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Authors: Deborah Murphy, John Van Ham and John Drexhage

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International Institute for Sustainable Development
161 Portage Avenue East, 6th Floor
Winnipeg, Manitoba
Canada R3B 0Y4
Tel: +1 (204) 958-7700
Fax: +1 (204) 958-7710

E-mail: info@iisd.ca
Web site: http://www.iisd.org/

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Abbreviations and Acronyms

BAT	Best Available Technologies
CCS	Carbon Dioxide Capture and Storage
CDM	Clean Development Mechanism
COP	Conference of the Parties
CTI	Climate Technology Initiative
DD&D	Development, Deployment and Diffusion
ECA	Export Crediting Agency
EGTT	Expert Group on Technology Transfer
EU	European Union
FDI	Foreign Direct Investment
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Green Investment Scheme
IEA	International Energy Agency
IET	International Emissions Trading
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
JI	Joint Implementation
LOI	Lines of Inquiry
MOP	Meeting of the Parties
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
ppm	parts per million
R&D	Research and Development
SCCF	Special Climate Change Fund
UNFCCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organization
ZETT	Zero Emission Technology Treaty

1.0 Introduction

1. This paper examines how a global climate regime for post-2012 could more effectively promote the development, deployment and diffusion (DD&D) of appropriate technologies.

2. Technology is expected to play a critical role in the mitigation of and adaptation to climate change, and achieving the objective of the United Nations Framework Convention on Climate Change (UNFCCC) (Article 2) to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The Intergovernmental Panel on Climate Change (IPCC, 2001) estimated that emission reductions of more than 60 percent would be necessary to stabilize global concentrations at 2001 levels. Meeting the long-term objective of the UNFCCC will require, over decades or centuries, that society reduces GHG emissions to near zero. To achieve the required reductions will require a significant transformation of the conventional technology used to produce and distribute energy, manufacture goods and enable transportation (both the mode and fuel).

3. The deployment and diffusion of existing technologies, as well as the DD&D of new technologies will be essential to stabilize anthropogenic GHG concentrations. Pacala and Socolow (2004) note that stabilizing emissions at 500 parts per million (ppm)[1] requires that emissions be held near the present level for the next 50 years, even though they are projected to more than double due to population growth, poor countries getting richer and the failure of wealthy countries to reduce greenhouse gases. There is widespread agreement (e.g., IPCC, 2001; Pacala & Socolow, 2004) that known technologies could reduce emissions significantly from the business as usual trends in the short-term. For these technologies, development is not the issue, more critical is their effective deployment and dissemination in all countries. Over the long-term, the current portfolio of technologies is unlikely to reach the objective of the UNFCCC, indicating that increased technology DD&D is critical.

4. Article 4 of the UNFCCC states that Parties are committed to "Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control reduce or prevent anthropogenic emission of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors." Technology transfer is defined by the IPCC (2000, section 1.4) as the:

   > broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions.... The broad and inclusive term "transfer" encompasses diffusion of technologies and technology cooperation across and within countries.

5. Much work has been undertaken to promote technology transfer within the UNFCCC regime, including the adoption of a framework on the transfer of technology, the establishment of an Expert Group on Technology Transfer (EGTT) that aims to enhance the technology transfer goals of the UNFCCC and the establishment of the Special Climate Change Fund (SCCF) that is intended to support activities in the areas of, *inter alia*, adaptation and the transfer of technologies.

6. In the context of the UNFCCC, technology transfer has generally referred to the transfer of technologies from developed to developing countries, despite the definition in the IPCC special report, which also correctly points to the potential of technology transfer on a South–South basis or between industrialized

[1] Proposals to limit atmospheric carbon dioxide to a concentration that would prevent the most damaging impacts of climate change have focused on a goal of 500 ± 50 ppm, or less than double the pre-industrial concentration of 280 ppm. The current concentration is ~375 ppm (Pacala & Socolow, 2004: 968).

countries. Rolfe (2000) notes that most funding under the UNFCCC has focused on needs assessments, barriers to the transfer and dissemination of environmentally sound technologies, and capacity building. In practical terms, very little transfer of hard technologies has taken place, certainly not enough to begin decreasing carbon emission trends. The lack of progress within the international negotiations has certainly contributed to this state of affairs. The controversy stems from the differing perceptions of technology transfer: developing counties have wanted developed countries to facilitate technology transfer through increased financial and technical support; while developed countries have expressed an unwillingness to share their technologies without commercial benefit and have pointed to the need for incentives for private companies that own the technologies.

7. To be effective, a future international climate change regime will need to find ways to encourage and enhance technology DD&D. Technology development could be encouraged through research programs and technology partnerships. Deployment efforts, through project-oriented initiatives and actions, could assist in creating the necessary market transformation to support the uptake of new technologies. Technology diffusion, the successful market penetration of technologies in both developed and developing countries, could be supported through the dissemination of technical information and know-how to encourage the subsequent adoption of new technologies and techniques. Technology cooperation—those efforts made to share technology research, development and diffusion, including both goods and knowledge—and technology transfer are means to support DD&D of climate-friendly technologies. Nor should the prospects for South–South technology transfer be understated—often times more similar socio-economic circumstances between developing countries might mean better prospects for sustainable technology transfer in those regions. Biofuels in transportation is but one example to consider in this regard.

8. A fully effective technology DD&D will include the creation of incentives for developed countries to expand markets and share their technologies by encouraging and supporting commercial benefits, while assisting developing countries that are unable to pay the extra price or lack the technical capacity and know-how required to deploy these technologies. This is a tall order for which there is no single or simple immediate solution. While a variety of technology DD&D approaches can be encouraged, the challenge is to identify and design those approaches that will be most effective under the UNFCCC, as well as to encourage complementary initiatives (e.g., international technology research partnerships, G8 Gleneagles Agreement on Climate Change, Clean Energy and Sustainable Development) to support the goal of the Convention. Since technology DD&D occurs both within and outside of the UNFCCC, effective technology DD&D in a post-2012 regime will need to be defined in a manner that leverages, rather than duplicates, existing mechanisms.

9. It is also becoming increasingly apparent that diversifying power fuel sources beyond traditional fossil fuels is an increasingly attractive option from an energy security perspective – non-fossil fuel sources, including renewables and nuclear, can play a constructive contribution in this process.

10. This paper examines the contribution of technology DD&D in building the post-2012 climate change regime and the role of the UNFCCC in promoting DD&D initiatives that will assist in stabilizing GHG atmospheric concentrations. Section 2.0 provides the background and context for the discussion by providing information on the technology challenge. The section also includes a brief review of technology cooperation and transfer activities in and outside of the UNFCCC. Section 3 reviews the barriers to successful technology DD&D, as well as strategies to overcome those barriers. Section 4 examines options for enhancing technology DD&D in a post-2012 regime and Section 5 puts forward key questions for discussion and moving forward.

