

# APPENDIX

**A1 Tokyo Declaration on Asian Biomass**

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# A1 Tokyo Declaration on Asian Biomass

## A1.1 Tokyo Declaration on Asian Biomass

At the Biomass Asia Forum, which was organized mainly by the Ministry of Agriculture, Fishery, and Forestry, Japan, Tokyo Declaration on Asian Biomass was adopted. This declaration arranged the things to be considered and the direction of activities for the utilization of biomass in Asian countries based on the discussion in the forum. The declaration is as following.

### Tokyo Declaration on Asian Biomass

Considering the increasing expectations held for biomass, the Biomass Asia Forum adopts the following declaration for the effective utilization of Asian biomass resources.

1. The renewability and carbon neutrality of biomass resources should be recognized and the utilization of biomass resources promoted.
2. When using biomass resources, the importance of sustainability should be emphasized and reductions in carbon dioxide emissions properly evaluated.
3. The contribution of biomass resources to the activation of Asian industry and regional economies should be recognized and appropriate measures taken to make the most of these economic effects.
4. When using biomass resources, the possibility of creating a recycling society should be discussed and appropriate measures for realizing such a society promoted.
5. The effectiveness of the development and introduction of appropriate technologies in the

utilization of biomass resources should be recognized and the development of related technologies through appropriate support and subsidization promoted.

6. An association to promote biomass resource utilization, composed of members from Asian countries, should be organized and should conduct self-supporting activities.

7. Utilization of biomass resources should contribute to the improvement of conditions in all countries; thus biomass utilization that contributes to the solution of poverty, prevention of environmental damage, suppression of disease, and realization of a better quality of life should be promoted and policies for realizing such utilization pursued.

## **A1.2 Biomass Asia Workshop and Biomass Asia Forum**

Structuring of a network for the purpose of sharing information among members related to Asian biomass and developing mutual understanding is important. There are two streams in this term. The one is Biomass Asia Forum, which was organized mainly by the Ministry of Agriculture, Forestry, and Fishery, Japan, and the other is Biomass ASEAN Project, which is proceeded mainly by the National Institute of Advanced and Industrial Science and Technology, Japan (AIST), and Japan International Research Center for Agricultural Science (JIRCAS) with the subsidies from the Ministry of Education, Culture, Sports, Science and Technology, Japan. In the year of 2004, these two projects started independently, but soon it was notice that both projects have similar goals, and it was decided to have a joint-workshop, which was the 1<sup>st</sup> Biomass Asia Workshop, held in January, 2005, in Tokyo and Tsukuba, Japan. In December, 2005, the 2<sup>nd</sup> Biomass Asia Workshop was held in Bangkok, Thailand, and Biomass Asia Forum was held in January, 2006 in Tokyo. Through these workshops and forum, the situation of biomass in Asian countries was studied, and the purpose of its effective use was discussed. Based on these concept, the network development was discussed at the 3<sup>rd</sup> Biomass Asia Workshop in Novemer, 2006. This flow is shown in Fig. 1.

The 4<sup>th</sup> Biomass Asia Workshop was held in November, 2007 in Shah Alam, Malaysia. The 5<sup>th</sup> workshop is to be held in China.

To overview the trend of recent biomass activities, the program of the 4<sup>th</sup> Biomass Asia Workshop is also shown here.

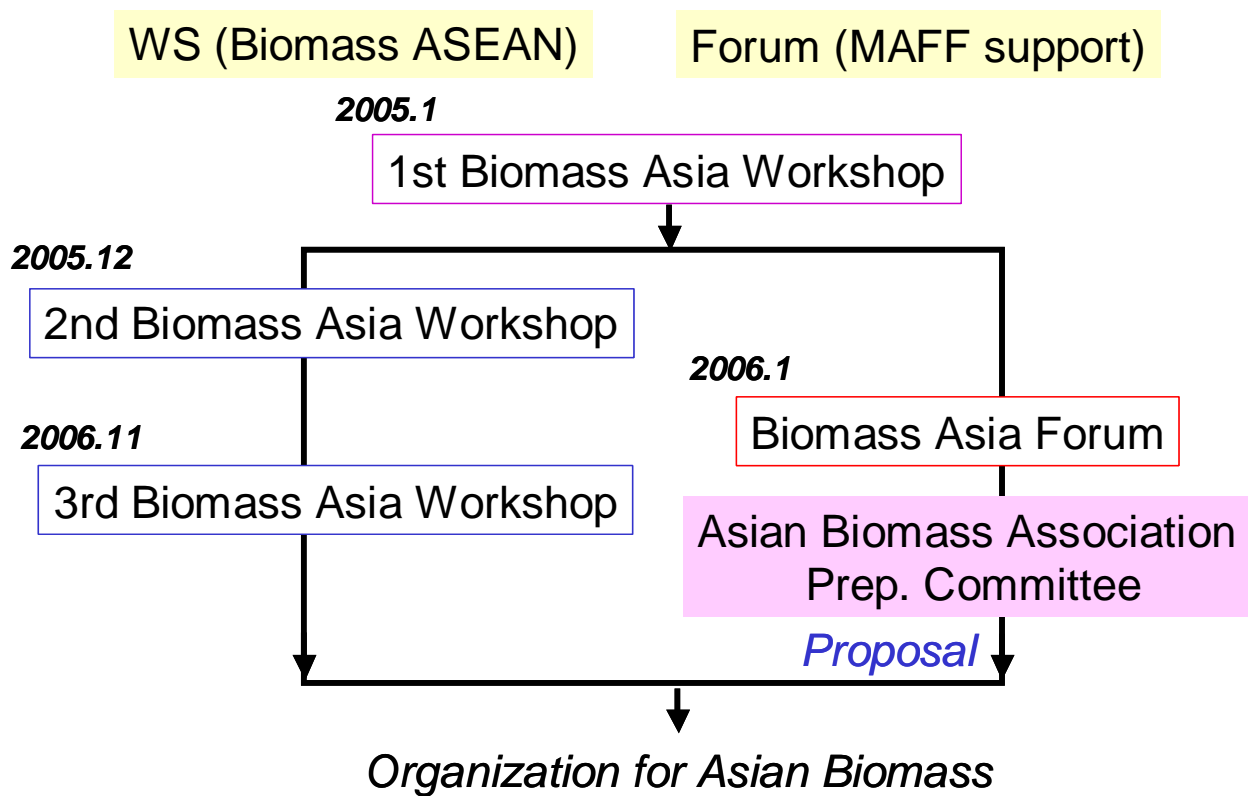


Fig. A1.2.1 Events regarding the networking on Asian Biomass utilization.

# Fourth Biomass-Asia Workshop

Date: 20-22 November, 2007

Venue: Grand BlueWave Hotel Shah Alam

Perbandaran, Seksyen 14, 40000 Shah Alam, Selangor Darul Ehsan, Malaysia

## Day 1 (Nov. 20, 2007)

0830-0900 Registration

Opening Remarks

0900-0915 Tatsuo Katsura

Senior Vice President, AIST, on behalf of Representative of Biomass-Asia Research Consortium, Japan

0915-0930 Kunio Oguri

Deputy Director General, Agriculture, Forestry and Fisheries Research Council Secretariat, MAFF, Japan

0930-1000 Break

Special Lecture

Chair: Zainal Abidin Mohd Yusuf (Vice President, SIRIM, Malaysia)

1000-1030 Lignocellulose refinery system must be realized for global environment and economy

Kenji Iiyama

President, JIRCAS, Japan

1030-1100 Coffee Break

Plenary Lecture

Chair: Yasuyuki Yagi (Councillor, International Affairs Dept., AIST, Japan)

1100-1125 Food Security with Biofuels: FAO Perspective

Abdolreza Abbassian

Secretary of the Intergovernmental Group on Grains, FAO, UN

1125-1150 Biomass for Energy Generation in Malaysia

Anuar Abdul Rahman

CEO of Pusat Tenaga Malaysia (PTM)

1150-1215 Biomass for Material Application

Peesamai Jenvanitpanjakul

Deputy Governor, Thailand Institute of Scientific and Technological Research (TISTR), Thailand

1215-1240 Policy and Legislation on Biofuel Utilisation

Datu Dr. Michael Dosim Lunjew

Secretary General, Ministry of Plantation Industries and Commodities Malaysia

1240-1420 Lunch / Poster Session

Keynote Speech

1430-1500 H.E. Dato' Sri Dr. Lim Keng Yaik  
Minister of Energy, Water and Communications, Malaysia

Future Prospect of Biomass Utilisation in Asian Countries  
Chair: Masayuki Kamimoto (Research Coordinator, AIST, Japan)  
1500-1525 Biomass-Asia Project-Second Stage: Research and Technological Development for Sustainable Biomass Utilization in Asian Countries

Kinya Sakanishi

Representative of Research Core for Asian Biomass Energy, AIST, Japan

1525-1550 The Road Map of Chinese Biomass Energy Development

Haibin Li

Guangzhou Institute of Energy Conversion (GIEC),

Chinese Academy of Sciences (CAS), China

1550-1610 Coffee Break

1610-1635 Rice-Sugarcane Complex Model

Klanarong Sriroth

Associate Professor, Department of Biotechnology, Faculty of Agro-Industry, Kasetsart University, Thailand

1635-1700 Palm Complex Model

Wahono Sumaryono

Deputy Chairman for Agroindustry and Biotechnology,

Agency for Assessment and Application of Technology (BPPT), Indonesia

- Panel Discussion -

Asian Partnership on Sustainable Environmentally Benign Biomass Production and Utilisation

Moderator: Yukihiro Matsumura (Professor, Hiroshima University, Japan)

1700-1830

< Panelists >

China: The Development of Biofuels in China

Dehua Liu

Professor, Director of Institute of Applied Chemistry, Department of Chemical Engineering, Tsinghua University

Indonesia : Biofuel Development in Indonesia

Petrus Panaka

Professor, Project Development Advisor, PT Gikoko Kogyo Indonesia

Malaysia : Sustainable Biomass Production and Utilisation

- Profit, People and Planet -

Mohamad Ali Hassan

Dean, Faculty of Biotechnology and Biomolecular Sciences, University Putra Malaysia (UPM)

Philippines: Non-fossil Energy

Luis F. Razon

Director, University Research Coordination Office, Associate Professor, Department of Chemical Engineering, De La Salle University

Thailand : Asian Partnership on Sustainable Environmentally Benign Biomass Production and Utilization

Nuwong Chollacoop



National Metal and Materials Technology Center (MTEC),  
National Science and Technology Development Agency (NSTDA)  
Vietnam : Seaweed: Potential Biomass for Ethanol Production  
Truong Nam Hai  
Deputy Director, Institute of Biotechnology,  
Vietnamese Academy of Science and Technology (VAST)

2000-2130 Reception  
hosted by Dato' Dr. Halim Man  
Secretary General for Ministry of Energy, Water and Communications, Malaysia

## **Day 2 (Nov. 21, 2007)**

### **<Room 1>**

Palm Oil Energy Complex Model

Chair:

Chen Sau Soon (SIRIM, Malaysia)  
Tomoaki Minowa (AIST, Japan)

0900-0920 Palm Oil Industry in Malaysia  
Dato' Dr. Choo Yuen May,  
Deputy Director-General, Malaysian Palm Oil Board

0920-0940 Electricity Generation from Palm Oil Mills in Indonesia  
(extended abstract)  
Soni Solistia Wirawan  
Head of Institute for Engineering  
and Technology System Design  
(Engineering Center), BPPT,  
Indonesia

0940-1000 Palm Oil Energy Complex and CDM  
Yoshihito Shirai  
Professor, Graduate School of Life  
Science and Systems Engineering,  
Kyushu Institute of Technology,  
Japan

1000-1020 Potential of Oil Palm Trunk as a Source for Ethanol Production  
Ryohei Tanaka  
FFPRI, Japan  
co-authored by Yutaka Mori (JIRCAS)  
Mohd Nor Mohd Yusoff (FRIM)  
Othman Sulaiman (USM)  
Shu Yoshida (Sojitz Machinery Corporation)

1020-1040 Coffee Break

1040-1100 Biomass Plastics from Palm Oil Mill Effluent in Malaysia

Mohamad Ali Hassan  
Dean, Faculty of Biotechnology  
and Biomolecular Sciences,  
University Putra Malaysia(UPM),  
Malaysia

1100-1120 Co-firing of Biomass with Coal for Power Generation

Suthum Patumsawad  
Assistant Professor, Department of Mechanical Engineering, King Mongkut's  
Institute of Technology North  
Bangkok (KMITNB), Thailand

1120-1140 Benchmarking of Biodiesel Fuel Standards for Vehicles in East Asia

Shinichi Goto  
Director, Research Center for New  
Biomass Technology Research  
Center, AIST, Japan

1140-1200 Production of Second-Generation Biofuels from Palm Wastes

Shinichi Yano  
Senior Research Scientist,  
Biomass Technology Research  
Center, AIST, Japan

1200-1220 Discussion

### <Room 2>

Utilisation of Agriculture and Wood Wastes

Chair :

Guangwen Xu (CAS, China)  
Takahiro Yoshida (FFPRI, Japan)

Brazil: Brazilian Present and Future Ethanol Production - Biomass Ethanol Potential

Elba P.S.Bon  
Associate Professor in Biochemistry,  
Chemistry Institute,  
Federal University of Rio de Janeiro

Cambodia: Biomass in Cambodia

Lieng Vuthy  
Deputy Director, Department of  
Energy Techique, Ministry of  
Industry, Mines and Energy

China: High Efficient Conversion of Cellulosic Process Residue into Middle-Caloric Gas

Guangwen Xu  
Professor, Institute of Process Engineering, CAS

Indonesia: Agricultural and Wood Waste Potentials and Utilization in Indonesia  
Unggul Priyanto  
Director, Energy Resources Development Technology Center, BPPT

Japan: Biomass Refinery Systems -Case Study at Miyako Island, Japan-  
Yoshiyuki Shinogi  
Head, Laboratory of Farmland  
Engineering, Department of Land and Water Resources, National Institute for Rural  
Engineering, NARO

1020-1040 Coffee Break

Laos: Brief Report of Biomass in LAO PDR  
Bouathep Malaykham  
Chief of Electric Power Management  
Division, Department of Electricity,  
Ministry of Energy and Mines

Myanmar: Anhydrous Ethanol Production  
Su Su Hlaing  
Lecturer of Department of Chemical  
Engineering, Mandalay  
Technological University

Philippines : Outlook of Biomass Industry in the Philippines  
Ruby B. De Guzman  
Supervising Science Research  
Specialist Alternative Fuels and  
Energy Technology Division,  
Department of Energy

Thailand : Zero Waste Agriculture for Jatropha Plantation  
Siriluck Nivitchanyong  
Assistant Director, MTEC,  
Alternative Energy Program Host,  
NSTDA

Vietnam : Utilization of Agricultural and Wood Wastes in Vietnam  
Tran Dinh Man  
Deputy Director, Institute of  
Biotechnology, VAST

Discussion  
Moderator's Summary  
Moderator: Yukihiro Matsumura  
(Hiroshima University, Japan)

1220-1330 Lunch / Poster Session

For Sustainable Biomass Utilization

Chair: Yoshihito Shirai (Professor, Kyushu Institute of Technology, Japan)

1330-1355 Asia Biomass Community

Issei Sawa

Senior Manager, Liquid Biofuel, New Energy Business Unit, Mitsubishi Corporation, Japan

1355-1420 Financing for Biomass and Renewable Energy Projects

Mohd Nordin Che Omar

Manager of High Technology, representing Chairman of Bank Pembangunan Malaysia

1420-1445 Evaluation of Environmental Impacts of Biomass Utilisation by LCA

Masayuki Sagisaka

Deputy Director, Life Cycle Assessment Research Center, AIST, Japan

1445-1510 Improving Drought and Salt Stress Tolerance in Plants by Gene Transfer

Yasunari Fujita

Senior researcher, Biological Resources Division, JIRCAS, Japan

1530-1600 Coffee Break

Way Forward Session

-Panel Discussion-

Moderator: Shinya Yokoyama (Professor, The University of Tokyo, Japan)

1600-1730 Moderator's Summary : Energy Situation in Asian Region

< Panelists >

Haibin Li, China

Wahono Sumaryono, Indonesia

Kinya Sakanishi, Japan

Mohamad Ali Hassan, Malaysia

Peesamai Jenvanitpanjakul, Thailand

Tran Dinh Man, Vietnam

for the 5th Biomass-Asia Workshop

Closing Remarks

1730-1740 Masakazu Yamazaki

Vice President, AIST, Japan

1740-1750 Chen Sau Soon

Senior General Manager, Environment & Bioprocess Technology Centre

SIRIM, Malaysia

2000-2130 Workshop Dinner hosted by AIST

## Day 3 (Nov. 22, 2007)

Technical tour

1. Waste to Energy Plant, Banting

2. Biodiesel Palm Oil Mill, Labu

## A1.3 Asia Biomass Association

Based on the discussion on structuring of network, which is also clearly stated in the Tokyo Declaration on Asian Biomass, setting of Asia Biomass Association was proposed at the Biomass Asia forum.

