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# Promotion of new and renewable sources of energy

## Report of the Secretary-General

*Summary*

New and renewable sources of energy have begun to enter the mainstream of national and international energy policy formulation and now constitute an integral element of the global vision for sustainable development and the achievement of the Millennium Development Goals. The further development and increased use of advanced and cleaner energy technologies, including new and renewable sources of energy, offer options with multiple benefits for sustainable development. Global interest in new and renewable energy technologies and in their investment has been growing rapidly since the 2002 World Summit on Sustainable Development adopted the Johannesburg Plan of Implementation, which calls for substantially increasing, with a sense of urgency, the global share of energy obtained from renewable sources. However, in spite of recent investments, the share of energy derived from new and renewable sources still remains considerably below its economic potential. Policy options for the promotion of new and renewable sources of energy were extensively reviewed by the Commission on Sustainable Development during its second implementation cycle. The third implementation cycle of the Commission will focus on the thematic cluster of agriculture, rural development, land, drought, desertification and Africa. The sixteenth and seventeenth sessions may thus provide an opportunity to address, among other issues, Africa's continuing widespread dependence on the unsustainable use of traditional biomass to meet its growing basic energy needs.

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# I. Introduction

1. The General Assembly, in its resolution 60/199, reaffirmed the Plan of Implementation of the World Summit on Sustainable Development (Johannesburg Plan of Implementation)[1] as the intergovernmental framework for energy for sustainable development, and called for its full implementation, including the implementation of recommendations concerning energy for sustainable development. The Assembly encouraged the United Nations system to continue to raise awareness of the importance of energy for sustainable development, including the need for the promotion of new and renewable sources of energy and of the increased role they can play in the global energy supply, particularly in the context of development and poverty eradication.

2. In recalling the 2005 World Summit Outcome,[2] the General Assembly also welcomed initiatives aimed at improving access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services for sustainable development in order to contribute to the achievement of internationally agreed development goals, including those set out in the United Nations Millennium Declaration.[3] The Assembly encouraged national and regional initiatives on renewable energy to promote access to energy and emphasized the need to intensify research and development in support of energy for sustainable development, requiring increased commitment on the part of all stakeholders, including Governments and the private sector, to deploy financial and human resources for accelerating research efforts. The Assembly also stressed that the wider use of available renewable sources of energy requires technology transfer and diffusion on a global scale, including through North-South and South-South cooperation.

3. The General Assembly requested the Secretary-General to submit to it at its sixty-second session a report on the implementation of its resolution 60/199. The present report is submitted pursuant to that request.

# II. Multiple benefits of using new and renewable sources of energy

4. Since the adoption of the Johannesburg Plan of Implementation, international interest in new and renewable sources of energy has grown significantly, motivated by different yet interrelated concerns of significant importance. The increased use of new and renewable sources of energy offers important options for the provision of energy for sustainable development, with multiple economic, social and environmental benefits.

5. Meeting the energy needs of developing countries in a sustainable manner is an urgent challenge. The persistent lack of access to energy is seriously impeding socio-economic development, particularly in sub-Saharan Africa and in countries of

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[1] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

[2] See General Assembly resolution 60/1.

[3] See General Assembly resolution 55/2.

South Asia, but also in many other developing countries, including many of the small island developing States. In the developing countries, some 1.6 billion people still lack access to electricity and, as shown in table 1, an estimated 2.5 billion people continue to rely on traditional biomass for cooking and heating, mainly in rural areas.

Table 1
**Reliance on biomass resources as primary fuel for cooking in developing countries, 2004**

| | *Rural* | | *Urban* | | *Total population* | |
|---|---|---|---|---|---|---|
| | *(Percentage)* | *(Millions)* | *(Percentage)* | *(Millions)* | *(Percentage)* | *(Millions)* |
| Africa | 75 | 417 | 44 | 162 | 44 | 579 |
| Sub-Saharan | 93 | 413 | 58 | 162 | 58 | 575 |
| Asia | 70 | 1 656 | 17 | 267 | 17 | 1 865 |
| China | 55 | 428 | 10 | 52 | 10 | 480 |
| India | 87 | 663 | 25 | 77 | 25 | 740 |
| Latin America | 60 | 75 | 7 | 33 | 7 | 83 |
| Brazil | 53 | 16 | 5 | 8 | 5 | 23 |
| **Total** | **83** | **2 147** | **52** | **461** | **23** | **2 528** |

*Source*: Based on data compiled by the International Energy Agency for *World Energy Outlook 2006* (Paris, 2006) arranged according to the regions of the United Nations, and population data based on United Nations, "World Population Prospects, 2006: highlights" (ESA/P/WP.202).

6. National and local programmes aimed at expanding traditional biomass energy supply (for example, community wood lots) or aimed at improving the efficiency of traditional biomass use (for example, more fuel-efficient cook stoves) will continue to play an important role in sustainable development until affordable and efficient modern stoves and fuels become more widely available to meet the cooking and heating needs of the urban and rural poor.

7. The achievement of the Millennium Development Goals and of more equitable socio-economic development will depend on providing the poor with increased access to modern energy services to enable them to meet their basic needs and for income-generation. Energy policymakers and planners in the developing countries are taking a growing interest in using renewable energy systems in the process of rural electrification wherever the necessary technical and financial support is available.

8. Another major concern that can be addressed by increasing the use of energy from new and renewable sources is climate change. The United Nations Intergovernmental Panel on Climate Change concluded in its recent Fourth Assessment Report that global temperatures were rising and that the primary cause was human activity. In addition, with temperatures rising, projections indicate the possibility of major changes in ecosystem structure and function, with predominantly negative consequences for biodiversity and ecosystems, for example, freshwater and food supply. Human-induced carbon dioxide and other greenhouse-gas emissions originate mainly from the combustion of fossil fuels. Therefore, in

addition to increasing the efficiency of energy production and use, expanding the use of new and renewable sources of energy for electricity generation offers important options for reducing anthropogenic emissions of greenhouse gases in both developed and developing countries.