2.0 Climate Change and Technology – An Overview

11. The goal of stabilizing atmospheric concentrations of GHGs poses a large technological challenge as world energy demand is projected to rise and new technologies will be required to meet this demand. For example, the IEA's *World Energy Outlook 2004* estimates that up to US$16 trillion will be invested in the energy sector up to 2030. The IEA estimates that total energy demand, under a business as usual scenario, will increase by

more that 50 percent between 2000 and 2030, with developing countries expected to account for 70 percent of the growth in global energy demand and two-thirds of the growth in global GHG emissions. Fossil fuels are expected to remain the primary source of energy and will meet more than 90 percent of the projected increase in demand (IEA, 2004b).

2.1 Mitigation Technologies

12. "Mitigation technologies" is a term used to describe those technologies that reduce the levels of GHG emissions, covering short, medium or long term periods. Many of the mitigation technologies focus on reducing carbon dioxide emissions from fossil fuel combustion as they form the largest share of overall GHG emissions. Commercially available technologies can play a large role in meeting the short-term goals of the Kyoto Protocol, as well as the goal of the UNFCCC over the medium-term. For example, Pacala and Socolow (2004) have outlined a portfolio of existing technologies in the form of "stabilization wedges" that could solve the climate change problem for the next 50 years.

13. The wedges focus on technologies that have the potential to produce a material difference by 2054, and include efforts beyond business as usual in the areas of carbon dioxide capture and storage (CCS), renewable energy (e.g., wind, solar, biomass fuel), energy efficiency and conservation (e.g., efficient vehicles, efficient buildings), fuel switching, nuclear fission, forest management and agricultural soils management). Many of these available technologies are not yet fully competitive under current policies and markets.

14 There is a significant potential for new investments in the short-term to utilize more efficient supply and demand-side technology as energy efficiency gains translate into both absolute reductions and a reduction in the carbon dioxide intensity of economies. Advances in energy efficiency and renewable energy technologies are required to enhance energy security, an increasingly important concept. This is a critical issue for many least developed nations that are dependent on imported oil for their energy needs, and access to energy is a key consideration for economic development and poverty alleviation in most developing countries. Energy security is also important for many developed nations, especially those that are net importers of oil and gas and reliant on supplies from around the world. Disruptions in the energy supply could have serious impacts on the economy and security of a nation.

15. Finance portfolio theory is now being used to show that diversifying the electricity generation mix at the national level to include, for example, renewable energy – can help deliver increased energy security by reducing the impact of fossil price volatility within the energy system, as well as reduced emissions. Renewable energy may have a higher capital cost, but it reduces overall system risk and cost, as its costs move independently of fossil prices. Recent research by Awerbuch (2005) highlights an important alignment in many countries of the response to climate change and energy security (security and affordability of supply, role of national renewable energy resources, energy efficiency).

16. The production of renewable energy sources is expected to rise, but these sources are projected to meet only 2.5 percent of overall global demand in 2030 under a business as usual scenario (IEA, 2004). The potential market for renewable energy is impressive in developing countries because of climate, untapped potential, geographic size and undeveloped power infrastructure. Advanced renewable energy technologies, including those in the areas of small hydro, biomass and photovoltaic technologies, will be in high demand in all developing countries. The DD&D of renewable energy technologies can have significant economic, social and health benefits. The World Bank (2000) notes that the quality of energy is low for two billion people worldwide who are dependent on biofuels, and combustion of these fuels leads to poor indoor air quality. Decentralized electricity generation based on renewable energy supplies (e.g., wind, solar, biomass) can be a key complement to grid extension in socio-economic development and lead to improved local and indoor air quality with associated health benefits.

17. There are socio-economic and geographic considerations in regard to technology DD&D. For example, China and India have large coal reserves, and economic development and energy security priorities will ensure these two countries account for two-thirds of the increase in world coal demand over the next thirty years (EIA, 2004). Given the size and projected growth rates of these two economies, clean coal technologies and carbon capture and storage (CCS) will be absolutely critical for limiting global GHG emissions.

19. Nuclear technologies can offer near-zero emission options, and China, Japan, Korea and India all plan to build more capacity. Most developed nations have not invested heavily in nuclear technologies since the 1970s, and public acceptability may inhibit their uptake in the short-term (Planet Ark, 2004).

20. Over the longer term, more advanced technologies will emerge that have the potential to further significantly reduce GHG emissions. Ultimately solving the climate problem will require the decarbonization of the world's energy supply, and many contend (e.g., Hoffert *et al.* (2002)) that revolutionary energy technologies will be needed, indicating that R&D investments are required now to ensure the necessary long-term technology DD&D. For example, technologies such as CCS, fuel cells, hydrogen systems, renewables, biotechnology and advanced vehicles have the potential to be transformational technologies in future global energy systems if cost-effective technologies are available that meet other societal requirements including health, safety, reliability, other environmental concerns and cost. There is no one clear-cut technology option for moving forward and many areas of overlap exist among technology categories, where the success of one technology depends on the success of others.

21. DD&D is also required for technologies in other sectors that are important sources of GHG emissions. Forest management practices, afforestation and reforestation can increase the size of carbon sinks and enhance mitigation. Advanced technologies in the agricultural sector, such as aerobic composting of manure and the use of air seeders to reduce fertilizer use, can reduce methane and nitrous oxide emissions. Improvements in industrial processes can reduce non-energy related emissions in such sectors as cement, iron, steel and aluminum. Landfill gas recovery and use technologies and recycling and waste containment programs can reduce methane emissions related to the disposal and treatment of industrial and municipal waste.

2.2 Technologies for Adaptation

22. Technologies for adaptation are those that "reduce the vulnerability, or enhance the resilience, of a natural or human system to the impacts of climate change" (Vladu, 2005). Examples include agricultural and forestry practices, coastal zone management, watershed management and disaster reduction and preparedness. This includes both "hard" (e.g., drought resistant seeds, air conditioning) and "soft" technologies (e.g., insurance mechanism, hazard assessment). Technologies for adaptation will be required both in the short-term as impacts of climate change are already being noted, and in the long-term as the need to adapt will grow over the coming decades. Technologies for adaptation are particularly important for developing nations, where climate change will further pressure "survival" needs such as access to drinking water and food security, as well as pose a threat to environment and heath standards. The macroeconomic costs of climate change are uncertain, but have the potential to seriously threaten development in many countries.

23.. Effective technology DD&D that leads to reduced GHG emissions and improved adaptation can lead to significant co-benefits and assist countries in meeting development goals. The health impacts of a changing climate are likely to be overwhelmingly negative, and are associated with extreme weather events (e.g., heat waves, smog, droughts, extreme rainfall), increased air pollution and water and food borne enteric diseases. Technologies for adaptation can assist countries in coping with extreme weather events, and improved air quality, which results from decreased burning of fossil fuels, can reduce the cost of health care expenditures associated with air pollution-related illnesses A report in the *Lancet* (Working group on Public Health and Fossil Fuel Combustion, 1997) estimated that strategic climate policies could prevent about 8 million deaths globally that would occur between 2000 and 2020 in a business as usual scenario.