This proposal is further based on the concept that conventional collaborative activities on Asian biomass are based on programs supported by a specific budget, and when the program is over, the activity is also over, but that the network should be continued, and thus the network should be free from specific budget. For example, the Ministry of Agriculture, Forestry, and Fishery, Japan does not have the eternal budget for the Biomass Asia Forum. The Ministry of Education, Culture, Sport, Science, and Technology, Japan is supporting the Biomass ASEAN Project only for three year. The network so far built up should not be cancelled, but the activities of the network are wanted to continue even when these budgets are over. Thus, structuring of the framework of the association was decided.

As the first step, a preparation committee was decided to be placed where the detail of the network that allows voluntary based activities without any budget is discussed. The name of the network was decided to be Asia Biomass Association (tentative), and the following fundamental policies were agreed.

- The Asia Biomass Association should be a voluntary-based neutral and non-political group.
- The association is composed of individual and group members, and has a steering committee, management committee, and, when necessary, working groups.
- Its activity is based on the membership fee, and the membership fee is decided by the steering committee based on the GDP per capita of each country.
- The least activities should be management of a mailing list and homepages. When budget is available, publication of brochure, organization of Biomass Asia Conference, and other activities by the proposal of other members should be made.

Members of the preparation committee is selected from the attendants of the Forum, one from each of 9 countries including Japan, and as the chair, Dr. Shin-ya Yokoyama was nominated. The management of the preparation committee was undertaken by the research group SETA, where Dr. Yokoyama is working as the International Steering Committee Chair.

This preparation committee decided to officially start the Asia Biomass Association in March, 2008. For this purpose, the following agreement was made.

## **Agreement of the Asian Biomass Association**

1. This association should be known as the “Asian Biomass Association”, and abbreviated as “ABA”. It is a framework network based on voluntary activities and shall be a neutral and apolitical association.

2. The purpose of this association is to achieve effective utilization of Asian biomass based on the Tokyo Declaration on Asian Biomass. For this purpose, the association manages its homepage and the mailing list of the members.

3. The members of the association are a person or a group from Asian countries who are interested in the purpose of this association.

4. This association has the following bodies.

Steering Committee

Management Committee

Working Groups

5. The Steering Committee is composed of representatives from Asian countries. The number of the representatives is one for a country. The representative of a country is decided by the discussion among the members of the country’s nationality.

6. The Organization Committee has a Chair who is selected by election among the members of the committee. The duration of the Chairmanship is 2 years, and re-election is limited to 2 times.

7. The Organization Committee nominates members of the Management Committee.

8. The Organization Committee decides the activities of the association other than those shown above, and entrusts it to the Management Committee, and other parties. The Organization Committee decides the place of the office of the Association.
9. The Organization Committee starts and terminates the Working Groups for the activities of the association.
10. The Association Members includes personal members and group members. The joining and removal of a member needs approval by the Organizing Committee.
11. The membership fee is decided by the Organization Committee.
12. Amendment of this agreement requires the consent of 2/3 of its members.

The management of the mailing list and homepages were entrusted to Japan Institute of Energy. The Steering Committee members from each country are shown in Table A1.3.1.

Table A1.3.1 Steering Committee members

Country	Steering Committee member
Japan	Prof. Shin-ya Yokoyama*
Malaysia	Prof. Mohamad Ali Hassan
Philippines	Dr. Jessie Cansanay Elauria
Indonesia	Dr. Petrus Panaka
Vietnam	Dr. Hai Nam Truong
China	Prof. Dehua Liu
Thailand	Dr. Paritud Bhandhubanyong
Korea	Dr. Jin-Suk Lee
Taiwan	Prof. Tzay-An Shiau
Laos	Mr. Bouathep Malaykham



## **A2. Kyoto Protocol**

### **A2.1 The United Nations Framework Convention on Climate Change (UNFCCC)**

The Parties to this Convention,

Acknowledging that change in the Earth's climate and its adverse effects are a common concern of humankind,

Concerned that human activities have been substantially increasing the atmospheric concentrations of greenhouse gases, that these increases enhance the natural greenhouse effect, and that this will result on average in an additional warming of the Earth's surface and atmosphere and may adversely affect natural ecosystems and humankind,

Noting that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries, that per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs,

Aware of the role and importance in terrestrial and marine ecosystems of sinks and reservoirs of greenhouse gases,

Noting that there are many uncertainties in predictions of climate change, particularly with regard to the timing, magnitude and regional patterns thereof,

Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions,

Recalling the pertinent provisions of the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972,

Recalling also that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction,

Reaffirming the principle of sovereignty of States in international cooperation to address climate change,

Recognizing that States should enact effective environmental legislation, that environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply, and that standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries,

Recalling the provisions of General Assembly resolution 44/228 of 22 December 1989 on the United Nations Conference on Environment and Development, and resolutions 43/53 of 6 December 1988, 44/207 of 22 December 1989, 45/212 of 21 December 1990 and 46/169 of 19 December 1991 on protection of global climate for present and future generations of mankind,

Recalling also the provisions of General Assembly resolution 44/206 of 22 December 1989 on the possible adverse effects of sea-level rise on islands and coastal areas, particularly low-lying coastal areas and the pertinent provisions of General Assembly resolution 44/172 of 19 December 1989 on the implementation of the Plan of Action to Combat Desertification,

Recalling further the Vienna Convention for the Protection of the Ozone Layer, 1985, and the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, as adjusted and amended on 29 June 1990,

Noting the Ministerial Declaration of the Second World Climate Conference adopted on 7 November 1990,

Conscious of the valuable analytical work being conducted by many States on climate change and of the important contributions of the World Meteorological Organization, the United Nations Environment Programme and other organs, organizations and bodies of the United Nations system, as well as other international and intergovernmental bodies, to the exchange of results of scientific research and the coordination of research,

Recognizing that steps required to understand and address climate change will be environmentally, socially and economically most effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in these areas,

Recognizing that various actions to address climate change can be justified economically in their own right and can also help in solving other environmental problems,

Recognizing also the need for developed countries to take immediate action in a flexible manner on the basis of clear priorities, as a first step towards comprehensive response strategies at the global, national and, where agreed, regional levels that take into account all greenhouse gases, with due consideration of their relative contributions to the enhancement of the greenhouse effect,

Recognizing further that low-lying and other small island countries, countries with low-lying coastal, arid and semi-arid areas or areas liable to floods, drought and desertification,

and developing countries with fragile mountainous ecosystems are particularly vulnerable to the adverse effects of climate change,

Recognizing the special difficulties of those countries, especially developing countries, whose economies are particularly dependent on fossil fuel production, use and exportation, as a consequence of action taken on limiting greenhouse gas emissions,

Affirming that responses to climate change should be coordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter, taking into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty,

Recognizing that all countries, especially developing countries, need access to resources required to achieve sustainable social and economic development and that, in order for developing countries to progress towards that goal, their energy consumption will need to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general, including through the application of new technologies on terms which make such an application economically and socially beneficial,

Determined to protect the climate system for present and future generations,

Have agreed as follows:

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ARTICLE 1  
DEFINITIONS\*  
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For the purposes of this Convention:

1. "Adverse effects of climate change" means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.
2. "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
3. "Climate system" means the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions.
4. "Emissions" means the release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time.

5. "Greenhouse gases" means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation.
6. "Regional economic integration organization" means an organization constituted by sovereign States of a given region which has competence in respect of matters governed by this Convention or its protocols and has been duly authorized, in accordance with its internal procedures, to sign, ratify, accept, approve or accede to the instruments concerned.
7. "Reservoir" means a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored.
8. "Sink" means any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.
9. "Source" means any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.

\* Titles of articles are included solely to assist the reader.

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## ARTICLE 2 OBJECTIVE

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The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. 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.

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## ARTICLE 3 PRINCIPLES

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In their actions to achieve the objective of the Convention and to implement its provisions, the Parties shall be guided, *INTER ALIA*, by the following:

1. The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly,

the developed country Parties should take the lead in combating climate change and the adverse effects thereof.

2. The specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration.
3. The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties.
4. The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.
5. The Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change. Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.

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#### ARTICLE 4 COMMITMENTS

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1. All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:
  - (a) Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties;

- (b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change;
- (c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors;
- (d) Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;
- (e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods;
- (f) Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change;
- (g) Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies;
- (h) Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change, and to the economic and social consequences of various response strategies;
- (i) Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations; and
- (j) Communicate to the Conference of the Parties information related to implementation, in accordance with Article 12.

2. The developed country Parties and other Parties included in Annex I commit themselves specifically as provided for in the following:

- (a) Each of these Parties shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention, recognizing that the return by the end of the present decade to earlier levels of anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol would contribute to such modification, and taking into account the differences in these Parties' starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties to the global effort regarding that objective. These Parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention and, in particular, that of this subparagraph;
- (b) In order to promote progress to this end, each of these Parties shall communicate, within six months of the entry into force of the Convention for it and periodically thereafter, and in accordance with Article 12, detailed information on its policies and measures referred to in subparagraph (a) above, as well as on its resulting projected anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for the period referred to in subparagraph (a), with the aim of returning individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol. This information will be reviewed by the Conference of the Parties, at its first session and periodically thereafter, in accordance with Article 7;
- (c) Calculations of emissions by sources and removals by sinks of greenhouse gases for the purposes of subparagraph (b) above should take into account the best available scientific knowledge, including of the effective capacity of sinks and the respective contributions of such gases to climate change. The Conference of the Parties shall consider and agree on methodologies for these calculations at its first session and review them regularly thereafter;
- (d) The Conference of the Parties shall, at its first session, review the adequacy of subparagraphs (a) and (b) above. Such review shall be carried out in the light of the best available scientific information and assessment on climate change and its impacts, as well as relevant technical, social and economic information. Based on this review, the Conference of the Parties shall take appropriate action, which may include the adoption of amendments to the commitments in subparagraphs (a) and (b) above. The Conference of the Parties, at its first session, shall also take decisions regarding criteria for joint implementation as indicated in subparagraph (a) above. A second review of subparagraphs (a) and (b) shall take place not later than 31 December 1998, and thereafter at regular intervals determined by the Conference of the Parties, until the objective of the Convention is met;

- (e) Each of these Parties shall :
- i) Coordinate as appropriate with other such Parties, relevant economic and administrative instruments developed to achieve the objective of the Convention; and
  - (ii) Identify and periodically review its own policies and practices which encourage activities that lead to greater levels of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur;
- (f) The Conference of the Parties shall review, not later than 31 December 1998, available information with a view to taking decisions regarding such amendments to the lists in Annexes I and II as may be appropriate, with the approval of the Party concerned;
- (g) Any Party not included in Annex I may, in its instrument of ratification, acceptance, approval or accession, or at any time thereafter, notify the Depositary that it intends to be bound by subparagraphs (a) and (b) above. The Depositary shall inform the other signatories and Parties of any such notification.
3. The developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.
4. The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.
5. The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.
6. In the implementation of their commitments under paragraph 2 above, a certain degree of flexibility shall be allowed by the Conference of the Parties to the Parties included in Annex I undergoing the process of transition to a market economy, in order to enhance the ability of these Parties to address climate change, including with regard to the historical level of anthropogenic emissions of greenhouse gases not controlled by the



Montreal Protocol chosen as a reference.

7. The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.
8. In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on:
  - (a) Small island countries;
  - (b) Countries with low-lying coastal areas;
  - (c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay;
  - (d) Countries with areas prone to natural disasters;
  - (e) Countries with areas liable to drought and desertification;
  - (f) Countries with areas of high urban atmospheric pollution;
  - (g) Countries with areas with fragile ecosystems, including mountainous ecosystems;
  - (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and
  - (i) Land-locked and transit countries.

Further, the Conference of the Parties may take actions, as appropriate, with respect to this paragraph.

9. The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology.
10. The Parties shall, in accordance with Article 10, take into consideration in the implementation of the commitments of the Convention the situation of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change. This applies notably to Parties with economies that are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives.

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ARTICLE 5  
RESEARCH AND SYSTEMATIC OBSERVATION

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In carrying out their commitments under Article 4, paragraph 1(g), the Parties shall:

- (a) Support and further develop, as appropriate, international and intergovernmental programmes and networks or organizations aimed at defining, conducting, assessing and financing research, data collection and systematic observation, taking into account the need to minimize duplication of effort;
- (b) Support international and intergovernmental efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities, particularly in developing countries, and to promote access to, and the exchange of, data and analyses thereof obtained from areas beyond national jurisdiction; and
- (c) Take into account the particular concerns and needs of developing countries and cooperate in improving their endogenous capacities and capabilities to participate in the efforts referred to in subparagraphs (a) and (b) above.

