INTERNATIONAL SCIENCE AND TECHNOLOGY CO-OPERATION FOR SUSTAINABLE DEVELOPMENT: BACKGROUND AND ISSUES[1]

1. Introduction

1.1 Background

1. The important contribution of science and technology as an enabler for sustainable development was affirmed at the World Summit on Sustainable Development (WSSD) in 2002. This recognition resulted from one of the major parallel events of the WSSD, the Science and Technology Forum on Sustainable Development, and its conclusions[2] were well reflected in the Johannesburg Plan of Implementation (JPOI). In this Plan the governments participating in the Summit acknowledged the essential role of science and technology for generating possible solutions to environmental and developmental issues. Notably, the document devoted a number of paragraphs stressing the importance of enhancing development and transfer of technology to the developing countries, especially environmentally sound technologies, building capacities science and technology so as to be able to access international research and development programmes, and building partnerships and networks among various public and private actors in science and technology including building knowledge institutions such as centres of excellence. The Plan emphasised the important role of governments in implementing appropriate policies to promote these developments in science and technology capacity and institutions.

2. New Partnership for Africa's Development (NEPAD), with its call for building a "new relationship of partnership between Africa and the international community" is an initiative in a similar spirit as the WSSD. It is an attempt to apply the recommendations implied in the JPOI to the specific context of the African continent. Its strategy aims "to help eradicate poverty in Africa and place African countries, both individually and collectively, on a path of sustainable growth and development and thus halt the marginalisation of Africa in the globalisation process" and has as one of its goals, to implement national strategies for sustainable development. Its priority areas include energy, water, human resources development including reversing the brain drain, as well as health and agriculture. Priority is attached to "developing training institutions and networks that can develop and produce highly skilled technicians and engineers in these infrastructure sectors" [3].

3. Its more recent *Africa's Science and Technology Consolidated Plan of Action* (NEPAD 2005), puts emphasis on "developing an African system of research and technological innovation by establishing networks of centres of excellence dedicated to specific R&D and capacity building programmes". Its

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[1] This document has been prepared by the Government of South Africa and the OECD Secretariat on the basis of contributions from the members of the OECD-CSTP Steering Group set up to organise this workshop.

[2] The Ministerial Session of this Forum adopted *Ubuntu Minute on Science and Technology for Sustainable Development.*

[3] Quotes from NEPAD (2001).

vision is "that of Africa that is free of poverty and well integrated into the global knowledge economy" with goals to enable Africa to harness and apply science, technology and related innovations to eradicate poverty and achieve sustainable development; and to ensure that Africa contributes to the global pool of scientific knowledge and technological innovations". The Plan enumerates specific flagship R&D programmes and projects that will be developed and implemented including in the areas of water and energy.

4. The aims of the the WSSD and JPOI as well as the NEPAD initiatives have been to meet the Millennium Development Goals (MDGs). However, progress made by the developing countries in implementing the MDGs and the JPOI, has been slow and uneven, as reflected in the country reports to the United Nations Commission on Sustainable Development (UNCSD), which is responsible for monitoring the progress made in the recommendations included in the JPOI. One of the obstacles to progress is limited research and access to technologies. More science and innovation capacities in human resources as well as physical infrastructure need to be built. Knowledge and technology need to be brought to places where they are needed the most. The key role of science and innovation for development in meeting MDGs is well argued, in the UN Millennium Project report on science, technology and innovation (UN Millennium Project Task Force on Science, Technology and Innovation, 2005).

1.2 International science and technology cooperation for sustainable development

5. As aptly pointed out in the JPOI, international cooperation is an effective tool for building scientific and technological capacities. Moreover, the aim of that international science and technology co-operation should be "sustainable development" rather than "development". The manifestation of a number of environmental issues at the global level, such as climate change, implies that further development anywhere in the world, especially in the developing countries, needs to be a "sustainable" one. The planet earth can no longer accommodate the "unsustainable" development paths.

