions, entering into the Asia-Pacific Partnership (APP) with China, India, Japan, Korea, and Australia. APP is a collaborative arrangement designed to promote development of low carbon emitting technologies. Individual US states have gone further and adopted various forms of mandatory measures to reduce GHG emissions. California, which is the world's seventh largest economy and twelfth largest carbon emitter, has put a cap on the state's emissions through the passage of a Global Warming Solutions Act.

5. However, most of the growth in GHG emissions is now coming from the developing world, so simply prolonging the model of the Kyoto Protocol, whereby the developed economies lead the way in demonstrating how to achieve emissions reductions, will be very inadequate to the magnitude of the task. In a dramatic manifestation of this new reality, China will shortly overtake the United States as the world's largest carbon emitter. While China has eschewed the setting of emissions reductions targets, it is attempting to achieve significant increases in energy efficiency and renewable energy use. There is also a growing realisation in India that environmental concerns need to play an increased role in energy development, and that renewable technologies such as wind power can provide a future hedge against rising conventional energy costs.

The goal of greater energy price stability is also a major driver of renewable projects in Mexico, as a larger basket of technologies can help cushion the impact of fluctuations in fossil fuel prices.

6. Yet, electrification, economic growth, and energy security rather than GHG emissions reduction constitute the overwhelming priorities in the developing world. There are 1.6 billion people in the world without access to electricity, 600 million of whom are in India, and 2.4 billion who cook using traditional biomass fuels. Excluding South Africa, 90% of the population of sub-Saharan Africa is without electricity. Energy has not featured prominently on the international development agenda, but there is now growing realisation that the Millennium Development Goals (MDG) cannot be met without improved energy access.

7. The Indian government is pursuing an ambitious plan to electrify all households by 2012. The supply-demand gap rather than environmental issues drives most energy developments in India. The goal of maintaining high levels of economic growth constitutes the most important driver of Chinese energy policy. The SRES's A1 scenario, also based largely on continued BAU energy policies, reflects the huge pressure on carbon emissions stemming from the drive for economic growth in the developing world. It projects, for example, that by 2030 Latin America will produce 662 Mt of industrial CO_2 emissions to North America's 450, and sub-Saharan Africa 430 Mt to Western Europe's 316. The daunting global challenge is to produce 2.5 times more energy than today but with only half of today's carbon emissions.

8. Thus, the world remains on a path of rapidly increasing GHG emissions, and it will be very difficult to achieve dramatic, long-term emissions reductions targets. An IEA 'accelerated technology scenario', based on financial incentives equivalent to US$25/tonne CO_2 and on relatively optimistic assumptions regarding advances across all low carbon technologies, would result in lowering

2050 emissions almost to the level of 2003. The IEA has not estimated the cost of a 50% emissions reduction by 2050, but it is an extremely demanding target and is likely to be very expensive to achieve. SRES emissions scenario B1, which has a high relative probability of limiting climate change to less than 2^0 C, requires financial incentives of up to US$100/tonne CO_2 and a tripling of R&D on energy technology, investing billions of dollars to move ahead simultaneously on efficiency, renewables, nuclear, and carbon capture and storage (CCS). The Stern Review in the UK on the economics of climate change concluded that adverse impacts from climate change will start to go up rapidly; delaying mitigation could therefore be both dangerous and even more costly.

9. An internationally agreed upon paradigm shift is urgently needed that can simultaneously restrain energy demand growth, drive new production towards low carbon sources, and provide sufficient, secure energy supply for global economic growth. The World Economic Council (WEC), an energy industry association, has encapsulated this paradigm shift as '3 A's': accessibility to affordable and modern energy services for all; availability of reliable and secure energy supplies; and acceptability of energy services and supplies with minimal environmental damage and without compromising future welfare. All three of these elements are critical to the formulation and success of a new global, energy policy paradigm.

