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Report on the analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change

Key findings

1. **The additional estimated amount of investment and financial flows needed in 2030** to address climate change is large compared with the funding currently available under the Convention and its Kyoto Protocol, but small in relation to estimated global gross domestic product (GDP) (0.3-0.5 per cent) and global investment (1.1-1.7 per cent) in 2030.

2. In many sectors the lifetime of capital stock can be thirty years or more. The fact that total **investment in new physical assets is projected to triple between 2000 and 2030** provides a window of opportunity to direct the financial and investment flows into new facilities that are more climate friendly and resilient. The investment decisions that are taken today will affect the world's emission profile in the future.

3. **When considering means to enhance investment and financial flows to address climate change in the future**, it is important to focus on the role of **private-sector** investments as they constitute the largest share of investment and financial flows (86 per cent). Although Official Development Assistance (ODA) funds are currently less than 1 per cent of investment globally, ODA represents a larger share of the total investments in some countries such as in Least Developed Countries (LDCs) (6 per cent).

4. Particular attention will need to be given **to developing countries**, because although they currently account for only 20–25 per cent of global investments, their expected rapid economic growth means that they will require **a large share of investment and financial flows.**

5. With **appropriate policies and/or incentives**, a substantial part of the additional investment and financial flows needed could be covered by the currently available sources. However, **improvement in, and an optimal combination of, mechanisms**, such as the carbon markets, the financial mechanism of the Convention, ODA, national policies and, in some cases, **new and additional resources**, will be needed to mobilize the necessary investment and financial flows to address climate change.

6. **The carbon market**, which is already playing an important role in shifting private investment flows, would have to be significantly expanded to address needs for additional investment and financial flows. **National policies** can assist in shifting investments and financial flows made by private and public investors into more climate-friendly alternatives and optimize the use of available funds by spreading the risk across private and public investors. **Additional external funding for climate change mitigation and adaptation will be needed,** particularly for sectors in developing countries that depend on government investment and financial flows.

7. If the funding available under the **financial mechanism** of the Convention remains at its current level and continues to rely mainly on voluntary contributions, it will not be sufficient to address the future financial flows estimated to be needed for mitigation and adaptation.

8. Several **other options** for generating additional funds have been suggested. Some of these options, such as the expansion of the carbon market and the auction of allowances for emissions, could generate revenues commensurate with the additional needs.

A. Mitigation

9. It is estimated that global additional investment and financial flows of USD 200–210 billion will be necessary in 2030 to return global greenhouse gas (GHG) emissions to current levels. In particular:

(a) **For energy supply**, investment and financial flows of about USD 67 billion would be reduced owing to investment in energy efficiency and biofuel of about USD 158 billion. About USD 148 billion out of USD 432 billion of projected annual investment in power sector is predicted to be shifted to renewables, carbon dioxide (CO_2) capture and storage (CCS), nuclear energy and hydropower. Investment in fossil fuel supply is expected to

continue to grow, but at a reduced rate. Currently most of the power sector investment is made by government-owned or private, usually regulated, electric utilities, and is made domestically in most regions;

(b) **For industry,** additional investment and financial flows are estimated at about USD 36 billion. More than half of the additional investment is for energy efficiency, one third for installation of CCS and the rest for reduction of non-CO_2 gases, such as N_2O and other GHG high global warming potential ;

(c) **For buildings,** additional investment and financial flows amount to about USD 51 billion. Currently commercial and residential energy efficiency investment comes from building owners and is financed domestically;

(d) **For transportation,** additional investment and financial flows amount to about USD 88 billion. Efficiency improvements for vehicles and increased use of biofuels are likely to require government policies, but the investment would come mostly from the private sector;

(e) **For waste,** additional investment and financial flows are estimated at about USD 1 billion. Capture and use of methane from landfills and wastewater treatment could reduce emissions by about 50 per cent in 2030 mainly in Parties not included in Annex I to the Convention (non-Annex I Parties);

(f) **For agriculture,** additional investment and financial flows are estimated at about USD 35 billion. Non-CO_2 emissions from agriculture production could be reduced by about 10 per cent at cost of USD 20 billion in 2030. With a concerted international effort and an annual investment of about USD 15 billion agroforestry could be expanded at a rate of about 19 million ha per year by 2030;

(g) **For forestry,** additional investment and financial flows are estimated at about USD 21 billion. An indicative estimate of the cost of reducing deforestation and forest degradation in non-Annex I Parties to zero in 2030 is USD 12 billion. The estimated investment and financial flows in 2030 to increased GHG removals by sinks through sustainable forest management is USD 8 billion and the estimated investment and financial flows needed for afforestation and reforestation is USD 0.1–0.5 billion;

(h) **For technology research and development (R&D) and deployment,** additional investment and financial flows are estimated at about USD 35– 45 billion. Government spending on energy R&D worldwide has stagnated, while private sector spending has fallen. Government budgets for energy R&D and support for technology deployment need to double, increased expenditures in 2030 are expected at USD 10 and 30 billion respectively.

10. Investment and financial flows for mitigation in developing countries are likely to be particularly cost effective. While **additional investment flows in non-Annex I Parties are estimated at about 46 per cent** of the total needed in 2030, the **emission reductions achieved by the countries amount to 68 per cent** of global emission reductions.

11. The **entities that make the investment decisions are different in each sector, and the policy and/or financial incentives needed will vary** accordingly. For example:

(a) Increased energy efficiency is best achieved through appropriate policies or regulations (the investments are internal and often incremental, and have short payback periods, but adoption is hampered by recognized barriers);

(b) Shifting investment in the power sector to CCS and low GHG emitting generation technologies will need both policies and, more importantly, financial incentives which

make these technologies economically more attractive than high GHG emitting technologies. This requires national or international policy frameworks, such as carbon markets and higher feed-in tariffs;

(c) Financial incentives will be needed to achieve significant reductions in emissions through reduced deforestation and forest management.

12. Currently most of the investment in mitigation measures is domestic; however, ODA plays an important role in Africa and the LDCs. **With appropriate policies and/or incentives, a substantial part of the additional investment and financial flows needed could be covered by the currently available sources. However, there will be a need for new and additional external sources of funds dedicated to mitigation**.

13. The **Global Environment Facility (GEF), as an operating entity of the financial mechanism of the Convention**, has allocated over USD 3.3 billion to projects addressing climate change since its inception (1991), with further co-financing of USD 14 billion. Most of the funding has been for renewable energy and energy efficiency projects. The GEF share of total multilateral and bilateral funding between 1997 and 2005 is 1.6 per cent. The next replenishment of the GEF trust fund should be concluded at the end of 2009.

14. The **carbon market** and policies to promote renewables are already playing an important role in shifting investment flows. This is indicative of how quickly investment flows can respond to changes in policies and incentives.

15. It is estimated that the clean development mechanism (CDM) project activities in the pipeline in 2006 will generate investment of about USD 25 billion, of which approximately 50 per cent represents capital invested in unilateral projects by host country project proponents. Renewable energy and energy efficiency projects account for 90 per cent of the overall investment.

16. The supply of Kyoto units will be abundant compared with to the level of compliance demand for the period 2008–2012. The voluntary market could represent about 15 per cent of the total carbon market.

17. The low estimate of compliance demand by Parties included in Annex I to the Convention (Annex I Parties) in 2030 is a market of USD 5–25 billion per year, which is basically a continuation of the current flow of projects. The high estimate of compliance demand is a market of USD 100 billion per year; to meet this demand, a large fraction of the potential emission reductions, from all existing and some new categories of projects, would need to earn emission reduction credits.

18. All Parties need to adopt **climate change policies**. International coordination of policies in an appropriate forum is often effective. Areas where international coordination would be beneficial include:

(a) Technology R&D and deployment;

(b) Energy efficiency standards for internationally traded appliances and equipment.

19. Funding from external sources will play an important role in helping developing countries formulate and implement national policies.

B. Adaptation

20. The global cost of adaptation to climate change is difficult to estimate, largely because climate change adaptation measures will be widespread and heterogeneous. More analysis of the costs of adaptation at the sectoral and regional levels is required to support the development of an effective and appropriate international response to the adverse impacts of climate change. Nevertheless it is clear that a large amount of new and additional investment and financial flows will be needed to address climate change adaptation.

21. Estimated overall **additional investment and financial flows needed for adaptation in 2030** amount to several tens of billion United States dollars. In particular:

(a) About USD 14 billion in investment and financial flows are estimated to be needed for **agriculture, forestry and fisheries** (AFF);

(i) About USD 11 billion is estimated to be needed for production and processing, most of which is expected to be financed by domestic private sources;

(ii) About USD 3 billion is estimated to be needed for research and development (R&D) and extension activities. Based on current trends, it can be expected that public sources of funding will need to cover a large part of this additional need.

(b) The additional investment needed in **water supply** infrastructure in 2030 is estimated at USD 11 billion, 85 per cent of which will be needed in non-Annex I Parties. About 90 per cent of the cost for all aspects of water resource use is currently covered by public domestic funding sources and 10 per cent by external public funding sources and this trends in unlikely to change significantly by 2030;

(c) The costs of treating the increased cases of **diarrhoeal disease, malnutrition and malaria** due to climate change are estimated at USD 5 billion in 2030. This additional need for financial flows will occur solely in developing countries and corresponds to the current annual ODA for health. The additional cost is likely to be borne mainly by the families of those affected. Where private individuals cannot cope with the additional cost of treatment, additional public financing will be necessary;

(d) The investment needed in 2030 for **beach nourishment and dykes**, is estimated to be about USD 11 billion. About half of the global investment would be needed in non-Annex I Parties. Efforts to protect **coastal areas** from coastal storms and sea level rise are typically undertaken by governments. The necessary public resources for coastal zone adaptation are likely to be available in developed and some developing countries. However, deltaic regions, particularly the large coastal deltas in Asia and Africa as well as the small island developing States, may have significant problems in raising the required investment and financial flows to respond to sea level rise;

(e) The additional investment needed to adapt **new infrastructure** vulnerable to climate change is estimated at USD 8–130 billion, which is less than 0.5 per cent of global investment in 2030. The extra cost is likely to be met in the same manner as the overall infrastructure cost.

22. The change in investment and financial flows for adaptation that will need to occur in developed and developing countries varies by sector. **A significant share of the additional investment and financial flows will be needed in non-Annex I Parties (USD 28–67 billion)**.

23. **Private sources** of funding can be expected to cover a portion of the adaptation costs in sectors (such as **AFF and infrastructure**) with privately owned physical assets , in developed countries, in particular. However, public resources will be needed to implement policies or regulations to encourage the investment of private resources in adaptation measures especially in developing countries. Public domestic resources will also be needed to cover adaptation costs related to climate change impacts on public infrastructure.

24. **For all sectors, additional external public funding is likely to be needed for adaptation measures**. Such additional funding will be needed in particular for sectors and countries that are already highly dependent on external support, for example in the health sector in least developed countries, or for coastal infrastructure in developing countries that are highly vulnerable to sea level rise. **Current**

mechanisms and sources of financing are limited and it is likely that new sources of funding will be required.

25. The **funds that are managed** by the **GEF that are** available for adaptation projects, including the Piloting an Operational Approach for Adaptation (SPA)(SPA) of the GEF Trust Fund, the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), amount to over USD 275 million. Since 2005 the GEF has provided USD 110 million for adaptation projects.

26. The **level of funding for the Adaptation Fund** under the Kyoto Protocol depends on the quantity of certified emission reductions (CERs) issued and their price. Assuming annual sales of 300-450 million CERs and a market price of USD 24, the Adaptation Fund would receive USD 80-300 million per year for the period 2008–2012. Funding for the Adaptation Fund post 2012 depends on the continuation of the CDM and the level of demand in the carbon market. Assuming a share of proceeds for adaptation of 2 per cent continues to apply post 2012, the level of funding could be USD 100–500 million per year in 2030 for a low demand by Annex I Parties for credits from non-Annex I Parties, and USD 1–5 billion per year for a high demand. This will still be less than the amount likely to be needed.

27. **Bilateral contribution** for adaptation is estimated to have been in the order of USD 100 million per year between 2000 and 2003.