2.3 Overview of Activities to Support Technology Development, Deployment and Diffusion

24. A number of activities and initiatives have been undertaken to support technology DD&D in the area of climate change. While too numerous to mention all, key initiatives with linkages to the UNFCCC are listed in Annex A of this report.

25. The salient point is that actions to date offer valuable lessons for the development of effective initiatives to enhance technology DD&D. Successful DD&D requires cooperation among stakeholders—including multilateral and bilateral development agencies, international and regional financial institutions, governments, research institutions and the private sector. The creation of an enabling environment (e.g., creating market conditions through policy and regulatory drivers, improved human resources, good governance) can assist in bringing together partners and creating the conditions for climate-friendly investments and focused initiatives to link climate change mitigation and adaptation with broader sustainable development goals. A key challenge for the post-2012 regime will be to identify and implement technology DD&D actions that build on current initiatives to ensure that climate change is a key consideration in investment decisions to allow for significant technology change over the medium- to long-term. This will require significant mobilization of public and private sector finance toward zero and low carbon technologies, including a determined shift toward demand and supply side energy efficiency.

3.0 Barriers to and Strategies for Technology Development, Deployment and Diffusion

3.1 Barriers

26. A number of barriers must be overcome to enhance technology DD&D. The EGTT has undertaken extensive work in analyzing barriers to technology transfer, including hosting workshops on technology needs assessments, enabling environments and innovative financing. The issue was explored in the 1998 UNFCCC technical paper, *Barriers and opportunities related to the transfer of technology.* As well, a senior level round table on enabling environments for technology transfer was held on 8th December 2003 in Milan, Italy at COP9, where discussion highlighted, *inter alia,* different technology transfer experiences, including macro and micro barriers. The session (UNFCCC, 2004a: 5) noted that "barriers exist at every state of the technology transfer process—technical, economic, political, cultural, social, behavioral and institutional." Challenges to the effective deployment and dissemination of technology in developing countries include the need to adapt technologies to local conditions, lack of supply chains, insufficient human capabilities, and lack of integral institutional structures, such as stable grids and stable investment climates.

27. The UNFCCC workshop on enabling environments (as reported in IISD, 2003) identified commonly encountered barriers to technology transfer, including failures in "reflecting economic and environmental costs in prices; enforcing regulations; ensuring awareness of relevant measures; and developing affordable cleaner technology" as well as the "high cost of patented technology, limited short-term profitability of some environmentally sound technologies, limited finance, insufficient technological know-how, and inadequate institutional capability." The report on the UNFCCC workshop on innovative financing (UNFCCC, 2004b) outlined the main barriers to accessing finance for technology transfer and noted that "many investors view renewable energy and GHG projects as compounding risk—combining risky sectors with risky markets with a risky commodity", and that future work should focus on removing the barriers in both developed and developing countries.

28. The work of the EGTT has tended to focus on barriers to technology transfer between developed and developing countries. Barriers can also be looked at in a wider context when assessing technology DD&D, which takes place within countries and regions, between developed countries, between developing countries,

and between developed and developing countries. For example, technology lock-in is a major barrier to the rapid uptake of new climate-friendly technology in all of the above circumstances. Established systems have market advantages arising from existing infrastructure, services and institutions. Fundamental shifts in technology take time, and DD&D can take decades before new technologies become widely accepted and economically competitive. Sanden and Azar (2005) note that escaping technology lock-in will be a slow process extending over decades, having to overcome such barriers as technology inter-relatedness, vested interests, legal frameworks that fit the use of historical and present technologies, and the limitations imposed by the evolved consensus over how technology should be designed limiting the vision of business and governments.

29. In developed countries, social and behavioral preferences for existing technologies and lifestyles at the household level are a major barrier, often reinforced by media and advertising. Within the business and industry sector, some may resist politically-driven technological change if there are insufficient incentives. Once built, large units of physical capital (i.e. factories, power generation plants, transportation infrastructure) can operate for many decades. In the near term, patterns of capital consumption are driven by factors largely unrelated to climate change, and will likely only use climate change as an investment decision factor when obligated to do by regulations (Lempert, *et al.*, 2002).

30. New technologies often face a major disadvantage when competing on a direct cost basis with conventional technologies - they generate fewer environmental externalities than conventional technologies, a benefit which is typically not (or not fully) reflected in market prices. Thus, mechanisms (e.g., taxes, regulations) are required to provide the right signal about the full social costs of technology choices. Price signals that reflect the negative environmental and social externalities related to energy use can improve the DD&D of climate-friendly technologies, as well as influence the diffusion of energy-using technologies that are being innovated and commercialized at a rapid rate. Jaccard and Mao (2003) note that financial instruments (e.g., emission caps, market-share requirements) that change energy prices to reflect negative externalities are becoming increasing popular, and can be directed at "fuel choices, emission levels of each fuel, and at the amount of energy consumption to provide a given level of energy services." A key consideration is how to design an international framework that can encourage price signals of similar magnitude in developed and developing countries.

31. Neuhoff (2004) argues that an uneven playing field exists because of direct and indirect subsidies. He estimates that OECD countries spent between US$20-30 billion on energy subsidies in 2002 and such subsidies may delay investment in energy efficiency and renewable energy provision. Traditional export credit guarantees by OECD countries benefit traditional energy technologies. In the late 1990s, Export Crediting Agencies (ECAs) facilitated $US17 billion annual investment in fossil energy and only US$0.8 billion in renewables. Neuhoff notes the lock-in of technologies is exacerbated by the lower production costs for conventional technologies and the adoption cost (including learning-by-doing) of adopting new, more efficient technologies.

32. Purvis (2004) notes that foreign ownership restrictions may restrict the diffusion of climate-friendly technologies. For example, China requires that all power investments over $30 million be approved by the central government, and India caps foreign ownership on energy investments over $350 million. Other barriers also impede technology DD&D, including informal administrative practices, bureaucratic red tape and corruption.

33. Weak intellectual property rights (IPR) regimes are often perceived as barriers to technology DD&D, as technology owners fear their technology may be stolen if they sell equipment without a license agreement. Development of IPR regimes in developing countries can assist those countries in attracting private sector investment, as well as encourage innovation and the development of indigenous technologies.

34. Many developing countries face additional challenges when trying to attract investment into the energy and infrastructure technologies needed for social development due to the perception of high risk and inadequate returns, alongside substantial transaction costs (van Aalst, 2004). In addition, IEA's *World Energy Investment Outlook* notes: "Investing in energy projects in developing countries and the transition economies is generally riskier than in the OECD because of less well-developed institutional and organisational structures, lack of clear and transparent energy, legal and regulatory frameworks, and poorer political and economic management".