10. A broad range of instruments are required to implement such a new paradigm. These instruments include:

- measures to create markets for low carbon technologies by putting a price on carbon emissions or by enacting different forms of 'command and control' regulations and standards.
- Government support for research, development and deployment (RD&D) can help push out new low carbon technologies to meet newly created market demand.

- Education and information for both consumers and stakeholders has a critical role to play in bringing about behavioural change. Consumers, for example, need information to enable them to distinguish between high and low-carbon goods and services.
- International collaboration, technology transfer, and financing assistance are essential in order to give all of these instruments greater effectiveness and to help developing countries take up low carbon energy supply options.

Carbon Pricing

11. Carbon pricing can provide major economic incentives for boosting the deployment of low carbon energy technologies by sending a strong signal to the market that will drive marginal decision-making on what technologies to deploy. The early entry costs for new, low carbon technologies are generally very high, so carbon pricing provides a mechanism to make them competitive with long established fossil fuel technologies. A high cost of oil by itself does not provide an adequate substitute for carbon pricing, as it will not necessarily result in greater deployment of low carbon technologies. High oil prices can also lead to transformation technologies such as coal to liquids, which are heavy GHG emitters.

12. A carbon tax provides one approach to its pricing. One benefit of a carbon tax is that it can be more administratively efficient than a cap and trade scheme, which has very large administrative costs. An argument against carbon taxes states that they are very blunt instruments with no guarantee of delivering the desired results. Increased taxes on petrol, for example, may not deliver any reduction in consumption.

13. Emissions cap and trade schemes have taken a leading position amongst carbon pricing initiatives due to their ability to reduce the overall global cost of action on climate change by allowing companies to seek out the cheapest possible abatement opportunities. Verification mechanisms are a key tool to support cross border trading of allowances to ensure that carbon reduction will actually take place. Many multinational companies, accepting that the world must take steps to manage GHG emissions, have embraced the cap and trade approach to carbon pricing as the most cost effective means of creating an agreed international framework for their long-term investment decisions.

14. A cap and trade approach seems most suitable in the case of power generators and other large emitters that can engage in 'make or buy' decision-making (make operational adjustments to lower their emissions or buy additional emissions allowances). Smaller emitters and others with insufficient scope for the 'make or buy' premise to apply, may be more appropriately subject to regulatory command and control measures. Thus, governments have resorted to command and control regulations in areas such as vehicle standards and domestic energy efficiency.

15. Nonetheless, the functioning to date of the EU Emissions Trading Scheme (ETS) has raised questions whether cap and trade schemes will achieve real reductions in GHG emissions. The initial 2005-2007 start-up period for ETS mostly allocated allowances for free, and set insufficiently ambitious levels for emissions reductions. The carbon price consequently collapsed due to the over allocation of credits, which could not be carried over into the second phase of ETS and therefore had to be sold at bargain prices. Emissions reductions that have occurred in Europe from 1990-2010 are largely due to unique factors that are non-recurring, such as the bankruptcy of many heavily polluting businesses in Eastern Europe and the much greater use of natural gas in the UK. Germany

is the only Western European country that has already achieved significant emissions reductions on a sustainable basis.

16. Thus, Western European countries are only meeting their emissions reductions commitments under the Kyoto Protocol through the purchase of offsets under the Clean Development Mechanism (CDM). The distribution of emissions reductions between the developed and developing world constitutes an important issue in considering the future evolution of ETS. The use of offsets through the CDM can reduce GHG emissions worldwide at lower cost, but without lowering them in the developed world. Some observers believe that European use of offsets should decline in the next phase of ETS so that greater actual emissions reductions take place there, otherwise the scheme could lose credibility. The next phase of ETS will be a critical period for convincing other countries to enter into a global emissions trading scheme, an important consideration to take into account in thinking about the role that offsets should play.