28. **National policies** may also play an important role in ensuring that the use of resources for adaptation purposes, both public and private, is optimized. In particular, there is a need for:

(a) Domestic policies that provide incentives for private investors to adapt new physical assets to the potential impacts of climate change;

(b) National policies that integrate climate change adaptation in key line ministries;

(c) Local government adaptation policies in key sectors.

29. Although the additional investment and financial flows needed for adaptation described above are significant**, the value of the climate change impacts that those expenditures would avoid could be larger.** This study does not estimate the total value of impacts avoided by adaptation to climate change, so it does not determine whether benefits of avoided damage exceed the adaptation costs. Existing estimates of the future damage caused by climate change vary substantially; however, available studies yield two important common findings:

(a) Damages increase with the magnitude of climate change. The more that climate changes, typically measured as the increase in global mean temperature, the greater the damage;

(b) Investment needs for adaptation would almost certainly increase substantially in the latter decades of the twenty-first century. They will be particularly high if no mitigation measures are implemented;

(c) On average, developing countries suffer more damage as a percentage of their GDP than developed countries, which implies that damages and benefits are not distributed evenly.

II. Introduction

30. This paper presents an analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change. This work was requested by Parties during the second workshop under the dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention (the Dialogue)[1] and was endorsed by the Conference of the Parties at its twelfth session.

31. The findings and analysis presented in this paper are based on information available in a background paper[2] prepared by the secretariat, which covers an assessment of investment and financial flows needed in 2030 to meet worldwide mitigation and adaptation requirements under different scenarios of social and economic development. The analysis does not provide an estimate of the total cost of climate change mitigation or of the total cost of adaptation to the impacts of climate change.

32. This paper is based on the following material discussed in detail in the background paper:

(a) Information on current investment and financial flows in as much detail as is available;

(b) Estimated future investment and financing needs and corresponding flows from major sources, including:

(i) Projections of future investment flows and financing under a reference scenario;

(ii) Projections of future investment flows and financing under a GHG emissions mitigation scenario.

(c) A summary of priorities identified by non-Annex I Parties as part of the UNFCCC process;

(d) The role of different sources of investment and financing and their future potential.

33. A summary of the methodology used for the analysis is provided in annex 1.

34. To ensure that this analysis is beneficial to the UNFCCC process, the secretariat has collaborated with a number of international financial institutions (IFIs), United Nations agencies, intergovernmental organizations and non-governmental organizations, other relevant agencies, and representatives of the private sector and civil society. These organizations and representatives were invited to participate in a consultative process to share their relevant experience and views on existing and planned investment and financial flows.

III. Current investment and financial flows

35. Summaries of total current investment flows in 2000 and current and projected investment flows by economic sector and region are provided in tables 1 and 2 in annex 2.

36. Most investment (75–80 per cent) occurs in Annex I Parties. Globally, corporations are responsible for about 60 per cent of total investment, but this varies from 50–75 per cent in different regions, with Africa at the low end and developing Asia at the high end. Households, individuals, farmers and small businesses are responsible for 26 per cent of global investment, ranging from 20 per cent in developing countries to 30 per cent in OECD countries. Governments are responsible for 14 per cent of total investment, ranging from 10 per cent in some regions to 25 per cent in Africa.

37. Globally, about 60 per cent of total investment comes from domestic sources, and about 20 per cent each from FDI and international debt. The domestic share ranges from 20 per cent in the European Union to 90 per cent in Africa and the Middle East. ODA funds less than 1 per cent of

[1] FCCC/CP/2006/5, paragraph 61.

[2] <http://unfccc.int/cooperation_and_support/financial_mechanism/items/4053.php>.

investment globally, but this rises to over 2 per cent in Africa and over 6 per cent in least developed countries.

38. In almost every sector and region, domestic sources account for most of the funds invested. FDI tends to be invested in mining, including oil and gas production; manufacturing; and financial services. Only small amounts of FDI are invested in agriculture, forestry and construction. ODA is invested in energy and water supply in least developed countries.

IV. Potential investment and financial flows under the Convention and the Kyoto Protocol

39. This chapter covers the international carbon markets, whose growth has been stimulated largely by the Kyoto Protocol, as well as sources of specific financial and investment flows relevant to climate change mitigation or adaptation under the Convention and its Kyoto Protocol such as the Adaptation Fund, the GEF as an entity operating the financial mechanism of the Convention, the LDCF and the SCCF. Table 3 in annex 2 provides an overview of the current investment and financial flows generated by these mechanisms.

A. Potential of the carbon markets

40. The potential of the international carbon markets for the period from 2006 to 2030 is assessed in the background paper and summarized in table 1 below.[3] The data for 2006 relate to trading activity: the credits and allowances traded irrespective of whether or not they are used for compliance. The projections for 2010 and 2030 are estimates of the net compliance needs of Annex I Parties as a group; they cover purchases by Annex I Parties from non-Annex I Parties, but do not include trades among Annex I Parties or trades by entities covered by national or sub-national emissions trading schemes.

Table 1. Current and projected size of the international carbon markets

Year	Market	Sales (2006 USD billion per year)	Quantity (Mt CO_2 eq)	Average price and range (2006 USD/t CO_2 eq)
		Trading activity		
2006	Clean development mechanism (CDM)	5	475	11 (6–27)
	Joint implementation (JI)	<1	16	9
	European Union emissions trading scheme allowances	24	1 101	22 (5–40)
		Compliance needs		
2010	Compliance by Parties to the Convention that are also Parties to the Kyoto Protocol with commitments inscribed in Annex B to the Kyoto Protocol (mainly CDM and JI)	10–15 (5–25)	400–600 excluding Canada	24 (14–34)
2030	Purchases by Parties currently included in Annex I to the Convention			
	Low estimate	10–15 (5–25)	400–600	24 (14–34)
	High estimate	100 (90–125)	4 000–6 000	24 (14–34)

41. The estimated revenue from the sale of the certified emission reductions (CERs) generated by the CDM projects in the pipeline during 2006 is USD 5 billion per year. The capital that is or will be invested in those projects is estimated at about USD 25 billion, of which approximately 50 per cent represents capital invested in unilateral projects by host country project proponents.[4] Renewable energy

[3] Details on assumptions and estimations are provided in chapter 7 of the background paper.

[4] India is home to the most unilateral projects (33 per cent of projected annual emission reductions of projects in the pipeline at the end of 2006), followed by China (20 per cent), Brazil (11 per cent) and Mexico (6 per cent).

and energy efficiency projects in the pipeline during 2006 accounted for 90 per cent of the overall investment.

42. The EU ETS has surplus allowances for Phase I (2005–2007) as a result of excess allocation and emission reductions by participants. With a few exceptions, these allowances cannot be carried over for use in Phase II (2008–2012). As a result, the price of Phase I EU allowances dropped from over EUR 30 in April 2006 to EUR 0.25 on 1 June 2007. The price of Phase II EU allowances has remained at over EUR 20 partly because the allocations suggest a shortage of allowances for the period 2008–2012. This shortage is expected to lead to mitigation by installations covered under the scheme and the use of CERs and ERUs for compliance.

43. During 2006 the voluntary carbon market accounted for estimated sales of about 13.4 Mt CO_2 eq at an average price of USD 4.10 and a total value of USD 55 million. Rapid growth is forecast to continue, leading to annual sales of 250 Mt CO_2 eq (120–400 Mt CO_2 eq) during the period 2008–2012 at an average price of USD 10 per t CO_2 eq. The voluntary market would then represent about 15 per cent of the total market. Growth of the voluntary market is contingent on satisfactory resolution of concerns about the integrity of the emission reductions being sold.

44. The supply of Kyoto units[5] is expected to be abundant relative to the compliance demand for the period 2008–2012 by Parties included in Annex B to the Kyoto Protocol (Annex B Parties). Demand is unlikely to change significantly unless the Government of Canada changes its decision not to buy Kyoto units.[6]

45. The estimated supply of CERs and ERUs is almost sufficient to meet the projected demand. Annual sales of 300–450 million CERs are projected with a value of USD 7–11 billion and initial investment of USD 40–60 billion.[7] Annual sales of 40–100 million ERUs are projected with a value of USD 1.0–2.5 billion and initial investment of USD 5–20 billion.

46. Most of the potential supply for the period 2008–2012 consists of surplus assigned amount units (AAUs) held by the Russian Federation, Ukraine and other Eastern European countries. Rules relating to the use and carry-over of Kyoto units suggest that CERs and ERUs will be used for compliance whereas surplus AAUs will be carried over to future periods. With a high demand post-2012, the carry-over could be absorbed relatively quickly; but with a low demand, it could affect the market for a decade or more.

47. The low estimate of demand by Annex I Parties in 2030 for credits from non-Annex I Parties is assumed to be the same as in 2010: USD 5–25 billion. If the CDM continues after 2012, the current flow of projects would be sufficient to meet that demand.

48. The high estimate of demand is a market of USD 100 billion per year. It assumes commitments by all current Annex I Parties, including Australia and the United States of America, and none by any current non-Annex I Party. To meet this demand, a large fraction of the potential emission reductions, from all existing and some new categories of projects, would need to earn credits.

B. Potential of the financial mechanism of the Convention

49. The GEF was assigned as an operating entity of the financial mechanism of the Convention on an ongoing basis, subject to review every four years. The financial mechanism is accountable to the Conference of the Parties (COP), which decides on its climate change policies, programme priorities and eligibility criteria for funding, based on advice from the Subsidiary Body for Implementation (SBI).

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[5] CERs, tCERs, lCERs, ERUs, AAUs and RMUs.

[6] The Government of Canada has declared that it "will not purchase credits or otherwise participate in the carbon market". Canada, 2007. *Regulatory framework for Air Emissions*, Environment Canada, Ottawa, April, available at: <http://www.ecoaction.gc.ca/news-nouvelles/pdf/20070426-1-eng.pdf>, p.14.

[7] The initial capital cost of the projects that would generate 300–450 million CERs is estimated at USD 40-60 billion. That would include the estimated USD 7 billion investment for the projects registered during 2006.

50. As at July 2007, the GEF has allocated since its inception a total of just over USD 3.3 billion to climate change projects from the GEF Trust Fund. Further co-financing in excess of USD 14 billion has been leveraged for these GEF projects. The targeted amount of funding from the fourth replenishment of the GEF (GEF 4) is USD 990 million over the period 2006–2010 (see table 4 in annex 2).

51. The largest share of GEF Trust Fund resources for the climate change focal area has been assigned to long-term mitigation projects: renewable energy (USD 861.1 million); energy efficiency (USD 719.8 million); low GHG emitting technologies (USD 318.2 million); and sustainable transport activities (USD 160.6 million).

52. The GEF-managed funds available for adaptation projects, including the strategic priority SPA of the GEF Trust Fund, the SCCF and the LDCF, amount to a total of over USD 275 million. Since 2005 the GEF has provided USD 110 million for adaptation projects.

53. Replenishment of funds in the GEF depends on voluntary contributions from donors. The trust fund contributions follow predefined burden sharing by donors. The amount of funding under the GEF after 2010 will depend on negotiations on GEF 5. The trustee of the GEF will probably need to start making arrangements for GEF 5 in 2008. Negotiations and conclusion of GEF 5 should occur in 2009. The LDCF and SCCF are also voluntary funds but are operated separately, in keeping with COP guidance, and are open to replenishment on a rolling or continuous basis. The fourth review of the financial mechanism should start at the twenty-seventh session of the SBI (December 2007). As part of this review, the COP is expected to make an assessment of the amount of funds necessary to assist developing countries and provide an input to GEF 5.[8]

C. Potential of the Adaptation Fund

54. The Adaptation Fund under the Kyoto Protocol was established to finance concrete adaptation projects and programmes in developing country Parties that are also Parties to the Kyoto Protocol, especially those that are particularly vulnerable to the adverse effects of climate change. This fund will function under the guidance of, and be accountable to, the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. Negotiations on the details for operationalizing the Adaptation Fund, in particular the institutional arrangements, are currently ongoing.