35. Exchange rate risks are also a factor in projects where revenue is generated in local currency but fuel must be bought in foreign currency. The resulting higher risk premium means returns have to be 'significantly higher' than in OECD countries (IEA, 2004b: 76). This highlights the importance, at the national level, of creating the right enabling environments—through political and regulatory reform, together with greater local capacity, to stimulate private capital to flow to those regions. Increases in the production of renewable energy sources can also mitigate the exchange rate risk by reducing the inputs of foreign fuel.

36. Developed and developing countries also face challenges in developing and attracting technologies for adaptation. Klein, *et al.* (2005) note that the transfer of technologies for adaptation faces additional barriers when compared to mitigation technologies, in that the uptake of such technologies is dependent on the buy-in and involvement of an expanded stakeholder community, and there is unwillingness at present to provide the required funding for technologies for adaptation.

37. In summary, DD&D of new technologies are processes that can take years to decades. The identification of barriers, which vary from country to country, can assist with the identification of strategies and opportunities to overcome them. This will require a concerted effort, and the post-2012 framework could be designed to play an important role in encouraging appropriate strategies and initiatives.

3.2 Strategies

38. Much research has been undertaken on overcoming barriers and creating strategies to more broadly enhance technology DD&D. Technology "push" (e.g., incentives for investment, technology standards) and "pull" (e.g., R&D, regulations, fiscal instruments) options will be required to bring existing and emerging technologies into implementation. Many experts (e.g., Sanden & Azar, 2005) note that carbon prices needed to meet the Kyoto Protocol will likely not be high enough to create the "pull" required to develop more advanced technologies in the short-term. Thus, incentives will be required to support technology DD&D over both the short and longer term.

3.2.1 Innovative Financing Options

39. Innovative options are also required to attract financing for technology DD&D, and were addressed at the EGTT workshop on financing (UNFCCC, 2004b). A key message was that risk sharing can increase financial investment and stimulate local private sector participation. Governments have an essential role in risk management, including establishing priority investment areas, setting out framework conditions for transactions and shaping financial flows and providing a stable legislative and regulatory environment. Technology needs assessments can assist in identifying the key stakeholders and capacity building for local investors can assist in project preparation and development to improve access to finance. The workshop also emphasized the importance of seed capital (initial equity capital), as well as the need to develop a "common language" for ongoing dialogue between governments and the finance sector. An effective policy framework will be "loud, long and legal", to ensure the right signals attract capital, the rules and incentives are stable and sustained, and that the regulatory framework provides the basis for long-life capital-intensive investments.

3.2.2 Private Sector Investment

39. Encouraging private sector investment is critical for technology DD&D, as private markets have increasingly become the main avenue for the transfer of technology. Developing countries are expected to account for 70 percent of the growth in global energy demand and two-thirds of the growth in GHG emissions. Foreign direct investment (FDI) is the largest component of external funding to developing countries, and is expected to be the major player in financing energy and transportation infrastructure in both developed and developing countries. As FDI accounted for 60-80 percent of global financial flows in recent years (Violetti, 2004), private sector investment should be viewed as one of the main vehicles for ensuring that technology DD&D contributes to short and longer term climate change mitigation and adaptation, despite the fact that private investment remains low in many developing countries.

40. In this context, there is a need to ensure that the financial markets and public finance institutions are mutually reinforcing efforts to more effectively support sustainable development if the world is to stabilize GHG emission reductions over the long-term. Public-private partnerships are increasingly being used as an innovative means to promote private sector investment in climate-friendly technologies. For example, the UN Foundation (UNF) supports emerging climate change policies and promotes public-private partnerships with UN agencies that advance innovative sustainable energy programs, particularly in developing countries. UNF and the Shell Foundation have invested with the UNEP in an initiative to accelerate the market for financing solar power in India by helping two commercial banks develop lending portfolios.

41. The private sector needs to be better engaged to support technology DD&D. Private sector involvement can be encouraged through the development of incentives for companies. For example, market information that includes information about new project opportunities, potential projects and financing for projects can assist private sector companies in making investment decisions. Pre-feasibility studies can be undertaken and the information provided to potential investors. The establishment of business networks and transparent competitive solicitation processes can also promote private sector investment. Reducing the risks of investing in projects in developing countries is essential; requiring improved institutional and organisational structures, transparent legal and regulatory frameworks, and improved economic management.

42. Improvements to the protection of IPR in developing countries can assist in encouraging private sector investment for technology DD&D, although Kim (2002) reports that the effects of IPR regimes on technology transfer vary according to a country's level of development and the technological nature of economic activities. Effective IPR regimes are important for countries with accumulated indigenous capacity with science and technology infrastructure; yet IPR protection can hinder technology transfer in the early stages of industrialization. This suggests that strict IPR regimes are most likely to promote private sector investment in technology DD&D in more economically prosperous developing countries. While the protection of IPR is noted as a means to promote technology development, specific guarantees with investors may also offer a means to protect product, process and trade secrets and encourage private sector investment in climate-friendly technologies.

43. The promotion of technology DD&D to developing countries will require new and additional financial resources that can benefit both the technology provider and the technology recipient. Cost-sharing may be one means to increase private sector investment. Establishing the right price signals that account for negative externalities for could also assist in opening up markets for climate-friendly technologies, which are often not the lowest-cost option.

3.2.3 Multilateral Financial Institutions and Export Crediting Agencies

44. Multilateral financial institutions and Export Crediting Agencies (ECAs) leverage substantial private sector investments. ECAs invest or indirectly support development activities that are considered too risky for the private and/or public sector. Investments in climate-friendly technologies may be eligible for support from ECAs, and there is opportunity to encourage coherence of these activities with global climate change goals

through selectivity in the projects they support, the use of common approaches for evaluating the environmental impacts of projects and the introduction of energy efficiency and carbon intensity standards. The International Finance Corporation, which is the private sector arm of the World Bank, is increasingly supporting regional environmental business facilities, particularly small and medium size businesses that are active in the areas of energy efficiency and cleaner production methods, and other carbon finance opportunities.

3.2.4 Actions under the UNFCCC

45. Technology transfer between developed and developing nations has been an important topic within international climate change negotiations and some developing nations refused to sign the UNFCCC and Agenda 21 until developed countries more clearly committed to supporting technology transfer. Thus, technology transfer has been an incentive for developing country participation in the UNFCCC, and increased access to technology will continue to play that role in a post-2012 world.

46. The EGTT has identified and is working to improve technology transfer, and developed countries have supported technology transfer activities through both multilateral and bilateral channels. GEF support has been provided for capacity-building, technology needs assessments and technology transfer, including projects activities in the areas of renewable energy, energy efficiency and energy conservation. At COP10, developed countries pledged US$34.7 million to the SCCF to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.