17. It was arguably understandable that Europe took a cautious approach to its initial phase 1 experience with ETS. There will now be a mandatory banking of emissions allowances between phase 2 (2008-2012) of ETS and phase 3 (post 2012), with regulators able to tighten the allocation for phase 3 if there is an oversupply during phase 2. According to one estimate, a 17% cut in the emissions cap for phase 3 relative to phase 2 (already double the cut from phase 1) will be needed to achieve the EU's 20% emissions reduction target by 2020. Europe is potentially heading towards emissions caps that, together with decreased use of CDM offsets, will drive up the price of carbon allowances under ETS to around €35/tonne.

18. This price may still be insufficient to make deployment of most renewable technologies commercially viable. If all future ETS emissions credits were auctioned it would raise some €60 billion in revenue, which could subsidise the deployment of renewable technologies. However, the EU will only auction up to 10% of emissions allowances for the second phase of ETS, and the idea of 100% auctioning for the third phase is politically controversial.

19. While ETS has not had a major impact to date in reducing GHG emissions in Europe, it has constituted the driving force behind substantial activity in the CDM market. In addition to ETS, Japan has a pilot voluntary emissions trading scheme (JVETS). Emerging schemes could see new players come into the market for carbon credits, such as California and other US states as well as the federal and state governments in Australia.

20. There are currently approximately 2.2 billion potential Certified Emission Reductions (CERs) in the pipeline, although many will not come to fruition. Nonetheless, CDM has been providing access to financing for a wide range of technologies. Shortcomings in the CDM market have included its geographic concentration in a relatively small number of countries, notably China, India, Brazil, and Mexico. It has also been hampered by inadequate infrastructure and bureaucratic delays in the approval process. The process is improving in some instances, but seems likely to remain frustrating. Moreover, CDM project activity is starting to decline due to uncertainty regarding the details of ETS implementation beyond 2012 and more broadly the shape of an international post Kyoto regime.

21. Overall, emissions cap and trade schemes can only provide robust support for low carbon technology deployment if suppliers in the market believe that the price of carbon will be sustained over the long term. Otherwise, these schemes will not exert sufficient influence over investment decisions with horizons that

stretch out for decades. Investors need to be confident that policy will not change, and that if targets are not reached compliance mechanisms will come into play.

Command and Control Instruments

22. Carbon pricing by itself is not sufficient to create the desired uptake of energy efficiency and renewable technology options. In fact, there are a range of energy efficiency gains, such as insulation improvements, that would pay for themselves without any carbon price, but which hardly any countries have taken up on anything like a universal basis. In the US, for example, 65% of all homes are under insulated according to one estimate. The inability of companies and consumers completely to harvest this “low hanging fruit” highlights the need for command and control instruments, and there is no area more important for their use than that of energy efficiency enhancements, it is argued.

23. GHG emissions in 2004 would have been 56% higher if energy efficiency had remained at 1973 levels. After rapid gains from 1973-1990, however, the rate of energy efficiency growth slowed during the 1990s. Yet, the biggest carbon savings, equal to 60% of current emissions, could be gained through energy efficiency improvements, including almost 25% from measures such as improvements to building insulation that carry no net life cycle cost.

24. Moreover, without substantial, rapid increases in energy efficiency, new energy supply options are likely to come too late, be too small, and cost too much to stabilise the climate at a sufficiently low level and to expand access to energy for sustainable development. Consequently, the UN Foundation has proposed that G8 nations should double their annual energy efficiency improvement to an average rate of 2.5%, although countries that have already made major progress, such as Japan, should not be penalised and should

therefore have a lower target rate. Government efforts in the area of energy policy have focused to date above all on supply rather than demand, so there is a pressing need for greater focus on the latter area.

25. A range of command and control instruments are available to change companies' and people's energy-consumption patterns. Many countries are now setting energy efficiency targets, and the EU has established an overall European goal of a 20% gain in energy efficiency by 2020. The Chinese government has targeted a 20% reduction in the energy intensity of the Chinese economy between 2005 and 2010, and a 3% annual reduction from 2010 to 2020. It is attempting to meet these targets by phasing out energy intensive technologies and by improving energy efficiency in the transport and building sectors.