9. The multiple benefits of new and renewable sources of energy have received increasing attention at recent global conferences and summits. At the 2005 World Summit, participating world leaders agreed to promote the development and greater use of new and renewable energy sources. The Group of Eight, at its 2005 Summit, adopted the Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development and called for accelerated technology development and the increased use of energy-efficient and climate-friendly technologies. In 2006, leaders attending the Group of Eight Summit, held in Saint Petersburg, Russian Federation, adopted a plan of action in which they agreed to, among other measures promote the wider use of renewable and alternative energy sources and facilitate investments in that field. Building on those decisions, leaders participating in the Group of Eight and the Group of Eight Plus Five Summit, held in Germany in 2007, agreed to move forward within the United Nations framework and to act to address climate change.

10. Switching to new and renewable sources of energy can also have positive environmental and public-health impacts through the reduction of air pollution. Local, regional and transboundary air pollution from sulphur and nitrogen oxides, carbon monoxide and suspended particulate matter emanating from fossil-fuel use can have negative impacts on human health, cause acid precipitation and contribute to depletion of the stratospheric ozone layer.

11. Global primary energy supply and consumption are widely expected to increase from 10,579 million tons of oil equivalent in 2003 to 12,200 in 2010, and to 16,500 in 2030. Developing countries in particular face rising energy demand as a result of expanding per capita economic activity and increasing populations. Given the projected increase in their energy demand, all energy sources need to be tapped. At the same time, the carbon intensity of energy production and consumption will need to be reduced significantly, at least in the intermediate and longer term, if climate change is to be addressed effectively. Together with greater energy efficiency, greater reliance on advanced energy technologies, including advanced and cleaner fossil-fuel technologies, and the sustainable use of traditional energy resources, new and renewable sources of energy will have to make a greater contribution to the future energy supply if the rising global energy demand is to be met in ways that contribute to the achievement of sustainable development goals.

# III. New and renewable sources of energy and the Plan of Implementation of the World Summit on Sustainable Development

12. The promotion of new and renewable sources of energy figured prominently in the deliberations of the World Summit on Sustainable Development. The actions called for in the Johannesburg Plan of Implementation include a major focus on energy for poverty eradication, for changing unsustainable patterns of consumption and production and for the sustainable development of regions, including Africa and the small island developing States.

13. In addressing the contribution that renewable energy can make to poverty eradication, the Plan calls for (a) increased use of energy from renewable sources as one means of improving access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services and resources; (b) improved access to modern biomass technologies and fuelwood sources and supplies, and commercialized biomass operations in rural areas and where such practices are sustainable; and (c) improved patterns of use through better management of resources, more efficient use of fuelwood and new and improved products and technologies aimed at promoting sustainable use of biomass and, as appropriate, other renewable sources of energy.

14. With regard to the need to change unsustainable patterns of consumption and production, the Plan calls for substantially increasing, with a sense of urgency, the global share of energy obtained from renewable sources, hydro included, with the objective of increasing its contribution to the total energy supply, and for regularly evaluating available data to review progress to that end.

15. The Plan also calls for support for initiatives to increase the use of renewable energy, particularly in rural and peri-urban areas, and to support the efforts of African nations to achieve the goals of the New Partnership for Africa's Development (A/57304, annex), one of which is to secure access to energy for at least 35 per cent of the African population within 20 years, especially in rural areas.

16. The *Report of the International Meeting to Review the Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States*,[4] held in Port Louis from 10 to 14 January 2005, points out that energy dependence is a major source of economic vulnerability for those nations, as many remote and rural small island communities have little or no access to modern and affordable energy services. The report also noted that many small island developing States are particularly suited to the use of renewable sources of energy because of their geographical location. Many such States are also likely to be among the countries most seriously affected by the impact of climate change.

# IV. Review of new and renewable sources of energy under the second implementation cycle of the Commission on Sustainable Development

17. In the scope of its second implementation cycle, the Commission on Sustainable Development conducted an assessment of the progress made in the implementation of Agenda 21,[5] the Programme for the Further Implementation of Agenda 21,[6] decisions taken at the ninth session of the Commission and the Plan of Implementation of the World Summit on Sustainable Development, while focusing on identifying constraints and obstacles in the process of implementation with regard to the thematic cluster that includes the issues of energy for sustainable development, industrial development, atmosphere/air pollution and climate change.

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[4] United Nations publication, Sales No. E.05.II.A.4 and corrigendum.

[5] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992*, vol. I. *Resolutions adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

[6] General Assembly resolution S-19/2, annex.

The second implementation cycle constituted a comprehensive and inclusive global consultative process that included regional implementation meetings in all five regions, followed by a global review session held in New York in May 2006 and a policy session, also held in New York, in May 2007. All major groups actively participated in the deliberations.

18. In their deliberations, delegations recognized the multiple benefits of new and renewable sources of energy for sustainable development and highlighted the need to urgently and substantially accelerate the process of achieving the internationally agreed development goals, including the Millennium Development Goals and the Johannesburg Plan of Implementation. Many delegations stated that there was a need to further diversify the energy supply by developing advanced, cleaner, more efficient, affordable and cost-effective technologies, including advanced and cleaner fossil-fuel technologies and renewable energy technologies. Recognizing the contribution that new and renewable sources of energy can make to sustainable development, the Chairman of the Commission identified in his summary the need to, inter alia, accelerate the transition from the inefficient utilization of biomass to cleaner energy sources, technologies and appliances for cooking and heating, in particular in developing countries. The Commission also reflected on the important contribution that bioenergy and in particular liquid biofuels can make to sustainable development.

19. Information provided by Member States and other stakeholders on action taken to increase the use of new and renewable sources of energy is included in the matrix for the fourteenth and fifteenth sessions of the Commission, which can be accessed through the Commission's website (http://www.un.org/esa/sustdev/csd/csd15/csd15.htm). The Commission's Partnership Fair and Learning Centre also provided forums for the exchange of best practices and lessons learned by all relevant stakeholders.