3.2.5 Policies and Programs at the National Level

47. The IPCC (2001) notes that a comprehensive set of actions is needed to promote technology innovation, development and deployment. Policies and programs at the national level can enhance technology DD&D, and national governments can use fiscal measures; regulatory policies; and information, labelling, voluntary and other assistance programs to enhance technology DD&D. Lempert, *et al.* (2002) argue that government-funded research plays an essential role in developing new technologies and advancing new technologies to market readiness through such policies as tax credits, appreciated deceleration of investments reducing GHG emissions and government procurement of low-emitting technologies. Government policies can assist in reducing firms' uncertainty about new technologies and should be designed to enhance "learning by doing" to increase the likelihood that new technologies will be deployed during times of rapid capital turnover. Governments can also induce firms to retire old technologies through regulatory reform, introducing standards, infrastructure policies, and promoting information dissemination programs that promote environmentally-conscious consumer demand.

48. The OECD and IEA (2003: 19-20) promote these and other policy tools, such as cooperating with the private sector to develop and diffuse new technologies, facilitating public-private and inter-firm collaboration, seeking out opportunities for international collaboration and providing access to "learning opportunities" (e.g., protected niche markets). To ensure the involvement of the private sector in technology DD&D in developing countries, activities such as fair trade policies, protecting IPR, diversifying forms of assurance mechanisms, reducing transaction costs of collaboration and increasing public access to information about technologies are necessary. Flannery noted key roles for the public and private sectors at the 2004 *IPCC Expert Meeting on Industrial Technology Development, Transfer and Diffusion* (IPCC, 2004: 7). He stressed the need for governments to establish enabling frameworks (including rule of law, protection of intellectual property and safe and secure environment for workers and communities) to allow the private sector to bear the risks and capture the rewards of deploying technologies.

3.2.6 Official Development Assistance

49. The issue of climate change would significantly benefit from a fuller integration into the mainstream activities of development agencies. While a number of focused activities have assisted countries with National Communications and National Adaptation strategies, linkages between climate change and poverty alleviation are still not fully appreciated. This is beginning to change and increasingly initiatives of development agencies support the mitigation of and adaptation to climate change. There is substantial room for ODA to contribute to technology DD&D through projects in the areas of energy infrastructure (including renewable energy), energy efficiency, transportation infrastructure, agriculture and forestry. ODA is particularly well positioned to assist in technology DD&D in areas where the private sector is not active, such as adaptation or in gaps in the financing supply chain that create blockages to the development of commercial operations. ODA can also be used to enhance enabling environments and provide capacity building to create the necessary foundation and absorptive capacity for successful technology DD&D. Capacity building can also assist countries in identifying new technologies for their specific needs and the benefits associated with new technologies, such as improved productivity, cleaner air and water and related health benefits. For technology DD&D to be effective, it must address broader economic development and quality of life concerns. Many countries are facing increased problems with environmental degradation (e.g., air pollution) and clean technologies could help to improve health conditions.

50. Consistent with the approaches discussed in the *Climate Change and Adaptation* Line of Inquiry paper, technologies for adaptations are required that are appropriate to local circumstances. Strategies to support the DD&D of technologies for adaptation should be integrated with national plans to promote sustainable development, poverty alleviation and the Millennium Development Goals. The DD&D of technologies should account for activities in various multilateral and bilateral frameworks to ensure that synergies are exploited. As well, many technologies for adaptation are or will be developed for tropical climates (e.g., agriculture and forestry techniques), indicating that opportunities for South-South cooperation should be identified and encouraged.

3.2.7 Summary

51. In summary, a number of strategies involving a variety of stakeholders can be used to promote technology DD&D. Successful mitigation of and adaptation to climate change will require linking technology DD&D with investment cycles and integrating climate-friendly technology options in on-going investments. Such actions can be instrumental in inducing "leapfrogging" to best available technologies in developing countries to assist them in avoiding the polluting technologies of the past. This will require the establishment of an enabling environment that directs market forces to sustainable investment choices, which includes an appropriate mix of policy tools, human and institutional capacity, technology absorptive capacity and financing. Integrating new technologies through policy and practice is extremely important to induce staying power and move beyond a project mentality. Technology DD&D that builds on and complements the technology transfer work underway, could be encouraged under the post-2012 climate change regime.

4.0 Options for Technology Development, Deployment and Diffusion in a Post-2012 Regime

52. A number of options for enhancing technology DD&D in a post-2012 regime have been put forward. This section includes a review of the literature regarding these options and presents a menu of options for technology DD&D both within the UNFCCC and beyond, but complementary to and supportive of, the objectives the Convention.

53. There is no one technology or action that will induce the required emission reductions to meet the goal of the UNFCCC, but rather a suite of actions is required—of which technology DD&D will be one component. It

is important to note that the UNFCCC is only one of a number of actors promoting technology DD&D, which is a broad issue that encompasses not only climate change, but also economic development, poverty alleviation, sustainable development and energy security.

54. Philibert (2004:12) explains that actions to promote technology DD&D have the potential to ease barriers to strengthened emissions mitigation cooperation by promoting a deeper understanding of difficulties faced by countries, building confidence between countries, increasing the relationships between stakeholders in and between the various countries, and remaining engaged on common mitigation action even though countries may have difficulties agreeing on a global framework. Many experts (e.g., Sanden & Azar, 2005; Buchner & Carraro, 2005; Benedick, 2001; Philibert, 2004) agree that actions to promote technology DD&D will be most effective if they are a complement to a credible, global commitment to limit GHG concentrations. An exclusively technology-focused approach is unlikely to provide the emission reductions required, but should be considered as one component of a future climate regime.

4.1 Technology Agreements

55. Technology agreements and protocols are one option for promoting the DD&D of climate-friendly technologies. International commitments may relate to the use of common technology standards, such as energy efficiency standards for appliances, the prescribed use of low or zero-carbon technologies (e.g., minimum shares of renewable energy in energy production) or minimum standards for the energy efficiency of industrial processes or power plants. A number of proposals that could be developed under or outside the UNFCCC negotiating umbrella have been put forward regarding technology agreements and protocols. The main elements of key proposals are set out below.

4.1.1 Agreements for Technology Deployment and Diffusion

56. Barrett (2001) argues that common technology standards will provide incentives for investments in climate technology, as well as provide incentives for compliance and participation. He suggests that technology standards will be largely self-enforcing because if enough countries adopt the standards, other countries will follow common standards because of economies of scale in production and network effects. The most attractive approach would be to establish technology protocols in such areas as the use of hybrid engines, fuel cells or standards for fossil fuel power plants to capture and store carbon. Barrett's proposal would have developing countries be bound by technology standards set out in separate protocols, but the diffusion of required technologies would be financed by developed countries, with contributions based on ability and willingness to pay as determined by the UN's scale of assessments.

57. Benedick (2001) proposes a portfolio approach that emphasizes long-term international standards and incentives for technology development and deployment that aims to promote a technological revolution in energy production and consumption. The approach includes the adoption of a portfolio of policies that would be coordinated with like-minded nations and include technology targets for power generation and fuel efficiency standards for automobiles. The portfolio would include a carbon tax to fund new technology research and a program funded by developed countries to promote technology transfer to developing countries.