26. Buildings and homes constitute a critical area for energy efficiency gains. Buildings are the single most important contributor to GHG emissions, creating for example 39% of $C0_2$ emissions in the United States. Governments need to take a range of measures in order to exploit fully the potential efficiency gains available from buildings and homes. They must help tailor incentives for the construction of energy efficient buildings and homes. Mobilising public support to use low carbon technologies is also essential. For example, governments need to distribute information on the energy efficiency performance of buildings and homes as well as feedback to the public on the impact of its own behaviour.

27. Energy and building codes should be optimised on the basis of life cycle rather than upfront costs. New technical building codes in Spain, for example, will increase building costs by 0.5 to 0.8%, but the resulting energy savings will recover those costs. The codes should expand opportunities for using solar power in Spanish buildings. In Russia, the energy efficiency of new buildings has improved 40% since 1995, and they are now at a level comparable to those in

Germany. These gains have resulted from a new set of mandatory building codes and standards, which are verified during design, although not during the actual building process.

28. The ability to enforce building codes is vital. China, where massive new construction is taking place, has good building codes and standards, but they are not enforced evenly from one city to another. They also only apply to urban sites, but 70% of the Chinese population lives in rural areas, which do not have any codes and standards.

29. More dramatic possibilities for energy efficiency enhancements in the housing sector should emerge in the future. In Denmark a project is underway on 'passive homes' that would reduce home energy consumption by a factor of ten compared to the current standard. The UK's Energy White Paper contains a number of proposed command and control measures to realise greater energy efficiency, including a Carbon Emissions Reduction Target (CERT) that would double the requirement on energy suppliers to deliver energy efficiency measures to households. A public consultation will take place on making all new British homes 'zero carbon' by 2016.

30. Many governments use 'portfolio standards' to promote renewable energy development, requiring electricity suppliers to source a specific and annually increasing percentage of the electricity they provide from renewable sources. In the US, California has a portfolio standard requiring 20% of the energy consumed in the state come from renewable sources by 2010. China's renewable energy law has given substantial impetus to renewable energy development, with an overall target of increasing total energy from renewables from 10% in 2010 to 16% in 2020.

31. The EU has set an overall target for renewable energy to constitute 20% of Europe's total energy mix by 2020. As in the case of the EU's overall emissions reductions target, the 20% renewables portfolio standard's distribution between member states raises difficult burden-sharing issues tied in part to assessment of the potential for renewables use as well as to the level of renewables use already achieved. Within this context, the UK is considering tripling its national 'renewables obligation'.

32. In Europe, Germany and Spain have successfully employed 'feed-in tariffs' to support the deployment of renewable technologies. China is also using feed-in tariffs. The tariffs establish a regulatory, minimum guaranteed price that utilities have to pay for low carbon emitting power generation. Feed-in tariffs have secured Germany as first and Spain as second in the world for installed wind power. The Spanish government has also encouraged the public to accept the installation of wind farms by informing communities of the benefits accruing from them, such as employment opportunities, and by offering new amenities such as swimming pools.

Supporting Low Carbon Technology Development and Deployment

33. Government support for R&D can help bring the costs of low carbon technologies down to a level where the impact of carbon pricing will take effect. The Stern report argued a strong carbon price should be complemented by active public policy measures to promote low carbon technologies.

34. However, deployment support, such as financial assistance for demonstration plants, remains controversial. Since the 1970s, governments have tended to be wary of technology deployment support, but one view argues they have since learned how to provide such support more effectively. Other experts question

whether industry should receive subsidies for attempting to commercialise new technologies since at some point it will profit from their deployment.