20. It was also noted, during the Commission's deliberations, that the utilization of new and renewable energy technologies can assist in addressing gender inequalities, in particular in rural and remote areas of developing countries, by reducing the time spent on the collection of traditional fuelwood and by reducing the health hazards posed by indoor air pollution.

# V. Overview on recent trends, policies and technology development

## A. Contribution of new and renewable sources of energy to total primary energy supply

21. Many countries, both industrialized and developing, have in recent years adopted policies aimed at the promotion of accelerated development and the increased use of new and renewable energy sources. Hence, the overall trend in the development and use of new and renewable sources of energy is towards continued significant expansion, as shown for the various geographical regions in tables 2 and 3. A recent study on global trends in renewable energy and energy efficiency estimated global investments in 2006 at a record $100 billion.[7] Growth in the

[7] UNEP and New Energy Finance, Ltd. *Global Trends in Sustainable Energy Investment 2007* (Paris, 2007).

utilization of new and renewable sources of energy has been particularly rapid in Europe. Between 1990 and 2004, the utilization of new and renewable energy sources has also increased by more than 50 per cent in North America and more than doubled in Asia, in particular in Asian developing countries. In Africa, the use of renewable energy, in particular hydropower, has also increased, but many programmes have remained too small to have a significant impact on their national energy systems, owing largely to the continuing high cost of new and renewable energy technologies, for which all components need to be imported.

Table 2
**World geothermal, solar, wind, and wood and waste electric power consumption by region, 1985-2004**
(Billions of kilowatt hours)

| | *1985* | *1990* | *1995* | *2000* | *2004* |
|---|---|---|---|---|---|
| Northern America | 12.32 | 71.65 | 83.35 | 93.29 | 107.10 |
| Latin America and the Caribbean | 8.44 | 13.12 | 16.66 | 23.45 | 34.98 |
| Western Europe | 13.81 | 19.39 | 38.03 | 75.01 | 132.38 |
| Central and Eastern Europe and States of the former USSR | 0.51 | 0.31 | 2.37 | 3.83 | 4.72 |
| Western Asia | — | — | 0.001 | 0.003 | 0.01 |
| Africa | 0.37 | 0.39 | 0.43 | 0.90 | 2.01 |
| Asia and the Pacific | 20.05 | 26.69 | 36.62 | 53.03 | 51.21 |
| **Total** | **55.50** | **131.54** | **177.47** | **249.49** | **332.41** |

*Source*: United States Department of Energy, June 2007, arranged according to the regions of the United Nations (see www.eia.doe.gov).

Table 3
**World hydroelectric power consumption by region, 1985-2004**
(Billions of kilowatt hours)

| | *1985* | *1990* | *1995* | *2000* | *2004* |
|---|---|---|---|---|---|
| Northern America | 585.11 | 586.73 | 643.40 | 630.24 | 602.66 |
| Latin America and the Caribbean | 313.43 | 388.37 | 487.00 | 578.85 | 602.03 |
| Western Europe | 453.15 | 453.42 | 508.49 | 554.90 | 435.71 |
| Central and Eastern Europe and States of the former USSR | 228.63 | 251.72 | 268.14 | 258.04 | 295.35 |
| Western Asia | 3.22 | 6.52 | 8.33 | 10.58 | 14.08 |
| Africa | 46.50 | 54.82 | 58.87 | 73.96 | 87.43 |
| Asia and the Pacific | 323.53 | 410.12 | 486.29 | 545.21 | 664.04 |
| **Total** | **1 953.57** | **2 151.72** | **2 461.29** | **2 651.76** | **2 701.30** |

*Source*: United States Department of Energy, June 2007, arranged according to the regions of the United Nations (see www.eia.doe.gov).

22. Hydropower is by far the most important renewable source of energy for electric-power generation. While the share of hydropower-generated electricity consumed has remained relatively constant, with some decrease in industrialized countries where a number of dams have been decommissioned in response to ecological concerns, development of this resource has been comparatively strong in Africa and Asia, where the feasibility of several new large hydropower projects is currently under study.

23. Whereas the global energy supply and consumption from all sources grew on average by 1.8 per cent per year between 1990 and 2004, energy derived from new and renewable sources grew slightly faster, at an average rate of 1.9 per cent per year, during that same period. As shown in table 4, the amount of energy derived from certain new and renewable sources grew at a much faster rate than that derived from others. Worldwide, wind power generation grew on average by more than 24 per cent per year. Solar energy, renewable municipal solid waste, biogas and liquid biomass also proved to be significant growth areas for renewable energy use, as the technologies to exploit them continue to develop rapidly.

Table 4
**Average annual growth rates of energy supplied from renewable sources, 1990-2004**
(Percentage)

| *Energy source* | |
|---|---|
| All primary energy sources | 1.8 |
| All renewable energy sources | 1.9 |
| Wind | 24.4 |
| Solar | 6.1 |
| Hydropower | 1.9 |
| Geothermal | 2.2 |
| Solid biomass | 1.6 |
| Renewable municipal solid waste, biogas and liquid biomass | 8.1 |

*Source*: IEA, *Renewables Information: 2006 Edition* (Paris, 2006).

24. Emerging investment trends can take a considerable period of time to show their effect on global patterns of energy production and consumption. Hence, despite the marked overall increase in the development and use of new and renewable sources of energy and in their share of the total energy mix, that share remains small. It is estimated that in 2004 all renewable forms of energy provided only 13 per cent of the global primary energy supply, with 10 per cent emanating from combustible renewables (mainly traditional biomass such as fuelwood and charcoal), 2.2 per cent from hydropower, 0.4 per cent from geothermal energy and 0.5 per cent from various other new and renewable sources, including renewable municipal solid waste, liquid biofuels, gas from biomass, and wind, solar and tidal energy.