6. Many industrialized countries (most of which belong to the OECD) underwent "development" without paying due attention to its "sustainability" (i.e. maintaining the balance between environmental, social and economic components of development). The lack of the recognition of the environmental and social impacts of industrialization resulted in serious negative environmental legacies, social inequities and economic disruptions since the nineteenth century. The rising awareness in the second half of the twentieth century, of the global environmental issues (e.g., climate change and loss of biodiversity), finally has started to steer the policies of the industrialized countries towards "sustainable development". The so-called Brundtland report (World Commission of Environment and Development, 1987) and the Rio Earth Summit have been instrumental in giving new direction to the path of human development.

7. However, attempts to change the course of economic development policies towards a sustainable development path did not come by easily in the OECD countries. Until recently, it has been thought that environmental sustainability can be achieved only at the cost of economic growth. Current mindsets emphasize the sustainability of a development path if its impact on economic growth is positive. But for this, there is unequivocal agreement on the pivotal role of science and technology. The OECD work on sustainable development has been instrumental in developing such a perspective (e.g. OECD 2001a, 2001b). Increasing economic growth per unit of energy consumption in recent decades in the OECD countries, for example, confirms this. Also, decreasing emissions of environmental pollutants despite economic growth indicate that economic growth can be "decoupled" from the exertion of negative environmental effects. Such trends were brought about by the implementation of appropriate public policies (e.g, regulatory regimes) accompanied by rapid technological advances in energy conversion and use as well as increasing efficiency in industrial production.

8. These trends suggest that developing countries can benefit significantly from working together with OECD countries in developing technologies for sustainable development, and sharing experiences on developing appropriate policies for planning and managing key resources, such as energy and water for development. The *systemic* nature of the science and innovation enterprise in OECD countries has been revealed in the science and innovation policy work of the OECD (e.g., OECD 2002)**.** This range of work demonstrates that it is not investments in research and development alone that enhance the innovation capacities of a nation. It is the coordinated interplay between the different actors including the government, universities and other educational and research institutions, businesses and other entities such as Intergovernmental Organisations (IGOs) and NGOs supported by appropriate framework policies and conditions that enhance the scientific and technological capacities of a country. Equally significant is to make the results of research contribute to improving the quality of life in the developing countries, thus realizing MDGs. In other words, linking science to innovation requires effective linkages and interactions between different actors that constitute an *innovation system.*

9. Building research and innovation systems should lie at the base of any initiatives in international science and technology co-operation. Only a well-functioning innovation system can translate fruits of scientific research into concrete benefits for all in the developing countries. Existence of such a *national system of innovation* enables a country to participate and benefit from the ongoing economic globalization and the accompanying globalization of science and innovation systems. Therefore, international science and technology co-operation should involve building partnerships and networks with different stakeholders, both in the developed and developing countries, including governments, business, trade unions, academia, IGOs, NGOs, and local communities.

10. Based on above insights, OECD countries decided to affirm their commitments to achieving the objectives adopted at the WSSD. In January 2004, the OECD Ministers of Science and Technology adopted the *Declaration on International Science and Technology Cooperation for Sustainable Development*[4] at the Ministerial level meeting of the Committee for Scientific and Technological Policy. The Ministers reaffirmed "their commitment expressed at the WSSD to the promotion of sustainable development through the application of science and technology by strengthening national innovation policies and programmes and by enhancing existing global collaborative networks". They also stressed "the importance of international co-operation in science and technology to sustainable development, notably by transferring knowledge and technology among (OECD) member countries to less developed ones."

11. In the declaration, the OECD invited countries and relevant stakeholders to convene, in collaboration with OECD, an appropriate event to further enhance the consensus of the WSSD on the application of science and technology for sustainable development. The former Science and Technology Minister Ben Ngubane made an offer for South Africa to host this event. During the World Summit on Sustainable Development (WSSD) in 2002, South Africa played a key role in bringing science and technology to the forefront of the development agenda. Governments acknowledged the essential role of science and technology for generating and contributing to possible solutions of environmental and developmental issues as outlined in the Johannesburg Plan of Implementation. As custodians of the WSSD, South Africa has an important role to play in ensuring the successful implementation of the targets set out in the JPOI. South Africa's Department of Science and Technology shares the responsibility for continuously reaffirming the roles of science and technology in furthering the development agenda.