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ARTICLE 6  
EDUCATION, TRAINING AND PUBLIC AWARENESS

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In carrying out their commitments under Article 4, paragraph 1(i), the Parties shall:

- (a) Promote and facilitate at the national and, as appropriate, subregional and regional levels, and in accordance with national laws and regulations, and within their respective capacities:
  - (i) The development and implementation of educational and public awareness programmes on climate change and its effects;
  - (ii) Public access to information on climate change and its effects;
  - (iii) Public participation in addressing climate change and its effects and developing adequate responses; and
  - (iv) Training of scientific, technical and managerial personnel.
- (b) Cooperate in and promote, at the international level, and, where appropriate, using existing bodies:

- (i) The development and exchange of educational and public awareness material on climate change and its effects; and
- (ii) The development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries.

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ARTICLE 7  
CONFERENCE OF THE PARTIES

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1. A Conference of the Parties is hereby established.
2. The Conference of the Parties, as the supreme body of this Convention, shall keep under regular review the implementation of the Convention and any related legal instruments that the Conference of the Parties may adopt, and shall make, within its mandate, the decisions necessary to promote the effective implementation of the Convention. To this end, it shall:
  - (a) Periodically examine the obligations of the Parties and the institutional arrangements under the Convention, in the light of the objective of the Convention, the experience gained in its implementation and the evolution of scientific and technological knowledge;
  - (b) Promote and facilitate the exchange of information on measures adopted by the Parties to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under the Convention;
  - (c) Facilitate, at the request of two or more Parties, the coordination of measures adopted by them to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under the Convention;
  - (d) Promote and guide, in accordance with the objective and provisions of the Convention, the development and periodic refinement of comparable methodologies, to be agreed on by the Conference of the Parties, inter alia, for preparing inventories of greenhouse gas emissions by sources and removals by sinks, and for evaluating the effectiveness of measures to limit the emissions and enhance the removals of these gases;
  - (e) Assess, on the basis of all information made available to it in accordance with the provisions of the Convention, the implementation of the Convention by the Parties, the overall effects of the measures taken pursuant to the Convention, in particular environmental, economic and social effects as well as their cumulative impacts and the extent to which progress towards the objective of the Convention is being

achieved;

- (f) Consider and adopt regular reports on the implementation of the Convention and ensure their publication;
  - (g) Make recommendations on any matters necessary for the implementation of the Convention;
  - (h) Seek to mobilize financial resources in accordance with Article 4, paragraphs 3, 4 and 5, and Article 11;
  - (i) Establish such subsidiary bodies as are deemed necessary for the implementation of the Convention;
  - (j) Review reports submitted by its subsidiary bodies and provide guidance to them;
  - (k) Agree upon and adopt, by consensus, rules of procedure and financial rules for itself and for any subsidiary bodies;
  - (l) Seek and utilize, where appropriate, the services and cooperation of, and information provided by, competent international organizations and intergovernmental and non-governmental bodies; and
  - (m) Exercise such other functions as are required for the achievement of the objective of the Convention as well as all other functions assigned to it under the Convention.
3. The Conference of the Parties shall, at its first session, adopt its own rules of procedure as well as those of the subsidiary bodies established by the Convention, which shall include decision-making procedures for matters not already covered by decision-making procedures stipulated in the Convention. Such procedures may include specified majorities required for the adoption of particular decisions.
4. The first session of the Conference of the Parties shall be convened by the interim secretariat referred to in Article 21 and shall take place not later than one year after the date of entry into force of the Convention. Thereafter, ordinary sessions of the Conference of the Parties shall be held every year unless otherwise decided by the Conference of the Parties.
5. Extraordinary sessions of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any Party, provided that, within six months of the request being communicated to the Parties by the secretariat, it is supported by at least one third of the Parties.
6. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State member thereof or observers thereto not Party to the Convention, may be represented at sessions of the Conference of the Parties as observers. Any body or agency, whether national or international, governmental or non-governmental, which is qualified in matters covered by the Convention, and which has informed the secretariat of its wish to be represented at a session of the Conference of the Parties as

an observer, may be so admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Conference of the Parties.

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## ARTICLE 8 SECRETARIAT

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1. A secretariat is hereby established.
2. The functions of the secretariat shall be:
  - (a) To make arrangements for sessions of the Conference of the Parties and its subsidiary bodies established under the Convention and to provide them with services as required;
  - (b) To compile and transmit reports submitted to it;
  - (c) To facilitate assistance to the Parties, particularly developing country Parties, on request, in the compilation and communication of information required in accordance with the provisions of the Convention;
  - (d) To prepare reports on its activities and present them to the Conference of the Parties;
  - (e) To ensure the necessary coordination with the secretariats of other relevant international bodies;
  - (f) To enter, under the overall guidance of the Conference of the Parties, into such administrative and contractual arrangements as may be required for the effective discharge of its functions; and
  - (g) To perform the other secretariat functions specified in the Convention and in any of its protocols and such other functions as may be determined by the Conference of the Parties.
3. The Conference of the Parties, at its first session, shall designate a permanent secretariat and make arrangements for its functioning.

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## ARTICLE 9 SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE

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1. A subsidiary body for scientific and technological advice is hereby established to provide the

Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention. This body shall be open to participation by all Parties and shall be multidisciplinary. It shall comprise government representatives competent in the relevant field of expertise. It shall report regularly to the Conference of the Parties on all aspects of its work.

2. Under the guidance of the Conference of the Parties, and drawing upon existing competent international bodies, this body shall:
  - (a) Provide assessments of the state of scientific knowledge relating to climate change and its effects;
  - (b) Prepare scientific assessments on the effects of measures taken in the implementation of the Convention;
  - (c) Identify innovative, efficient and state-of-the-art technologies and know-how and advise on the ways and means of promoting development and/or transferring such technologies;
  - (d) Provide advice on scientific programmes, international cooperation in research and development related to climate change, as well as on ways and means of supporting endogenous capacity-building in developing countries; and
  - (e) Respond to scientific, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body.
3. The functions and terms of reference of this body may be further elaborated by the Conference of the Parties.

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ARTICLE 10  
SUBSIDIARY BODY FOR IMPLEMENTATION

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1. A subsidiary body for implementation is hereby established to assist the Conference of the Parties in the assessment and review of the effective implementation of the Convention. This body shall be open to participation by all Parties and comprise government representatives who are experts on matters related to climate change. It shall report regularly to the Conference of the Parties on all aspects of its work.
2. Under the guidance of the Conference of the Parties, this body shall:
  - (a) Consider the information communicated in accordance with Article 12, paragraph 1, to assess the overall aggregated effect of the steps taken by the Parties in the light of the latest scientific assessments concerning climate change;
  - (b) Consider the information communicated in accordance with Article 12, paragraph 2, in

order to assist the Conference of the Parties in carrying out the reviews required by Article 4, paragraph 2(d); and

- (c) Assist the Conference of the Parties, as appropriate, in the preparation and implementation of its decisions.

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## ARTICLE 11 FINANCIAL MECHANISM

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1. A mechanism for the provision of financial resources on a grant or concessional basis, including for the transfer of technology, is hereby defined. It shall function under the guidance of and be accountable to the Conference of the Parties, which shall decide on its policies, programme priorities and eligibility criteria related to this Convention. Its operation shall be entrusted to one or more existing international entities.
2. The financial mechanism shall have an equitable and balanced representation of all Parties within a transparent system of governance.
3. The Conference of the Parties and the entity or entities entrusted with the operation of the financial mechanism shall agree upon arrangements to give effect to the above paragraphs, which shall include the following:
  - (a) Modalities to ensure that the funded projects to address climate change are in conformity with the policies, programme priorities and eligibility criteria established by the Conference of the Parties;
  - (b) Modalities by which a particular funding decision may be reconsidered in light of these policies, programme priorities and eligibility criteria;
  - (c) Provision by the entity or entities of regular reports to the Conference of the Parties on its funding operations, which is consistent with the requirement for accountability set out in paragraph 1 above; and
  - (d) Determination in a predictable and identifiable manner of the amount of funding necessary and available for the implementation of this Convention and the conditions under which that amount shall be periodically reviewed.
4. The Conference of the Parties shall make arrangements to implement the above-mentioned provisions at its first session, reviewing and taking into account the interim arrangements referred to in Article 21, paragraph 3, and shall decide whether these interim arrangements shall be maintained. Within four years thereafter, the Conference of the Parties shall review the financial mechanism and take appropriate measures.
5. The developed country Parties may also provide and developing country Parties avail

themselves of, financial resources related to the implementation of the Convention through bilateral, regional and other multilateral channels.

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## ARTICLE 12

### COMMUNICATION OF INFORMATION RELATED TO IMPLEMENTATION

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1. In accordance with Article 4, paragraph 1, each Party shall communicate to the Conference of the Parties, through the secretariat, the following elements of information:
  - (a) A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties;
  - (b) A general description of steps taken or envisaged by the Party to implement the Convention; and
  - (c) Any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends.
2. Each developed country Party and each other Party included in Annex I shall incorporate in its communication the following elements of information:
  - (a) A detailed description of the policies and measures that it has adopted to implement its commitment under Article 4, paragraphs 2(a) and 2(b); and
  - (b) A specific estimate of the effects that the policies and measures referred to in subparagraph (a) immediately above will have on anthropogenic emissions by its sources and removals by its sinks of greenhouse gases during the period referred to in Article 4, paragraph 2(a).
3. In addition, each developed country Party and each other developed Party included in Annex II shall incorporate details of measures taken in accordance with Article 4, paragraphs 3, 4 and 5.
4. Developing country Parties may, on a voluntary basis, propose projects for financing, including specific technologies, materials, equipment, techniques or practices that would be needed to implement such projects, along with, if possible, an estimate of all incremental costs, of the reductions of emissions and increments of removals of greenhouse gases, as well as an estimate of the consequent benefits.
5. Each developed country Party and each other Party included in Annex I shall make its initial communication within six months of the entry into force of the Convention for that Party. Each Party not so listed shall make its initial communication within three



years of the entry into force of the Convention for that Party, or of the availability of financial resources in accordance with Article 4, paragraph 3. Parties that are least developed countries may make their initial communication at their discretion. The frequency of subsequent communications by all Parties shall be determined by the Conference of the Parties, taking into account the differentiated timetable set by this paragraph.

6. Information communicated by Parties under this Article shall be transmitted by the secretariat as soon as possible to the Conference of the Parties and to any subsidiary bodies concerned. If necessary, the procedures for the communication of information may be further considered by the Conference of the Parties.
7. From its first session, the Conference of the Parties shall arrange for the provision to developing country Parties of technical and financial support, on request, in compiling and communicating information under this Article, as well as in identifying the technical and financial needs associated with proposed projects and response measures under Article 4. Such support may be provided by other Parties, by competent international organizations and by the secretariat, as appropriate.
8. Any group of Parties may, subject to guidelines adopted by the Conference of the Parties, and to prior notification to the Conference of the Parties, make a joint communication in fulfilment of their obligations under this Article, provided that such a communication includes information on the fulfilment by each of these Parties of its individual obligations under the Convention.
9. Information received by the secretariat that is designated by a Party as confidential, in accordance with criteria to be established by the Conference of the Parties, shall be aggregated by the secretariat to protect its confidentiality before being made available to any of the bodies involved in the communication and review of information.
10. Subject to paragraph 9 above, and without prejudice to the ability of any Party to make public its communication at any time, the secretariat shall make communications by Parties under this Article publicly available at the time they are submitted to the Conference of the Parties.

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ARTICLE 13  
RESOLUTION OF QUESTIONS REGARDING IMPLEMENTATION  
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The Conference of the Parties shall, at its first session, consider the establishment of a multilateral consultative process, available to Parties on their request, for the resolution of questions regarding the implementation of the Convention.

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ARTICLE 14

## SETTLEMENT OF DISPUTES

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1. In the event of a dispute between any two or more Parties concerning the interpretation or application of the Convention, the Parties concerned shall seek a settlement of the dispute through negotiation or any other peaceful means of their own choice.
  2. When ratifying, accepting, approving or acceding to the Convention, or at any time thereafter, a Party which is not a regional economic integration organization may declare in a written instrument submitted to the Depositary that, in respect of any dispute concerning the interpretation or application of the Convention, it recognizes as compulsory ipso facto and without special agreement, in relation to any Party accepting the same obligation:
    - (a) Submission of the dispute to the International Court of Justice, and/or
    - (b) Arbitration in accordance with procedures to be adopted by the Conference of the Parties as soon as practicable, in an annex on arbitration.
- A Party which is a regional economic integration organization may make a declaration with like effect in relation to arbitration in accordance with the procedures referred to in subparagraph (b) above.
3. A declaration made under paragraph 2 above shall remain in force until it expires in accordance with its terms or until three months after written notice of its revocation has been deposited with the Depositary.
  4. A new declaration, a notice of revocation or the expiry of a declaration shall not in any way affect proceedings pending before the International Court of Justice or the arbitral tribunal, unless the parties to the dispute otherwise agree.
  5. Subject to the operation of paragraph 2 above, if after twelve months following notification by one Party to another that a dispute exists between them, the Parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1 above, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.
  6. A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall be composed of an equal number of members appointed by each party concerned and a chairman chosen jointly by the members appointed by each party. The commission shall render a recommendatory award, which the parties shall consider in good faith.
  7. Additional procedures relating to conciliation shall be adopted by the Conference of the Parties, as soon as practicable, in an annex on conciliation.
  8. The provisions of this Article shall apply to any related legal instrument which the

Conference of the Parties may adopt, unless the instrument provides otherwise.

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ARTICLE 15  
AMENDMENTS TO THE CONVENTION  
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1. Any Party may propose amendments to the Convention.
2. Amendments to the Convention shall be adopted at an ordinary session of the Conference of the Parties. The text of any proposed amendment to the Convention shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate proposed amendments to the signatories to the Convention and, for information, to the Depositary.
3. The Parties shall make every effort to reach agreement on any proposed amendment to the Convention by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted amendment shall be communicated by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.
4. Instruments of acceptance in respect of an amendment shall be deposited with the Depositary. An amendment adopted in accordance with paragraph 3 above shall enter into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to the Convention.
5. The amendment shall enter into force for any other Party on the ninetieth day after the date on which that Party deposits with the Depositary its instrument of acceptance of the said amendment.
6. For the purposes of this Article, "Parties present and voting" means Parties present and casting an affirmative or negative vote.

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ARTICLE 16  
ADOPTION AND AMENDMENT OF ANNEXES TO THE CONVENTION  
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1. Annexes to the Convention shall form an integral part thereof and, unless otherwise expressly provided, a reference to the Convention constitutes at the same time a reference to any annexes thereto. Without prejudice to the provisions of Article 14, paragraphs 2(b) and 7, such annexes shall be restricted to lists, forms and any other

material of a descriptive nature that is of a scientific, technical, procedural or administrative character.

2. Annexes to the Convention shall be proposed and adopted in accordance with the procedure set forth in Article 15, paragraphs 2, 3 and 4.
3. An annex that has been adopted in accordance with paragraph 2 above shall enter into force for all Parties to the Convention six months after the date of the communication by the Depositary to such Parties of the adoption of the annex, except for those Parties that have notified the Depositary, in writing, within that period of their non-acceptance of the annex. The annex shall enter into force for Parties which withdraw their notification of non-acceptance on the ninetieth day after the date on which withdrawal of such notification has been received by the Depositary.
4. The proposal, adoption and entry into force of amendments to annexes to the Convention shall be subject to the same procedure as that for the proposal, adoption and entry into force of annexes to the Convention in accordance with paragraphs 2 and 3 above.
5. If the adoption of an annex or an amendment to an annex involves an amendment to the Convention, that annex or amendment to an annex shall not enter into force until such time as the amendment to the Convention enters into force.