Table 5
**Fuel shares in total primary energy supply, 2001 and 2004**
(Percentage)

| *Fuel* | *2001* | *2004* |
|---|---|---|
| Oil | 35.0 | 34.3 |
| Coal | 23.4 | 25.1 |
| Natural gas | 21.2 | 20.9 |
| Nuclear | 6.9 | 6.5 |
| Non-renewable wastes | — | 0.2 |
| Solid biomass/charcoal | 10.4 | 10.0 |
| New and renewable sources of energy | 3.04 | 3.05 |
| Hydro | 2.214 | 2.188 |
| Geothermal | 0.432 | 0.414 |
| Renewable municipal solid waste | 0.162 | 0.092 |
| Liquid biomass | 0.095 | 0.157 |
| Gas from biomass | 0.068 | 0.092 |
| Wind | 0.027 | 0.065 |
| Solar and tidal energy | 0.041 | 0.039 |

*Source*: IEA, *Renewables Information: 2003 Edition* (Paris, 2003); and *Renewables Information: 2006 Edition* (Paris, 2006).

## B. Policy options for promoting new and renewable sources of energy

25. Governments use a variety of policy tools and measures to promote renewable energy use. Legal guarantees for access to the electricity grid are an important precondition for private-sector investments in electricity production using new and renewable sources of energy. Most countries that have undertaken recent electricity-sector and market reforms now provide conditional access to the grid for independent power producers, including small-scale renewable energy producers. Guaranteed feed-in tariffs and renewable energy quotas and portfolio standards are among the instruments most frequently used to attract investment in power generation from new and renewable sources of energy. In 2006, more than 40 countries, states and provinces enacted feed-in policies, including countries of the European Union, as well as Brazil and China, and a number of states of India, Indonesia, Israel, the Republic of Korea, Sri Lanka, Thailand and Turkey. In addition, more than 35 countries, states and provinces, including more than 20 states of the United States of America, had enacted renewable-energy portfolio standards. Public procurement and renewable energy tendering are also policy options used in a variety of countries to promote the utilization of new and renewable sources of energy. Ireland and the United Kingdom of Great Britain and Northern Ireland were among the first countries to introduce public tendering for the procurement of electricity from new and renewable sources of energy. Small and microscale power producers using new and renewable energies can also significantly benefit from net metering. In certain countries and in some 30 states of the United States, distribution service providers are placed under a legal obligation to ensure the availability of

interconnections enabling small-scale producers to sell their surplus electricity supply to the grid to offset their own consumption during other periods. Differential retail pricing of electricity from various sources is available in Australia, some provinces of Canada, some countries of the European Union, and some states of the United States. In liberalized electricity markets, electricity retailers seek to sell electricity from new and renewable energy sources as "green electricity" at a premium to environmentally conscious consumers. Many countries also use public-benefit funds to finance rural electrification, renewable energy, energy efficiency or public research projects. Public-benefit funds can be generated in various ways, including through small levies on electricity transmission or consumption. Incentives offered to consumers can also stimulate investment in new and renewable sources of energy. In Australia, some countries of the European Union and Japan, various incentive programmes offer cash rebates or tax credits to consumers who install their own renewable energy facilities, particularly solar home systems.

26. Institutional infrastructure and concessionary sources of financing are also important tools for the promotion of the use of new and renewable sources of energy. In many developing countries, private-sector investments in new and renewable energies are impeded by high commercial interest rates, which in some countries exceed 10 or 20 per cent per year. To address that constraint, several developing countries, including Brazil, China and India, have established dedicated renewable-energy development and financing agencies, which have been effective in the successful expansion of the use of new and renewable energy sources in those countries.

27. A growing number of countries, states and provinces also use medium- or long-term targets in their new and renewable energy promotion policies. The European Union, for example, has set a target for its member States whereby 10 per cent of its electricity would be derived from renewable sources by 2012 and 20 per cent by 2020. In several developing countries, energy planning and development authorities have also announced targets. In China, plans have been announced to increase the use of energy from new and renewable sources, including hydropower, to 16 per cent of total energy use by the year 2020. There, development planning includes separate targets for each type of technology, with plans to increase, by 2020, electricity production capacity from hydropower to 300 gigawatts, from wind energy to 30 gigawatts, from biomass to 30 gigawatts, from solar photovoltaics to 1.8 gigawatts, and from biofuels to 15 billion litres. In India, short-term targets include the full use of cogeneration in the sugar and other biomass-based industries by 2012.

28. In recent years, a growing number of municipalities, corporations and small businesses as well as individual consumers have been seeking to reduce the carbon intensity of their energy consumption. That can be achieved through energy efficiency and energy conservation measures or through the setting up of renewable energy systems. With growing climate-change concerns, interest in carbon offsets and carbon trading can also be expected to increase significantly, raising the prospect of greater mobilization of additional financial resources for new and renewable energy projects.

29. On World Environment Day 2007, a plan was announced at the United Nations Secretariat that would make United Nations offices and operations climate-neutral and environmentally sustainable, which could be achieved through the more

efficient use of energy as well as by switching to electricity derived from renewable sources of energy and by purchasing carbon credits to offset greenhouse-gas emissions arising from United Nations operations. The greater the number of consumers seeking to switch to climate-friendly or climate-neutral forms of energy use, the greater the demand for sustainable forms of energy, including from new and renewable sources.

## C. Costs of power generation using new and renewable sources of energy

30. Economic and financial considerations are of great importance to both producers and consumers. For energy-importing countries, and in particular for energy-importing least developed countries in sub-Saharan Africa, the increase in global oil prices since 2004 has further added to the challenge of ensuring affordable energy services and led to a growing interest in renewable-energy options. Increased demand for renewable-energy equipment has also enabled certain manufacturers to expand their production and reduce their costs, making those options more attractive for investors and affordable for consumers.

31. Perspectives for expanding the use of new and renewable sources of energy may in part also depend on the respective opportunity costs. Average costs of electricity generation in conventional power stations can vary considerably among countries, depending on technology, efficiency and type and cost of fuel used. However, most conventional power stations that use fossil fuels produce baseload electricity at costs ranging from $0.02-0.06 kilowatt hour. Peak-load power-generation costs can be higher. Costs are particularly high for off-grid power generators using diesel fuel, which are frequently found in rural areas of developing countries. As shown in table 6, average costs of electric-power generation using new and renewable sources of energy are still higher than average power-generation costs using fossil-fuel-based energy technologies. Whereas large and small hydropower can produce electricity at competitive rates, mini- and micro-hydro may need some form of public support to provide electricity at affordable rates. Under the best possible conditions — optimized system design, site and resource availability — small hydropower, wind, geothermal and biomass may also produce electricity at costs ranging from $0.02-0.06 kilowatt hour, but in many cases costs may be higher and public policy or financial support may be indispensable, at least during the investment start-up phase.