55. The Adaptation Fund is to be financed with a share of proceeds from CDM project activities and other sources of funding. The share of proceeds amounts to 2 per cent of CERs issued for a CDM project activity, with exemptions for some project types.

56. The level of funding for the Adaptation Fund depends on the quantity of CERs issued and their price. Assuming annual sales of 300–450 million CERs and a market price of USD 24 (range of USD 14–34) the Adaptation Fund would receive USD 80 –300 million per year for the period 2008–2012.

57. Funding for the Adaptation Fund for post 2012 depends on the continuation of the CDM and the level of demand in the carbon market. Assuming a share of proceeds for adaptation of 2 per cent continues to apply post 2012, the level of funding could be USD 100–500 million per year in 2030 for a low demand by Annex I Parties for credits from non-Annex I Parties, and USD 1–5 billion per year for a high demand.

[8] Decision 2/CP.12

V. Investment and financial flows for mitigation

58. This analysis assesses the additional investment and financial flows needed to return carbon dioxide equivalent (CO_2 eq) emissions to current levels by 2030.[9] The analysis is based on currently available scenarios, as explained in annex 1. The estimates should be considered indicative amounts only.

59. The investment and financial flows for mitigation have been estimated for eight major emission sectors identified in the Working Group III contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). In 2004 the share of anthropogenic GHG emissions in each sector was as follows: fossil fuel supply (4.5 per cent); power supply (21.4 per cent); industry (19.4 per cent); transportation (13.1 per cent); buildings (7.9 per cent); waste (2.8 per cent); agriculture (13.5 per cent); and forestry (17.4 per cent).[10]

60. Figures presented in this chapter are the estimated additional investment and financial flows required. For the first six sectors, the estimates are provided for the change to the investment flows needed to shift from the reference scenario to the mitigation scenario. For fossil fuel supply and power supply, estimates of total investment are developed for each scenario. For the industry, transportation, buildings and waste sectors, the data available is limited to the added investment needed for the mitigation scenario.

61. Agriculture and forestry involve both investment and financial flows: investment for agroforestry and afforestation/reforestation and financial flows for reduction of non-CO_2 emissions, reduced deforestation and forest management. Financial flows are also estimated for technology R&D and deployment.

A. Energy supply

62. Energy supply covers the production, transformation and transportation of fossil fuels. Here it is divided into two sectors: fossil fuel supply and power supply. Fossil fuel supply includes production of coal, oil, gas and peat, transformation of those fuels through petroleum refining or gas processing, and specialized transportation facilities such as pipelines and liquefied natural gas terminals. Power supply includes all types of electricity generation, and the transmission and distribution of electricity.

63. The mitigation scenario assumes substantial improvements in energy efficiency, which reduce total energy supply, as well as shifts to low GHG emitting energy sources. The estimated investment for energy supply under the reference and mitigation scenarios in 2030 are shown in table 2. The investments in energy efficiency are covered in the overview of the energy consuming sectors below: industry, buildings, transportation and agriculture.

[9] The year 2004 was used as the base year for emission levels, owing to the scenarios selected as well as the availability of data.

[10] IPCC. 2007. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

Table 2. Investment for energy supply under the reference and mitigation scenarios in 2030 (billions of United States dollars)

	Global			Non-Annex I Parties		
Sector	**Reference scenario**	**Mitigation scenario**	**Additional investment**	**Reference scenario**	**Mitigation scenario**	**Additional investment**
Fossil fuel supply						
Coal	20	12	-8	13	8	-5
Oil	154	125	-29	85	69	-16
Natural gas	148	126	-22	58	47	-11
Total	**322**	**263**	**-59**	**156**	**124**	**-32**
Power supply						
Coal-fired generation	75	24	-51	40	13	-27
Oil-fired plants	2	1.5	-1	1	1	0
Gas-fired plants	39	36	-3	17	13	-4
Nuclear energy	15	40	25	3	14	11
Hydropower	37	59	22	28	46	18
Renewable	41	79	38	12	30	18
CO_2 capture and storage facility coal-fired plants	-	40	40	0	21	21
CO_2 capture and storage facility gas-fired plants	-	23	23	0	6	6
Transmission and distribution	231	130	-101	149	101	-48
Total	**439**	**432**	**-7**	**251**	**245**	**-6**

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention

1. Fossil fuel supply

64. The projected reference scenario investment is USD 322 billion in 2030 for production of coal (6 per cent), oil (48 per cent) and natural gas (46 per cent). Upstream (production) investment accounts for 73 per cent of the total in the oil industry, 56 per cent of the total in the gas industry and 100 per cent in the case of coal.

65. In the mitigation scenario, the total investment is reduced by USD 59 billion in 2030, with a 40 per cent reduction for coal, 19 per cent for oil and 15 per cent for natural gas. Consumption of oil and natural gas is higher than, and consumption of coal is about the same as, at present. Therefore the lower investment reflects slower growth rather than declining output. A little over half (USD 32 billion) of the reduction in the reference scenario investment flow occurs in non-Annex I Parties.

66. Most of the investment is made by large corporations, either government owned or private.

2. Power supply

67. Investment in power supply in the reference scenario is projected to be USD 439 billion in 2030 for transmission and distribution (53 per cent), coal-fired generation (17 per cent), renewables (9 per cent), gas-fired generation (9 per cent), hydropower (8 per cent) and nuclear energy (3 per cent). Despite the significant investment in transmission and distribution, the IEA reference scenario projects that 1.4 billion people will not have access to electricity in 2030. The IEA estimated that universal electricity access by 2030 would require an additional annual investment of USD 25 billion. Almost all of this additional investment would be needed in sub-Saharan Africa and South Asia.

68. In the mitigation scenario, the total investment in 2030 is about the same as in the reference scenario (USD 432 billion), but the investment mix is significantly different. Less investment will be needed for transmission and distribution (USD 101 billion) and fossil-fired generation (USD 55 billion, mainly coal). Additional investment will be needed for renewables (excluding hydropower) (USD 38 billion), CCS in power plants (USD 63 billion), nuclear energy (USD 25 billion) and hydropower (USD 22 billion).

69. The projected decline in transmission and distribution investment warrants further analysis. The IEA estimates transmission and distribution investment based on generation capacity with one third of the investment for transmission and two thirds for distribution. Increased energy efficiency and wider use of distributed generation[11] should reduce the need for additional transmission and distribution capacity in the mitigation scenario, but further analysis is needed to ensure that the lower investment projected is consistent with the level of energy access of the reference scenario. .

70. As a result of rapid economic growth in developing countries, about 57 per cent of the power sector investment is projected to occur in non-Annex I Parties under both scenarios (USD 251 billion for the reference scenario and USD 245 billion for the mitigation scenario). The shift in the mix of global investments described in paragraph 67 above occurs in non-Annex I Parties as well.

71. Most of the investment in electricity generation, transmission and distribution is made by government-owned or private, usually regulated, electric utilities, and is raised domestically in all regions. FDI and borrowings constitute important additional sources of funding in developed countries. ODA is important in least developed countries. Investment in renewables is currently concentrated in a few countries and a significant share is financed by sources other than electric utilities, although both these patterns are changing.

72. Changing the mix of technologies in power supply as projected for the mitigation scenario poses some challenges:

(a) Electric utilities will continue to add fossil-fired plants rather than switch to nuclear energy and large hydropower unless these options are less costly and their environmental, social and safety concerns are addressed;

(b) Electric utilities may resist adoption of CCS for fossil-fired plants owing to the cost, newness of the technology, legal uncertainties and for other reasons;

(c) Rapid growth of renewables may be constrained by their relatively high cost, supply bottlenecks, locational constraints and grid management considerations;

(d) Private investors financing renewable energy projects seek supportive government policies, financial incentives, such as feed-in tariffs and renewable energy credits, and secure markets for the power generated.

73. These are challenges for both Annex I Parties and non-Annex I Parties, since over half of the projected additional investment is expected to occur in non-Annex I Parties. Non-Annex I Parties may need financial incentives or assistance with national policies to address these challenges.

B. Investments in energy consuming and in the waste sectors

74. The mitigation scenario assumes substantial improvements in energy efficiency in the industry, buildings and transportation sectors, as well as CCS for some industries. Table 3 shows the additional investment needed to implement those measures in 2030.

[11] Production of electricity close to where it is used.

Table 3. Additional investment for emission reductions under the mitigation scenario in 2030 (billions of United States dollars)

	Additional investment	
Sector	**Global**	**Non-Annex I Parties**
Industry		
Electrical equipment	10.8	3.8
Stationary fuel consuming equipment	8.7	3.1
CO_2 capture and storage	14.1	11.0
Non-CO_2 gases	2.0	1.2
Total	**35.6**	**19.1**
Buildings		
Electrical equipment	42	10.0
Stationary fuel consuming equipment	8.8	4.0
Total	**50.8**	**14.0**
Transportation		
Hybrid vehicles and efficiency improvement in vehicles	78.7	31.5
Biofuel	9.2	4.0
Total	**87.9**	**35.5**
Waste total	**0.9**	**0.6**

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention
Note: Additional investments are calculated based on the capital costs of different measures to achieve the emission reductions projected for the mitigation scenario as compared with the reference scenario.

1. Industry

75. Industry[12] consumes nearly 27 per cent of the world's energy, about half of it in OECD countries. Energy and GHG emission intensity[13] varies greatly across industries. Industrial emissions consist of GHGs from the combustion of fossil fuels (57 per cent), non-CO_2 gases from industrial processes (32 per cent) and CO_2 from industrial processes (11 per cent).

76. The mitigation scenario envisions aggressive policies to spur implementation of technically feasible measures, leading to the following energy and emission savings in 2030 compared to the reference scenario:

(a) A 15 per cent reduction in electricity consumption;

(b) A 14 per cent reduction in fossil fuel consumption, which cuts emissions by 1.5 Gt CO_2;

(c) CCS of 0.5 Gt CO_2;

(d) A 36 per cent reduction in non-CO_2 emissions (1.8 Gt CO_2);

(e) An 11 per cent reduction in process CO_2 emissions (0.2 Gt CO_2).

77. The additional investment needed in 2030 to realize these emission reductions totals USD 21.6 billion for improvements in energy efficiency and non-CO_2 emission reductions and USD 14.1 billion for CCS. Almost half of the additional investment would occur in non-Annex I Parties.

[12] Petroleum refining is included in energy supply.
[13] Emissions per unit of output.

78. In industry, financing for energy efficiency and emission reduction measures is generally internal, although external financial incentives are sometimes available. The energy efficiency measures assumed have very short payback periods (two to four years).

79. Achieving the projected emission reductions discussed above in the industrial sector will require:

(a) Aggressive policies to increase energy efficiency and reduce emission. Such policies could include mandatory energy efficiency standards, emission regulations (for non-CO_2 gases for example), emissions trading systems for industrial sources and, in non-Annex I Parties, CDM projects;

(b) Regulations and/or incentives to adopt CCS. The technological challenges, legal aspects, costs and other issues will also need to be addressed.

80. These are challenges for both Annex I and non-Annex I Parties, since almost half of the projected additional investment is expected to occur in non-Annex I Parties. Non-Annex I Parties may need access to financial incentives or assistance with national policies to address these challenges.

2. Buildings

81. The buildings sector includes all residential, commercial and institutional buildings. Most fuel use and emissions result from the combustion of fossil fuels for space and water heating. The largest contributor to CO_2 emissions is space heating and ventilation (36 per cent), followed by lighting (16 per cent), residential appliances (15 per cent), water heating (13 per cent), commercial appliances (9 per cent) and air conditioning (8 per cent). Electricity demand has been growing due to increased use of air conditioning and new appliances and computers. OECD countries are responsible for 64 per cent of total emissions, developing countries for 25 per cent and economies in transition for 11 per cent.

82. The mitigation scenario envisions aggressive policies to spur implementation of technically feasible measures at an unprecedented scale and rate, leading to the following energy and emission savings in 2030 compared to the reference scenario:

(a) A 22 per cent reduction in electricity consumption;

(b) A 13 per cent reduction in fossil fuel consumption, which cuts emissions by 0.5 Gt CO_2.