58. Edmonds (1999) and Edmonds and Wise (1998) put forward a proposal for a technology backstop protocol, that would serve as a backstop in the event that other options (such as tradable permits) failed. A technology-based protocol would set out medium- to long-term international technology targets and/or standards for new fossil-fuel electric power plants and synthetic fuel plants installed in industrialized countries after 2020. Developing countries would be required to do the same upon reaching identified levels of development, defined as when their per capita income has risen to the average 2020 income level for industrialized countries in purchasing power parity terms.

59. Tol (2002) proposes a technology protocol that would specify the speed at which Best Available Technologies (BAT) standards would progress, with standards only applying to developed countries.

60. Ninomiya (2003) proposes an international agreement on energy efficiency levels in major emitting industries and energy efficiency standards for major appliances in the residential and transportation sectors. The proposed agreement would complement the Kyoto Protocol and aim at participation by developed and major developing (e.g., China, India, Brazil) countries. He suggests that a global R&D fund should be considered to support the development of appropriate technologies.

61. Sugiyama, *et al.* (2003) suggest an orchestra of treaties, including three that are outside of the UNFCCC: a group of emissions markets to include countries with domestic emissions trading systems; a zero emissions technology treaty (ZETT) to foster long-term technological change; and a climate-wise development treaty (CDT) to promote development, technology transfer and adaptation. The fourth block, which would be within the UNFCCC, includes protocols for emissions monitoring and information exchange and the establishment of a fund for capacity building for least development countries and small island states. The ZETT is expected to include funding commitments for R&D, with a focus on zero-emitting technologies, while the CDT would modify flows of financial assistance to developing countries to ensure that climate issues are accounted for in development policy.

62. In summary, he proposed agreements for technology deployment and diffusion offer flexibility in the design of a post-2012 climate regime as such agreements could be undertaken under the UNFCCC or as a separate regime. Technology agreements could build on current initiatives such as the IEA implementing agreements or programs of the GEF, be developed between like-minded countries, or be set up to promote technology cooperation between developed and developing nations. den Elzen and Berk (2005) note that technology agreements are easy to monitor, enhance technology spill-over and transfer, and encourage compliance through market forces. Weaknesses of this approach include uncertainty on environmental effectiveness, difficult negotiations, technology lock-in and the possibility of reduced incentive for technology innovation.

4.1.2 Technology Research and Development Agreements

63. Many experts have indicated that increases in R&D are critical to develop new technologies for a carbon-constrained future. Technology R&D agreements can be useful components of a future climate regime by enhancing the long-term perspective and effectiveness, and making use of market forces. Cooperation on R&D can allow participants to benefit from each others' efforts, help disseminate technologies, and reduce the costs of such efforts by sharing results and preventing duplication of efforts.

64. Barrett (2001) has proposed an international agreement on R&D funding as the "push" component to his proposal for agreements on technology standards. He proposes common research efforts for the development of climate-friendly technologies, whereby countries make a financial commitment to research programs based on ability and willingness to pay. Incentives for participation would include that the results of the R&D effort would be shared among participating countries only (e.g. through shared patents). Barrett proposes a research emphasis on electric power and transportation. Sanden and Azar (2005) put forward a similar proposal whereby R&D is supported through an R&D carbon levy of US$1 per tonne of carbon to raise revenues.

65. Similar to technology agreements to promote deployment and diffusion, R& D agreements offer potential flexibility in the design of a post-2012 climate framework as such agreements could be undertaken under the UNFCCC or as a separate regime. The strengths of R&D agreements, as noted by den Elzen and Berk (2005), include an enhanced long-term perspective and enhanced technological capacity in participating countries. The weaknesses include uncertainty on environmental effectiveness, lack of market incentives to apply technologies (indicating a need for deployment agreements), and risk of selecting and promoting less effective technologies.

4.2 Sectoral Agreements

66 National or regional sectoral agreements could be related to limitation or reduction commitments for levels of GHG emissions or energy use. Watson, *et al.* (2005) note that sectoral agreements could be designed to encourage climate-friendly investments in certain sectors, or to encourage the adoption of climate-friendly policies in a sector through taxes, standards or other regulation. Schmidt *et al.* (2005) explain that sector-based approaches can be developed in a variety of forms, such as "fixed-based limits, dynamic targets, benchmarked-based, harmonized policies and measures or combinations." Sectoral agreements could be global, defining commitments or targets for specific sectors such as cement or steel production. These types of targets could work for internationally oriented sectors with a fairly limited number of actors, and the commitments could consist of emission limitations or reduction targets for the entire sector, or process-related targets such as the use of low-emission technologies. As well, country-wide sector targets could also be negotiated and, as an intermediate step in establishing sectoral targets, best practices with existing technologies could be used as a benchmark.

67. Jaccard and Mao (2002) provide examples of successful sectoral agreements, including the Renewable Portfolio Standard in electricity that requires electricity providers to ensure that a minimum percentage of electricity sold in the market is produced by wind, solar, biomass, small hydro or other designated renewables. This has been adopted by a number of jurisdictions in developed countries (Europe, North America and Australia). The Vehicle Emission Standard is focused on technologies and requires automobile manufacturers to guarantee that a minimum percentage of vehicle sales meet different categories of maximum emission levels. The policy originated in the state of California and has been adopted by other states.

68. Sectoral targets and commitments offer advantages when viewed in an international climate regime. Such agreements could be undertaken under the UNFCCC or as a separate regime, and could be voluntary or mandatory. Sectoral agreements may be easier to negotiate than other technology agreements, as they help to create a level playing field for international sectors, and could enhance technology spill-over and transfer. They are also suitable for developing countries as it allows them to address GHG emissions in a step-by-step manner. Another benefit is potential linkages with sectoral CDM. Weaknesses include the potential for carbon leakage to other sectors without targets if substitutes to the products are available (Aldy, *et al.*, 2003), and standards run the risk of being either unambitious or unachievable because regulators do not know the exact amount of improvement that is feasible.

4.3 Regional/Bilateral Technology Initiatives

69. Agreements to cooperate on climate technology are taking place outside of the UNFCCC, and a number of countries have signed bilateral agreements on technology and scientific cooperation. Buchner and Carraro (2005) note that the European Union cooperates on international science policy with more than 30 countries and is engaged in an number of technology agreements aimed at the improvement of energy technologies and climate-friendly production processes, the United States has signed various bilateral climate technology agreements (e.g. with Australia, Japan, Russia, Italy, India, China), and Japan has strengthened its role in climate cooperation with Asia, including a joint research initiative with seven developing nations aimed at providing technological assistance to these countries to reduce their GHGs in exchange for carbon dioxide emission credits.

70. The Asia-Pacific Partnership on Clean Development and Climate (signed by Australia, China, India, Japan, Korea and the USA in July 2005) aims to promote the development, diffusion, deployment and transfer of existing and emerging cost-effective cleaner technology and practices. This partnership is to be consistent with and contribute to efforts under the UNFCCC and will complement the Kyoto Protocol.