[4] Available at http://www.oecd.org/sti

1.3 Objectives and themes of the workshop

12. The result is this workshop, which is organized by the South African Department of Science and Technology (DST), Multilateral Cooperation, in collaboration with the OECD. The workshop is aimed at fostering closer collaboration and networking between the OECD and developing country partners involved in science and technology for sustainable development.

13. The specific objectives of the workshop are:

- To identify good practices in international science and technology cooperation between OECD and developing countries, aiming at fostering capacity building in science and technology, facilitating effective diffusion of scientific knowledge and technology transfer, and at developing knowledge infrastructure and networks, in order to meet sustainable development objectives at national and global levels. Such good practices include highlighting concrete and efficient solutions that have been implemented in the areas of water and energy.
- To consider possible indicators of good practices in international science and technology cooperation for sustainable development and to evaluate international science and technology co-operation initiatives.

14. Two sectoral themes have been chosen for the workshop, energy and water. These themes are in line with the current work plan of the UNCSD, which deals with thematic issues over a two-year cycle with the first year dealing with the review and the second year identifying policy options. CSD 12 and 13 in 2004 and 2005 respectively have dealt with Water, Sanitation and Human settlements. CSD 14 and 15 in 2006 and 2007 will deal with energy for sustainable development; industrial development; air pollution/atmosphere and climate change. The science and technology policy options adopted at CSD 13 for the thematic areas of water, sanitation and human settlements address issues of research and development, technology transfer and earth observations systems. The two theme areas have been chosen deliberately so that the results and insights gained through this workshop can contribute to the work of UNCSD.

2. Needs and challenges in the developing countries for international science and technology co-operation

15. However desirable and urgent it may be to build effective research and innovation systems, the realities in the developing countries, especially Africa, suggest that this is a daunting task. In many countries, the elements that make up an effective research and innovation system do not exist or are in insufficient state. In addition, the institutions that steer development towards sustainability, such as effective public regulations or economic incentive schemes as well as other framework policies, are not in place.

16. Innovation requires well-trained scientists and engineers including women. There is increasing evidence that less than satisfactory progress is being made in producing scientists, engineers in the developing countries. There is little emphasis on science subjects at school level and this reduces the participation of youth in science and technology related courses at the tertiary level. There is a need for a number of policy schemes (e.g., student exchange programmes at school and tertiary levels, post-doctoral fellowships and internships.) to strengthen the transformation of our science and technology capacity to achieve increased numbers of people working in key fields that are of importance to the future (Government of South Africa 2002).

17. The widespread poverty means that the economic base for building a research and innovation system is weak. This implies inadequate investments in research and innovation, weak infrastructure

support for these, and fewer opportunities for children and youth to achieve higher levels of education to build up necessary human resources with potential to become scientists and engineers. The small pool of the highly qualified human resources who have secured positions in their countries of origin confront meagre resources and facilities needed for their research or innovation activities. Such discouraging environment results in the brain-drain of valuable human resources for science and innovation.

18. The absence of innovation systems also implies the weak networks of agents that normally participate in the innovation process, especially local businesses and communities. This suggests that the knowledge and technology transferred from industrialized countries are not necessarily appropriate for the needs of the people who need them the most. The efficient flow of information and active participation of all those concerned, especially on the demand side, enables the innovation system to deliver needed knowledge and technology.

19. Such weak economic base, capacities and disconnectedness bring about a spiral-down effect in terms of sustainable development. The lack of capacities, framework conditions and the knowledge networks results in the persistence of unsustainable modes of production and consumption that increase social, economic and environmental fragility. International co-operation to build up effective innovation systems can contribute to stop such negative spiral-down. The failure of an innovation system also owes to poor governance, incorrect institutional setup or inappropriate choice of technology.