83. The additional investment needed in 2030 to realize these reductions amounts to USD 50.8 billion, of which USD 14 billion (28 per cent) would occur in non-Annex I Parties. Most of the measures assumed have a very quick payback period (less than four years). Most commercial and residential energy efficiency investment comes from the building owner and is financed domestically.

84. Aggressive policies, in particular stringent mandatory efficiency standards for appliances, equipment and buildings, will be needed to overcome the recognized barriers to the adoption of cost-effective efficiency measures. Policies to overcome these barriers and promote energy efficiency will be needed in both Annex I and non-Annex I Parties. Non-Annex I Parties may need access to financial incentives or assistance to develop and implement such policies.

3. Transportation

85. The transportation sector includes passenger and freight movements by road vehicles, railways, aircraft and both inland and maritime vessels. For aircraft and marine transportation, both domestic and international emissions are included. Transportation emitted 14 per cent of global GHGs, 5.8 Gt CO_2 eq, in 2004, nearly all of which was CO_2. Road transportation, including passenger and freight, is responsible for almost three quarters (73 per cent) of the sector's energy use and CO_2 emissions, followed by air transport (12 per cent[14]), marine transport (10 per cent), rail (4 per cent) and other modes (e.g. two- or three-wheelers) (1 per cent).

[14] Aircraft emissions of other gases, which are not considered in this analysis, also contribute to climate change.

86. Projected emissions in 2030 drop from 8.7 Gt CO_2 eq under the reference scenario to 6.7 Gt CO_2 eq under the mitigation scenario. The emission reductions are achieved through increased use of biofuels (from 92 Mto eq under the reference scenario to 294 Mto eq under the mitigation scenario, corresponding to over 11 per cent of global transport energy use), hybrid electric vehicles (from 18 to 60 per cent of vehicle stock) and further vehicle efficiency improvements. Biofuel production in non-Annex I Parties is growing fastest in Brazil, India, Indonesia, China and other Asian developing countries.

87. The investment needed in 2030 to achieve the mitigation scenario is USD 79 billion for hybrid vehicles and efficiency improvements in vehicles and USD 9 billion for biofuels.

88. Efficiency improvements for vehicles leading to a higher market share for hybrid vehicles is likely to require government policies such as vehicle efficiency standards. Increased use of biofuels as blends with conventional fuels will also need to be driven by policies. Given the rapid growth of vehicle ownership in non-Annex I Parties, these countries need to adopt such policies as well. Nearly all additional investment will go into the purchase of motor vehicles and production of transport fuels, which would be made mostly by the private sector. The mitigation scenario involves no significant change to the investment in infrastructure, such as roads, airports and ports, in which governments are usually the principal investors.

4. Waste

89. The waste sector includes landfills and wastewater. Both release methane produced by anaerobic degradation of organic matter. Global emissions in 2000 were 1.2 Gt CO_2 eq; 58 per cent from landfills and 42 per cent from wastewater. Developing countries are the source of 53 per cent of global emissions, with China and India responsible for 14 per cent and 10 per cent respectively.

90. The major abatement opportunity is capture of the methane and use of the methane for fuel or electricity production. The mitigation scenario reduces global emissions by about 50 per cent (0.7 Gt CO_2 eq) in 2030 compared to the reference scenario with an investment of USD 0.9 billion, with two thirds of the emission reductions and investment occurring in non-Annex I Parties.

91. Most of the abatement opportunities are in developing countries, coincident with the emissions. Local policies and financial incentives will be needed to achieve the projected reductions. Some action to reduce these emissions is likely to be undertaken for environmental and public health reasons but funding is still the major barrier, particularly in developing countries. The CDM improves the economics of these projects appreciably. Over 100 projects to reduce methane emissions from landfill gas and wastewater treatment, representing almost 10 per cent of the projected emission reductions, were in the pipeline at the end of 2006.

C. Agriculture and forestry

92. The mitigation scenario includes measures for both emission reduction and removals by sinks in the agriculture and forestry sectors. Table 4 shows the additional investment and financial flows needed in 2030 to implement those measures.

Table 4. Additional investment and financial flows under the mitigation scenario for forestry and agriculture in 2030 (billions of United States dollars)

Sector	Global	Non-Annex I Parties
Agriculture		
Non-CO_2 gases[a]	20	13
Agroforestry	15	N.A.[b]
Grassland management	N.A.	N.A.
Forestry		
Reduced deforestation [a,c]	12	12
Forest management[a,d]	8	8
Afforestation and reforestation	0.12–0.50	0.1–0.4

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention

Note: Additional investments are calculated based on the capital costs of different measures to achieve the emission reductions projected for the mitigation scenario. Additional financial flows are calculated based on the marginal costs of the measures to achieve the emission reductions projected for the mitigation scenario.

[a] Financial flows, minimum investments required.

[b] Only global estimates are currently available.

[c] Reducing emissions from deforestation in developing countries as defined in SBSTA Agenda Item 5.

[d] Part of this investment might also be considered in Reduced deforestation.

1. Agriculture

93. The agriculture sector offers mitigation opportunities through GHG emission reductions and removals by sinks. Global emissions total 6.8 Gt CO_2 eq of which 0.6 Gt CO_2 eq is energy related (including emissions from fertilizer manufacture) and 6.2 Gt CO_2 eq is non-CO_2 emissions from farm operation. The investment needed to reduce the energy emissions was not estimated. The principal sequestration opportunities are agroforestry and improved grassland management.

94. The non-CO_2 emissions are mainly nitrous oxide from soils (45 per cent), methane from enteric fermentation (30 per cent) and methane from rice cultivation (10 per cent). Total non-CO_2 emissions could be reduced by about 10 per cent (0.6 Gt CO_2 eq) in 2030 at a cost of USD 20.2 billion assuming a constant number of animals and cultivated area. Given the expected growth in population and the changes in diets to include more animal products as countries become more affluent, the estimates generated with these assumptions are conservative. About 35 per cent of the reduction would come from changes to rice cultivation practices, with the balance roughly equally split between cropland practices (fertilizer use) and livestock (enteric fermentation).

95. The land area available for agroforestry is estimated as being 630 million ha. The IPCC suggests that, with considerable international effort, 40 per cent of this area could be committed to agroforestry by 2040, at a rate of about 19 million ha per year after the first decade. Expanding agroforestry by 19 million ha per year would require an annual investment of about USD 15 billion (USD 780/ha).

96. The land area available for improved grassland management is estimated as being 3,400 million ha. The IPCC suggests that, with considerable international effort, 20 per cent of this area could be under improved pasture management by 2040, at a rate of about 68 million ha per year after the first decade. No estimate of the cost of improved grassland management is available.

97. The cost (USD 20.2 billion) of reducing non-CO_2 emissions is an ongoing financial flow, about 62 per cent of which occurs in non-Annex I Parties. Most of the costs of farm operation are borne by the farmer. But financial incentives may be needed to encourage adoption of these mitigation measures in developing countries.

98. Agroforestry is more profitable than cropping systems, but its adoption is inhibited by the initial cost, the negative cash flow for the first few years, lack of knowledge and the need to secure labour supply during harvesting periods. This suggests a role for a mechanism that provides the initial capital and knowledge and receives a return from a share of the new crops and carbon sequestration credits.

2. Forestry

99. This chapter focuses on the land in forests at each point in time. It does not include agroforestry, which is addressed in the agriculture sector, bio-energy, which is addressed in the transportation and energy supply sectors, or management of wood products.

100. The Fourth Assessment Report of the IPCC synthesizes the global emissions from deforestation for the year 2004 as 5.8 Gt CO_2 eq per year, excluding peat and bog fires. The reference scenario assumes that GHG emissions from the forestry sector remain constant from 2004 to 2030. The mitigation options for the forestry sector are reduction of deforestation, better management of productive forest (forest management), as well as afforestation and reforestation to increase the forest area.

101. The financial flow needed to **reduce deforestation**[15] is defined as the opportunity costs of converting forest to other land uses. The estimated opportunity cost differs for each of the following deforestation and forest degradation drivers: cattle ranching (large scale); small-scale agriculture or shifting cultivation; gathering fuelwood and non-timber forest products; and trading fuelwood or charcoal. The area lost due to each deforestation/forest degradation driver is assumed to remain constant at the current level. Applying the opportunity cost for each driver to the corresponding area yields an estimated annual cost of USD 12.2 billion to reduce deforestation/forest degradation of 12.9 million ha per year and emissions by 5.8 GtCO_2 in 2030.[16] .

102. Opportunity costs vary significantly by location and over time. The underlying drivers for deforestation (e.g. structural changes in land tenure or in agricultural or forest policies) also affect the opportunity costs. The opportunity costs do not include investment or maintenance costs of alternative land-use. They also do not include administrative and transaction costs for reducing emissions from deforestation and/or forest degradation. The estimates presented above therefore must be considered as indicative only.

103. **Forest management** can reduce GHG emissions from unsustainable harvesting of wood and non-wood products from production forests. The area of production forests in each country is assumed to remain constant from 2005 to 2030. For non-Annex I Parties in tropical and subtropical areas, the cost of achieving (sustainable) forest management in 602 million ha of production forests would be around USD 12 per ha for an annual total of USD 7.2 billion leading to increased annual removals of 5.4 Gt CO_2. Non-Annex 1 Parties with temperate and boreal forests have the potential to increase carbon stocks through sustainable forest management at a cost of USD 20 per ha for an annual cost of USD 1 billion and increased annual removals of 1.1 Gt CO_2. Thus the annual potential for increased removals through forest management in non-Annex 1 Parties is estimated at 6.5 Gt CO_2 at an annual cost of USD 8.2 billion in 2030.

104. The cumulative mitigation potential of **afforestation and reforestation** is estimated by the IPCC at 1 618–4 045 Mt CO_2 by 2030. Using establishment costs of USD 654–1 580 per hectare means an average annual reduction of 65–162 Mt CO_2 or annual investment in 2030 of USD 0.1–0.5 billion. Most of the potential is in non-Annex I Parties, where an estimated annual investments of USD 0.1–0.4 billion would be needed.

105. The majority of investment in the forestry sector comes from the private sector, mainly in plantation development and forestry concessions. Over 90 per cent of this is domestic. At present, virtually no funding is available to reduce deforestation, about USD 10 million per year is available for forest management through the International Tropical Timber Organisation (ITTO) and afforestation/reforestation projects can earn credits through the CDM. Implementing these mitigation measures will require substantial additional funding.

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[15] Estimates for reducing deforestation in developing countries include reducing emissions from both deforestation and degradation.

[16] Considering C content in forest as 449 t CO_2/ha as an average for the calculation.

106. The Global Forest Alliance and Forest Carbon Partnership Facility managed by the World Bank will provide future a pilot funding mechanism to support activities to reduce deforestation and forest degradation. While there might be substantial funding for a pilot phase, it is negligible relative to the projected annual funding needed to significantly reduce deforestation and forest degradation. Several options for supporting reduced deforestation and forest degradation have been proposed by Parties and non-governmental organizations.

D. Technology research, development and deployment

107. A portfolio of existing and well-advanced low GHG emitting technologies is expected to be deployed worldwide under the mitigation scenario. The key technologies are end-use efficiency, renewables, CCS, nuclear energy, large hydropower and biofuels. To meet the mitigation scenario, technology R&D and deployment are crucial in reducing the costs of these technologies.

108. Government spending on **energy R&D** worldwide has stagnated, while private sector spending has fallen. Total government spending of IEA member countries on energy R&D was about USD 9.5 billion in 2005, most of which was funded by Japan (34 per cent) and the United States of America (29 per cent). Funding for research in energy efficiency and renewables has been rising, but these areas still receive only 12 per cent of the total.

109. An ambitious and sustained increase in global funding for R&D of low GHG emitting technologies is required if these technologies are to be delivered within the time required. The Stern Review suggested that government energy R&D budgets need to double from roughly USD 10 billion to USD 20 billion per year.

110. The investment and financial flows needed to **deploy low GHG emitting technologies** (in particular renewables, biofuels and nuclear energy) is estimated to double from roughly USD 30 billion to about USD 60 billion annually.