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#### ARTICLE 17 PROTOCOLS

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1. The Conference of the Parties may, at any ordinary session, adopt protocols to the Convention.
2. The text of any proposed protocol shall be communicated to the Parties by the secretariat at least six months before such a session.
3. The requirements for the entry into force of any protocol shall be established by that instrument.
4. Only Parties to the Convention may be Parties to a protocol.
5. Decisions under any protocol shall be taken only by the Parties to the protocol concerned.

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#### ARTICLE 18 RIGHT TO VOTE

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1. Each Party to the Convention shall have one vote, except as provided for in paragraph 2 below.
2. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States that are Parties to the Convention. Such an organization shall not exercise its right to vote if any of its member States exercises its right, and vice versa.

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#### ARTICLE 19 DEPOSITARY

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The Secretary-General of the United Nations shall be the Depositary of the Convention and of protocols adopted in accordance with Article 17.

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#### ARTICLE 20 SIGNATURE

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This Convention shall be open for signature by States Members of the United Nations or of any of its specialized agencies or that are Parties to the Statute of the International Court of Justice and by regional economic integration organizations at Rio de Janeiro, during the United Nations Conference on Environment and Development, and thereafter at United Nations Headquarters in New York from 20 June 1992 to 19 June 1993.

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#### ARTICLE 21 INTERIM ARRANGEMENTS

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1. The secretariat functions referred to in Article 8 will be carried out on an interim basis by the secretariat established by the General Assembly of the United Nations in its resolution 45/212 of 21 December 1990, until the completion of the first session of the Conference of the Parties.
2. The head of the interim secretariat referred to in paragraph 1 above will cooperate closely with the Intergovernmental Panel on Climate Change to ensure that the Panel can respond to the need for objective scientific and technical advice. Other relevant scientific bodies could also be consulted.

3. The Global Environment Facility of the United Nations Development Programme, the United Nations Environment Programme and the International Bank for Reconstruction and Development shall be the international entity entrusted with the operation of the financial mechanism referred to in Article 11 on an interim basis. In this connection, the Global Environment Facility should be appropriately restructured and its membership made universal to enable it to fulfil the requirements of Article 11.

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ARTICLE 22  
RATIFICATION, ACCEPTANCE, APPROVAL OR ACCESSION

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1. The Convention shall be subject to ratification, acceptance, approval or accession by States and by regional economic integration organizations. It shall be open for accession from the day after the date on which the Convention is closed for signature. Instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.
2. Any regional economic integration organization which becomes a Party to the Convention without any of its member States being a Party shall be bound by all the obligations under the Convention. In the case of such organizations, one or more of whose member States is a Party to the Convention, the organization and its member States shall decide on their respective responsibilities for the performance of their obligations under the Convention. In such cases, the organization and the member States shall not be entitled to exercise rights under the Convention concurrently.
3. In their instruments of ratification, acceptance, approval or accession, regional economic integration organizations shall declare the extent of their competence with respect to the matters governed by the Convention. These organizations shall also inform the Depositary, who shall in turn inform the Parties, of any substantial modification in the extent of their competence.

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ARTICLE 23  
ENTRY INTO FORCE

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1. The Convention shall enter into force on the ninetieth day after the date of deposit of the fiftieth instrument of ratification, acceptance, approval or accession.
2. For each State or regional economic integration organization that ratifies, accepts or approves the Convention or accedes thereto after the deposit of the fiftieth instrument of ratification, acceptance, approval or accession, the Convention shall enter into force on the ninetieth day after the date of deposit by such State or regional economic integration organization of its instrument of ratification, acceptance, approval or

accession.

3. For the purposes of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by States members of the organization.

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ARTICLE 24  
RESERVATIONS

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No reservations may be made to the Convention.

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ARTICLE 25  
WITHDRAWAL

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1. At any time after three years from the date on which the Convention has entered into force for a Party, that Party may withdraw from the Convention by giving written notification to the Depositary.
  2. Any such withdrawal shall take effect upon expiry of one year from the date of receipt by the Depositary of the notification of withdrawal, or on such later date as may be specified in the notification of withdrawal.
  3. Any Party that withdraws from the Convention shall be considered as also having withdrawn from any protocol to which it is a Party.

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ARTICLE 26  
AUTHENTIC TEXTS

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The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary- General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have signed this Convention.

DONE at New York this ninth day of May one thousand nine hundred and ninety- two.

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## ANNEX I AND ANNEX II COUNTRIES

### Annex I

Australia  
Austria  
Belarus\*  
Belgium  
Bulgaria\*  
Canada  
Czechoslovakia\*  
Denmark  
European Economic Community  
Estonia\*  
Finland  
France  
Germany  
Greece  
Hungary\*  
Iceland  
Ireland  
Italy  
Japan  
Latvia\*  
Lithuania\*  
Luxembourg  
Netherlands  
New Zealand  
Norway  
Poland\*  
Portugal  
Romania\*  
Russian Federation\*  
Spain  
Sweden  
Switzerland  
Turkey  
Ukraine\*  
United Kingdom of Great Britain and Northern Ireland  
United States of America

\*Countries that are undergoing the process of transition to a market economy.

### Annex II

Australia  
Austria  
Belgium



Canada  
Denmark  
European Economic Community  
Finland  
France  
Germany  
Greece  
Iceland  
Ireland  
Italy  
Japan  
Luxembourg  
Netherlands  
New Zealand  
Norway  
Portugal  
Spain  
Sweden  
Switzerland  
Turkey  
United Kingdom of Great Britain and Northern Ireland  
United States of America

## **A2.2 Kyoto Protocol to the United Nations Framework Convention on Climate Change**

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the

Conference of the Parties to the Convention at its first session,

Have agreed as follows:

### Article 1

For the purposes of this Protocol, the definitions contained in Article 1 of the Convention shall apply. In addition:

1. "Conference of the Parties" means the Conference of the Parties to the Convention.
2. "Convention" means the United Nations Framework Convention on Climate Change, adopted in New York on 9 May 1992.
3. "Intergovernmental Panel on Climate Change" means the Intergovernmental Panel on Climate Change established in 1988 jointly by the World Meteorological Organization and the

United Nations Environment Programme.

4. "Montreal Protocol" means the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in Montreal on 16 September 1987 and as subsequently adjusted and amended.

5. "Parties present and voting" means Parties present and casting an affirmative or negative vote.

6. "Party" means, unless the context otherwise indicates, a Party to this Protocol.

7. "Party included in Annex I" means a Party included in Annex I to the Convention, as may be amended, or a Party which has made a notification under Article 4, paragraph 2(g), of the Convention.

## Article 2

1. Each Party included in Annex I, in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall:

(a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as:

(i) Enhancement of energy efficiency in relevant sectors of the national economy;

(ii) Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation;

(iii) Promotion of sustainable forms of agriculture in light of climate change considerations;

(iv) Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative

environmentally sound technologies;

(v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments;

(vi) Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;

(vii) Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;

(viii) Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy;

(b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the Convention. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation, taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on

other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9, of the Convention, taking into account Article 3 of the Convention. The Conference of the Parties serving as the meeting of the Parties to this Protocol may take further action, as appropriate, to promote the implementation of the provisions of this paragraph.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol, if it decides that it would be beneficial to coordinate any of the policies and measures in paragraph 1(a) above, taking into account different national circumstances and potential effects, shall consider ways and means to elaborate the coordination of such policies and measures.

### Article 3

1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

2. Each Party included in Annex I shall, by 2005, have made demonstrable progress in achieving its commitments under this Protocol.

3. The net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period, shall be used to meet the commitments under this Article of each Party included in Annex I. The greenhouse gas emissions by sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8.

4. Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall provide, for consideration by the

Subsidiary Body for Scientific and Technological Advice, data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories shall be added to, or subtracted from, the assigned amounts for Parties included in Annex I, taking into account uncertainties, transparency in reporting, verifiability, the methodological work of the Intergovernmental Panel on Climate Change, the advice provided by the Subsidiary Body for Scientific and Technological Advice in accordance with Article 5 and the decisions of the Conference of the Parties. Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990.

5. The Parties included in Annex I undergoing the process of transition to a market economy whose base year or period was established pursuant to decision 9/CP.2 of the Conference of the Parties at its second session shall use that base year or period for the implementation of their commitments under this Article. Any other Party included in Annex I undergoing the process of transition to a market economy which has not yet submitted its first national communication under Article 12 of the Convention may also notify the Conference of the Parties serving as the meeting of the Parties to this Protocol that it intends to use an historical base year or period other than 1990 for the implementation of its commitments under this Article. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall decide on the acceptance of such notification.

6. Taking into account Article 4, paragraph 6, of the Convention, in the implementation of their commitments under this Protocol other than those under this Article, a certain degree of flexibility shall be allowed by the Conference of the Parties serving as the meeting of the Parties to this Protocol to the Parties included in Annex I undergoing the process of transition to a market economy.

7. In the first quantified emission limitation and reduction commitment period, from 2008 to

2012, the assigned amount for each Party included in Annex I shall be equal to the percentage inscribed for it in Annex B of its aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A in 1990, or the base year or period determined in accordance with paragraph 5 above, multiplied by five. Those Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount.

8. Any Party included in Annex I may use 1995 as its base year for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, for the purposes of the calculation referred to in paragraph 7 above.

9. Commitments for subsequent periods for Parties included in Annex I shall be established in amendments to Annex B to this Protocol, which shall be adopted in accordance with the provisions of Article 21, paragraph 7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall initiate the consideration of such commitments at least seven years before the end of the first commitment period referred to in paragraph 1 above.

10. Any emission reduction units, or any part of an assigned amount, which a Party acquires from another Party in accordance with the provisions of Article 6 or of Article 17 shall be added to the assigned amount for the acquiring Party.

11. Any emission reduction units, or any part of an assigned amount, which a Party transfers to another Party in accordance with the provisions of Article 6 or of Article 17 shall be subtracted from the assigned amount for the transferring Party.

12. Any certified emission reductions which a Party acquires from another Party in accordance with the provisions of Article 12 shall be added to the assigned amount for the acquiring Party.

13. If the emissions of a Party included in Annex I in a commitment period are less than its assigned amount under this Article, this difference shall, on request of that Party, be added to the assigned amount for that Party for subsequent commitment periods.

14. Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1 above in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of funding, insurance and transfer of technology.

#### Article 4

1. Any Parties included in Annex I that have reached an agreement to fulfil their commitments under Article 3 jointly, shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of Article 3. The respective emission level allocated to each of the Parties to the agreement shall be set out in that agreement.

2. The Parties to any such agreement shall notify the secretariat of the terms of the agreement on the date of deposit of their instruments of ratification, acceptance or approval of this Protocol, or accession thereto. The secretariat shall in turn inform the Parties and signatories to the Convention of the terms of the agreement.

3. Any such agreement shall remain in operation for the duration of the commitment period specified in Article 3, paragraph 7.

4. If Parties acting jointly do so in the framework of, and together with, a regional economic integration organization, any alteration in the composition of the organization after adoption of this Protocol shall not affect existing commitments under this Protocol. Any alteration in the composition of the organization shall only apply for the purposes of those commitments under Article 3 that are adopted subsequent to that alteration.



5. In the event of failure by the Parties to such an agreement to achieve their total combined level of emission reductions, each Party to that agreement shall be responsible for its own level of emissions set out in the agreement.

6. If Parties acting jointly do so in the framework of, and together with, a regional economic integration organization which is itself a Party to this Protocol, each member State of that regional economic integration organization individually, and together with the regional economic integration organization acting in accordance with Article 24, shall, in the event of failure to achieve the total combined level of emission reductions, be responsible for its level of emissions as notified in accordance with this Article.

#### Article 5

1. Each Party included in Annex I shall have in place, no later than one year prior to the start of the first commitment period, a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. Guidelines for such national systems, which shall incorporate the methodologies specified in paragraph 2 below, shall be decided upon by the Conference of the Parties serving as the meeting of the Parties to this Protocol at its first session.

2. Methodologies for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol shall be those accepted by the Intergovernmental Panel on Climate Change and agreed upon by the Conference of the Parties at its third session. Where such methodologies are not used, appropriate adjustments shall be applied according to methodologies agreed upon by the Conference of the Parties serving as the meeting of the Parties to this Protocol at its first session. Based on the work of, inter alia, the Intergovernmental Panel on Climate Change and advice provided by the Subsidiary Body for Scientific and Technological Advice, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall regularly review and, as appropriate, revise such methodologies and adjustments, taking fully into account any relevant decisions by the Conference of the Parties. Any revision to methodologies or adjustments shall be used only for the purposes of ascertaining compliance with commitments under Article 3 in respect of any commitment period adopted subsequent to that revision.

3. The global warming potentials used to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of greenhouse gases listed in Annex A shall be those accepted by the Intergovernmental Panel on Climate Change and agreed upon by the Conference of the Parties at its third session. Based on the work of, inter alia, the Intergovernmental Panel on Climate Change and advice provided by the Subsidiary Body for Scientific and Technological Advice, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall regularly review and, as appropriate, revise the global warming potential of each such greenhouse gas, taking fully into account any relevant decisions by the Conference of the Parties. Any revision to a global warming potential shall apply only to commitments under Article 3 in respect of any commitment period adopted subsequent to that revision.

#### Article 6

1. For the purpose of meeting its commitments under Article 3, any Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

- (a) Any such project has the approval of the Parties involved;
- (b) Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur;
- (c) It does not acquire any emission reduction units if it is not in compliance with its obligations under Articles 5 and 7; and
- (d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3.

2. The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.

3. A Party included in Annex I may authorize legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

4. If a question of implementation by a Party included in Annex I of the requirements referred to in this Article is identified in accordance with the relevant provisions of Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

#### Article 7

1. Each Party included in Annex I shall incorporate in its annual inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, submitted in accordance with the relevant decisions of the Conference of the Parties, the necessary supplementary information for the purposes of ensuring compliance with Article 3, to be determined in accordance with paragraph 4 below.

2. Each Party included in Annex I shall incorporate in its national communication, submitted under Article 12 of the Convention, the supplementary information necessary to demonstrate compliance with its commitments under this Protocol, to be determined in accordance with paragraph 4 below.

3. Each Party included in Annex I shall submit the information required under paragraph 1 above annually, beginning with the first inventory due under the Convention for the first year of the commitment period after this Protocol has entered into force for that Party. Each such Party shall submit the information required under paragraph 2 above as part of the first national communication due under the Convention after this Protocol has entered into force for it and after the adoption of guidelines as provided for in paragraph 4 below. The frequency of subsequent submission of information required under this Article shall be determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol, taking into account any timetable for the submission of national communications decided upon by the Conference of the Parties.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall adopt at its first session, and review periodically thereafter, guidelines for the preparation of the information required under this Article, taking into account guidelines for the preparation of national communications by Parties included in Annex I adopted by the Conference of the Parties. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall also, prior to the first commitment period, decide upon modalities for the accounting of assigned amounts.