32. The cost of both on-shore and off-shore wind power generation has declined in recent years, while there have been increases in wind-turbine capacities and economies of scale in wind-turbine manufacturing. Electricity generation from wind is now almost competitive with fossil-fuel-based power generation. However, continued supportive policies will be essential if wind power generation is to be further increased. Solar photovoltaics remains the most expensive source of electricity supply and is therefore used primarily in locations where no other, more economical sources of energy are available.

Table 6
**Status and cost trends of renewable energy technologies**

| *Technology* | *Technical specifications* | *Average energy costs (United States cents)* |
|---|---|---|
| Power generation | | |
| Large hydro | Plant size: 10-18,000 MW | 3-4 |
| Small hydro | Plant size: 1-10 MW | 4-7 |
| Onshore wind | Turbine size: 1-5 MW | 4-6 |
| Offshore wind | Turbine size: 1.5-5 MW | 6-10 |
| Biomass power | Plant size: 1-20 MW | 5-12 |
| Geothermal power | Plant size: 1-100 MW | 4-7 |
| Solar photovoltaics | Rooftop-mounted | 20-40 |
| (Rural) off-grid energy | | |
| Mini-hydro | 100-1,000 kW | 5-10 |
| Microhydro | 1-100 kW | 7-20 |
| Pico-hydro | 0.1-1 kW | 20-40 |
| Biomass gasifier | Size: 20-5,000 kW | 8-12 |
| Solar home system | System size: 20-100 W | 40-60 |
| Biofuels | | |
| Ethanol | Feedstock: sugar cane or other lignocellulosic material | 25-30 cents/litre |
| Biodiesel | Feedstock: oil crops or waste vegetable oils | 40-80 cents/litre |

*Source*: Adapted from Renewable Energy Policy Network for the 21st Century, “Renewables 2005 global status report”, (Washington, D.C., Worldwatch Institute, 2005), pp. 12-13.

## D. Sustainable production and use of biofuels

33. Production and use of liquid biofuels has grown markedly during recent years. The value of biofuel projects currently under construction and planned for 2008 exceeded $3 billion in Brazil, $2.5 billion in the United States and $1.5 billion in France. The most dynamic areas of the biofuels industry include biomass power generation and ethanol and biodiesel production for transportation purposes. In recent years, biomass power generation and heat supply increased by more than 50 per cent in several countries of the Organization for Economic Cooperation and Development, including Germany, Hungary, the Netherlands, Poland and Spain. Also, some developing countries such as Brazil, the Philippines and Thailand are increasing their share of electricity generation from modern biomass.

34. World ethanol production increased from 30 to 33 billion litres between 2003 and 2005. In the United States, there were 95 operating ethanol plants in 2005, with a total annual capacity of 16.4 billion litres. In 2006, 35 additional plants were under construction and 9 plants were being expanded, representing an additional annual capacity of 8 billion litres. Brazil had more than 300 operating plants and 80 newly licensed distillers in 2005. Total ethanol consumption in Brazil was 12.3 billion litres in 2005, representing 41 per cent of all non-diesel vehicle fuel in the country. Flex-fuel vehicles, which can operate on pure ethanol, gasoline, or any combination

of the two, attained a 70 per cent share of the non-diesel vehicle market in 2005. The Brazilian ethanol industry is expected to expand considerably under a new national plan that will result in a 40 per cent increase in sugar-cane production by 2009. In the European Union, five countries — France, Germany, Poland, Spain and Sweden — now produce fuel ethanol totalling 0.9 billion litres.

35. World biodiesel production increased from 2.1 to 3.9 billion litres between 2003 and 2005. World capacity, production and consumption of biodiesel grew on average by 32 per cent per year from 2000 to 2005. Biodiesel is now produced in nine European Union countries, accounting for more than three quarters of worldwide biodiesel production in 2005. New and potentially large markets for biodiesel are expected to emerge in China and India. Governments in many countries are offering tax exemptions and are implementing blending mandates to accelerate the production and use of biodiesel.

36. The rapid rise in biofuel production and use had given rise to growing concerns regarding the various dimensions of sustainability, particularly the impact on food production, food prices and food security. However, in a number of African countries, the small-scale production and local use of liquid biofuels, in particular the production of straight vegetable oil, pure plant oil and biodiesel from jatropha or other oil crops as a substitute for expensive imported diesel fuel, can make important contributions to income generation and sustainable development in rural areas. That has been demonstrated by successful project experiences in, among other countries, Mali, South Africa and the United Republic of Tanzania.[8]

# VI. International cooperation and international programmes in new and renewable energy technologies and their application

## A. South-South cooperation in new and renewable sources of energy

37. The wider use of new and renewable sources of energy requires the sharing and transfer of technology and know-how as well as the diffusion of the relevant knowledge on a global scale, not only between developed and developing countries but also among developing countries. South-South cooperation between developing countries can offer mutual benefits for trading partners by opening up new markets and facilitating economies of scale in the manufacture of renewable-energy equipment. Renewable-energy technology and equipment importers may benefit from applying proven technologies and adapted designs that have been successfully tested and used in other developing countries. South-South cooperation can also result in significantly reduced costs.