35. One potential approach is to eliminate deployment subsidies for established technologies and focus them on new ones, at least for the early stages of commercialisation. For example, carbon prices will take quite some time to reach a level high enough to make the deployment of Carbon Capture and Storage (CCS) power plants a commercially viable proposition. Subsidies may be a necessity for low carbon technologies that remain beyond the carbon price and abatement curve. Overall, there seems little doubt that greater investment is needed in low carbon energy technology RD&D on the part of all stakeholders (government, industry, and the financial community). A variety of approaches are feasible for providing financial assistance and incentives in support of renewable technologies.

36. China has created a renewable energy fund to cover R&D, and is considering a reduction in taxes on renewable energy. India's Electricity Act of 2003 contains a variety of measures beneficial to the deployment of renewable technologies, and the government has supported renewable energy development through subsidies for R&D and demonstration projects. Renewable energy in India has also benefited from the creation of a dedicated investment organization, the Indian Renewable Development Energy Agency (IREDA), that helps launch private financing for renewable energy projects. Yet, progress has been somewhat limited due to the absence of either a national portfolio standard or feed-in tariffs that can compensate for the higher cost of renewable energy sources compared to more mature, proven conventional technologies.

37. Mexico has enacted an energy exchange programme that places energy into a ‘bank’ during surplus periods, and withdrawn during deficit phases. This programme consequently eliminates the intermittency problem of renewable energy, reducing the risk for investors in renewable energy projects.

38. The structure of the electric utility market can have an important impact on the operation of financial incentives for adopting low carbon emitting practices and technology. In the United States, for example, about half of the states have competitive electricity markets, while the others have integrated markets where one regulated utility is responsible for generation, transmission and distribution. The state regulator decides the utility’s rate of return. This structure is a considerable barrier to the deployment of new technology because the state regulator will not approve paying the higher cost. The utility’s rate of return is tied to the level of consumption, and it has no incentives to encourage energy efficiency. In a competitive market environment there is more leeway to provide financial incentives to utilities to deploy new technologies and to promote energy efficiency.

39. There is substantial promise for renewable technologies to generate power. There have been dramatic efficiency improvements in wind energy, which according to one estimate could potentially provide 20% of global power generation over the medium term. Solar power arguably has the most exciting technology curve for the future, and analysis suggests it could assume a dominant role in electricity production during the second half of the century. For example, China perceives huge future potential in solar power. The cost of thermal power in a hot climate country such as Spain is near market prices, and it could become fully competitive within several years.

40. The growth in coal-fired electricity generation is projected to be the single largest contributor of new GHG emissions over the next fifteen years, with China and India together accounting for roughly half the projected increase in emissions. Many observers therefore view commercialisation of CCS technology as urgent alongside measures to enhance energy efficiency and renewables use. CCS technology is already available for deployment, but is only cost competitive at a carbon price in the range of US$50-100/tonne. This range is significantly higher than the likely carbon price that ETS will create, so the challenge is how to make CCS economically competitive at a lower price.

41. Industry experts believe the cost of CCS could drop rapidly in a competitive environment if governments are able to create a market for it. A portfolio standard for CCS could provide one means of dealing with this cost competitiveness problem during a transition period. Governments must also put in place a regulatory framework for geological storage, with large scale deployment of CCS then needed in order to verify whether it can really deliver the hoped for technical and financial performance. The EU is planning to build 10-12 large CCS demonstration plants by 2015.

42. China views CCS as a promising technology and welcomes international assistance with its development and deployment. However, China does not want to become overly reliant on CCS as it is seen as more of a longer term option. After energy efficiency, China's top priority is to reduce reliance on coal through greater use of clean energy sources. While renewable energy is developing very quickly in China, most of the technology comes from Western countries. It will be important for China to develop its own renewable technology in future.