#### Article 8

1. The information submitted under Article 7 by each Party included in Annex I shall be reviewed by expert review teams pursuant to the relevant decisions of the Conference of the Parties and in accordance with guidelines adopted for this purpose by the Conference of the Parties serving as the meeting of the Parties to this Protocol under paragraph 4 below. The information submitted under Article 7, paragraph 1, by each Party included in Annex I shall be reviewed as part of the annual compilation and accounting of emissions inventories and assigned amounts. Additionally, the information submitted under Article 7, paragraph 2, by each Party included in Annex I shall be reviewed as part of the review of communications.

2. Expert review teams shall be coordinated by the secretariat and shall be composed of experts selected from those nominated by Parties to the Convention and, as appropriate, by intergovernmental organizations, in accordance with guidance provided for this purpose by the Conference of the Parties.

3. The review process shall provide a thorough and comprehensive technical assessment of all aspects of the implementation by a Party of this Protocol. The expert review teams shall prepare a report to the Conference of the Parties serving as the meeting of the Parties to this Protocol, assessing the implementation of the commitments of the Party and identifying any potential problems in, and factors influencing, the fulfilment of commitments. Such reports shall be circulated by the secretariat to all Parties to the Convention. The secretariat shall list those questions of implementation indicated in such reports for further consideration by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall adopt at its first session, and review periodically thereafter, guidelines for the review of implementation of this Protocol by expert review teams taking into account the relevant decisions of the Conference of the Parties.

5. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, with the assistance of the Subsidiary Body for Implementation and, as appropriate, the Subsidiary Body for Scientific and Technological Advice, consider:

(a) The information submitted by Parties under Article 7 and the reports of the expert reviews thereon conducted under this Article; and

(b) Those questions of implementation listed by the secretariat under paragraph 3 above, as well as any questions raised by Parties.

6. Pursuant to its consideration of the information referred to in paragraph 5 above, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall take decisions on any matter required for the implementation of this Protocol.

#### Article 9

1. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall periodically review this Protocol in the light of the best available scientific information and assessments on climate change and its impacts, as well as relevant technical, social and economic information. Such reviews shall be coordinated with pertinent reviews under the Convention, in particular those required by Article 4, paragraph 2(d), and Article 7, paragraph 2(a), of the Convention. Based on these reviews, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall take appropriate action.

2. The first review shall take place at the second session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. Further reviews shall take place at regular intervals and in a timely manner.

## Article 10

All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, without introducing any new commitments for Parties not included in Annex I, but reaffirming existing commitments under Article 4, paragraph 1, of the Convention, and continuing to advance the implementation of these commitments in order to achieve sustainable development, taking into account Article 4, paragraphs 3, 5 and 7, of the Convention, shall:

(a) Formulate, where relevant and to the extent possible, cost-effective national and, where appropriate, regional programmes to improve the quality of local emission factors, activity data and/or models which reflect the socio-economic conditions of each Party for the preparation and periodic updating of national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties, and consistent with the guidelines for the preparation of national communications adopted by the Conference of the Parties;

(b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change:

(i) Such programmes would, inter alia, concern the energy, transport and industry sectors as well as agriculture, forestry and waste management. Furthermore, adaptation technologies and methods for improving spatial planning would improve adaptation to climate change; and

(ii) Parties included in Annex I shall submit information on action under this Protocol, including national programmes, in accordance with Article 7; and other Parties shall seek to include in their national communications, as appropriate, information on programmes which contain measures that the Party believes contribute to addressing climate change and its adverse impacts, including the abatement of increases in greenhouse gas emissions, and enhancement of and removals by sinks, capacity building and adaptation measures;

(c) Cooperate in the promotion of effective modalities for the development, application and

diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programmes for the effective transfer of environmentally sound technologies that are publicly owned or in the public domain and the creation of an enabling environment for the private sector, to promote and enhance the transfer of, and access to, environmentally sound technologies;

(d) Cooperate in scientific and technical research and promote the maintenance and the development of systematic observation systems and development of data archives to reduce uncertainties related to the climate system, the adverse impacts of climate change and the economic and social consequences of various response strategies, and promote the development and strengthening of endogenous capacities and capabilities to participate in international and intergovernmental efforts, programmes and networks on research and systematic observation, taking into account Article 5 of the Convention;

(e) Cooperate in and promote at the international level, and, where appropriate, using existing bodies, the development and implementation of education and training programmes, including the strengthening of national capacity building, in particular human and institutional capacities and the exchange or secondment of personnel to train experts in this field, in particular for developing countries, and facilitate at the national level public awareness of, and public access to information on, climate change. Suitable modalities should be developed to implement these activities through the relevant bodies of the Convention, taking into account Article 6 of the Convention;

(f) Include in their national communications information on programmes and activities undertaken pursuant to this Article in accordance with relevant decisions of the Conference of the Parties; and

(g) Give full consideration, in implementing the commitments under this Article, to Article 4, paragraph 8, of the Convention.

## Article 11

1. In the implementation of Article 10, Parties shall take into account the provisions of Article 4, paragraphs 4, 5, 7, 8 and 9, of the Convention.

2. In the context of the implementation of Article 4, paragraph 1, of the Convention, in accordance with the provisions of Article 4, paragraph 3, and Article 11 of the Convention, and through the entity or entities entrusted with the operation of the financial mechanism of the Convention, the developed country Parties and other developed Parties included in Annex II to the Convention shall:

(a) Provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in advancing the implementation of existing commitments under Article 4, paragraph 1(a), of the Convention that are covered in Article 10, subparagraph (a); and

(b) Also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of advancing the implementation of existing commitments under Article 4, paragraph 1, of the Convention that are covered by Article 10 and that are agreed between a developing country Party and the international entity or entities referred to in Article 11 of the Convention, in accordance with that Article.

The implementation of these existing commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among developed country Parties. The guidance to the entity or entities entrusted with the operation of the financial mechanism of the Convention in relevant decisions of the Conference of the Parties, including those agreed before the adoption of this Protocol, shall apply *mutatis mutandis* to the provisions of this paragraph.

3. The developed country Parties and other developed Parties in Annex II to the Convention may also provide, and developing country Parties avail themselves of, financial resources for the implementation of Article 10, through bilateral, regional and other multilateral channels.



## Article 12

1. A clean development mechanism is hereby defined.
2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.
3. Under the clean development mechanism:
  - (a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and
  - (b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.
4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.
5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:
  - (a) Voluntary participation approved by each Party involved;
  - (b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
  - (c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and in the acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

### Article 13

1. The Conference of the Parties, the supreme body of the Convention, shall serve as the meeting of the Parties to this Protocol.

2. Parties to the Convention that are not Parties to this Protocol may participate as observers in the proceedings of any session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, decisions under this Protocol shall be taken only by those that are Parties to this Protocol.

3. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, any member of the Bureau of the Conference of the Parties representing a Party to the Convention but, at that time, not a Party to this Protocol, shall be replaced by an additional member to be elected by and from amongst the Parties to this Protocol.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall keep under regular review the implementation of this Protocol and shall make, within its mandate, the decisions necessary to promote its effective implementation. It shall perform the functions assigned to it by this Protocol and shall:

(a) Assess, on the basis of all information made available to it in accordance with the provisions of this Protocol, the implementation of this Protocol by the Parties, the overall effects of the measures taken pursuant to this Protocol, in particular environmental, economic and social effects as well as their cumulative impacts and the extent to which progress towards the objective of the Convention is being achieved;

(b) Periodically examine the obligations of the Parties under this Protocol, giving due consideration to any reviews required by Article 4, paragraph 2(d), and Article 7, paragraph 2, of the Convention, in the light of the objective of the Convention, the experience gained in its implementation and the evolution of scientific and technological knowledge, and in this respect consider and adopt regular reports on the implementation of this Protocol;

(c) Promote and facilitate the exchange of information on measures adopted by the Parties to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under this Protocol;

(d) Facilitate, at the request of two or more Parties, the coordination of measures adopted by them to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under this Protocol;

(e) Promote and guide, in accordance with the objective of the Convention and the provisions of

this Protocol, and taking fully into account the relevant decisions by the Conference of the Parties, the development and periodic refinement of comparable methodologies for the effective implementation of this Protocol, to be agreed on by the Conference of the Parties serving as the meeting of the Parties to this Protocol;

(f) Make recommendations on any matters necessary for the implementation of this Protocol;

(g) Seek to mobilize additional financial resources in accordance with

Article 11, paragraph 2;

(h) Establish such subsidiary bodies as are deemed necessary for the implementation of this Protocol;

(i) Seek and utilize, where appropriate, the services and cooperation of, and information provided by, competent international organizations and intergovernmental and non-governmental bodies; and

(j) Exercise such other functions as may be required for the implementation of this Protocol, and consider any assignment resulting from a decision by the Conference of the Parties.

5. The rules of procedure of the Conference of the Parties and financial procedures applied under the Convention shall be applied *mutatis mutandis* under this Protocol, except as may be otherwise decided by consensus by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

6. The first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall be convened by the secretariat in conjunction with the first session of the Conference of the Parties that is scheduled after the date of the entry into force of this Protocol. Subsequent ordinary sessions of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall be held every year and in conjunction with ordinary sessions of the Conference of the Parties, unless otherwise decided by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

7. Extraordinary sessions of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall be held at such other times as may be deemed necessary by the Conference of the Parties serving as the meeting of the Parties to this Protocol, or at the written request of any Party, provided that, within six months of the request being communicated to the Parties by the secretariat, it is supported by at least one third of the Parties.

8. The United Nations, its specialized agencies and the International Atomic Energy

Agency, as well as any State member thereof or observers thereto not party to the Convention, may be represented at sessions of the Conference of the Parties serving as the meeting of the Parties to this Protocol as observers. Any body or agency, whether national or international, governmental or non-governmental, which is qualified in matters covered by this Protocol and which has informed the secretariat of its wish to be represented at a session of the Conference of the Parties serving as the meeting of the Parties to this Protocol as an observer, may be so admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure, as referred to in paragraph 5 above.

#### Article 14

1. The secretariat established by Article 8 of the Convention shall serve as the secretariat of this Protocol.

2. Article 8, paragraph 2, of the Convention on the functions of the secretariat, and Article 8, paragraph 3, of the Convention on arrangements made for the functioning of the secretariat, shall apply *mutatis mutandis* to this Protocol. The secretariat shall, in addition, exercise the functions assigned to it under this Protocol.

#### Article 15

1. The Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation established by Articles 9 and 10 of the Convention shall serve as, respectively,

the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of this Protocol. The provisions relating to the functioning of these two bodies under the Convention shall apply *mutatis mutandis* to this Protocol. Sessions of the meetings of the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of this Protocol shall be held in conjunction with the meetings of, respectively, the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of the Convention.

2. Parties to the Convention that are not Parties to this Protocol may participate as observers in the proceedings of any session of the subsidiary bodies. When the subsidiary bodies serve as the subsidiary bodies of this Protocol, decisions under this Protocol shall be taken only by those that are Parties to this Protocol.

3. When the subsidiary bodies established by Articles 9 and 10 of the Convention exercise their functions with regard to matters concerning this Protocol, any member of the Bureaux of those subsidiary bodies representing a Party to the Convention but, at that time, not a party to this Protocol, shall be replaced by an additional member to be elected by and from amongst the Parties to this Protocol.

#### Article 16

The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, as soon as practicable, consider the application to this Protocol of, and modify as appropriate, the multilateral consultative process referred to in Article 13 of the Convention, in the light of any relevant decisions that may be taken by the Conference of the Parties. Any multilateral consultative process that may be applied to this Protocol shall operate without prejudice to the procedures and mechanisms established in accordance with Article 18.

#### Article 17

The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purposes of

fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article.

#### Article 18

The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, approve appropriate and effective procedures and mechanisms to determine and to address cases of non-compliance with the provisions of this Protocol, including through the development of an indicative list of consequences, taking into account the cause, type, degree and frequency of non-compliance. Any procedures and mechanisms under this Article entailing binding consequences shall be adopted by means of an amendment to this Protocol.

#### Article 19

The provisions of Article 14 of the Convention on settlement of disputes shall apply *mutatis mutandis* to this Protocol.

#### Article 20

1. Any Party may propose amendments to this Protocol.
2. Amendments to this Protocol shall be adopted at an ordinary session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. The text of any proposed amendment to this Protocol shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate the text of any proposed amendments to the Parties and signatories to the Convention and, for information, to the Depositary.
3. The Parties shall make every effort to reach agreement on any proposed amendment to this Protocol by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted amendment shall be communicated

by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.

4. Instruments of acceptance in respect of an amendment shall be deposited with the Depositary. An amendment adopted in accordance with paragraph 3 above shall enter into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to this Protocol.

5. The amendment shall enter into force for any other Party on the ninetieth day after the date on which that Party deposits with the Depositary its instrument of acceptance of the said amendment.

#### Article 21

1. Annexes to this Protocol shall form an integral part thereof and, unless otherwise expressly provided, a reference to this Protocol constitutes at the same time a reference to any annexes thereto. Any annexes adopted after the entry into force of this Protocol shall be restricted to lists, forms and any other material of a descriptive nature that is of a scientific, technical, procedural or administrative character.

2. Any Party may make proposals for an annex to this Protocol and may propose amendments to annexes to this Protocol.

3. Annexes to this Protocol and amendments to annexes to this Protocol shall be adopted at an ordinary session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. The text of any proposed annex or amendment to an annex shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate the text of any proposed annex or amendment to an annex to the Parties and signatories to the Convention and, for information, to the Depositary.

4. The Parties shall make every effort to reach agreement on any proposed annex or amendment to an annex by consensus. If all efforts at consensus have been exhausted, and no



agreement reached, the annex or amendment to an annex shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted annex or amendment to an annex shall be communicated by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.

5. An annex, or amendment to an annex other than Annex A or B, that has been adopted in accordance with paragraphs 3 and 4 above shall enter into force for all Parties to this Protocol six months after the date of the communication by the Depositary to such Parties of the adoption of the annex or adoption of the amendment to the annex, except for those Parties that have notified the Depositary, in writing, within that period of their non-acceptance of the annex or amendment to the annex. The annex or amendment to an annex shall enter into force for Parties which withdraw their notification of non-acceptance on the ninetieth day after the date on which withdrawal of such notification has been received by the Depositary.

6. If the adoption of an annex or an amendment to an annex involves an amendment to this Protocol, that annex or amendment to an annex shall not enter into force until such time as the amendment to this Protocol enters into force.

7. Amendments to Annexes A and B to this Protocol shall be adopted and enter into force in accordance with the procedure set out in Article 20, provided that any amendment to Annex B shall be adopted only with the written consent of the Party concerned.

## Article 22

1. Each Party shall have one vote, except as provided for in paragraph 2 below.

2. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States that are Parties to this Protocol. Such an organization shall not exercise its right to vote if any of its member States exercises its right, and vice versa.