38. In recent years, a number of significant South-South cooperation programmes in the area of renewable energy have been initiated in various areas, including liquid biofuels, hydropower, biomass and solar energy. Countries leading such international efforts include Brazil, China, India and South Africa. Brazil has initiated collaborative projects with several African countries, including Angola, Morocco, Mozambique, Nigeria and South Africa. In Asia, Brazil has cooperation

[8] Background paper No. 2 prepared for the fifteenth session of the Commission on Sustainable Development.

agreements with various countries, including China, the Republic of Korea and Viet Nam. In Latin America, Brazil cooperates, under various joint-venture agreements, with Mexico, Panama, Paraguay and Venezuela (Bolivarian Republic of). China, too, is engaged in extensive South-South cooperation programmes on renewable energy. Various centres, including the Shenzhen International Technology Promotion Centre for Sustainable Development, address the concerns of developing-country partners through the transfer and diffusion of renewable-energy technologies. The International Centre on Small Hydropower in Hangzhou conducts capacity-building activities that include the training of professionals from African and other Asian developing countries in various aspects of small hydropower. India, with the support of the United Nations Industrial Development Organization (UNIDO), is involved in technology-transfer activities on biomass gasification technology developed at the Indian Institute of Science in Bangalore.

## B. Programmes of international financial institutions advancing new and renewable energy

39. International financial institutions play a crucial role not only in mobilizing the necessary financial resources for large-scale investments but also in supporting national lending institutions and small-scale revolving-loan funds. That is crucial for those developing countries, particularly in Africa, that continue to face constraints in the process of substantially increasing the share of renewable energy in their energy supply mix because of limited capacity and lack of access to technologies and financing.

40. The World Bank Group, including the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA), continues to play a leading role in international cooperation for development financing. Whereas IBRD provides loans, loan guarantees and technical advisory services primarily to middle-income countries, donor contributions to IDA enable the World Bank to provide concessional loans to low-income countries. IFC and MIGA seek to encourage the engagement of the private sector in project development in developing countries. In recent years, the World Bank Group has made renewable energy and energy efficiency integral parts of its energy strategy. At the 2004 International Conference for Renewable Energies in Bonn, Germany, the World Bank Group announced a target of 20 per cent average annual growth in energy efficiency and new renewable commitments between fiscal years 2005 and 2009 (the “Bonn” target). The World Bank Group also reaffirmed its support for large-scale hydropower where economically and financially viable and where environmental and social safeguards are met.

41. A further important source of multilateral funding for renewable energy and energy efficiency projects is the Global Environment Facility (GEF). GEF is the financing mechanism for a range of international environmental agreements, providing support for projects that generate global environmental benefits. Projects that promote the use of new and renewable sources of energy as well as energy efficiency continue to receive financing under climate-change focal areas following the fourth replenishment of GEF.

42. The financial commitments of the World Bank Group, summarized in tables 7.A and 7.B, have contributed considerably to a steady and accelerating investment in, and production of energy from, new and renewable sources. In 2005 and 2006, the World Bank Group outperformed its Bonn target. In fiscal year 2006, the World Bank Group's financial support for renewable energy and energy efficiency was $860 million, more than double the Bonn 20 per cent target, supporting 61 projects in 34 countries.

Table 7.A
**World Bank Group renewable energy and energy efficiency commitments**

(Millions of United States dollars)

| | *2002* | *2003* | *2004* | *2005* | *2006* | *Total* |
|---|---|---|---|---|---|---|
| Renewable energy | 350 | 342 | 273 | 665 | 413 | 2 043 |
| Energy efficiency | 67 | 168 | 67 | 243 | 447 | 992 |
| **Total** | **417** | **510** | **339** | **908** | **860** | **3 035** |

*Source:* World Bank Group 2006, "Improving lives: World Bank Group progress on renewable energy and energy efficiency", Fiscal Year 2006, annex 2.

Table 7.B
**World Bank Group renewable energy and energy efficiency commitments by institution**

(Millions of United States dollars)

| | *2002* | *2003* | *2004* | *2005* | *2006* | *Total* |
|---|---|---|---|---|---|---|
| IBRD and IDA | 348 | 300 | 242 | 468 | 384 | 1 742 |
| IFC | 13 | 135 | — | 242 | 406 | 796 |
| GEF | 56 | 70 | 97 | 108 | 68 | 399 |
| MIGA | — | 5 | — | 91 | 2 | 98 |
| **Total** | **417** | **510** | **339** | **908** | **860** | **3 035** |

*Source:* World Bank Group 2006, "Improving lives: World Bank Group progress on renewable energy and energy efficiency, fiscal year 2006" (Washington, D.C., 2006), annex 2.

43. The regional development banks have also significantly increased their support and lending for renewable energy and energy efficiency projects. In March 2007, the Inter-American Development Bank (IDB) approved a new sustainable energy and climate change initiative aimed at helping the countries of Latin America and the Caribbean to expand the use of renewable-energy and energy-efficiency technologies, increase their participation in international carbon trading and support efforts to adapt to climate change. IDB also established and administers corresponding dedicated trust funds to mobilize additional project financing, including for new and renewable energy projects. In May 2006, the Asian Development Bank (ADB) began to review its energy policy with the aim of basing its energy strategy on three key pillars, including meeting Asia's growing energy

demand in a sustainable way, providing energy access for all and enhancing energy-sector reforms and governance. ADB large-scale lending projects for renewable energy include the $161 million Renewable Energy Sector Development Project in Indonesia, approved in 2002, and the $35 million Gansu Clean Energy Development Project in China, approved in 2003. Renewable energy projects do not as yet account for a significant share of the lending of the African Development Bank Group or of the European Bank for Reconstruction and Development.

44. International lending for new and renewable energy projects from bilateral and multilateral sources has increased significantly in recent years. However, in many of the developing countries, and in rural areas in particular, small-scale energy entrepreneurs and cooperatives continue to face obstacles in the process of securing financing for viable project proposals. More innovative financing arrangements for smaller-scale projects and further upscaling and replication of successful renewable energy projects will be important for the achievement of the goals set at the World Summit on Sustainable Development.

