INFORMATION NOTE

Policies and measures for mitigation of climate change

1. Introduction

1.1 This information note serves to provide the latest information on greenhouse gas emission, its effect on global warming and the policies and measures for mitigation of climate change for the deliberation of the Panel on Environmental Affairs at its meeting on 28 May 2007.

2. Definition of greenhouse gas emission

2.1 Greenhouse gases are components of the atmosphere that contribute to the greenhouse effect[1]. Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide and ozone. Some greenhouse gases occur naturally in the atmosphere, while others result from human activities.

2.2 Although greenhouse gases make up about 1% of the atmosphere, they act like a blanket around the earth, or like the glass roof of a greenhouse, trapping heat and keeping the planet warm. If the concentration of greenhouse gases in the atmosphere increases, the average surface temperature of the earth will increase, leading to global warming. According to the Intergovernmental Panel on Climate Change (IPCC), an international agency studying global warming (to be discussed in paragraphs 4.1 to 4.4), greenhouse gas emissions from industry, transportation and agriculture are causes of global warming. IPCC also found that 11 of the past 12 years (1995–2006) had been ranked among the warmest 12 years since 1850 when the instrumental record of global surface temperature was in place.

[1] The greenhouse effect is the process by which absorption and emission of infrared radiation by atmospheric gases warm the atmosphere and surface of a planet.

3. International agreements related to global warming

3.1 There are two major pieces of international agreements related to global warming, namely the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

United Nations Framework Convention on Climate Change

3.2 UNFCCC is an international environmental treaty signed among member countries of the United Nations (UN) at the United Nations Conference on Environment and Development in 1992. As of May 2007, a total of 191 countries have ratified the treaty. The objective of UNFCCC is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system". UNFCCC states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner"[2]. UNFCCC requires all industrialized member countries to report precise and regularly updated inventories of their greenhouse gas emissions.

3.3 The prime authority of UNFCCC is the Conference of the Parties (COP), an association of all member countries (or "Parties") which meets once a year. COP evaluates the status of climate change and the effectiveness of UNFCCC. There are two subsidiary bodies[3] and three expert groups[4] established under UNFCCC to assist COP and member countries in meeting requirements under UNFCCC.

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2 See United Nations Framework Convention on Climate Change (2007).

3 The two subsidiary bodies are the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation. While the former counsels COP on matters of climate, the environment and technology, the latter helps COP review how UNFCCC is being applied. It also deals with financial and administrative matters.

4 The three expert groups are as follows: (a) the Consultative Group of Experts on National Communications which helps developing countries prepare national reports on climate change issues; (b) the Least Developed Country Expert Group which advises underdeveloped nations on establishing programmes for adapting to climate change; and (c) the Expert Group on Technology Transfer which seeks to spur the sharing of advanced nations' technology with less-advanced nations.

Kyoto Protocol

3.4 The Kyoto Protocol is an agreement made under UNFCCC. Countries ratifying this protocol commit themselves to reducing their emissions of carbon dioxide and five other greenhouse gases, or engaging in emissions trading if they maintain or increase emissions of such gases. As of December 2006, a total of 169 countries and other governmental entities have ratified the agreement.[5]

4. Intergovernmental Panel on Climate Change

4.1 In 1988, the United Nations Environment Programme and the World Meteorological Organization (WMO)[6] jointly established IPCC, as concern over climate change became a political issue. IPCC is open to all members of both UN[7] and WMO[8]. The role of IPCC is to assess the state of knowledge on the various aspects of climate change including science, environmental and socio-economic impacts and response strategies.

Operation of the Intergovernmental Panel on Climate Change

4.2 IPCC holds its plenary meeting once a year. Hundreds of officials and experts from relevant ministries, agencies and research institutions from member countries attend this meeting. Decisions made during the plenary meeting include:

(a) mandate of working groups and task forces;

(b) work plan and budget;

(c) preparation for new climate assessment reports, their scope and outline; and

(d) election of IPCC Chair and IPCC Bureau[9].