## Article 23

The Secretary-General of the United Nations shall be the Depositary of this Protocol.

#### Article 24

1. This Protocol shall be open for signature and subject to ratification, acceptance or approval by States and regional economic integration organizations which are Parties to the Convention. It shall be open for signature at United Nations Headquarters in New York from

16 March 1998 to 15 March 1999. This Protocol shall be open for accession from the day after the date on which it is closed for signature. Instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.

2. Any regional economic integration organization which becomes a Party to this Protocol without any of its member States being a Party shall be bound by all the obligations under this Protocol. In the case of such organizations, one or more of whose member States is a Party to this Protocol, the organization and its member States shall decide on their respective responsibilities for the performance of their obligations under this Protocol. In such cases, the organization and the member States shall not be entitled to exercise rights under this Protocol concurrently.

3. In their instruments of ratification, acceptance, approval or accession, regional economic integration organizations shall declare the extent of their competence with respect to the matters governed by this Protocol. These organizations shall also inform the Depositary, who shall in turn inform the Parties, of any substantial modification in the extent of their competence.

#### Article 25

1. This Protocol shall enter into force on the ninetieth day after the date on which not less than 55 Parties to the Convention, incorporating Parties included in Annex I which accounted in total for at least 55 per cent of the total carbon dioxide emissions for 1990 of the Parties included in Annex I, have deposited their instruments of ratification, acceptance, approval or accession.

2. For the purposes of this Article, "the total carbon dioxide emissions for 1990 of the Parties included in Annex I" means the amount communicated on or before the date of adoption of this

Protocol by the Parties included in Annex I in their first national communications submitted in accordance with Article 12 of the Convention.

3. For each State or regional economic integration organization that ratifies, accepts or approves this Protocol or accedes thereto after the conditions set out in paragraph 1 above for entry into force have been fulfilled, this Protocol shall enter into force on the ninetieth day following the date of deposit of its instrument of ratification, acceptance, approval or accession.

4. For the purposes of this Article, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by States members of the organization.

#### Article 26

No reservations may be made to this Protocol.

#### Article 27

1. At any time after three years from the date on which this Protocol has entered into force for a Party, that Party may withdraw from this Protocol by giving written notification to the Depositary.

2. Any such withdrawal shall take effect upon expiry of one year from the date of receipt by the Depositary of the notification of withdrawal, or on such later date as may be specified in the notification of withdrawal.

3. Any Party that withdraws from the Convention shall be considered as also having withdrawn from this Protocol.

#### Article 28

The original of this Protocol, of which the Arabic, Chinese, English, French, Russian and

Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

DONE at Kyoto this eleventh day of December one thousand nine hundred and ninety-seven.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have affixed their signatures to this Protocol on the dates indicated.

## Annex A

## Annex B

Greenhouse gases	Party	Quantified emission limitation or reduction commitment (percentage of base year or period)
Carbon dioxide (CO <sub>2</sub> )		
Methane (CH <sub>4</sub> )		
Nitrous oxide (N <sub>2</sub> O)	Australia	108
Hydrofluorocarbons (HFCs)	Austria	92
Perfluorocarbons (PFCs)	Belgium	92
Sulphur hexafluoride (SF <sub>6</sub> )	Bulgaria*	92
Sectors/source categories	Canada	94
Energy	Croatia*	95
Fuel combustion	Czech Republic*	92
Energy industries	Denmark	92
Manufacturing industries and construction	Estonia*	92
Transport	European Community	92
Other sectors	Finland	92
Other	France	92
Fugitive emissions from fuels	Germany	92
Solid fuels	Greece	92
Oil and natural gas	Hungary*	94
Other	Iceland	110
Industrial processes	Ireland	92
Mineral products	Italy	92
Chemical industry	Japan	94
Metal production	Latvia*	92
Other production	Liechtenstein	92
Production of halocarbons and sulphur hexafluoride	Lithuania*	92
Consumption of halocarbons and sulphur hexafluoride	Luxembourg	92
Other	Monaco	92
Solvent and other product use	Netherlands	92
Agriculture	New Zealand	100
Enteric fermentation	Norway	101
Manure management	Poland*	94
Rice cultivation	Portugal	92
Agricultural soils	Romania*	92
Prescribed burning of	Russian Federation*	100
	Slovakia*	92

savannas	Slovenia*	92
Field burning of agricultural residues	Spain	92
Other	Sweden	92
Waste	Switzerland	92
Solid waste disposal on land	Ukraine*	100
Wastewater handling	United Kingdom of Great Britain and Northern Ireland	92
Waste incineration	Ireland	
Other	United States of America	93

\* Countries that are undergoing the process of transition to a market economy.

## A3. Statistics on Asian Countries

Representative statistic data of the Asian countries for which data was available is shown in TableA3.1.1.

Table A3.1.1 Statistics on Asian countries. (As of 2003)

	GDP [GUSD]*1	Population [M]*2	Primary energy consumption [Mtoe]*3	CO2 emission [Mt-C]*4
Brunei Darussalam	5	0.3	3	2
Indonesia	168	215	118	91
Japan	4,876	128	517	336
Korea	586	48	205	124
Malaysia	99	25	54	41
Philippines	85	82	32	19
P. R. China	1,375	1,288	1,190	1,127
Singapore	93	4	22	14
Taipei, Chinese	314	23	98	69.6
Thailand	141	62	74	58
Vietnam	38	81	21	17
Whole Asia	9,246	3,467	2,783	2,280

\*1 billion US dollar

\*2 million people

\*3 million ton oil equivalent

\*4 million ton as C

## A4. Unit Conversion

Literatures of biomass is found in many fields, and sometimes, unfamiliar units are used. Since utilization of SI unit is recommended, SI unit is explained first, and then conversion with other units is explained in this part. If you can read Japanese, books by Koizumi and Ebihara are useful.

### A4.1 SI Unit System

Utilization of SI Unit Systems was recommended at the International at the General Conference on Weights and Measures in 1960, and many countries including Japan officially employs this unit system. SI unit system is composed of seven base units, and derived units, which are derived by combining these base units. It also employs prefixes to express integer power of 10 to be multiplied to the base unit. The following are the list of these units.

Table A4.1.1 SI base units

Base quantity	Symbol (name)	Base quantity	Symbol (name)
Length	m (meter)	Thermodynamic temperature	K (kelvin)
Mass	kg (kilogram)	Amount of substance	mol (mole)
Time	s (second)	Luminous intensity	cd (candela)
Electric current	A (ampere)		



Table A4.1.2 Units for angles

Base quantity	Symbol (name)
Plane angle	rad (radian)
Solid angle	sr (steradian)

\*1 To understand the concept of solid angle, consider the light emitted from a flash light. How wide the light is emitted is the solid angle. Considering a sphere with radius R whose center is the light source, 1 sr of solid angle is the wideness of the light when the light forms area or  $R^2$  on the sphere.

\*2 These units were originally supplementary units, but became derived units in 1995.

Table A4.1.3 Representative SI derived units

Base quantity	Symbol (name)	Expression in terms of SI base units
Force	N (newton)	$\text{m kg s}^{-2}$
Pressure	Pa (pascal)	$\text{N m}^{-2} = \text{m}^{-1} \text{kg s}^{-2}$
Energy, work	J (joule)	$\text{N m} = \text{m}^2 \text{kg s}^{-2}$
Power	W (watt)	$\text{J s}^{-1} = \text{m}^2 \text{kg s}^{-3}$

TableA4. 1.4 SI prefixes

Symbol (name)	Factor	Symbol (name)	Factor
da (deca)	10 <sup>1</sup>	d (deci)	10 <sup>-1</sup>
h (hecto)	10 <sup>2</sup>	c (centi)	10 <sup>-2</sup>
k (kilo)	10 <sup>3</sup>	m (milli)	10 <sup>-3</sup>
M (mega)	10 <sup>6</sup>	μ (micro)	10 <sup>-6</sup>
G (giga)	10 <sup>9</sup>	n (nano)	10 <sup>-9</sup>
T (tera)	10 <sup>12</sup>	p (pico)	10 <sup>-12</sup>
P (peta)	10 <sup>15</sup>	f (femto)	10 <sup>-15</sup>
E (exa)	10 <sup>18</sup>	a (atto)	10 <sup>-18</sup>
Z (zetta)	10 <sup>21</sup>	z (zepto)	10 <sup>-21</sup>
Y (yotta)	10 <sup>24</sup>	y (yocto)	10 <sup>-24</sup>

\*1 When possible, choose a prefix so that preceding number falls in 0.1-1000. For example, 50 pm is recommended, not 0.05 nm.

\*2 The base unit of mass is "kg", but the prefix is added to "g". For example, 29 mg is used, not 20 mkg.

\*3 To produce derived units formed from multiple units, only one prefix is used. For example, 20 kg/m<sup>2</sup> is used, not 20 kg/m<sup>2</sup>. The exception is "kg." For example, 21 MJ/kg is used, not 21 kJ/g.

## A4.2 Unit conversion

Although using SI unit system is recommended, in the field of energy, traditional unit such as “barrel” or “ton oil equivalent” are often used even today. Conversion of unit is also needed when reading old literature.

When a quantity in one unit is to be expressed in another unit, a conversion formula is needed. For example, temperature in °C  $T_C$  is converted to temperature in K  $T_K$  by the following formula.

$$T_K = T_C + 273.15$$

When the conversion formula takes the form of the proportional equation, the proportionality constant is called conversion factor. For example, in the conversion formula to convert length in in (inch) to length in m (meter)

$$L_m = 2.54 \times 10^{-2} L_{in},$$

the conversion factor is  $2.54 \times 10^{-2}$  m/in .

To convert derived units formed from multiple units, substitute the original unit with the corresponding conversion formulae. For example, to convert 1 500 ft/h to a value in m/s,  $1 \text{ ft} = 3.048 \times 10^{-1} \text{ m}$  and  $1 \text{ h} = 3\,600 \text{ s}$  are used as follows.

$$\begin{aligned} 1\,500 \text{ ft/h} &= 1\,500 \left(3.048 \times 10^{-1} \text{ m}\right) / \left(3\,600 \text{ s}\right) \\ &= \left(1\,500\right) \left(3.048 \times 10^{-1}\right) / \left(3\,600\right) \text{ m/s} \\ &= 0.127 \text{ m/s} \end{aligned}$$

To convert an equation expressed in one unit system to the equation expressed in another unit system, substitute the conversion formulae to the variables in the equation. For example, when the following formula for water vapor pressure

$$\ln(p_{Torr}) = 18.30363 - \frac{3816.44}{227.02 + T_C}$$

is to be converted to SI unit systems, the conversion formulæ

$$p_{Torr} = 7.50062 \times 10^{-3} p_{Pa}$$

$$T_C = T_K - 273.15$$

are substituted. Then,

$$\ln(7.50062 \times 10^{-3} p_{Pa}) = 18.30363 - \frac{3816.44}{227.02 + (T_K - 273.15)}$$

$$\ln(7.50062 \times 10^{-3}) + \ln p_{Pa} = 18.30363 - \frac{3816.44}{227.02 - 273.15 + T_K}$$

$$\ln p_{Pa} = 18.30363 - \ln(7.50062 \times 10^{-3}) - \frac{3816.44}{227.02 - 273.15 + T_K}$$

and finally,

$$\ln p_{Pa} = 23.1964 - \frac{3816.44}{-46.13 + T_K}$$

is obtained.

In the following pages are shown the tables of conversion factors. The horizontal line shows the same quantity. Fortran expression is employed where  $3.937 \times 10^1$  is expressed as 3.9370E+01 and so on. For example, the first line of the Table A4.2.1 means

$$1 \text{ m} = 3.2808 \text{ ft} = 39.37 \text{ in}$$

Table A4.2.1 Conversion factors for length

m	ft	in
1	3.2808E+00	3.9370E+01
3.0480E-01	1	1.2000E+01
2.5400E-02	8.3333E-02	1

Table A4.2.2 Conversion factors for area

m <sup>2</sup>	km <sup>2</sup>	a	ha	acre	mu (畝)* <sup>1</sup>	tan (反)* <sup>2</sup>	tsubo (坪)* <sup>3</sup>
1	1.0000E-06	1.0000E-02	1.0000E-04	2.4711E-04	1.5000E-03	1.0083E-03	3.0248E-01
1.0000E+06	1	1.0000E+04	1.0000E+02	2.4711E+02	1.5000E+03	1.0083E+03	3.0248E+05
1.0000E+02	1.0000E-04	1	1.0000E-02	2.4711E-02	1.5000E-01	1.0083E-01	3.0248E+01
1.0000E+04	1.0000E-02	1.0000E+02	1	2.4711E+00	1.5000E+01	1.0083E+01	3.0248E+03
4.0468E+03	4.0468E-03	4.0468E+01	4.0468E-01	1	6.0702E+00	4.0805E+00	1.2241E+03
6.6667E+02	6.6667E-04	6.6667E+00	6.6667E-02	1.6474E-01	1	6.7222E-01	2.0165E+02
9.9174E+02	9.9174E-04	9.9174E+00	9.9174E-02	2.4507E-01	1.4876E+00	1	2.9998E+02
3.3060E+00	3.3060E-06	3.3060E-02	3.3060E-04	8.1694E-04	4.9590E-03	3.3335E-03	1

\*1 Traditional Chinese unit.

\*2 Traditional Japanese units: 1 cho (町) = 10 tan (反), 1 tan (反) = 10 se (畝).

\*3 For the case of rice field and forest, 1 tsubo is called 1 bu (步).

Table A4.2.3 Conversion factors for mass

Kg	t	short ton (tn)	long ton (l.tn)	lb (pound)	oz (ounce)	kan (貫, Japanese)
1	1.0000E-03	1.1023E-03	9.8421E-04	2.2046E+00	3.5274E+01	2.6667E-01
1.0000E+03	1	1.1023E+00	9.8421E-01	2.2046E+03	3.5274E+04	2.6667E+02
9.0719E+02	9.0719E-01	1	8.9286E-01	2.0000E+03	3.2000E+04	2.4192E+02
1.0160E+03	1.0160E+00	1.1200E+00	1	2.2400E+03	3.5840E+04	2.7095E+02
4.5359E-01	4.5359E-04	5.0000E-04	4.4643E-04	1	1.6000E+01	1.2096E-01
2.8349E-02	2.8349E-05	3.1250E-05	2.7902E-05	6.2500E-02	1	7.5600E-03
3.7500E+00	3.7500E-03	4.1336E-03	3.6907E-03	8.2672E+00	1.3228E+02	1

Short ton is used in US. Long ton is used in UK.