## C. Other international programmes raising awareness of new and renewable sources of energy

45. Several organizations of the United Nations system support, through policy and technical advisory services, developing-country efforts to expand the use of energy from renewable sources. At the request of many developing countries, the Department of Economic and Social Affairs of the Secretariat has provided technical and policy advisory services to, inter alia, projects in China for the commercializing of renewable energy technologies and in several small island developing States for the practical application of solar energy systems, as well as in several Arab States for the strengthening of renewable-energy development capacities. With funds from the Human Security Fund, supported by Japan and the United Nations Foundation, the Department of Economic and Social Affairs has recently implemented projects in the Gambia, India and Timor-Leste, adopting an integrated approach to capacity-building involving productive activities, community development and improvement of the basic water and energy infrastructure. With support provided by the Government of Iceland, the Department of Economic and Social Affairs also organized an international seminar in 2006 that was attended by experts from several small island developing States as well as from other developing countries to exchange experiences on the production and use of hydrogen from renewable sources of energy and their possible contribution to sustainable development. The conclusions and recommendations of the seminar were reported by the Government of Iceland to the Commission on Sustainable Development at its fifteenth session.[9]

46. The United Nations Development Programme (UNDP) has been continuously expanding its development cooperation and technical assistance so as to enable developing countries to address their priority development needs and to achieve the Millennium Development Goals. In 2005, UNDP disbursed $774 million, equivalent to 25 per cent of its total expenditure, for poverty reduction projects and $326 million, equivalent to 11 per cent of its expenditure, for energy and environment projects. UNDP country projects are aimed at establishing national policy frameworks that reflect the role of energy in poverty reduction and sustainable development;

[9] E/CN.17/2007/8.

increasing access to energy services, electricity or cleaner fuels in rural areas; introducing low-emission energy technologies, including renewable energy; and expanding access to energy investment financing through the Clean Development Mechanism and public-private partnerships. UNDP also implements a large number of GEF projects. In 2005, UNDP secured $284.5 million from GEF and attracted $1.02 billion in co-financing from Governments and donors for the implementation of GEF projects, both large- and small-scale.

47. The United Nations Environment Programme (UNEP) addresses the environmental consequences of energy production and use, such as global climate change and local air pollution. UNEP promotes policies that place energy and transport within the broader sustainable development context and steers project developers and investors towards greater engagement in renewable-energy and energy-efficiency programmes. The UNEP Rural Energy Enterprise Development Programme supports the development of clean-energy enterprises in selected African countries, in North-East Brazil and in China's Yunnan Province. By "buying down" the costs of small loans for solar home systems, the UNEP Indian Solar Loan Programme, completed in 2005, has helped almost 20,000 southern Indian families to buy better energy services using clean, renewable energy. Based on its success, UNEP is now introducing the concept of actively expanding local and national markets for new and renewable energy technologies to other regions.

48. Demonstration projects using new and renewable sources, including biogas, small hydropower and wind, to provide modern energy services to the poor are also being implemented under the United Nations Human Settlements Programme (UN-Habitat), in particular in African developing countries.

49. The Food and Agriculture Organization of the United Nations (FAO) continues to help developing countries, through policy advice, projects and technical advisory services, to meet their energy requirements in the areas of agriculture, forestry and fisheries as a means of achieving sustainable development. FAO field projects are aimed at improving the living conditions of rural populations through an integrated sustainable-livelihoods approach, promoting rural income generation, public participation in decision-making and gender equality. FAO also hosts the secretariat of the Global Bioenergy Partnership (GBEP), launched on the occasion of the fourteenth session of the Commission on Sustainable Development.

50. In promoting new and renewable energy development, technology dissemination and application, the programmes of United Nations Industrial Development Organization (UNIDO) provide technical assistance and capacity-building support for productive uses and for industrial applications. UNIDO promotes renewable-energy entrepreneurship, the manufacture of renewable-energy equipment and rural industrialization using new and renewable energy in several countries in Africa, Asia and Latin America. The current UNIDO new and renewable energy project portfolio includes projects in China, Cuba, India, Mexico, Mozambique, Nicaragua, Rwanda, the United Republic of Tanzania and Zambia, as well as in several Caribbean small island developing States.

51. Building on the implementation of the World Solar Programme 1996-2005, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has continued to provide support for national and regional training activities in Africa, Asia, Latin America and the Caribbean, as well as for a variety of recent international seminars and conferences, such as the international seminar on the

theme “Access to energy for all”, organized in Paris in 2006, and the Ministerial Conference on “Energy in a changing world”, held at UNESCO in Paris in 2007. Under its African Global Renewable Energy Education and Training Programme, UNESCO carries out activities aimed at improving the establishment, maintenance and management of renewable-energy projects as well as the transfer of technological know-how, inter alia through continuing and distance education. In addition to several renewable-energy demonstration projects, UNESCO organized a series of summer schools that were attended by more than 300 participants, primarily from African nations.

52. The United Nations regional economic commissions have also made significant contributions to promoting the development and use of new and renewable sources of energy. The contribution of new and renewable energy technologies to poverty alleviation has remained the main focus of studies by the Economic Commission for Africa (ECA), including innovative financing mechanisms to facilitate access to energy services for the poor. In March 2006, the ECA Southern Africa Office proposed a subregional policy framework for new and renewable energy for the 14 countries of the Southern African Development Community. In the 2006-2007 biennium, the Economic and Social Commission for Asia and the Pacific (ESCAP) also expanded its regional capacity-building activities to support environmentally benign economic growth, including the greater utilization of new and renewable sources of energy for poverty eradication. Based on successful mini-hydropower projects in Indonesia, ESCAP advocates greater multi-stakeholder cooperation through public-private-community partnerships to provide basic energy services and income-generating opportunities to the rural poor. In partnership with other regional organizations, the Economic Commission for Latin America and the Caribbean (ECLAC) also contributes to and conducts studies on the potential and use of new and renewable sources of energy in the region. Options to expand the use of renewable energy are also under study at the Economic and Social Commission for West Asia (ESCWA), which disseminates information on renewable-energy technologies, in particular in the context of water desalination and rural electrification.