20. Developing countries face serious needs and challenges in the areas of energy and water that effective international science and technology co-operation can eventually address. In both areas, there is sufficient supply, but the quality of these essential services is not conducive to sustainable development. The use of these resources can be greatly enhanced through cooperative development of science and technology. This applies to the Nile River whose water cannot be used for human consumption due to lack of technology to improve the water quality. The meagre supplies usually do not reach the poorest. International science and technology co-operation brings about appropriate knowledge and innovation to improve the situation considerably. It can develop efficient and cost-effective ways to deliver and use sustainable water and energy resources by tapping knowledge available to the global community of practitioners of science and innovation.

21. The internationally agreed development goals, including those contained in the Millennium Declaration and Agenda 21, as well as in the JPOI, will require significant increases in the flow of financial resources as elaborated in the Monterrey Consensus, including through new and additional financial resources, in particular to developing countries, to support the implementation of national policies and programmes, improved trade opportunities, access to and transfer of environmentally sound technologies on a concessional or preferential basis, education and awareness-raising, capacity-building and information for decision-making and scientific capabilities within the agreed time required to meet these goals and initiatives (WSSD 2002).

3. Improving and enhancing International Science and Technology Co-operation

3.1. Experiences in international S&T co-operation

22. A large number of international science and technology co-operation programmes have attempted to address the needs and issues discussed above. Some of the well-known initiatives that have been or are being undertaken may illustrate some of the key elements that make international co-operation and collaboration effective.

3.1.2. Millennium Science Initiative (World Bank)

23. The MSI was launched in 1999 with the primary goal of creating and nurturing world-class science and scientific talent in the developing world. It seeks to strengthen science and technology capacity of developing nations through integrated programmes of research and training planned and driven by local scientists. These programmes are linked in partnership with other programmes, local governments and the international scientific community. The MSI programmes have various formats, according to local strength, needs and customs. Some take the form of one or more “MSI institutes” that function as centres of excellence in their domains; others consist of small groups or individual researchers.

24. For the World Bank this was not a new initiative. It has been making use of the Bank’s existing lending instruments. The latter is designed to support projects that award large multi-year research grants to top researchers, through a transparent and highly selective competition. The basic idea behind MSI projects is to stimulate a part of the national science and technology system to function according to international best practice for research funding. The belief is that if these practices are followed, the quality and cost-effectiveness of research performed in the developing world could more closely resemble that of rich countries (Holm-Nielsen 2001).

25. All MSI projects will provide targeted support that focuses on research excellence; human resources training; and linkages to partners in the international science community and in the private sector. The expected direct and indirect benefits include:

- A model for the transparent, merit-based allocation procedures that forge “cultures of quality”;
- Increased training opportunities for young people, and reduction of “brain drain”; and.
- Global and regional networking with other researchers.

26. Since 1999, MSI programmes have been initiated in Chile, Brazil, Mexico, Vietnam and Africa. In Chile, where the programme created competitive grants and three MSI institutes, the government increased attention to science, technology and innovation policy. The programme provided advanced training opportunities to PhD and post-doctoral students. As a result, research productivity and international collaboration increased, as was monitoring, evaluation and accountability in scientific research. The Uganda programme provided pre-university science education, and promoted research in new universities outside Kampala. It assured coherence with health, agriculture and environment policies. The programme was not only research focused, but also focused on engineering, and strengthened undergraduate education.

3.1.3. Consultative Group on International Agricultural Research (CGIAR)

27. Although not directly concerned with neither water nor energy, the Consultative Group on International Agricultural Research is a long-term international co-operation initiative that has produced concrete advances in putting results of agricultural research to provide concrete solutions in the developing countries. These include:

- Developing New Rices for Africa (NERICAs), a new strain of rice adapted to the conditions in West Africa, and the spread of its planting has enabled significant rice imports in countries such as Guinea.
- Integrating aquaculture/agriculture techniques resulting in increased rice and fish production in Asia through new strains of tilapia that grow 60% faster.

- Adoption of zero or low-till farming practices in Africa and Asia, minimising soil erosion and boosting farm incomes and productivity.

28. The CGIAR was established in 1971 and is a strategic alliance of countries, international and regional organizations and private foundations supporting 15 international agricultural Centres that work with national agricultural research systems and civil society organisations including the private sector. There are approximately 8,500 CGIAR scientists and staff working in over 100 countries. CGIAR research scope is broad and mobilizes agricultural science to reduce poverty, foster human well-being, promote agricultural growth and protect the environment.