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5 Countries that have not ratified the protocol include the United States and Australia. While countries like India and China have ratified the protocol, they are not required to reduce carbon emissions under the agreement because they are not the main contributors to the greenhouse gas emissions during the industrialization period which is believed to be the cause of the current climate change.

6 Established in 1950, WMO became the specialized agency of UN in 1951 for meteorology (weather and climate), operational hydrology and related geophysical sciences.

7 As at 28 June 2006, UN had 192 member states.

8 As of 24 January 2007, WMO has 188 member states and territories.

9 The work of IPCC Bureau is to prepare IPCC assessment reports on climate change. Members of IPCC Bureau are experts in the field of climate change. The current IPCC Bureau has 30 members.

4.3 IPCC itself does not carry out research, nor does it monitor climate-related data or other relevant parameters. The assessment is primarily based on peer reviews and published scientific/technical literature. Currently, IPCC has three working groups and a task force to assist with its work:

(a) Working Group I to assess the scientific aspects of the climate system as well as climate change;

(b) Working Group II to address the vulnerability of the socio-economic and natural systems to climate change, the negative and positive consequences of climate change and options for adapting to them;

(c) Working Group III to assess options for both limiting greenhouse gas emissions and mitigating climate change; and

(d) Task Force on National Greenhouse Gas Inventories to carry out work on inventory-related methodologies and practices.

4.4 Since IPCC is recognized as the most authoritative scientific and technical voice on climate change, its assessments have a profound influence on shaping both UNFCCC and the Kyoto Protocol. [10]

5. The *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change

5.1 Since November 2003, IPCC has been working on the *Fourth Assessment Report* which provides policymakers of member nations with comprehensive scientific, technical and socio-economic information on climate change, its causes, possible impacts and related response measures. The *Assessment Report* consists of four reports, namely three summary reports for policymakers prepared by IPCC's working groups and a synthesis report which is based on the information of the three summary reports as well as other special reports and technical papers of IPCC. The full *Fourth Assessment Report* will be available in November 2007. The ensuing paragraphs highlight the main conclusions/findings of the three summary reports for Members' information.

[10] See United Nations (2007).

Working Group I : *Summary for Policymakers*

5.2 On 5 February 2007, Working Group I published its revised *Summary for Policymakers*.[11] The conclusions made by Working Group I are as follows:

(a) Warming of the climate system is unequivocal.

(b) Increase in the average temperatures since the mid-20th century is likely due to the increase in anthropogenic greenhouse gas concentrations.

(c) Increase in temperatures and rise in the sea level "would continue for centuries" despite pollution control, and the extent of rise varies greatly depending on the fossil intensity[12] of human activity in the following century.

(d) The probability of global warming caused by natural climatic processes is less than 5%.

(e) World temperatures could rise by between 1.1°C and 6.4°C during the 21st century and that:

(i) the sea level will probably rise by 18 cm to 59 cm;

(ii) there will be more frequent warm spells, heat waves and heavy rainfall; and

(iii) there will be an increase in droughts, tropical cyclones and extreme high tides.

(f) Both past and future anthropogenic carbon dioxide emissions will continue to contribute to global warming and sea level rise for more than a millennium.

(g) Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and they have far exceeded pre-industrial values over the last 650 000 years.

Working Group II : *Summary for Policymakers*

5.3 On 6 April 2007, Working Group II published its *Summary for Policymakers*. Table 1 shows the trends and impacts of extreme changes in weather, climate and the sea level as observed by Working Group II.

[11] The full report of Working Group I was published in March 2007.

[12] Fossil intensity is the energy produced by fossil fuels divided by the total annual generation of the fossil fuels such as hydrocarbons, primarily coal and petroleum.