Table A4.2.4 Conversion factors for volume

m <sup>3</sup>	L	ft <sup>3</sup>	US gallon	UK gallon	bb1	koku (石)*1
1	1.0000E+03	3.5315E+01	2.6417E+02	2.1997E+02	6.2898E+00	5.5440E+03
1.0000E-03	1	3.5315E-02	2.6417E-01	2.1997E-01	6.2898E-03	5.5440E+00
2.8317E-02	2.8317E+01	1	7.4805E+00	6.2288E+00	1.7811E-01	1.5699E+02
3.7854E-03	3.7854E+00	1.3368E-01	1	8.3267E-01	2.3810E-02	2.0986E+01
4.5461E-03	4.5461E+00	1.6054E-01	1.2010E+00	1	2.8594E-02	2.5204E+01
1.5899E-01	1.5899E+02	5.6146E+00	4.2000E+01	3.4972E+01	1	8.8143E+02
1.8038E-04	1.8038E-01	6.3699E-03	4.7650E-02	3.9677E-02	1.1345E-03	1

\*1 Traditional Japanese units: 1 koku (石) = 100 sho (升).

\*2 Sometimes, the amount of gaseous substance is expressed using the unit of volume with “N”. This amount corresponds to the amount of substance in the gas of the stated volume at normal state (0°C, 1.013x10<sup>5</sup> Pa). For example, gas of 22.4 Nm<sup>3</sup> corresponds to 1 kmol.

\*3 For liter, “L” is recommended to distinguish from “l (capital i)” and “1 (one)”.

Table A4.2.5 Conversion factors for energy (1)

J	kWh	kcalIT	KcalJP	kL oil equivalent	t oil equivalent
1	2.7778E-07	2.3885E-04	2.3889E-04	2.5826E-11	2.3885E-11
3.6000E+06	1	8.5984E+02	8.6000E+02	9.2973E-05	8.5984E-05
4.1868E+03	1.1630E-03	1	1.0002E+00	1.0813E-07	1.0000E-07
4.1860E+03	1.1628E-03	9.9982E-01	1	1.0811E-07	9.9982E-08
3.8721E+10	1.0756E+04	9.2483E+06	9.2500E+06	1	9.2483E-01
4.1868E+10	1.1630E+04	1.0000E+07	1.0002E+07	1.0813E+00	1

\*1 Ton oil equivalent is abbreviated as TOE.

\*2 To calculate the efficiency of process, especially when heat demand and electricity demand are compared, the amount of electric energy is converted to the equivalent thermal energy by dividing it by power generation efficiency. The efficiency used for this purpose should differ from country to country, or depending on the case. In Japan, governmental statistics employs 1 kWh = 9.42 MJ, assuming power generation efficiency of 38.1% for the case after 1971.

Table A4.2.6 Conversion factors for energy (2)

J	Btu	kgf m	ft lbf	HP h
1	9.4782E-04	1.0197E-01	7.3750E-01	3.7417E-07
1.0551E+03	1	1.0759E+02	7.7810E+02	3.9477E-04
9.8066E+00	9.2948E-03	1	7.2324E+00	3.6693E-06
1.3559E+00	1.2852E-03	1.3827E-01	1	5.0734E-07
2.6726E+06	2.5331E+03	2.7253E+05	1.9710E+06	1

Btu stands for British thermal unit.



Table A4.2.7 Conversion factors for pressure

Pa	psi	kgf/cm <sup>2</sup>	atm	bar	Torr
1	1.4499E-04	1.0194E-05	9.8697E-06	1.0000E-05	7.5010E-03
6.8971E+03	1	7.0307E-02	6.8073E-02	6.8971E-02	5.1735E+01
9.8100E+04	1.4223E+01	1	9.6822E-01	9.8100E-01	7.3585E+02
1.0132E+05	1.4690E+01	1.0328E+00	1	1.0132E+00	7.6000E+02
1.0000E+05	1.4499E+01	1.0194E+00	9.8697E-01	1	7.5010E+02
1.3332E+02	1.9329E-02	1.3590E-03	1.3158E-03	1.3332E-03	1

\*1 1 Torr = 1mmHg. Also expressed as torr, but since this unit is named after a person's name (Torricelli), capitalization is recommended.

\*2 There are two expression of pressure: absolute and gauge. The absolute and gauge pressures are expressed by adding A and G after the unit, respectively. The absolute pressure is measured from the absolute vacuum. The gauge pressure is measured from the atmospheric pressure. Thus, the former is larger than the latter by 1 atm. For example, 5 atmG = 6 atmA.

### Gauge pressure

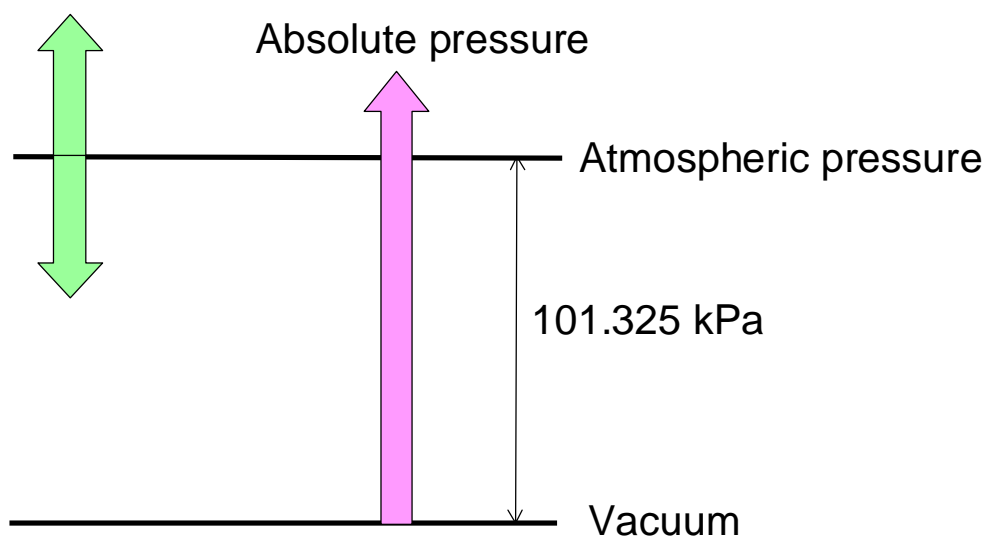


Fig. 4.2.1 Absolute pressure and gauge pressure

Table A4.2.8 Conversion factors for power

W	metric horse power	HP	kgf m/s	ft lb/sec	kcal/sec
1	1.3596E-03	1.3410E-03	1.0197E-01	7.3756E-01	2.3885E-04
7.3550E+02	1	9.8630E-01	7.5000E+01	5.4248E+02	1.7567E-01
7.4571E+02	1.0139E+00	1	7.6042E+01	5.5001E+02	1.7811E-01
9.8066E+00	1.3333E-02	1.3151E-02	1	7.2330E+00	2.3423E-03
1.3558E+00	1.8434E-03	1.8182E-03	1.3826E-01	1	3.2383E-04
4.1868E+03	5.6925E+00	5.6145E+00	4.2694E+02	3.0880E+03	1

## A4.3 Concentrations of alcohol and sugar

There exists various expressions for the concentration of sugar and alcohol due to tradition. Ethanol production from sugar is an important technology for biomass use, but various units are used from literature to literature. Special caution should be taken when reading literatures.

### A4.3.1 Concentration of alcohol

The following units are used.

Molar concentration: SI unit. Molar number of alcohol (ethanol) in 1 L of the solution. The unit is mol(-EtOH)/L(-solution). Sometimes it is expressed as “M”.

Molal concentration: SI unit. Molar number of alcohol in 1 kg of solvent. The unit is mol(-EtOH)/kg(-solvent). Sometimes it is expressed as “m”.

Volumetric percentage: The ratio of volume of alcohol before mixing to the sum of the volumes of water and alcohol before mixing. Because the volume decreases by mixing of water and alcohol, the volumes before mixing is employed as the base. The unit is expressed as vol%.

Proof (US): Used in US. The volumetric percentage is doubled.

Proof (British): Special measure with water being 100 proof under and pure alcohol being 75.1 proof over. When the volumetric percentage is  $w$ , the value in this unit is  $(w/57.1) \times 100 - 100$ . Namely, for the alcohol concentration of 57.1 vol %, the British proof is zero.

### A4.3.2 Concentration of sugar

Molar and molal concentration is defined in the same way as alcohol. However, make clear which sugar is stated; mol-glucose, total mole of sugars available for ethanol fermentation, monomer only, or monomer equivalent for monomer, dimer, trimer, etc.

Weight percentage: percentage of weight of sugar in 1 kg of solution. The unit is wt % or mass %.

Brix: The same as weight percentage. However, this is not equivalent to the brix used as a unit of density.

## A4.4 Temperature

Absolute temperatures and others are to be distinguished. Absolute temperature corresponding to the Celsius temperature °C is K (kelvin), and that corresponding to the Fahrenheit temperature °F is R (rankine). Since they are not in proportional relation, the following conversion formulae have to be used. Table A4.4.1 shows the conversion formulae.

Table A4.4.1 Conversion formulae for temperature

Unit conversion	Conversion formulae
°C → K	$TK = TC + 273.15$
°C → °F	$TF = 1.8 TC + 32$
°C → R	$TR = 1.8 TC + 491.67$
K → °C	$TC = TK - 273.15$
K → °F	$TF = 1.8 TK - 459.67$
K → R	$TR = 1.8 TK$
°F → °C	$TC = (5/9) (TF - 32)$
°F → K	$TK = (5/9) (TF + 459.67)$
°F → R	$TR = TF + 459.67$
R → °C	$TC = (5/9) TR - 273.15$
R → K	$TK = (5/9) TR$
R → °F	$TF = TR - 459.67$

## A4.5 Heating values (See also Chap. 2.4)

Heating values are the amount of heat that is released when an organic compound is completely burned. Depending on the state of product water, i.e. steam or liquid water, the value differs by the latent heat. When the product water is in the form of steam, the heating value is smaller, and called lower heating value (LHV). When the product water is in the form of liquid, the heating value is called higher heating value (HHV). It is always to be noted which heating value is used, and proper heating value should be used depending on the situation. These heating values are equivalent to the value of the change in enthalpy for the corresponding combustion reaction, but with the changed sign. The conversion formula between these values are:

$$HHV[\text{MJ/kg}] = LHV[\text{MJ/kg}] + 20.3w_H$$

where  $w_H$  is the weight fraction of the hydrogen atoms in the organic compound.

When heating values of biomass whose water content is not zero is discussed, the following are to be noted.

1. Is the heating value for dry weight or wet weight?
2. Is the latent heat of the contained water subtracted from the heating value or the latent heat is neglected?

As for the item 1, the following section of “mass basis” should be consulted. As for the item 2, when processes such as combustion is discussed, this latent heat cannot be practically recovered, and usually subtracted from the beginning, but when process such as biomethanation is discussed, this latent heat is neglected.

When the water content based on weight is  $w_w$  [kg-water/kg-wet], the heating value from which latent heat of the contained water is subtracted,  $HV_{net}$  [J/kg-wet], and the value where this subtraction is not made,  $HV_{int}$  [J/kg-wet] are related as:

$$HV_{net} = HV_{int} - w_w \Delta H_{ww}$$

where  $\Delta H_{ww}$  is the latent heat based on mass. The value of  $\Delta H_{ww}$  is  $2.443 \times 10^6$  J/kg - H<sub>2</sub>O at 25°C.

## A4.6 Weight basis

When characteristic value of biomass per unit weight is discussed, the caution should be made for the following:

1. Is the unit weight with water, or without?
2. Is the unit weight with ash, or without?

When the biomass with low water and ash contents such as dry wood is discussed, the effect of this difference is small. However, when biomass with high water and ash contents such as sewage sludge is discussed, this effect is important. The relation between values based on dry weight  $x_{db}$  and that based on wet weight  $x_{wb}$  are expressed as following, using weight fraction of water  $w_w$ .

$$x_{db} = \frac{p}{m_{db}} = \frac{p}{m_{wb}(1-w_w)} = \frac{p/m_{wb}}{(1-w_w)} = \frac{x_{wb}}{(1-w_w)}$$

where,  $p$  is the physical value to be discussed,  $m_{db}$  and  $m_{wb}$  are dry weight and wet weight, respectively. Similarly, the relation between values based on weight free of ash  $x_{af}$ , and that based on weight including ash,  $x_{wa}$ , are expressed as following, using weight fraction of ash,  $w_{ash}$ .

$$x_{af} = \frac{p}{m_{af}} = \frac{p}{m_{wa}(1-w_{ash})} = \frac{p/m_{wa}}{(1-w_{ash})} = \frac{x_{wa}}{(1-w_{ash})}$$

For example, when biomass with water content of 20 wt% is gasified, and gas production based on wet weight is  $0.75 \text{ m}^3/\text{kg}$  - wet, gas production based on dry weight is:

$$\frac{0.75}{(1-0.2)} = 0.9375 \text{ m}^3/\text{kg} \text{ - dry}$$

## A4.7 Other comments

In the engineering field in US, the symbol “MM” is sometimes used. This corresponds to  $10^6$  from the fact that M expresses 1000 in Roman numeric system, and that  $1000 \times 1000 = 10^6$ . For example, 500 MMG means  $500 \times 10^6$  gallon = 500 million gallon.

When unfamiliar unit ending with M is found, it can mean some amount “per minute”. For example, 200 rpm means 200 revolutions per minute, 4 GPM means 4 gallon per minute, and 35 ccm means 35 cubic centimeters per minute.

# A5. Atomic weight

## A5.1 Atomic weight

Atomic weight is often needed in the calculation related biomass. Table A5.1.1 shows the list of atomic weight. The values for C, H, O, N, S are often used.