111. A substantial share of the investment in each of the low GHG emitting technologies is projected to occur in developing countries. This suggests that developing country participation in research, development and deployment of these technologies could facilitate the projected investment. A great deal of international cooperation on low GHG emitting technology R&D and deployment is already taking place, but more is needed as part of the increased global effort required.

E. Conclusions

112. To achieve emission reductions consistent with the mitigation scenario will require changes to the investment and financial flows of the reference scenario:

(a) Investment in fossil fuel supply is predicted to continue to grow, but at a reduced rate (0.5 per cent per year rather than 1.2 per cent per year);

(b) About USD 148 billion out of the USD 432 billion of projected annual investment in the power sector needs to be shifted to renewables, CCS, nuclear energy and hydropower;

(c) Additional investment of almost USD 190 billion in 2030 is needed for energy efficiency, biofuels, hybrid vehicles, CCS for industry, capture of methane emissions, agroforestry, and afforestation and reforestation;

(d) Reduction in emissions from agriculture (USD 20 billion for non-CO_2 gases) and forestry (USD 8 billion for forest management and USD 12 billion for reduced deforestation) will need large ongoing financial flows;

(e) Government budgets for energy R&D and support for technology deployment need to double, increased expenditures in 2030 are expected at USD 10 and 30 billion respectively.

113. The entities that make the investment decisions are different in each sector, and the policy and/or financial incentives needed will vary accordingly. For example:

(a) Increased energy efficiency is best achieved through appropriate policies or regulations (the investments are internal and often incremental, and have short payback periods, but adoption is hampered by recognized barriers);

(b) Shifting investment in the power sector to CCS and low GHG emitting generation technologies will need both policies and, more importantly, financial incentives which make these technologies economically more attractive than high GHG emitting technologies. This requires national or international policy frameworks, such as carbon markets and higher feed-in tariffs;

(c) Financial incentives will be needed to achieve significant reductions in emissions through reduced deforestation and forest management.

114. All Parties need to adopt climate change policies. International coordination of policies in an appropriate forum is often effective. Areas where international coordination would be beneficial include:

(a) Technology R&D and deployment;

(b) Energy efficiency standards for internationally traded appliances and equipment.

115. Funding from external sources will play an important role in helping developing countries formulate and implement national policies.

116. Some mitigation measures, especially reduced deforestation and forest management, are likely to need significant external funding for large-scale implementation.

VI. Investment and financial flows for adaptation to climate change

A. Overview

117. This analysis assesses the order of magnitude of additional investment and financial flows that could be required in 2030 to adapt to the impacts of climate change. Although the intimate link between economic and population growth, human development and adaptation is acknowledged, this analysis focuses on the additional need for adaptation over and above the investment and financial flows required to address needs related to expected economic and population growth.

118. The investment and financial flows needed for adaptation to climate change have been estimated for five sectors identified by the Working Group II contribution to the Fourth Assessment Report of the IPCC: AFF (agriculture, forestry and fisheries), water supply, human health, coastal zones and infrastructure. The figures presented in table 5 can be interpreted as the investment and financial flows needed for adaptation in 2030 in addition to the investment and financial flows needed under a situation in which there is no climate change. There are several assumptions underlining these estimates and these should be taken as indicative estimates only.

119. Adaptation of natural ecosystems was also analysed; however, as there is very limited literature on adaptation in this sector, it was not possible to estimate the investment needs associated with climate change. Instead, the investment needed to protect ecosystems from all current threats was analysed.

Table 5. Estimated additional investment and financial flows needed for adaptation in the year 2030 (billions of United States dollars)

Sector	Global	Non-Annex I Parties
Agriculture, forestry and fisheries	14	7
Water supply	11	9
Human health	5	5
Coastal zones	11	5
Infrastructure	8–130	2–41

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention

120. These estimates should be treated as indicative and may be more conservative than the amount actually required for adaptation because some activities likely to need additional financial and investment flows to adapt to climate change impacts have not been included. For example, water supply does not address other aspects of water resource management; the estimate for human health does not include many diseases that are expected to become more widespread due to climate change; for coastal zones estimates are based on the additional cost related to investment in dykes and beach nourishment only; and the estimate for infrastructure includes only the cost of building new infrastructure whose design takes climate change into account. On the other hand, the estimates do not account for the potential for improved technologies for adaptation or for learning through doing, which could lower costs of adaptation.

121. The figures presented in table 5 above should not be equated with the need for new external public resources dedicated to adaptation. For some sectors and regions, domestic public and private investors can be expected to bear the additional cost with no appreciable impact on overall sectoral or regional economic growth. In other cases, especially in sectors and regions that are vulnerable and already highly dependent on external public resources, additional external sources of financing will be needed. The estimates presented in table 5 above were used to assess the adequacy of expected future investment and financial flows for adaptation and to identify potential gaps.

122. Given the important differences in the sources and types of financing required in each sector, the analysis of the adequacy of expected future investment and financial flows focuses on the individual sectors rather than on the aggregated needs.

B. Agriculture, forestry and fisheries

123. The AFF sector analysis examined the additional investment in physical assets needed to cope with the impacts of climate change on the primary sector (e.g. the growing of crops, the farming of animals, logging and fish farms) and the secondary sector (e.g. the food, wood product, and pulp and paper manufacturing industries).

124. Overall, it is likely that a substantial increase in 2005 levels of investment and financial flows will be needed for the AFF sector in 2030 in order to address population and economic growth (about USD 575 billion). To address climate change impacts in this sector, an additional USD 14 billion in investment and financial flows is estimated to be needed. About half of this amount is estimated to be needed in developing countries. It is estimated that approximately USD 11 billion will be needed to purchase new capital; for example to irrigate areas, adopt new practices and to move processing facilities. The additional financing needed in the AFF sector for research and extension activities to facilitate adaptation would be about USD 3 billion (see paragraph 145 below).

125. Most of the additional investment needed in the AFF sector is for assets that are currently financed by domestic private agents and would therefore need to come from private sources such as domestic AFF producers and processing firms and multinational seed companies, chemical companies and companies in the manufacturing industries.

126. It is likely that additional public resources would be needed to provide the necessary information and incentive for the private sector to make the investment required to adapt to climate change. Coherent national policies could play a key role in influencing investment patterns and targeted support will be needed for this to happen. Substantial external public resources are already channelled into agricultural and forestry policies in developing countries, in particular in Africa and Latin America. A higher fraction of these resources might need to support the integration of adaptation in national policies; new resources might also be needed for this depending on the region.

C. Water supply

127. The analysis of adaptation needs in the water sector considered only the additional investment needed for water supply. It was not possible, due to data and model limitations, to address other potentially costly areas that would require adaptation measures such as water quality maintenance and flood control.

128. The total cost associated with the construction of additional infrastructure needed to meet the projected demand for water supply is estimated to further increase investment needs in 2030 by USD 11 billion. About 85 per cent of the investment is estimated to be needed in non-Annex I Parties.

129. About 90 per cent of the cost for all aspects of water resource use is currently covered by public domestic funding sources and 10 per cent by external public funding sources. Both sources might be insufficient to meet the estimated needs associated with climate change.

130. ODA, which currently totals USD 5.2 billion per year in the water infrastructure sector, would need to rise by about 150 per cent between now and 2030 purely to meet the additional requirements due to climate change in non-Annex I Parties. ODA for water infrastructure increased by approximately 40 per cent from 2000 to 2005, but it is unlikely that this trend will be sustained until 2030. New domestic and external public resources are likely to be needed.

D. Human health

131. The analysis of adaptation needs in the human health sector focused on three human health outcomes: diarrhoeal disease, malnutrition and malaria. For malnutrition, the only health impacts considered were stunting and wasting. It is also assumed that the diseases will not spread to new areas. Other health effects of climate change such as increased heat stress, spread of other diseases and risk to human health from increased incidents of extreme weather events are not considered.

132. Assuming that the cost of treating a case remains unchanged between now and 2030, the current financial flow would need to increase by 3 per cent to treat diarrhoeal disease, by 10 per cent to treat malnutrition and by 5 per cent to treat malaria. The financial flows needed in 2030 to cover the cost of treating the additional number of cases due to climate change is estimated to be USD 5 billion.

133. Although the additional financial flows needed due to climate change could not be allocated to different regions in a meaningful way, it is assumed to be all in developing countries. The costs of treating the additional cases of diarrhoeal disease, malnutrition and malaria caused by climate change alone in the year 2030 would be almost as much as current annual ODA for health.

134. Based on current financing patterns for health care, the additional cost is likely to be paid for mainly by the families of those affected, with some domestic public funds covering the costs of the operation of health care facilities. In countries where private individuals cannot cope with the additional cost of treatment, additional public financing will be necessary. This additional funding may be particularly needed in developing countries. Not being able to treat these diseases will increase morbidity and mortality. Countries already highly reliant on external funding sources for health care, such as least developed countries, may need additional external support to cope with the human health effects of climate change.

E. Coastal zones

135. The coastal zones analysis focused on additional investment in dykes for protection against coastal flooding and in beach nourishment to preserve land and beaches.

136. Without sea level rise, investment needs in 2030 for beach nourishment and dykes are estimated to be about USD 5 billion. With sea level rise, the investment needed is estimated to represent an additional USD 11 billion in 2030. The latter figure assumes that decision makers take into account the expected sea level rise in 2080. About half of the required investment will be needed in non-Annex I Parties. Planning for a shorter time frame is likely to result in lower adaptation costs in 2030, whereas planning for 100 years (to 2130), rather than for 50 years, would increase costs by about two thirds in 2030.

137. Although much of the infrastructure in coastal areas may be private (e.g. buildings and homes), efforts to protect coastal areas from coastal storms and sea level rise are typically undertaken by governments. In developed and some developing countries, the necessary public resources for coastal zone adaptation are likely to be available. However, deltaic regions, particularly the large coastal deltas in Asia and Africa as well as the small island developing States, may have significant problems responding to sea level rise. In these countries, additional sources of public financing will probably be needed. Developing and implementing coastal zone management institutions and processes do not need a large amount of resources and could increase the efficiency of adaptation to climate change and sea level rise.

F. Infrastructure

138. The analysis of the impact of climate change on infrastructure estimates the additional investment needed to adapt new infrastructure vulnerable to climate change. In this analysis, it is estimated that 1 to 3 per cent of the total global investments in new infrastructure in 2030 will be vulnerable to climate change. The additional investment needed to adapt new infrastructure vulnerable to climate change is estimated at 5 to 20 per cent of its cost.

139. The additional investment needed is estimated at USD 8–130 billion, or less than 0.5 per cent of global investment in 2030. About one third of the additional investment would be needed in non-Annex I Parties, and more than 80 per cent of that in Asian developing countries.

140. The additional investment is assumed to be a small part of the total cost of each new facility that is vulnerable to climate change. Therefore the additional investment is likely to be financed in the same manner as the overall infrastructure: from private sources for infrastructure such as commercial buildings and industrial plants, and from public sources for infrastructure such as roads and public buildings.

141. More public resources will be needed to provide adequate support and incentives for new private facilities that are vulnerable to climate change to be adequately designed and built. New or amended domestic policies, such as building codes, design standards and sitting regulations, may need to be introduced and enforced. More public resources will also be needed to adapt new public infrastructure.

G. Natural ecosystems

142. There is very limited literature on managing adaptation of natural ecosystems to climate change. There is virtually no information on the effectiveness of these management options, or on the costs of adaptation. It is thus not possible to estimate the additional investment needed to help ecosystems adapt to climate change (nor how effective such investment would be).

143. Estimates in the literature indicate that improving protection, expanding the network of protected areas in line with World Conservation Union guidelines and compensating local communities that currently depend on resources from fragile ecosystems could all be achieved for an increase in annual expenditure of USD 12–22 billion. This estimate does not consider the level of spending needed to

reduce other threats to natural ecosystems, such as pollution. Nor does it explicitly consider any additional requirements for protecting natural ecosystems from climate change.

144. Current annual spending to ensure natural ecosystem protection is of the order of USD 7 billion. Thus protection of natural ecosystems would require a substantial increase in public domestic and external funding.