71. Regional and bilateral initiatives can promote technology DD&D between developed countries, between developed and developing countries and between developing countries. Support for south-south cooperation

can be a cost-effective means of assisting developing nations. For example, considerable expertise in the area of bioenergy exists in developing countries and would be much more easily transferable than northern solutions. Bilateral and regional technology agreements most likely would be complementary to the UNFCCC process, but proper reporting processes could ensure that the UNFCCC Secretariat or the EGTT is informed of activities and able to fulfill a coordination role to prevent duplication of efforts and encourage sharing of information and lessons learned.

4.4 Flexibility Mechanisms under the Kyoto Protocol

72. Technology deployment mechanisms exist under the Kyoto Protocol in the form of the CDM. Suggested enhancements to the CDM to encourage technology diffusion include an expansion to include policy-based CDM, sectoral crediting mechanisms, and the Japanese proposal regarding credits for technology. Sectoral crediting mechanisms would provide incentives for developing countries to develop national, regional or sectoral projects, based on the adoption of policies and measures, rather than project-based investments, to achieve emission reductions. Examples include the modernization of country's cement sector or reduction of emissions in the transportation sector. Policy-based CDM would grant credits to governments that enacted GHG-reducing policy reforms. A government might, for example, adopt a particularly strong efficiency standard in its building code, saving on the energy used in heating and cooling. The resulting emission reduction (or some portion of it) would be credited to the government. Japan plans to present a proposal at COP-11/MOP-1 in which industrialized nations would be able to transfer energy-saving technologies to developing nations as part of emissions quota transactions. The details of this proposal are not yet clear, but Japan is attempting to estimate the amount of credits that could be gained from technology transfer.

73. Joint Implementation (JI) also offers opportunity to encourage technology deployment between developed nations and economies in transition. Many Eastern European nations and former Soviet states view JI as a means to attract investment from OECD nations, as well as fulfill international commitments under the UNFCCC as they anticipate that their own countries and firms will be able to use part of the reductions to help fulfill their commitments. Many of the economies in transition aim to increase energy efficiency and reduce the environmental impacts of energy production and consumption, as many of these countries have severe problems with acid rain, urban smog and the health impacts of air pollution. JI may be able to assist with technology DD&D by encouraging projects in areas that may be difficult to secure financing (such as renewable energy and energy efficiency), and assisting in attracting private capital.

74. International Emissions Trading (IET) could also stimulate technology cooperation with and technology transfer to developing countries. Egenhofer and Fujiwara (2003: 53) argue that developing countries could import advanced technology on favorable terms if they agree to discount prices of emission allowances on sale. Hence an equal per capita emissions approach linked with IET could help developing countries strengthen their technical base. However, this kind of package would not benefit countries without excess emission allowances to sell or only with small emission allowances. Green Investment Schemes (GIS) also offer opportunity to encourage technology cooperation. These schemes could ensure that purchases of surplus emission allowances are directly linked to projects that generate real reductions. The idea behind GIS is relatively simple—revenues collected through IET could be earmarked for environmental purposes in the seller country, and the purchasing country could use it to promote appropriate climate-friendly technologies.

4.5 Technology Transfer

75. Technology DD&D could be encouraged through increased support for the framework for technology transfer established under the UNFCCC. This could assist in technology development and deployment in developed and developing countries by building on the work led by the EGTT in the areas of technology needs assessments, technology information, enabling environments, capacity building and mechanisms for technology transfer. Important work has been undertaken to identify technology needs and key stakeholders in the technology transfer process, develop a technology information system (TT:CLEAR), identify barriers

and develop strategies for governments to overcome barriers, and build capacity to identify appropriate technologies for local conditions. These actions lay the groundwork for broader technology DD&D, including attracting private sector investment.

76. Even if an international technology cooperation agreement were adopted, a large technology transfer role would remain, both to fulfil developed country obligations under Article 4.5 and to provide advice and support to developing nations in need, particularly the least developed nations which are not well-positioned to attract private investment. Actions to promote technology DD&D, such as international technology cooperation agreements, that involve developing countries should build on the work of the EGTT.

4.6 Support for Technologies for Adaptation

77. While technologies for adaptation could be, and should be, included under broader technology agreements and in technology transfer efforts, specific actions have been recommended to support the DD&D of technologies for adaptation in a post-2012 regime. These options are described in Section 6.1 of the Line of Inquiry Paper, *Climate Change and Adaptation,* and include:
    - Three Track Global Framework proposal – includes an adaptation track that would build upon the Marrakesh Funds, be funded by industrialized countries and include compensation for damages;
    - Global Climate Agreement – includes funding provided by Annex I Parties for building the adaptive capacity of vulnerable countries in line with the 'polluter-pay' principle of the UNFCCC; support for capacity building in developing countries in areas such as development of sector-specific adaptation strategies; modification of GEF rules to better facilitate adaptation projects that provide local benefits and increase capacity to access to funding; and innovative insurance schemes; and
    - Broadening the Climate Regime – puts forward an Adaptation Protocol designed to secure the transfer of funds and technology to those countries most vulnerable to the impacts of climate change.

4.7 Review of Options

78. The preceding discussion put forward a menu of options related to how the global climate regime can more strongly promote technology DD&D. Technology cooperation to support DD&D will be a long-term approach, but in the short-term it may serve as a complement to other efforts to reduce emissions and adapt to the impacts of climate change. To create the required long-term effects, it will be necessary to start directing investment toward climate-friendly technologies in the short-term and to persist with these investments thereafter. Moving forward in this regard could include a combination of approaches, as well as identifying options to build on work completed to date by building synergies with existing programs and institutions.

79. There is opportunity for technology agreements among regional or like-minded partners to create niche markets, which in turn can bring costs down and assist in diffusion to the rest of the world. Technology agreements will be a critical component of any future climate regime if it is to be effective, irrespective of whether or not such agreements are better negotiated within or outside the formal parameters of the UNFCCC. Clearly outside efforts are playing an increasingly important role: witness the many on-going efforts, including the G8 Action Plan on Climate Change, Clean Energy and Sustainable Development; Asia-Pacific Partnership on Clean Development and Climate; implementing agreements of the IEA; Renewable Energy and Energy Efficiency Partnership (REEEP); Carbon Leadership Sequestration Forum and Methane to Markets partnership. It is important that progress under these initiatives be carefully monitored and reported to the Parties to the UNFCCC (e.g., through national communications or implementation reports) so that the effective contribution of such initiatives to the objectives of the Convention and the Kyoto Protocol can be assessed. A global framework under the UNFCCC that recognizes a variety of technology agreements could assist in legitimizing their activities and ensure recognition of DD&D actions under the agreements.