Table A5.1.1 Atomic weight

Atomic number	Symbol of element	Element	Atomic weight [g/mol]
1	H	Hydrogen	1.0079
2	He	Helium	4.0026
3	Li	Lithium	6.941
4	Be	Beryllium	9.0122
5	B	Boron	10.811
6	C	Carbon	12.0107
7	N	Nitrogen	14.0067
8	O	Oxygen	15.9994
9	F	Fluorine	18.9984
10	Ne	Neon	20.1797
11	Na	Sodium	22.9897
12	Mg	Magnesium	24.305
13	Al	Aluminum	26.9815
14	Si	Silicon	28.0855
15	P	Phosphorus	30.9738
16	S	Sulfur	32.065
17	Cl	Chlorine	35.453
18	Ar	Argon	39.948
19	K	Potassium	39.0983
20	Ca	Calcium	40.078



Table A5.1.1 Atomic weight (Continued)

Atomic number	Symbol of element	Element	Atomic weight [g/mol]
21	Sc	Scandium	44.9559
22	Ti	Titanium	47.867
23	V	Vanadium	50.9415
24	Cr	Chromium	51.9961
25	Mn	Manganese	54.938
26	Fe	Iron	55.845
27	Co	Cobalt	58.9332
28	Ni	Nickel	58.6934
29	Cu	Copper	63.546
30	Zn	Zinc	65.39
31	Ga	Gallium	69.723
32	Ge	Germanium	72.64
33	As	Arsenic	74.9216
34	Se	Selenium	78.96
35	Br	Bromine	79.904
36	Kr	Krypton	83.8
37	Rb	Rubidium	85.4678
38	Sr	Strontium	87.62
39	Y	Yttrium	88.9059
40	Zr	Zirconium	91.224
41	Nb	Niobium	92.9064
42	Mo	Molybdenum	95.94
43	Tc	Technetium	98
44	Ru	Ruthenium	101.07
45	Rh	Rhodium	102.9055
46	Pd	Palladium	106.42
47	Ag	Silver	107.8682
48	Cd	Cadmium	112.411
49	In	Indium	114.818
50	Sn	Tin	118.71

Table A5.1.1 Atomic weight (Continued)

Atomic number	Symbol of element	Element	Atomic weight [g/mol]
51	Sb	Antimony	121.76
52	Te	Tellurium	127.6
53	I	Iodine	126.9045
54	Xe	Xenon	131.293
55	Cs	Cesium	132.9055
56	Ba	Barium	137.327
57	La	Lanthanum	138.9055
58	Ce	Cerium	140.116
59	Pr	Praseodymium	140.9077
60	Nd	Neodymium	144.24
61	Pm	Promethium	145
62	Sm	Samarium	150.36
63	Eu	Europium	151.964
64	Gd	Gadolinium	157.25
65	Tb	Terbium	158.9253
66	Dy	Dysprosium	162.5
67	Ho	Holmium	164.9303
68	Er	Erbium	167.259
69	Tm	Thulium	168.9342
70	Yb	Ytterbium	173.04
71	Lu	Lutetium	174.967
72	Hf	Hafnium	178.49
73	Ta	Tantalum	180.9479
74	W	Tungsten	183.84
75	Re	Rhenium	186.207
76	Os	Osmium	190.23
77	Ir	Iridium	192.217
78	Pt	Platinum	195.078
79	Au	Gold	196.9665

Table A5.1.1 Atomic weight (Continued)

Atomic number	Symbol of element	Element	Atomic weight [g/mol]
80	Hg	Mercury	200.59
81	Tl	Thallium	204.3833
82	Pb	Lead	207.2
83	Bi	Bismuth	208.9804
84	Po	Polonium	209
85	At	Astatine	210
86	Rn	Radon	222
87	Fr	Francium	223
88	Ra	Radium	226
89	Ac	Actinium	227
90	Th	Thorium	232.0381
91	Pa	Protactinium	231.0359
92	U	Uranium	238.0289
93	Np	Neptunium	237
94	Pu	Plutonium	244
95	Am	Americium	243
96	Cm	Curium	247
97	Bk	Berkelium	247
98	Cf	Californium	251
99	Es	Einsteinium	252
100	Fm	Fermium	257
101	Md	Mendelevium	258
102	No	Nobelium	259
103	Lr	Lawrencium	262

## **A6. Thermodynamic Properties**

### **A6.1 Thermodynamic properties of fundamental chemicals**

Heat release and heat absorption with chemical reaction or phase transition, and the extent to which a chemical reaction proceeds can be obtained using thermodynamics. In this chapter is shown part of the data needed for this calculation. Detail can be found in Chemical Handbook, a book by Ried et al., Steam Table, Chemical Engineering Handbook etc. For thermodynamic calculation, books by Atkins, Komiiyama (in Japanese), Yamaguchi (in Japanese), and other textbook on physical chemistry or chemical thermodynamics can be consulted. There is a book that collects thermodynamic data of general substances including biomass.

### **A6.2 Standard enthalpy of formation, standard entropy, and standard Gibbs free energy of formation**

Table A6.2.1 shows the standard enthalpy of formation, standard entropy, and standard Gibbs free energy of formation for chemical substances related to biomass. “g”, “l”, and “s” for state stand for gas, liquid, and solid, respectively.

Table A6.2.1 Standard enthalpy of formation, standard entropy, and standard Gibbs free energy of formation for chemical substances related to biomass.

Substance	Chemical formula	State	Standard enthalpy of formation [kJ mol <sup>-1</sup> ]	Standard entropy [J mol <sup>-1</sup> ]	Standard Gibbs free energy of formation [kJ mol <sup>-1</sup> ]
Carbon monoxide	CO	g	-110.53	197.67	-137.17
Ethanol	C <sub>2</sub> H <sub>5</sub> OH	l	-277.1	159.86	-173.9
Ethane	C <sub>2</sub> H <sub>6</sub>	g	-83.8	229.60	-31.9
Ethene (Ethylene)	C <sub>2</sub> H <sub>4</sub>	g	52.5	219.56	68.4
Formic acid	HCOOH	l	-425.1	131.84	-362.6
Glucose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	s	-1273.3	N/A	N/A
Acetic acid	CH <sub>3</sub> COOH	l	-484.3	158.0	-388.9
Oxygen	O <sub>2</sub>	g	0	205.14	0
Hydrogen	H <sub>2</sub>	g	0	130.68	0
Carbon (graphite)	C	s	0	5.74	0
Carbon dioxide	CO <sub>2</sub>	g	-393.51	213.74	-394.36
Propane	C <sub>3</sub> H <sub>8</sub>	g	-104.7	270.02	-24.2
Water	H <sub>2</sub> O	l	-285.83	69.91	-237.13
Water	H <sub>2</sub> O	g	-241.82	188.83	-228.57
Methanol	CH <sub>3</sub> OH	l	-239.1	127.19	-166.8
Methane	CH <sub>4</sub>	g	-74.4	186.38	-50.3

From Chemistry Handbook (Kagaku Benran).

## A6.3 Enthalpy change of transition for water, methanol, and ethanol

Table A6.3.1 shows the enthalpy change of transition for water, methanol, and ethanol.

Table A6.3.1 Enthalpy change of transition for water, methanol, and ethanol.

	Transition	Temperature of transition	Enthalpy change of
		at 1.013×10 <sup>5</sup> Pa [°C]	transition [kJ/mol]
Water	s → l	273.15	6.01
Water	l → g	373.15	40.66
Methanol	l → g	337.9	35.27
Ethanol	l → g	351.7	38.6

From Chemistry Handbook (Kagaku Benran).

## A6.4 Enthalpy change of combustion

Table A6.4.1 shows the enthalpy change of complete combustion of chemical substances. These values are for the case when liquid water is formed, and by changing the sign, higher heating value for the substance is obtained. These values can be calculated using data in Table A6.2.1.

Table A6.4.1 Enthalpy change of combustion

Substance	State	Enthalpy of combustion [kJ mol <sup>-1</sup> ]	Substance	State	Enthalpy of combustion [kJ mol <sup>-1</sup> ]
Carbon monoxide	g	-282.98	Acetic acid	l	-874.3
Ethanol	l	-1367.6	Hydrogen	g	-285.83
Ethane	g	-1560.7	Carbon (graphite)	s	-393.51
Ethene (Ethylene)	g	-1411.2	Propane	g	-2219.2
Formic acid	l	-254.24	Methanol	l	-725.7
Glucose	s	-2803.3	Methane	g	-890.7

From Chemistry Handbook (Kagaku Benran). Some values are calculated by the author.

# A7. Heating Values of Fossil Fuels and Lifetime

## A7.1 Heating values of fossil fuels and lifetime

Table A7.1.1 shows the heating values of fossil fuels and lifetime.

Table A7.1.1 Heating values of fossil fuels and lifetime

	Petroleum	Coal	Natural gas
Heating value (representative)* [MJ/kg]	40	28	56
R/P ratio [year]**	46	219	64

\* These are representative values, and actual values differs largely depending on the production site and treatment. These values are higher heating values.

\*\* Reserve/Production ratio.



# A8. APEC Framework

## A8.1 What is APEC?

APEC (Asia-Pacific Economic Cooperation) is a forum that aims at sustainable development in the Asia and Pacific region, and all main countries and regions participate with. It started at the ministerial conference in November, 1989 (Canberra, Australia), and has been organizing top-level conferences since 1993. Its main activities are liberalization and harmonization of trade and investment, and economical and technological collaboration in the region.

Table A8.1.1 APEC Countries

Australia	Russia
Brunei Darussalam*	Singapore*
Cambodia	Taipei, Chinese
Canada	Thailand*
Chili	United States of America
Hongkong, Chinese	Vietnam*
Indonesia*	
Japan	
Korea	
Laos	
Malaysia*	
Mexico	
New Zealand	
Papua New Guinea	
Peru	
Philippines*	
P. R. China	

\* ASEAN Countries

## A9. Each Country's Targets

### A9.1 Each country's target for biomass introduction

Table A9.1.1 shows the target of biomass introduction for each country.

Table A9.1.1 Target of each country

Country	Target
Cambodia	There are no targets.
Indonesia	Development of biofuel plantation in 5.25 M ha unused land. According to Road Map Biofuel Development the Biofuel utilization (biodiesel, bioethanol, bio-oil) will be 2% of national energy mix of 5.29 M kL by 2010.
Japan	Thermal use of biomass: 3.08 M kL, Electricity production from biomass and wastes: 5.86 M kL oil equivalent at 2010
Korea	Thermal use of biomass: 0.679 million kL, Electricity production from biomass and wastes: 0.367 million kL oil equivalent at 2011
Laos	Now the government drafting the policy and target for the biofuel especially biodiesel from the Jatropha to mix with the fossil diesel to be B5 by the year 2012, B5 by the year 2015 and B15 by 2020. And For the Ethanol is E10 by the year 2015 and E20 by the year 2020. These target is under drafting of the document.
Malaysia	The target for electricity generation from renewable energy (including biomass) is set at 350MWe in Peninsular Malaysia and 50MWe in Sabah

Table A9.1.1 Target of each country (Continued)

Country	Target
Philippines	Two years from the effectivity of the Act, at least 5% bioethanol by volume of the total volume of gasoline fuel sold and distributed by each and every oil company in the country. Within four years from the effectivity of the Act, the Philippine Department of Energy, may mandate a minimum of 10% blend depending on the results of the study by the national Board created under the Act. Three months after the approval of the Act, a minimum of 1% biodiesel by volume shall be blended into all diesel engine fuels sold in the country. Within two years from the effectivity of the Act, the Philippine Department of Energy, may mandate a total of 2% blend depending on the results of the study by the national Board created under the Act. Provided that the ethanol and biodiesel blends conform to Philippine National Standard.
P. R. China	Percentages of renewable energy consumption will be 10% by 2010 and 15% by 2020. By 2010, annual consumption of non-grain based fuel ethanol shall reach 2 M tons, and that of biodiesel shall reach 200 000 tons in China. By 2020, annual consumption of fuel ethanol shall reach 10 M tons, and that of biodiesel shall reach 2 M tons in China.
Taipei, Chinese	<ol style="list-style-type: none"> <li>1. Electricity installed capacity of 741MW from biomass and wastes in 2010</li> <li>2. Biodiesel production : 100 thousand KL in 2010</li> <li>3. Bioethanol production: 100 thousand KL in 2011</li> </ol>

# A10. Related histories

## A10.1 History related to Asian biomass

Table A10.1.1 shows the recent history related to Asian biomass.

Table A10.1 Time table on Asian biomass

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2005.1	1 <sup>st</sup> Biomass Asia Workshop (Tokyo and Tsukuba)
2005.12	2 <sup>nd</sup> Biomass Asia Workshop (Bangkok)
2006.1	Biomass Asia Forum (Tokyo)
2006.11	3 <sup>rd</sup> Biomass Asia Workshop (Tokyo and Tsukuba)
2007.3	Startup of Asia Biomass Association
2007.4	Laos joins Asia Biomass Association
2007.11	4 <sup>th</sup> Biomass Asia Workshop (Shar Alam)

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# A11 Each country's language

## A11.1 Each country's language and greeting words

Table A11.1.1 shows each country's language and greeting words.

Table A11.1.1 Language and "Hello" in each country

Country	Language	"Good morning/ afternoon"
Brunei Darussalam	Malay	Selamat pagi/ petang
Cambodia	Khmer	Arun suo sdei/ Tiveah suor sdei
Indonesia	Bahasa Indonesia	Selamat pagi/ sinag
Japan	Japanese	Ohayo/ Kon'nichiwa
Korea	Korean	Annyunghaseyo/ Annyunghashimnikka
Laos	Lao	Sabaidee
Malaysia	Bahasa Melayu	Selamat pagi/ petang
Philippines	Filipino, English	Magandang umaga
P. R. China	Chinese	Nihao
Singapore	Mandarin, English, Malay, Hokkien	Nihao
Taipei, Chinese	Chinese, Taiwanese	Nihao
Thailand	Thai	Sawatdee
Vietnam	Vietnamese	Xin chao

# A12 Related books

## A12.1 Books in English

Knoef, H. Ed., “Handbook Biomass Gsification”, BTG Biomass Technology Group (2005)

Van Loo, S. and Koppejan, J. Eds., “Handbook of Biomass Combustion and Co-Firing”, Twente University Press (2002)

Klass, D. L., “Biomass for Renewable Energy, Fuels, and Chemicals,” Academic Press (1998)

Boyle, G. Ed., “Renewable Energy Power for a Sustainable Future,” Oxford University Press (1996)

Wyman, C. E. Ed., “Handbook on Bioethanol: Production and Utilization”, Taylor & Francis (1996)

Kitani, O. and Hall, C. W. Eds., “Biomass Handbook”, Gordon and Breach Science (1989)

E. S. Domalski, T. L. Jobe, Jr., T. A. Milne, Eds., “Thermodynamic data for biomass materials and waste components”, American Society of Mechanical Engineers (1987)

## A12.2 Books in Japanese (in Japanese)

日本エネルギー学会「バイオマス用語事典」 オーム社 (2006)

坂志朗「バイオディーゼルのすべて」 アイピーシー (2005)

木谷収「バイオマスー生物資源と環境」 コロナ社 (2004)

小宮山宏ら編著「バイオマス・ニッポンー日本再生に向けて」 日刊工業新聞社 (2003)

日本エネルギー学会「バイオマスハンドブック」 オーム社 (2002)

湯川英明編「バイオマスー究極の代替エネルギー」 化学工業日報社 (2002)

横山伸也「持続社会へむけて バイオエネルギー最前線」 森北出版 (2001)

坂志朗編著「バイオマス・エネルギー・環境」 アイピーシー (2001)

山地憲治、山本博巳、藤野純一「バイオエネルギー」 ミオシン出版 (2000)

坂井正康「バイオマスが拓く 21世紀エネルギー 地球温暖化の元凶 CO2 排出はゼロにできる」  
森北出版 (1998)

本多淳裕「バイオマスエネルギー：生物系資源・廃棄物の有効利用」 省エネルギーセンター (1986)

鈴木周一編「バイオマスエネルギー変換」 講談社 (1983)

M.スレッサー, C.レウイス著；須之部淑男, 増川重彦訳「バイオマス：生物エネルギー資源」 共立  
出版 (1982)

山沢新吾編「バイオマスエネルギー」 朝倉書店 (1982)

柴田和雄, 木谷収編「バイオマス：生産と変換」 上, 下, 学会出版センター (1981)

## **A12.3 Books in Chinese (in Chinese)**

日本能源学会編、史仲平、華兆哲訳「生物質和生物能源手冊」化学工業出版社（2007）

小宮山宏他編著、李大寅、蔣偉忠訳「日本生物質総合戦略」中国環境化学出版社（2003）

中国農村能源年鑑編集委員会編「中国農村能源年鑑 1997」中国農業出版社（1997）