29. The CGIAR has four areas of focus:

- Increasing productivity of crops, livestock, fisheries, forests and the natural resource base
- Strengthening national systems through joint research, policy support, training and knowledge-sharing.
- Protecting the environment by developing new technologies that make more prudent use of land, water, and nutrients and help reduce agriculture's adverse impacts on ecosystems
- Saving biodiversity by collecting, characterising and conserving genetic resources. The CGIAR holds in public trust one of the world's largest seed collections freely available to all.

30. Its research portfolio has evolved from the original focus on increasing productivity in individual critical food crops. Today's approach recognises that biodiversity and environment research are also key components in the drive to enhance sustainable agricultural productivity. The fundamental belief of the programme is that agricultural growth and increased farm productivity in developing countries creates wealth, reduces poverty and hunger and protects the environment (CGIAR 2005).

3.2 Towards more effective international science and technology co-operation

31. The discussion above points to the multi-faceted nature of the issues involved in making international science and technology co-operation contribute to the needs of the developing countries. That the set of the issues are diverse imply both the importance and difficulty of building up effective research and innovation systems in the developing countries.

32. A fundamental component of research and innovation system is human resources. Well-educated scientists and engineers and other science and technology specialists constitute a major part of the necessary capacities to build a research and innovation system. Of course, enhanced enrolments in primary and secondary education constitute the base of creating scientifically literate human resources. But for effective research and innovation system to be in place, attention should also be paid to the tertiary level as well as specialised training in specific areas of scientific research or technological development and use. In the African context, the recent report of the Commission for Africa emphasized the need to improve Africa's capacity, "starting with its system of higher education, particularly in science and technology" (Commission for Africa 2005).

33. This is probably the reason that the international science and technology co-operation initiatives often integrate training. The advantage of international co-operation, as a means of training and human resource development, is that it takes place within the context of a network of international specialists in the specific science or technology area. This means that, not only training on the place, but also international exchange of scientists and engineers is also a part. This provides for controlled flow of scientific talents that include brain "return", and not just brain "drain."

34. Science and technology capacity building also includes the "hardware", the various infrastructure components for research and innovation activities. These include research institutions and industrial testing and standards centres, the suppliers of scientific instruments and tools, the scientific and engineering information centres that provide updated information and data, and which in recent years is becoming increasingly dependent on advanced ICT and the Internet.

35. Given the realities in many of the developing countries, especially in Africa, building such infrastructure in the numerous fields of science and innovation is a long-term challenge. In the meantime, cost-effective solutions need to be found. Particular focus on building centres of excellence that bring together researchers and engineers from different countries to conduct scientific research or innovation jointly is such a solution. International science and technology co-operation initiatives in many cases involve building or strengthening such centres of excellence. G8 leaders at the Gleneagles Summit this year, explicitly pointed to the focal role that centres of excellence could play in "helping develop skilled professionals for Africa's private and public sectors, through supporting networks of excellence between African and other countries' institutions of higher education and centres of excellence in science and technology institutions" (G8 Gleneagles 2005).

36. International co-operation will not deliver concrete results, if the needed knowledge and technologies are not delivered to those places in the developing world where they are needed the most. Both in the OECD countries and in the developing world, the needed knowledge and technologies are held by, among others, businesses, governments, international institutions and universities. These resources need to be tapped into and harnessed for the needs of the developing countries. Collaboration with the private sector, international co-operation between universities and science councils, and networks that promote international collaboration become an indispensable part of international science and technology co-operation.

37. In order for science and innovation to alleviate poverty and bring about equitable economic development, needed knowledge and technology should reach the local communities. This means that solution focused research and innovation need to be conducted in close collaboration with 'local' stakeholders and decision makers, not just at the national level. International science and technology co-operation initiatives also need to be bottom-up and demand-driven. In many cases, this means that smaller projects that cater for local needs should have priority over large development projects that have been agreed between decision makers at the national level.