Table 1 – Trends and impacts of extreme changes in weather, climate and the sea level

Phenomena and direction of trend	Examples of major projected impacts			
	Agriculture, forestry and ecosystems	**Water resources**	**Human health**	**Industry, settlement and society**
Over most land areas: (a) warmer and fewer cold days and nights; and (b) warmer and more frequent hot days and nights.	(a) increased yields in colder environments; (b) decreased yields in warmer environments; and (c) increased insect outbreaks.	(a) increased water supply due to snow melt; and (b) increased water supply in moist tropical and high latitude areas and decreased water supply in low latitude areas.	(a) reduced human mortality from decreased cold exposure.	(a) reduced energy demand for heating; (b) increased demand for cooling; (c) declining air quality in cities; (d) reduced disruption to transport due to snow and ice; and (e) reduced winter tourism.
Over most land areas: increased warm spells/heat waves	(a) reduced yields in warmer regions due to heat stress; and (b) increased wildfire danger.	(a) increased water demand; and (b) water quality problems, e.g. algal blooms.	(a) increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially-isolated persons.	(a) reduction in the quality of life of people in warm areas without appropriate housing; and (b) marked impacts on elderly, very young and poor who have limited adaptive capabilities.
Over most areas: increased frequency of heavy precipitation events	(a) damage to crops; and (b) soil erosion, inability to cultivate land due to water logging of soils.	(a) adverse effects on quality of surface and groundwater; (b) contamination of water supply; and (c) water scarcity being relieved in some cases.	(a) increased risk of deaths, injuries, infectious, respiratory and skin diseases.	(a) disruption of settlements, commerce, transport and societies due to flooding; (b) pressures on urban and rural infrastructures; and (c) loss of property.

Table 1 – Trends and impacts of extreme changes in weather, climate and the sea level (cont'd)

Phenomena and direction of trend	Examples of major projected impacts			
	Agriculture, forestry and ecosystems	**Water resources**	**Human health**	**Industry, settlement and society**
Increased areas affected by drought	(a) land degradation, lower yields/crop damage and failure; (b) increased livestock deaths; and (c) increased risk of wildfire.	(a) more widespread water stress.	(a) increased risk of food and water shortage; (b) increased risk of malnutrition; and (c) increased risk of water- and food-borne diseases.	(a) water shortages for settlements, industry and societies; (b) reduced hydropower generation potentials; and (c) potential for population migration.
Increased intense tropical cyclone activity	(a) damage to crops; (b) wind-throw (uprooting) of trees; and (c) damage to coral reefs.	(a) power outages causing disruption of public water supply.	(a) increased risk of deaths, injuries, water- and food-borne diseases; and (b) post-traumatic stress disorders.	(a) disruption by floods and high winds; (b) withdrawal of risk coverage in vulnerable areas by private insurers; (c) potential for population migration; and (d) loss of property.
Increased incidence of extreme high sea level (excluding tsunamis)	(a) salinization of irrigation water, estuaries and freshwater systems.	(a) decreased freshwater availability due to salt-water intrusion.	(a) increased risk of deaths and injuries by drowning in floods; and (b) migration-related health effects.	(a) increased costs of coastal protection; and (b) potential for movement of population and infrastructure.

Source: Intergovernmental Panel on Climate Change (2007a).

Working Group III : *Summary for Policymakers*

5.4 On 4 May 2007, Working Group III published its *Summary for Policymakers*. The *Summary* analyzes mitigation options for climate change in various areas such as energy supply, transportation, construction, industry and agriculture in the short, medium and long term. It also stipulates policies, measures and instruments facilitating the implementation of these options.