H. Technology research, development and deployment

145. The additional financing needed in the AFF sector for research and extension activities to facilitate adaptation would be about USD 3 billion in 2030. About half of this amount will be needed in developing countries. Public sources account for two thirds of the current funding for AFF research worldwide but for as much as 90 per cent of AFF research funding in developing countries. Thus for the additional research and extension needs in developing countries, most of the additional funding would probably need to come from public sources. Assuming public spending continues to increase by slightly more than 2 per cent per year in developing countries, an additional USD 1.4 billion would need to come from new sources of external public financing in 2030.

146. Much of the research for the health sector is carried out or financed by pharmaceutical companies. Thus the research is largely financed by the private sector. The pharmaceutical industry spends about 15 per cent of its total revenue on R&D, among the highest share of R&D spending of all industries. The result is a high rate of innovation and rapid technological change. However, it is not clear if the R&D efforts will be focused on diseases affected by climate change impacts. Reduction in cases of diarrhoea may depend more on improvement in local conditions and sanitation and affordability of treatment.

I. Conclusion

147. Addressing the investment and financial flow requirements related to economic and population growth and to human development is highly likely to facilitate adaptation to the adverse impacts of climate change. Nevertheless, new and additional investments and financial flows will be needed to address climate change adaptation directly. The analysis summarized in this paper demonstrates that for all sectors and regions covered, several tens of billion USD of additional investment and financial flows will be needed for adaptation to the adverse impacts of climate change.

148. In the sectors dependent on privately owned physical assets (such as the AFF sector and a portion of the infrastructure sector), private sources of funds may be adequate to meet the adaptation needs, especially in developed countries. The additional spending likely to be required will be for climate proofing physical assets or to shift investment to infrastructure or production activities that are less vulnerable to the adverse impacts of climate change. However, policy changes, incentives and direct financial support to encourage or require a shift in investment patterns and additional spending of private resources may be needed.

149. For all sectors, additional external public funding is likely to be needed for some adaptation measures. Such additional funding will be needed in particular for sectors and countries that are already highly dependent on external support, for example in the health sector in least developed countries, or for coastal infrastructure in developing countries that are highly vulnerable to sea level rise.

150. National policies may play an important role in ensuring that the use of resources, both public and private, is optimized. In particular there is a need for:

(a) Domestic policies that provide incentive for private investors to adapt new physical assets to the potential impacts of climate change;

(b) National policies that integrate climate change adaptation in key line ministries;

(c) Local government adaptation policies in key sectors.

151. Bilateral donors and multilateral lenders have been directing financial resources to support the design of policies in developing countries in these sectors. It is not possible to determine how much of these financial resources address climate change issues let alone adaptation issues. However, the current level of support channelled explicitly for adaptation purposes is likely to be suboptimal.

152. Although the additional investment and financial flows needed for adaptation described above are significant, the value of the climate change impacts that those expenditures would avoid could be larger. This study does not estimate the total value of impacts avoided by adaptation to climate change so it does not determine whether benefits of avoided damage exceed the adaptation costs. Existing estimates of the future damages caused by climate change vary substantially; however, available studies yield two important common findings:

(a) Damages increase with the magnitude of climate change. The more that climate changes, typically measured as the increase in global mean temperature, the greater the damage;

(b) Investment needs for adaptation would almost certainly increase substantially in the latter decades of the twenty-first century. They will be particularly high if no mitigation measures are implemented;

(c) On average, developing countries suffer more damage as a percentage of their GDP than developed countries, which implies that damages and benefits are not distributed evenly.

153. The global cost of adaptation to climate change is difficult to estimate, largely because adaptation measures to climate change will be widespread and heterogeneous. More analysis of the costs of adaptation at the sectoral and regional levels is required.

VII. Priorities identified by developing country Parties in the UNFCCC process

154. In addition to considering the needs for investment and financial flows identified above, when tailoring incentives for financial and investment flows it is important to take into account priority areas for climate change mitigation and adaptation as identified by non-Annex I Parties under the Convention process.

155. Although these priorities have been identified in various contexts and do not constitute a comprehensive view of non-Annex I Parties' priorities and needs, they complement the discussion of investment and financing needs.

156. The background paper contains a summary of information from initial national communications (INCs), technology needs assessments (TNAs), national adaptation programmes of action (NAPAs) and reports from regional workshops and expert meetings on adaptation and response measures.[17]

157. Information on priority areas for mitigation and adaptation provided so far by developing countries under the Convention has been mostly qualitative in nature as calculating costs of priority actions is not required of Parties. Therefore, the analysis did not include an assessment of the total costs of mitigation and adaptation measures. Instead it identifies specific measures and technologies non-Annex I Parties are willing to implement.

158. Two thirds of non-Annex I Parties have reported in INCs energy supply measures as a priority area, and a majority of the **mitigation** project proposals in the energy sector submitted by Parties in their INCs involve switching to renewable sources of energy. Examples of other proposed mitigation measures identified as priorities include switching to less carbon-intensive fuels, installing more efficient industrial boilers, improving cooking stoves for the residential/commercial sector, promoting electric and compressed natural gas (CNG) vehicles, reducing waste generation at source, making changes in cattle management practices and promoting forest conservation and restoration.

[17] Please refer to chapter 6 of the background paper.

159. **Adaptation** measures related to water supply were reported as a priority area in all regions. Measures proposed in this sector are aimed at increasing water supply, improving water management and improving flood, drought, and water level monitoring. Other adaptation measures identified as priorities by Parties relate to the development of resistant crop and livestock varieties and salt-tolerant fish species. Measures related to the prevention of soil erosion and to the integrated management of coastal areas were also highlighted, along with the need for early warning systems for extreme events and measures for flood prevention. Development of health infrastructure and protection of tourism infrastructure were also identified as priority areas. The need for an integrated approach to adaptation was emphasized by Parties.

160. With regard to the **adverse impacts of response measures**, measures prioritized by Parties include development of low GHG emitting technologies, financial risk management such as commodity price hedging and economic shock funds, and the development of key infrastructure needed to diversify economic activity.

VIII. Potential for enhanced investment and financial flows

161. The previous chapters have illustrated that addressing climate change will require significant changes in the patterns of investment and financial flows. Such changes fall into three categories:

(a) **Shift investments and financial flows** made by private and public investors to more sustainable climate-friendly alternatives, for example by redirecting investments from traditional energy supply sources and technologies to low-GHG emitting ones;

(b) **Scale up** international private and public capital dedicated to investments and financial flows in mitigation or adaptation activities or technologies, for example by expanding the carbon markets, by increasing contributions from Parties included in Annex II to the Convention (Annex II Parties) or by identifying new sources of funding;

(c) **Optimize the allocation of the funds** available by spreading the risks across private and public investors, for example by providing incentives for private investment in the early deployment of new technologies or by improving the capacity of the insurance market.

A. Shift investments and financial flows

162. As highlighted in this paper, substantial shifts in investment patterns will be required to mitigate and adapt to climate change. About half of these shifts should occur in developing countries, which will require incentives and support for policy formulation and implementation.

163. Shifting investment is particularly important for the power supply. About USD 148 billion needs to be shifted from fossil-fired generation to renewables, CCS, nuclear energy and hydropower. Currently investment in the power sector is mostly domestic (about 70 per cent) with significant international FDI and international borrowing in some regions. Shifting domestic investments into more climate-friendly alternatives may require national policies and/or financial incentives.

164. Investment in improved efficiency by energy consumers and biofuel (USD 158 billion) would reduce the investment required in energy supply by USD 67 billion in 2030. Such a shift will require appropriate policies to encourage consumers to implement energy efficiency measures.

165. Adaptation in the infrastructure and AFF sectors will require a shift in public- and private-sector investment patterns and associated production activities. In both sectors, investment in physical assets will need to be shifted towards assets that are less vulnerable to the adverse impacts of climate change. The shift can be characterized, for example, by a change in location, design, building material or primary input in the case of manufacturers. The optimal shift will occur only with adequate policies and incentives. In the case of poor populations, direct financial support may also be required.

1. Private investments and financial flows

166. Governments – primarily those at the national level – set the rules for the markets in which investors seek profits. If current market rules are failing to attract – or drive – private investors into lower GHG, more climate-proof alternatives, there are a variety of steps governments can take to help address these market failures, including:

(a) Overcoming policy-based barriers to entry, for example by reducing or removing standards that inhibit implementation of lower carbon solutions (such as building codes and energy efficiency or zoning codes);

(b) Making the polluter pay (internalizing externalized costs), for example by imposing GHG emission limits or performance standards on production operations and products (such as vehicle emission standards);

(c) Paying the innovator (internalizing externalized benefits), for example by creating tradable rights to reward investments in reducing GHG emissions (such as a cap and trade regime);

(d) Filling information gaps, for example by requiring disclosure of data on emissions from production operations or energy use by products.

167. The carbon markets and policies to promote renewables are already playing an important role in shifting investment flows. This is indicative of how quickly investment flows can respond to changes in policies and incentives.

168. Some of the existing funding sources under the Convention and its Kyoto Protocol are already providing incentives for the development and implementation of climate change related policies. The financial mechanism of the Convention may be used to support the development of such policies. The programme of activities in the CDM has the potential to promote the implementation of policies. The level of funding available via these mechanisms is, however, limited at present.

169. IFIs can also stimulate shifts of private sector investments into clean energy and more climate resilient development. They can, for example, play an important role in providing guarantees to investment risks that the private sector would not take. As elaborated in chapter VIII C on optimizing resources below, sharing risks among private and public, domestic and external sources is a key strategy that can also encourage the shifting of resources.

170. Shifting investments into high-cost, low GHG emitting technologies poses additional challenges. Since the risks and costs are higher than those of conventional technologies, private investors need financial incentives or other arrangements to enable them to earn a comparable risk-adjusted return. This means it will be necessary, in particular in developing countries, to scale up funding (in the form of grants, concessional loans, promotional programmes, demonstration projects, etc) to shift the investments (see chapter VIII B on scaling up funding below).

2. Public investments and financial flows

171. In addition to providing incentives for the private sector, governments also need to shift the focus of their own investments. Governments are responsible for 10–25 per cent of the investment in new physical assets. Currently most of those investments are driven by local development priorities. In developing countries in particular, shifting funding to climate change related investments has to take social and development priorities into account.

172. Here too the mechanisms of the Convention and its Kyoto Protocol and carbon markets can play an important role. The CDM may for example provide an opportunity for governments to promote and implement projects. The financial mechanism may play an important role in assisting developing countries in integrating adaptation and mitigation costs and concerns in national planning.

173. The lending and assistance provided by IFIs also plays an important role in financing development projects in sectors with high potential for adaptation and mitigation. The shift of their investments and financial flows to more climate-resilient projects and cleaner energy can complement and reinforce development goals.

B. Scale up funding

174. As estimated in this paper there is a need for a significant increase (USD 248–381 billion) in investment and financial flows to mitigate and adapt to climate change. Much of this will be needed in for adaptation (USD 49–171 billion), but substantial amounts are also required for mitigation measures (such as technology development and deployment (USD 35–45 billion), forestry (USD 21 billion) and agriculture (USD 35 billion)).

175. The capacity of national governments, in developing countries in particular, to increase pools of financing is limited. For private investment and finance, expansion of the international carbon markets or provision of other economic incentives to invest more in specific sectors, particularly in developing countries, will therefore be needed. For public investment, expansion of the climate-focused funding from Annex II Parties (in accordance with Article 4, paragraph 3 of the Convention), as well other potential sources of funding to address climate change, will be needed.

1. International carbon markets

176. The international carbon markets stimulate private investment in mitigation measures in non-Annex I Parties. Such investment flows could be increased by expanding the market. Proposals to expand the international carbon markets should consider the following factors:

(a) An increase in demand for emission reduction credits is largely determined by the aggregate emission reduction resulting from limits on GHG emissions established at the national and international level and by the policies implemented to comply with these limits;

(b) An increase in investment flows to developing countries is limited by the potential and the cost of eligible mitigation measures in those countries and by requirements to maintain the environmental integrity of the system (additionality, preventing double counting, etc);

(c) The carbon markets direct investment to mitigation measures for which the revenue from the sale of credits has the biggest impact on profitability. The investment flows stimulated will therefore vary among mitigation measures. Stimulating investment in specific types of mitigation measures may require complementary measures or different mechanisms, as explained in chapter VIII C below on optimizing investments and financial flows;

(d) Policy certainty is important for investors. A longer-term international agreement on climate change broadens the range of mitigation measures that are attractive investments.