80. The most likely approach for the post-2012 regime to encourage technology DD&D would be the development of a technology agreement that includes developed countries in the short-term, with economies in transition and developing countries having to satisfy the same obligations when they meet a certain level of development (e.g., per capita welfare as measured by purchasing power parity as set out by Edmonds and Wise, 1998). For example, if developed countries adopted a technology agreement on stationary source standards commitments or a minimum share of renewable energy in energy production, it could create the critical mass to encourage global diffusion of technologies. Such a technology agreement could consider obligations for new investments in the medium-term (up to 2020) and over the longer term (up to 2050).

81. A second viable option for the post-2012 regime would be an international R&D technology agreement, whereby developed nations commit to increase R&D spending and work in partnership with developing countries (an example is the Canadian government proposal that 5 percent of R&D programs be done in partnership with developing nations (Anderson, 2004)). Sectoral, technology cooperation and R&D agreements could be negotiated as an amendment to the UNFCCC, or alternatively be negotiated beyond the UNFCCC between like-minded countries as a demonstration of commitment to action to increase technology DD&D.

82. Technology DD&D is inherently a long-term approach, yet there are actions that can be undertaken in the short-term. In particular, a viable alternative might be to seek agreement at COP-11/MOP-1 on the need to begin discussions on an agreement to promote technology DD&D and how such actions can be meaningfully reflected as part of the broader commitments in the post-2012 regime.

5.0 Key Questions for Discussion

83. Technology DD&D has the potential to assist in meeting the objective of the UNFCCC. A number of proposals and ideas have been put forward that could be further developed both within and outside of the Convention. To move forward on enhanced technology DD&D in a post-2012 climate regime, a number of key questions need to be considered:

How best to ensure that climate change friendly technology efforts are effectively complemented within and outside the formal UNFCCC negotiations?

In that context, is there a more defined role for the UNFCCC in enhancing technology DD&D?

What are the realistic elements of a technology approach? Is it a necessary but insufficient condition for developing an effective future regime on climate change?

How can technology DD&D programs be integrated into, or designed to support, the UNFCCC, and where in the UNFCCC should this discussion take place?

What international architecture would correct externality costs and account for the risks of GHG emissions to allow technology DD&D to take place on a global scale?

How can technology agreements to promote DD&D be designed to best allow for the involvement of developing countries?

Is there a role for technology cooperation beyond the UNFCCC, i.e., in the form of bilateral/regional initiatives or in the form of separate multilateral agreements?

Would it be helpful as well to bring together the current international technology initiatives outside the UNFCCC under a technology umbrella? How do we ensure a source of funds for these initiatives?

Is there a role for the WTO, regional agreements (e.g. NAFTA, ASEAN, EU) or multilateral institutions in actively supporting market-based policy frameworks (e.g., intellectual property protection, removal of foreign investment restrictions) that would encourage technology diffusion?

Would a global fund to promote technology R&D with shared IPR be helpful in meeting technology DD&D goals?

How can the human health benefits of new GHG technologies be used to promote international technology DD&D while potential health risks are minimized?

How to enhance and focus efforts on technology efforts related to adaptation?

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Annex A: Overview of Activities to Support Technology Development, Deployment and Diffusion

A number of activities and initiatives have been undertaken to support technology DD&D in the area of climate change. While too numerous to mention all, key initiatives with linkages to the UNFCCC are listed below:

- Expert Group on Technology Transfer (EGTT) – established by the COP to enhance Article 4.5 of the Convention. The work focuses on five themes that are intended to be part of a strategy to create conditions for private and public technology transfer: technology needs assessments, technology information, enabling environments, capacity building and mechanisms for technology transfer.
- Flexibility mechanisms of the Kyoto Protocol – can contribute to technology dissemination and transfer, with the Clean Development Mechanism (CDM) expected to assist with technology transfer to developing countries, and Joint Implementation (JI) expected to encourage technology deployment and diffusion between Annex I countries.
- Climate Change Fund, Adaptation Fund and Least Developed Countries Fund under the Marrakech Accords – provide additional assistance for adaptation, technology transfer, energy, transport, industry, agriculture, forestry, waste management and broad-based economic diversification. These funds were designed to create conditions and leverage for private financing.
- Global Environment Facility (GEF) – as the financial mechanism for the UNFCCC, the GEF has given over $1 billion for climate change projects, and its operating program No. 7 has as one of its objectives to reduce the costs of low GHG emitting technologies by increasing their market share. The technologies emphasized in this program include photovoltaics, advanced biomass power, solar technologies, wind power, fuel cells and advanced fossil fuel gasification and power generation technologies.
- International Energy Agency (IEA) implementing agreements – includes more than 40 international collaborative energy research, development and demonstration projects (including technologies in the areas of energy end-use, renewable energy, nuclear fusion and fossil fuels, and agreements devoted to the dissemination of information).
- Climate Technology Initiative (CTI) – an implementing agreement under the IEA, the CTI was launched by OECD countries and the EU at COP1 to accelerate the development, application and diffusion of climate-friendly technologies and practices, with an emphasis on technology transfer. Its work is closely linked to the UNFCCC process, and it is an important institutional means of implementing the work of the EGTT, including supporting technical capacity building in developing countries.
- G8 Agreement and Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development – reaffirms commitment to the UNFCCC and includes actions to promote the deployment of cleaner technologies and to work with developing countries to enhance private investment and transfer of technologies.
- G8 Action Plan on Science and Technology – includes a substantive section aimed at accelerating the research, development and diffusion of energy technologies.
- Renewable Energy and Energy Efficiency Partnership (REEEP) – is an international NGO organized as a private-public partnership that actively structures policy initiatives for clean energy markets and facilitates financing mechanisms for sustainable energy projects.
- UN Agencies, including UNDP, UNEP and UNIDO – support technology transfer programs. Examples include UNEP's Global Network on Energy for Sustainable Development and the UNDP-GEF Technology Transfer Network.
- Multilateral institutions such as the World Bank, Asian Development Bank, OECD and others – develop and implement international technology cooperation programs.

- Bilateral programs on international technology cooperation – many are listed in national communications of the UNFCCC and include such initiatives as Canada Climate Change Development Fund, the US Climate Technology Partnership and the Netherlands' Miliev Programme that facilitates the purchase of climate-friendly technologies in developing by subsidizing a portion of the cost.
- Cooperation between like-minded nations – includes the International Partnership for the Hydrogen Economy, the Carbon Leadership Sequestration Forum, the International Thermonuclear Experimental Reactor and the Methane to Markets Partnership. Many of these plurilateral initiatives are relatively new and have not demonstrated substantial outcomes to-date, often because they have not secured a permanent source of funding.
- The Asia-Pacific Partnership on Clean Development and Climate – signed in July 2005, this initiative (between Australia, China, India, Japan, the Republic of Korea and the United States) aims to create a partnership to develop, deploy and transfer cleaner, more efficient technologies and to meet national pollution reduction, energy security and climate change concerns, consistent with the principles of the UNFCCC. The partnership is intended to be a complement to the Kyoto Protocol.