Mitigation options

5.5 Table 2 shows the key mitigation technologies and practices commercially available in the short and medium term.

Table 2 – Key mitigation technologies and practices commercially available in the short and medium term

Sector	Key mitigation technologies and practices currently commercially available	Key mitigation technologies and practices projected to be commercialized before 2030
Energy supply	(a) improved supply and distribution efficiency; (b) fuel switching from coal to gas; (c) nuclear power; (d) renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); (e) combined heat and power; and (f) early applications of carbon capture and storage (CCS), e.g. storage of removed carbon dioxide from natural gas.	(a) CCS for gas, biomass and coal-fired electricity generating facilities; (b) advanced nuclear power; and (c) advanced renewable energy, including tidal and waves energy, concentrating solar and solar photovoltaic (PV).
Transport	(a) more fuel efficient vehicles; (b) hybrid vehicles; (c) cleaner diesel vehicles; (d) biofuels; (e) modal shifts from road transport to rail and public transport systems; (f) non-motorized transport (cycling and walking); and (g) land-use and transport planning.	(a) second generation biofuels; (b) higher efficiency aircraft; and (c) advanced electric and hybrid vehicles with more powerful and reliable batteries.

Table 2 – Key mitigation technologies and practices commercially available in the short and medium term (cont'd)

Sector	Key mitigation technologies and practices currently commercially available	Key mitigation technologies and practices projected to be commercialized before 2030
Buildings	(a) efficient lighting and day-lighting; (b) more efficient electrical appliances and heating and cooling devices; (c) improved stoves; (d) improved insulation; (e) passive and active solar design for heating and cooling; (f) alternative refrigeration fluids; and (g) recovery and recycle of fluorinated gases.	(a) integrated design of commercial buildings such as intelligent meters that provide feedback and control on energy consumption; and (b) solar PV integrated in buildings.
Industry	(a) more efficient end-use electrical equipment; (b) heat and power recovery; (c) material recycling and substitution; (d) control of non-carbon dioxide gas emissions; and (e) a wide array of process-specific technologies.	(a) advanced energy efficiency; (b) CCS for cement, ammonia, and iron manufacture; and (c) inert electrodes for aluminium manufacture.
Agriculture	(a) improved crop and grazing land management to increase soil carbon storage; (b) restoration of cultivated peaty soils and degraded lands; (c) improved rice cultivation techniques and livestock and manure management to reduce methane emissions; (d) improved nitrogen fertilizer application techniques to reduce nitrous oxide emissions; (e) dedicated energy crops to replace fossil fuel use; and (f) improved energy efficiency.	(a) improvements of crop yields.

Table 2 – Key mitigation technologies and practices commercially available in the short and medium term (cont'd)

Sector	Key mitigation technologies and practices currently commercially available	Key mitigation technologies and practices projected to be commercialized before 2030
Forestry/ forests	(a) afforestation; (b) reforestation; (c) forest management; (d) reduced deforestation; (e) harvested wood product management; and (f) use of forestry products for bioenergy to replace fossil fuel use.	(a) tree species improvement to increase biomass productivity and carbon sequestration; and (b) improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential and mapping land use change.
Waste	(a) landfill methane recovery; (b) waste incineration with energy recovery; (c) composting of organic waste; (d) controlled waste water treatment; and (e) recycling and waste minimization.	(a) biocovers and biofilters to optimize methane oxidation.

Source: Intergovernmental Panel on Climate Change (2007c).

Policies, measures and instruments facilitating mitigation of climate change

5.6 The *Summary for Policymakers* of Working Group III recommends four criteria for the formulation and evaluation of policies and instruments facilitating mitigation of climate change. They are:

(a) environmental effectiveness;

(b) cost effectiveness;

(c) distributional effects, including equity; and

(d) institutional feasibility.