43. Bio-energy constitutes the primary supply side option for reducing carbon emissions from the transport sector. It could potentially provide some 20-25% of global energy demand using currently available technology, and could therefore

constitute a key means to foster a low carbon economy. However, the management of bio-energy presents three challenges. The first is that tropical areas are most suitable for bio-fuels, but the greatest per capita consumption of them is outside the tropics. Secondly, development of the bio-fuels market will require a change in trade rules, entailing difficult negotiations within the World Trade Organisation (WTO). Europe will need to import bio-fuels from the developing world in order to meet its 10% bio-energy target for 2020. Thirdly, governments must give careful consideration to ensuring that bio-energy does not harm bio-diversity and food security. A strong argument can be made that only countries with surplus land should develop bio-fuels. China, for example, has banned further bio-fuels development due to its impact on food prices.

44. There is concern over the extent of net GHG savings from bio-fuels given the input costs, although they could still play a useful role in providing for greater energy security. The transport sector constitutes by far the greatest area of energy import dependence for most countries. The development of next generation technology using cellulose may be a prerequisite for bio-energy to reach its full potential as a low carbon technology option.

45. In the aviation sector, new airframes and engine designs have produced 10-20% gains in energy efficiency. This new technology is now locked in for the next 40 years, however, and a mere few years aviation growth will wipe out the emissions reductions resulting from these efficiency gains. Additional efficiency gains could emanate from changes in operational practice, but there are institutional restraints and sovereignty barriers to doing so. Aviation currently only accounts for around 2% of global carbon emissions, but this percentage could rise dramatically in coming decades. The total climate impact of aviation emissions is also double that from CO_2 alone due to the combination of NO_x/O_3 and contrail/cirrus effects. Emissions trading, offsetting, and taxes could all provide revenues to help reduce emissions in other industrial sectors to

compensate for increased levels from aviation, but would require international agreement.

The Need for Effective International Collaboration

46. International technology cooperation helps to achieve a more diverse global portfolio and to reduce the costs of key technologies by providing access to a larger market. It allows sharing knowledge, co-ordinating R&D support, and hence pooling risk and reward. Coordinating R&D on an international basis requires multiple fora to share information and robust IEA technology networks.

47. International exchange of information on 'best practices' can play an important role in moving towards a low carbon economy. The IEA is carrying out a multinational comparison of existing building codes, which should be helpful in assessing which codes work best and why. The Renewable Energy and Energy Efficiency Partnership (REEEP) will publish a global review on energy efficiency in 2008. It also identifies barriers to progress on renewable energy and energy efficiency, and carries out projects, mainly in developing countries, to overcome those barriers. The Renewable Energy and International Law (REIL) project, in association with REEEP, specifically addresses legal and policy issues affecting the development of clean energy markets, and provides an international network bringing together policymakers, financiers, and industry officials.

48. Beyond information sharing and R&D co-ordination, technology transfer to the developing world is critical to the reduction of global GHG emissions. China and India should constitute major targets for international technology and financing assistance with regard to CCS as well as other low carbon technology investment and energy efficiency initiatives. The EU has an active energy cooperation programme with China, especially on CCS, and could consider in the future providing financing assistance to Chinese CCS deployment. India is also

interested in working with foreign partners on clean coal technology, propelled by the assessment that the country will have to live with coal for at least the next twenty-five years.

49. Attracting international investment from the private sector is complicated. In the case of China, the dominant role of state owned enterprises (SOE) still comprise 60% of China's GDP. Economics and efficiency are not necessarily the primary drivers of SOE decision-making. Moreover, while a 1% long-term rate of return is acceptable for Chinese companies, it is far below Western investor expectations. Attracting capital for investment in Chinese industry is therefore difficult. Since energy technologies are owned by private companies, it may be necessary to develop new approaches for private sector technology transfer and investment in China and other developing country markets.

50. In addition to promoting both technology collaboration and information sharing between its six participating nations, the APP has attempted to leverage government involvement and funding contributions to help catalyze innovative public-private partnerships. The Asia-Pacific Partnership (APP) has received grant requests totalling US$168 million and has endorsed over 100 projects. One project resulted in the construction of the world's largest coal mine methane powered facility in China, which APP claims will prevent the annual emissions equivalent to one million cars.