53. In order to enhance and ensure system-wide coherence and the effective use of limited resources, the various United Nations departments, programmes and agencies implementing energy-related programmes also actively collaborate as members of the UN-Energy network, which was established in 2004 following a decision by the United Nations System Chief Executives Board for Coordination (CEB) at the recommendation of the High-level Committee on Programmes (HLCP). During the start-up phase, members of UN-Energy have undertaken a comprehensive organizational mapping of their various energy-related programmes and project activities that are aimed at enhancing access to energy services, improving efficiency in energy use and increasing the use of new and renewable sources of energy. Mapping of the activities of UN-Energy members is periodically updated and published via the UN-Energy webpage (http://esa.un.org/un-energy). Today, UN-Energy brings together 20 United Nations departments, programmes and agencies. Collaborative activities are organized in interdisciplinary and inter-agency teams in selected areas of work. With regard to the promotion of new and renewable sources of energy, the International Atomic Energy Agency (IAEA), the Department of Economic and Social Affairs, FAO, UNDP, UNEP and UNIDO have jointly initiated a modelling project that applies, tests and demonstrates the versatility of

computer-model toolkits for energy planning and for the quantitative analysis of alternative renewable-energy policy measures and their projected impacts. Initial demonstration case studies have been undertaken by UN-Energy in Ghana and in China's Sichuan province. Under another initiative lead by FAO, UN-Energy also issued a common policy paper entitled "Sustainable bioenergy: A framework for decision makers" on the occasion of the fifteenth session of the Commission on Sustainable Development.

### D. International partnerships, non-governmental organizations and other stakeholders

54. International partnerships, non-governmental organizations and other stakeholders that promote the development of new and renewable sources of energy also contribute significantly to advancing the Johannesburg Plan of Implementation. During the period 2005-2006, the Renewable Energy and Energy Efficiency Partnership (REEEP) supported 31 projects in 30 countries. REEEP projects seek to mobilize private-sector and community initiatives for new and renewable energy and energy efficiency, and to promote innovative financing and improvements in regulatory frameworks for sustainable energy. REEEP established a Renewable Energy Exchange, based in Singapore, which acts as an intermediary between financiers and renewable-energy project developers. REEEP collaborates with other initiatives, including the Johannesburg Renewable Energy Coalition (JREC) and the Renewable Energy Policy Network for the 21st Century. The latter monitors industry and policy trends and issues annual global status reports as well as discussion papers on selected issues. The Global Village Energy Partnership (GVEP) and the Global Network on Energy for Sustainable Development (GNESD) continued and expanded their networking, advisory services, resource-mobilization efforts and innovative project financing aimed at expanding access to modern forms of energy for the rural poor in developing countries. The e8 Network of Expertise for the Global Environment also expanded its support for renewable-energy projects in developing countries, including in Bhutan, Ecuador, Madagascar and Nicaragua. New partnerships registered with the secretariat of the Commission on Sustainable Development include the International Renewable Energy Alliance, the International Solar Energy Society and the Small Island Developing States Partnership for Implementation of New Technologies for Sustainable Development.

## VII. Conclusions: perspectives for further increasing the use of new and renewable sources of energy

55. **Since the World Summit on Sustainable Development, new and renewable sources of energy have received increased attention worldwide at both the policy and operational levels due to their multiple economic, social and environmental advantages. New and renewable sources of energy are now considered valuable options for addressing the challenges of access to energy, poverty eradication and climate change, and their role in the achievement of the Millennium Development Goals is increasingly recognized.**

56. **In the context of its recently concluded second implementation cycle and its review of the thematic cluster that includes the issues of energy for**

**sustainable development, industrial development, air/atmosphere pollution and climate change, the Commission on Sustainable Development identified existing gaps, constraints and challenges and engaged in an extensive exchange of information on recent progress in increasing the use of new and renewable sources of energy. There was wide recognition, in the deliberations of the Commission, of the contribution that new and renewable sources of energy can make to the achievement of the sustainable-development goals.**

57. **Policies aimed at encouraging national and international investment in renewable-energy utilization have been implemented or are under consideration in many countries, resulting in a continued trend of rapidly expanding renewable-energy use. Although the share of energy derived from new and renewable sources is increasing, the total share of commercial energy derived from these sources remains far below its economic potential. According to the latest available estimates, the share of new and renewable energy in the total global energy supply, including large hydropower but not including combustible renewables and waste, has yet to increase beyond 3 per cent. The General Assembly may thus consider possible options or programmes to further the international cooperation to that end.**

58. **International conferences also provide important forums for exchanges of experience that can enhance international cooperation as well as provide awareness-raising opportunities. In 2004, participants attending the International Conference for Renewable Energies in Bonn, adopted an International Action Programme. In 2005, the Governments of China and Germany jointly organized the Beijing International Renewable Energy Conference, facilitated by the Department of Economic and Social Affairs. The Washington International Renewable Energy Conference, to be held in 2008, could also provide an important forum for expanding the global dialogue on opportunities for business and development cooperation in renewable-energy technologies, investments, capacity-building and training.**

59. **Increased local, national and international efforts will be needed to achieve the new and renewable energy elements of the Plan of Implementation of the World Summit on Sustainable Development. In addition to continued awareness creation, technical training and capacity-building, the mobilization of the necessary means of implementation, including financial resources, technology transfer and investments will continue to play a key role in the further increase of new and renewable energy use.**

60. **The Clean Development Mechanism established under the Kyoto Protocol offers possibilities for financing the development and use of new and renewable sources of energy in developing countries. An early agreement on a post-2012 arrangement for reducing greenhouse-gas emissions could greatly help to support and stimulate a more rapid expansion in the use of new and renewable energy in the future.**

61. **During its third implementation cycle in 2008 and 2009, the Commission on Sustainable Development will consider the thematic cluster that includes agriculture, rural development, land, drought, desertification and Africa. Expanding access to modern energy services for sustainable development remains particularly urgent in sub-Saharan Africa, where only 26 per cent of the population has access to electricity and 575 million people still rely on**

**traditional biomass for their cooking. The third implementation cycle may provide an opportunity to review the situation in Africa, including the widespread lack of access to modern energy services and Africa's continuing dependence on the unsustainable use of traditional biomass for meeting its basic energy needs.**