5.7 Listed below are recommended policy options on mitigation of climate change as well as possible concerns as regards implementation:

(a) integrating climate policies in broader development policies to facilitate implementation and overcome barriers;

(b) limiting emission levels by regulations and standards although there is a risk that regulations and standards may not induce innovations or the development of more advanced technologies;

(c) taxing or charging a fee for carbon emission; literature has identified taxes as an efficient way of internalizing costs of greenhouse gas emissions;

(d) introducing tradable permits[13] for carbon emission; while the volume of allowed emissions determines the impact on the environment, the allocation of permits brings in distributional consequences;

(e) introducing financial incentives such as subsidies and tax credits to stimulate the development and diffusion of new technologies; while economic costs of financial incentives are generally higher than those of taxes and tradable permits, they are acceptable amongst economies;

(f) promoting voluntary agreements between industry and governments, as voluntary agreements are politically attractive, raise awareness among stakeholders and play a role in the evolution of many national policies; nevertheless, there is a concern that the majority of agreements have not achieved significant reduction in emissions;

(g) organizing awareness campaigns which may positively affect environmental quality by promoting informed choices and contributing to behavioural change; and

(h) encouraging research, development and demonstration activities, as they help stimulate technological advances, reduce costs and enable progress toward stabilization.

5.8 Table 3 shows the sectoral policies, measures and instruments that have proved to be environmentally effective in the mitigation of climate change in some countries.

[13] Tradable permits are economic policy instruments under which the right to discharge pollution or exploit resources can be exchanged through either a free or a controlled permit-market.

Table 3 – Selected sectoral policies, measures and instruments proved to be environmentally effective in the mitigation of climate change

Sector	Policies, measures and instruments proved to be environmentally effective	Key constraints or opportunities
Energy supply	Reduction of fossil fuel subsidies	Resistance by vested interests may make them difficult to implement
	Taxes or carbon charges on fossil fuels	
	Feed-in tariffs for renewable energy technologies	Appropriate to create markets for low emissions technologies in some cases
	Renewable energy obligations	
	Producer subsidies	
Transport	Mandatory fuel economy, biofuel blending and carbon dioxide standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
	Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing	Effectiveness may drop with higher incomes
	Influence mobility needs through land use regulations, and infrastructure planning	Particularly appropriate for countries that are building up their transportation systems
	Investment in attractive public transport facilities and non-motorized forms of transport	

Table 3 – Selected sectoral policies, measures and instruments proved to be environmentally effective in the mitigation of climate change (cont'd)

Sector	Policies, measures and instruments proved to be environmentally effective	Key constraints or opportunities
Buildings	Appliance standards and labelling	Periodic revision of standards needed
	Building codes and certification	Attractive for new buildings Enforcement can be difficult
	Demand-side management programmes	Regulations required
	Public sector leadership programmes, including procurement	Government purchasing can expand demand for energy-efficient products
	Incentives for energy service companies	Success factor: Access to third-party financing
Industry	Provision of benchmark information	Appropriate to stimulate technology uptake in some cases
	Performance standards	Stability of national policy important in view of international competitiveness
	Subsidies, tax credits	
	Tradable permits	Predictable allocation mechanisms and stable price signals important for investments
	Voluntary agreements	Success factors include clear targets, a baseline scenario, third-party involvement in design and review and formal provisions of monitoring, close co-operation between government and industry
Agriculture	Financial incentives and regulations for improved land management, maintaining soil carbon content, and efficient use of fertilizers and irrigation	May encourage synergy with sustainable development and reducing vulnerability to climate change, thereby overcoming barriers to implementation

Table 3 – Selected sectoral policies, measures and instruments proved to be environmentally effective in the mitigation of climate change (cont'd)

Sector	Policies, measures and instruments proved to be environmentally effective	Key constraints or opportunities
Forestry/ forests	Financial incentives (national and international) to increase forest area, to reduce deforestation, and to maintain and manage forests	Constraints include lack of investment capital and land tenure issues May help poverty alleviation
	Land use regulation and enforcement	
Waste management	Financial incentives for improved waste and wastewater management	May stimulate technology diffusion
	Renewable energy incentives or obligations	Local availability of low-cost fuel
	Waste management regulations	Most effectively applied at national level with enforcement strategies

Source: Intergovernmental Panel on Climate Change (2007c).

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25 May 2007
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