177. A high post-2012 demand for emission reduction credits could allow the expansion of existing market mechanisms, which would in turn stimulate additional supply of credits. A number of proposals for expanding market mechanisms are currently being tabled, such as sectoral CDM, policy CDM, 'no-lose' targets and credits for reduced deforestation. If Parties agree to any of these mechanisms, there would be a need for modalities to define baseline emissions and verify the actual emissions to determine the credits earned.

2. Adaptation Fund

178. The level of funding available to the Adaptation Fund depends on the quantity of CERs issued and their price. Funding for the Adaptation Fund post 2012 depends on the continuation of the CDM and

the level of demand in the carbon market, as discussed in chapter IV C above. Assuming that the concept of share of proceeds for adaptation continues to apply post 2012, the level of funding could be USD 100−500 million for low demand by Annex I Parties in 2030 for credits from non-Annex I Parties and USD 1−5 billion in 2030 for high demand.

179. The level of funding available to the Adaptation Fund would be small compared with the estimated needs for adaptation. The Adaptation Fund could be further expanded with additional sources of funding.

2. Financial mechanism of the Convention

180. The role of the financial mechanism as a source of funding has been mainly as a catalyst for adaptation and mitigation activities. While the level of funds for the climate change focal area in the GEF Trust Fund and in the LDCF and SCCF is low relative to the other sources of public investment in climate change, these funds have demonstrated the ability to leverage larger investments. Other GEF focal areas (biodiversity, land degradation and international waters) also played an important role in financing adaptation and mitigation activities, such as the protection of ecosystems.

181. Funding from the GEF is available as a grant and can be used for higher risk, longer term projects (such as the commercialization of new technology) and to meet project development costs for which other sources of funding are typically difficult to obtain. The GEF can also play an important role in promoting capacity-building on the ground.

182. As mentioned in chapter IV B above, replenishment of the GEF depends on voluntary contributions from donors and, in the case of the Convention, on how much Annex II Parties allocate to the financial mechanism in accordance with their obligations under Article 4, paragraph 3 of the Convention. The fourth review of the financial mechanism should start at COP 13 (December 2007) and as part of this review, the COP is expected to make an assessment of the amount necessary to assist developing countries and provide an input to GEF 5.[18]

183. If the funding available to the financial mechanism remains at its current level and continues to rely mainly on voluntary contributions, it will not be sufficient to address the future financial flows estimated to be needed for adaptation and mitigation.

3. Other potential sources of financial flows

184. Other potential options to generate additional funds to address climate change could be considered, including possibilities originally suggested for other purposes (see table 6).

[18] Decision 2/CP.12.

Table 6. Illustrative options for raising additional revenue for addressing climate change

Option	Revenue	Notes
Application of a levy similar to the 2 per cent share of proceeds from the CDM to international transfers of ERUs, AAUs and RMUs	USD 10 to USD 50 million	Annual average for 2008 to 2012
	Depends on size of carbon markets post-2012	Any estimate for post 2012 requires assumptions about future commitments
Auction of allowances for international aviation and marine emissions	USD 10 to USD 25 billion	Annual average for aviation rises from 2010 to 2030
	USD 10 to USD 15 billion	Annual average for marine transport rises from 2010 to 2030
International air travel levy	USD 10 to USD 15 billion	Based on charge of USD 6.50 per passenger per flight
Funds to invest foreign exchange reserves	Fund of up to USD 200 billion	Voluntary allocation of up to 5 per cent of foreign exchange reserves to a fund to invest in mitigation projects determined by the investors to diversify foreign exchange reserve investments
Access to renewables programmes in developed countries	USD 500 million	Eligible renewables projects in developing countries could earn certificates that could be used toward compliance with obligations under renewables programmes in developed countries to a specified maximum, such as 5 per cent
Debt-for-efficiency swap	Further research needed	Creditors negotiate an agreement that cancels a portion of the non-performing foreign debt outstanding in exchange for a commitment by the debtor government to invest the cancelled amount in clean energy projects domestically
Tobin tax	USD 15 to USD 20 billion	A tax of 0.01 per cent on wholesale currency transactions to raise revenue for Convention purposes
Donated special drawing rights	USD 18 billion initially	Special drawing rights are a form of intergovernmental currency provided by the IMF to serve as a supplemental form of liquidity for its member countries. Some special drawing rights issued could be donated to raise revenue for Convention purposes

Abbreviations: CDM = Clean development mechanism, ERU = Emission reduction units, AAU = Assigned amount units, RMU = Removal units, IMF = International Monetary Fund

185. Any of these options would require further analysis and agreement at the intergovernmental level; the list in table 6 is included to illustrate the availability of possible new sources of funds to address climate change which could generate revenues commensurate with the additional needs. Negotiations on a future regime could consider, inter alia, new commitments, new funding options and needs that would be funded under the Convention.

C. Optimize the allocation of the funds

186. In addition to shifting and scaling up funding, the allocation of resources available needs to be optimized. How the available funds are allocated across different projects depends on three major factors:

(a) The source of investment, as public and private investors differ in their preference for risk and return over time;

(b) The nature of the technology or project requiring investment, as these vary in the risks they present, both generally (technology risk) and specifically (project risk);

(c) The host country of the investment, as countries vary in their attractiveness to investors (country risk).

187. Allocating investment risks to the parties and investors most willing and able to manage them is key to optimizing the use of the funds available for climate change mitigation and adaptation. For example, an investment in a wind farm in a developing country could involve: equity investment from privately held or publicly listed companies; debt financing from banks or the bond markets; export credits and other insurance from public or private sources; and possibly public grants.

188. Some risks are best borne by the private investors involved (e.g. commercial risks). Some can be borne by governments through the policy and investment frameworks they set. Still others can be borne by IFIs and other sources of public money to spur additional private investment.

189. Governments can increase the diversity of the sources of capital available through the policy and investment frameworks they set. Attracting more private (domestic and foreign) investment to climate mitigation and adaptation projects means that such projects require less government funding and (in developing countries) ODA funding, which can then be redirected to social priorities. The policy and investment frameworks that can attract more private capital include:

(a) Tailored policies for specific types of projects, such as secure access with fair prices for renewables supplying the electricity grid and mandatory energy efficiency standards for buildings, appliances and equipment;

(b) Policies that promote diversification of the domestic financial market;

(c) Implementing measures to make the country more attractive to foreign private investors.

190. The ability to distribute the risks associated with a proposed investment among different public and private entities while providing each with a reasonable return over time depends on the diversity of the sources of capital available in the host country of the investment. In a country with a large and sophisticated financial market there are numerous sources of capital, with varying preferences for risk and return, creating more opportunities to bring different sources of capital together to cover the cost of any particular investment.

191. Most developing countries do not have a large and sophisticated financial market. In addition, many are considered by foreign private investors to involve relatively high country risks. As a result the range of private investors is more limited and the return they expect are higher than in developed countries. Projects in these countries therefore need more of the scarce domestic government or ODA funding available.

192. The preference for investment risk also depends on the technologies and projects concerned. The CDM helps stimulate private investment in eligible projects by providing an additional source of revenue: the sale of the CERs generated. But the impact of that incentive on the profitability of the project varies significantly by technology. For example, the sale of CERs makes hydrofluorocarbon-23 projects much more profitable. In contrast, the sale of CERs has little effect on the profitability of renewable energy projects, which have a high capital cost per unit of emissions reduced. To promote investment in renewables in developing countries, the carbon markets will need to be complemented with other sources of financing willing to bear the inherent risk.

193. The increased risk due to the adverse impacts of climate change has led insurers to make major modifications to their risk profiling and coverage strategies. The premiums and coverage of catastrophic risk insurance are reviewed every year based on the most recent experience. Rising insurance costs and declining coverage have led to protests by consumers and political interventions on their behalf. As a result, interest is growing among governments and IFIs in the use of a wider range of risk management

instruments, particularly catastrophe bonds and weather derivatives, to help address the macro-economic financial impact of disasters. This is because it has become clear that ex-post financing is inefficient for several reasons (e.g. tardiness and impact on other projects uncertainty), while insurance also has some deficiencies, principally lack of continuity of coverage and terms.

194. IFIs also help stimulate additional public and private investment. Even though GEF funds are small relative to other public sources of investment in climate change mitigation and adaptation, these funds have been able to leverage funding six times their size. IFIs also leverage investment from private-sector sources by providing guarantees for project, technology, country or other risks.

D. Conclusions

195. In developing options for long-term cooperative action for improving the potential of investments and financial flows to address climate change, it will be important to consider that:

(a) Future measures to address climate change have to take into account the need to increase global investment and financial flows. This increase is large compared with the existing funding available under the Convention and its Kyoto Protocol but is small compared with global GDP (0.3–0.5 per cent) and investments (1.1–1.7 per cent) estimated for 2030;

(b) Needs for future investment and financial flows to address climate change vary substantially across sectors and regions. Solutions to provide the necessary incentives to address needs will require better optimization and complementarity of sources of investment and financial flows;

(c) The required shift in future investment and financial flows need a combination of actions by the intergovernmental process (including under the UNFCCC process and under other processes such as IFIs), national governments and the private sector (including corporations and households);

(d) Solutions will also require a combination of:

(i) Policy frameworks, national and international, that increase the economic and financial attractiveness of investments in technologies and measures, such as carbon markets or feed-in tariffs;

(ii) Incentives and assistance to support developing countries in providing an enabling environment to change patterns of investments and financial flows to address climate change;

(iii) Policy frameworks, national and international, that regulate GHG emissions and promote their reduction;

(iv) Options for scaling up additional financial flows, from existing and new sources, that provide adequate and sustainable financing of developing country needs, in particular in areas such as adaptation, forestry and technology deployment;

(v) Collaborative efforts in: (a) R&D in low GHG emitting technologies; (b) understanding better the costs and opportunities relating to adaptation and mitigation measures.

Annex 1

Methodology

A. Definitions

1. The analysis presented in this paper and in the background paper use the following definitions for investment and financial flows:

(a) **An investment flow** is the initial (capital) spending for a physical asset;

(b) **A financial flow** is an ongoing expenditure related to climate change mitigation or adaptation that does not involve investment in physical assets.

B. Scenarios

2. The background paper draws on existing work wherever possible. The analysis therefore used **existing scenarios** to project investment and financial flows. The scenarios were selected based on their suitability for the analysis, the detail they provide on estimated investment and financial flows, and how representative they are of the literature.[19]

3. Relevant investment and financial flows for **mitigation** are projected for a reference scenario and a mitigation scenario. For energy-related CO_2 emissions, the reference scenario used is the "International Energy Agency (IEA) World Energy Outlook 2006 Reference Scenario" and the mitigation scenario is the "IEA World Energy Outlook 2006 Beyond the Alternative Policy Scenario Case".[20] For non-CO_2 emissions, the reference scenario is the reference scenario developed by the United States Environmental Protection Agency (EPA) and the mitigation scenario is based on potential cost-effective emission reductions identified by the EPA. For other emissions and sink enhancement in the agriculture and forestry sectors, the reference and mitigation scenarios are drawn from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

4. Additional investment and financial flows for mitigation are estimated as the difference between the reference and mitigation scenarios.

5. The impacts of those emission scenarios on climate change and the associated **adaptation** measures needed have not been modelled. To estimate the investment and financial flows for the adaptation measures in the sectors of water supply and coastal zones, the A1B scenario from SRES[21] was used. For the health sector the scenario used was based on the IPCC IS92a[22] and on a model from the World Health Organization on the global burden of disease. For agriculture and infrastructure the additional investment and financial flows were estimated using the OECD ENV-linkage model, which corresponds to the World Energy Outlook scenario of the IEA.