51. Above all, agreement on a new climate change framework to replace the Kyoto Protocol is needed to enable far-reaching international collaboration, technology transfer, and financial assistance. In the absence of an agreed international framework major equity issues are likely to arise, with some countries' viewing others as not pulling their weight. The result will be less all round effort on emissions reductions. This reality is already reflected in the EU's position that it will only adopt a 30% emissions reduction target for 2020 if there

is broad international agreement to do so. Extensive international participation in emissions cap and trade schemes will give a renewed, enhanced impetus as well as critical long-term credibility to the market for carbon offsets, which is an essential instrument for stimulating technology and financial transfers from the developed to the developing world.

52. Japan has proposed three overarching principles to guide the creation of a post-Kyoto international framework for global emissions reduction. These principles are:

- that all major emitters must participate,
- that the framework must be flexible and diverse in order to take into consideration the circumstances of each country, and
- that it must achieve compatibility between environmental protection and economic growth by utilising energy conservation and other technologies.

53. A flexible framework implies an ability to incorporate countries' working with different instruments, such as a carbon tax versus a cap and trade scheme. It should also be able to facilitate links between different cap and trade schemes in order to allow countries to achieve their objectives more efficiently. Constructing such a framework will require a great deal of national transparency, using common metrics where possible, such as the price of carbon. However, reaching international agreement on a target carbon price may be extremely difficult. Europe's potential carbon price of €35/tonne during the second and third phases of ETS will probably be unacceptable in the United States and Australia. Given the high EU carbon price that could emerge, it may be difficult to link EU ETS with other compliance markets.

What Next?

54. Energy supply fuels economic growth, which in turn drives increased energy demand. Developing countries' access to energy must be improved if they are to achieve growth and poverty reduction. The international community is confronting the fundamental question of whether the supply of fuel and infrastructure investment can keep pace with rising energy demand in a growing and urbanising world, while at the same time managing the consequences for the global environment to avoid catastrophic effects. There is a strong argument to give priority to low carbon energy supply over other environmental concerns. Large hydropower projects could be a massive, hitherto largely unexploited, clean energy source for sub-Saharan Africa, but opposition from non-governmental organisations in developed countries has blocked support for them.

55. Wind and solar power look set for substantial growth, especially if supported by ambitious emissions reductions targets along with command and control measures such as portfolio standards and feed-in tariffs. Widespread use of CCS and bio-fuels, however, awaits resolution of key technical and commercialisation issues. Emissions from the aviation sector remain a difficult problem with no direct technology solution in sight. There is tremendous energy inefficiency in the developing world, and a strong focus on energy efficiency as well as on establishing the viability of CCS technology as rapidly as possible would appear to be major priorities.

56. Overall, there still appears to be a very large gap between the level of effort that countries are willing to make to stabilise the climate and the level of effort that is needed, with no clear way ahead to bridge this gap. As a starting point, Europeans argue the US will need to accept some form of legally binding emissions reductions. Europeans believe strongly that the voluntary, bottom up

approach Washington has advocated to date, as embodied in the APP, will not produce sufficient progress on emissions reductions, even if it may very well lead to some interesting technology approaches.

57. If the US does not undertake to enter into a mandatory international framework for emissions reductions, China will certainly not do so. China does not currently have a post Kyoto strategy and is waiting to see what positions other countries take. China regularly points out that its per capita emissions are still low, that it has not been a major emitter for very long, and that Western companies have built many heavy manufacturing plants in China, raising the issue of who should bear responsibility for at least some part of Chinese emissions. There is considerable support for the view that developed countries need to take on the toughest commitments to reduce GHG emissions, with developing countries treated in a variable way.

58. Many argue implementation of a new energy paradigm requires a 'rewiring' of the global economy. There is considerable optimism about achieving progress towards this paradigm, but pessimism about meeting the ambitious goals needed to develop enough energy supply for global economic growth while stabilising the climate at less than a 2^{0} C temperature increase.

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