6. Additional investment and financial flows for adaptation were estimated using different assumptions and models for different sectors.

7. The analysis was geographically disaggregated to the extent possible. Owing to the limited data available, especially in terms of regional detail, most of the results have been compiled under the following **regional groupings:** OECD North America, OECD Pacific, OECD Europe, Transition

[19] A detailed explanation of the selection of scenarios is available in chapter 2.3 of the background paper.
[20] International Energy Agency (IEA). 2006. IEA World Energy Outlook 2006. Paris: IEA.
[21] Nakicenovic N. and Swart R. (eds). 2000. Emission Scenario: Special Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.
[22] Leggett et al. 1992. Emissions Scenarion for the IPCC: An Update. Assumptions, Methodology, and Results. IPCC Working Group I.

Economies, Developing Asia, Latin America, Africa and Middle East[23]. Results in this summary are, however, presented at a global level and for non-Annex I Parties.

8. Unless otherwise specified, all monetary values have been converted to 2005 United States dollars.

C. Investment and financial flows

1. Investment flows

9. **Current investment flows** are compiled from various sources. The total investment in physical assets is the gross fixed capital formation (GFCF) reported in countries' national accounts. GFCF is reported for ten economic sectors. The sources responsible for the investments – governments, households and corporations – are also reported. Funds from other countries are subtracted from GFCF to obtain the domestic funding. Governments borrow internationally and receive official development assistance (ODA). Corporations raise funds domestically, receive foreign direct investment (FDI) and borrow from foreign sources. The most recent year for which national accounts data are available for a large number of countries is 2000.

10. FDI data cover investment in new physical assets and acquisition of existing physical and financial assets. Globally, purchases and sales of existing assets roughly balance each other. But for an individual country, purchases and sales of existing physical and financial assets can be a large component of FDI. Since the analysis focuses on the investment in new physical assets, two values of total FDI are compiled for each country:

(a) FDI as reported: both equity investment in new physical assets and acquisition of existing physical and financial assets;

(b) Adjusted FDI: FDI as reported plus the value of international asset purchases less the value of international asset sales.

11. Projections of **future investment flows** are available by economic sector, but not by source. Projections of future FDI, international debt and ODA are also not available. In addition, the economic sectors for which current and future investment flows are available do not always coincide with those relevant to the analysis of climate change mitigation and adaptation. This means that the future investment flow projected for a sector was assessed on the basis of the current sources of investment for the sector.

2. Financial flows

12. The reference scenario assumes no new international agreement to address climate change. Thus the reference scenario has no future financial flows (recurrent expenditures) to reduce emissions or enhance removals by sinks. Climate change would occur and adaptation to its impacts would be needed. Financial flows would be needed under the reference scenario for some sectors analysed for adaptation, such as human health, and these future financial flows are estimated.

13. For the mitigation scenario, current and future financial flows are estimated by sector, specifically for reduction of non-CO_2 emissions in agriculture, reduced deforestation, forest management, human health, extension services for agriculture, and technology research, development and deployment.

3. Current investment and financial flows under the Convention and its Kyoto Protocol

14. The Convention and its Kyoto Protocol have established mechanisms that provide investment and financial flows for adaptation and mitigation. These include the clean development mechanism (CDM), joint implementation (JI), the Global Environment Facility (GEF) as an operating entity of the financial

[23] Please refer to annex 2 of the background paper for more details regarding the regional groups definition.

mechanism of the Convention, the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF) and the Adaptation Fund of the Kyoto Protocol.

Annex 2

Table 1. Sources of investment as a percentage of total investment by region in 2000

	Africa	Dev Asia	LA	Mid East	OECD Europe	OECD NA	OECD Pacific	Other Europe	TE	World	AI Parties	NAI Parties	LDC
Total investment, billions of 2005United States dollars	**118**	**804**	**332**	**140**	**2 067**	**2 488**	**1 695**	**2**	**105**	**7 750**	**6 014**	**1 654**	**40**
Households (in per cent)													
Domestic	19.24	16.91	21.55	25.34	28.29	33.34	20.51	19.43	15.90	26.38	28.52	18.69	17.92
Total investment	19.24	16.91	21.55	25.34	28.29	33.34	20.51	19.43	15.90	26.38	28.52	18.69	17.92
Corporations [a](in per cent)													
Domestic	45.59	54.15	13.67	57.55	-19.52	13.84	58.44	66.10	60.38	20.78	20.78	13.26	57.28
Debt	0.48	0.01	25.57	1.09	31.87	22.27	0.13	0.00	0.61	16.81	16.81	20.20	0.02
FDI	8.75	18.61	27.68	5.58	46.87	18.33	2.29	0.00	12.19	22.40	22.40	23.99	11.81
FDI adjusted [b]	5.41	17.90	36.81	4.84	34.29	27.49	3.14	-12.75	15.06	22.46	22.46	23.65	13.96
Domestic adjusted [b]	40.18	36.25	-23.14	52.70	-53.81	-13.65	55.29	78.86	45.32	-1.68	-1.68	-10.39	43.32
Total investment	54.81	72.78	66.92	64.22	59.23	54.44	60.86	66.10	73.18	59.99	59.99	57.45	69.11
Government (in per cent)													
Domestic	23.25	8.67	3.32	7.40	11.12	12.50	18.63	14.39	-15.98	12.37	13.29	9.05	15.26
Debt	0.38	0.31	7.48	2.81	1.33	-0.28	-0.01	0.00	26.28	1.03	0.74	2.12	-0.39
ODA bilateral	1.41	0.80	0.59	0.19	0.01	0.00	0.00	0.08	0.48	0.14	0.00	0.65	3.17
ODA multilateral	0.91	0.54	0.14	0.05	0.01	0.00	0.00	0.00	0.15	0.08	0.00	0.38	3.09
Total ODA	2.32	1.34	0.73	0.24	0.02	0.01	0.00	0.08	0.63	0.23	0.00	1.03	6.26
Total investment	25.95	10.32	11.52	10.44	12.48	12.22	18.62	14.47	10.93	13.62	14.04	12.20	21.14
Total (in per cent)													
Domestic	88.07	79.72	38.55	90.28	19.90	59.68	97.58	99.92	60.29	59.54	55.07	85.02	82.05
FDI	8.75	18.61	27.68	5.58	46.87	18.33	2.29	0.00	12.19	22.40	23.99	11.81	12.00
Domestic adjusted [b]	91.41	80.44	29.41	91.02	32.48	50.52	96.74	112.67	57.42	59.48	55.41	82.87	79.45
FDI adjusted [b]	5.41	17.90	36.81	4.84	34.29	27.49	3.14	-12.75	15.06	22.46	23.65	13.96	14.61
Debt	0.86	0.33	33.04	3.90	33.21	21.99	0.12	0.00	26.89	17.84	20.94	2.14	-0.32
ODA	2.32	1.34	0.73	0.24	0.02	0.01	0.00	0.08	0.63	0.23	0.00	1.03	6.26
Total investment (in per cent)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Data Sources: United Nations Statistics Division, National Accounts Main Aggregates Database; Bank for International Settlements, Monetary and Economic Department, International Finance Statistics and Electronic data for International Bonds and Bondware, World Bank, World Development Indicator 2006, Organisation for Economic Co-operation and Development, The Creditor Reporting System Database.

Abbreviations: AI Parties included in annex I to the Convention, Dev Asia = Developing Asia, FDI = Foreign direct investment, LA = Latin America, LDC = Least developed countries, Mid Eas t= Middle East, NA = North America, NAI = Parties not included in Annex I to the Convention, OECD = Organisation for Economic Co-operation and Development, , ODA = Official development assistance, TE = Transition Economies,

[a)] Combined financial and non-financial corporations.

[b)] Adjusted for mergers and acquisitions.

Table 2. Investment by sectors and sources as a percentage of total global investment

Investment flows	Agriculture, hunting, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas and water supply	Wholesale retail trade	Construction	Transport, storage and communications	Financial intermediation; real estate, renting and business activities	Public administration and defence; compulsory social security	Education; health and social work; other community, social and personal services	Total
Total investment, (billions of United States dollars)	**175**	**139**	**1 301**	**257**	**621**	**438**	**889**	**2 611**	**622**	**696**	**7 750**
Domestic investment	93.14	66.44	71.93	68.81	64.74	97.04	65.45	43.40	84.96	81.92	64.64
FDI flows	**0.97**	**33.18**	**22.09**	**12.19**	**19.44**	**1.16**	**16.73**	**23.92**	**-**	**17.30**	**17.89**
International debt	5.39	0.16	5.95	16.44	15.82	1.79	16.91	32.67	15.04	0.60	17.25
ODA total	0.50	0.23	0.04	2.55	-	-	0.90	-	-	0.19	0.23
Bilateral	**0.30**	**0.19**	**0.03**	**1.67**	**-**	**-**	**0.50**	**-**	**-**	**0.17**	**0.14**
Multilateral	**0.20**	**0.04**	**0.00**	**0.88**	**-**	**-**	**0.41**	**-**	**-**	**0.01**	**0.08**

Data Sources: United Nations Statistics Division, National Accounts Main Aggregates Database.
Bank for International Settlements, Monetary and Economic Department, International Finance Statistics and Electric data for International Bonds and Bondware,
World Bank, World Development Indicator 2006.
Organisation for Economic Co-operation and Development, The Creditor Reporting System Database.
Abbreviations: FDI = Foreign direct investment, ODA = Official development assistance, Wholesale retail trade = wholesale retail trade, repair of motor vehicles, motorcycles, etc. and hotels and restaurants.

Table 3. Overview of current sources of financial flows relevant to climate change

Sources	Amount (in millions of United States dollars)	Notes
Mitigation		
Clean development mechanism	2006USD 5 259	Value of trades during 2006
	2006USD 947 to 1 572	Value of estimated annual emission reductions for projects registered during 2006
	2006USD 1 569 to 2 602	Value of estimated annual emission reductions for projects that entered the pipeline during 2006
	2006USD 6 939	Investment by projects registered during 2006
	2006USD 26 467	Investment by projects that entered the pipeline during 2006
Joint implementation	2006USD 140	Value of trades during 2006
	2006USD 132 to 266	Value of estimated annual emission reductions for projects that entered the pipeline during 2006
	2006USD 6 269	Investment by projects that entered the pipeline during 2006
Carbon funds	2006USD 6 996	Subscribed capital at end of 2006
	2006USD 2 110	Increase in subscribed capital during 2006
Global Environment Facility (GEF)	3 326.6	Cumulative funding allocated since GEF inception for operational programmes (OPs) 5, 6, 7, 11, EA, STRM and joint OPs. Pilot phase and three replenishment periods and six projects approved under the fourth GEF replenishment (GEF 4) as at June 2007
	990	Targeted allocations as per GEF 4 to be spent between 2006 and 2010
Adaptation		
GEF strategic priority "Piloting an Operational Approach to Adaptation (SPA)"	50 (over 3 years)	Pilot to be evaluated
Least Developed Countries Fund (LDCF)	160 (pledged)	
Special Climate Change Fund (SCCF)	67 (pledged)	Adaptation part only
Adaptation Fund (AF)	2006USD 80–300	Estimated annual revenue during 2008 to 2012 from 2 per cent share of proceeds levy on CERs issued

Source: Chapters 7 and 8 of background paper.
Note: Activity under the clean development mechanism and joint implementation is relatively recent and growing rapidly, so data for 2006 are presented.

Table 4. Global Environment Facility Trust Fund allocations and co-financing (millions of United States dollars)

GEF phase	GEF grant	Co-financing amount
Pilot phase	280.60	2 402.89
GEF I	507.00	2 322.10
GEF 2	667.20	3 403.40
GEF 3	881.80	4 609.69
GEF 4[a]	990.00	
From which in 2007	76.35	1 651.82
Total	**3 326.60**	**14 389.90**

Source: FCCC/CP/2006/3; GEF. 2007. Work Program Submitted for Council Approval, GEF/C.31/8

[a] Targeted allocations as per GEF 4, see:
<http://thegef.org/Documents/coucil_documents/GEF_29/documents/C29.3SummaryofNegotiations.pdf>

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