38. A broad range of technologies can be realised through such demand-driven international co-operation. Moving rapidly towards a sustainable development path implies deploying more of the advanced knowledge and technology that can be transferred or innovated in the developing countries. Rather than those technologies that have been available for decades in the industrialized countries and which in many cases are no longer environmentally sustainable, more recently developed ones may better be suited to meet sustainable development requirements in the developing countries. This implies both opportunities and the imperative to "leapfrog." Developing countries may be the best places to diffuse technology and innovation based on advanced scientific knowledge such as ICT, biotechnology and nanotechnology. Cell phones that by-pass the necessity to build landed cable infrastructures are a case in point.

39. Searching for suitable advanced knowledge and technology underlines the importance of creating knowledge and innovation networks globally. This is a key role that international science and technology co-operation can play. The actors in the national innovation systems need to be linked to their counterparts as well as other stakeholders in the industrialized as well as developing countries. Integration in global knowledge networks facilitates participation in the globalisation process itself.

40. Finally, if successful international co-operation initiatives have been long-standing initiatives, long-term sustainability of such initiatives is probably key to building national science and innovation systems. This does not necessarily mean detailed long-term planning and funding, but the willingness to let co-operation and collaboration activities evolve and adapt to changing conditions and the changing physical and social environments. Sustaining efforts to build science and innovation systems lead to sustainable development.

4. Specific issues and expected outputs in the areas of water and energy

4.1. Issues in Water

4.1.1 Introduction

41. The WSSD and the 3rd World Water Forum 2003 held in Kyoto, Japan, highlighted the importance of the UN Millenium Declaration and the MDGs. Water, as one of the key natural resources, is vital for all human development and is a crosscutting issue for most of the eight MDGs. The JPOI recognises the role of science and technology in meeting water goals committing governments to "improve water resource management and scientific understanding of the water cycle through cooperation in joint observation and research, and for this purpose encourage and promote knowledge-sharing and provide capacity-building and the transfer of technology, as mutually agreed, including remote-sensing and satellite technologies, particularly to developing countries and countries with economies in transition.". The Plan also recognises that affordable rural water technologies will be required to ensure that adequate clean water is available to marginalised communities.

42. The decision of the CSD 13 (2005) further acknowledges the role of science and technology, emphasising implementation to:

- Develop and strengthen human and institutional capacities for effective water management and service delivery;
- Expand and improve wastewater treatment and reuse;
- Support more effective water demand and water resource management across all sectors;
- Develop and transfer low-cost technologies for safe water supply and treatment;
- Develop and strengthen national monitoring systems on quantity, quality and use of surface and groundwater resources.

43. This recognition of the role of science for supporting sustainable development policies includes recognition that an interdisciplinary approach is required with regard to the successful management of water resources. The following sections present insights into the multitude and complexity of the water management challenge. Highlighted are priorities for international cooperation in water research, including mechanisms for such cooperation.

4.1.2 Endowment opportunities and threats to water resources

44. Life on earth would not exist without water. Water as the key natural resource is essential for the development of life, functioning of ecosystems and the preservation of the environment. Water is also of vital importance to all socio-economic sectors – human, social and economic development simply is not possible without a safe, stable water supply. Water is globally distributed by the hydrological cycle, which is driven by the energy cycle. The circulation of water powers most of the other natural cycles and conditions the weather and the climate.

45. There is extreme variability in the distribution of world water resources. For example, Africa's renewable water resources average 4050 km^3/year – significantly less than the world average of 7000 m^3 per capita/year and less than one-quarter of the South American average of 23000 m^3 per capita/year (UNEP 2002). The spatial and temporal distribution of water resources also manifests itself at various scales. At the spatial level there are contrasts between the very arid regions and rainforests; on smaller spatial scales, contrasts exist between one side of a mountain range and the other, e.g., the south and north flanks of the Himalayas. On time scales from hours to decades, there is often high variability, from high-intensity precipitation events of short duration, through marked differences between seasons in precipitation to inter-annual and inter-decadal variation (UNESCO-WWAP 2003).

46. Despite the spatial and temporal complexity, significant progress has been made in harnessing water resources for both economic and social development Water has been utilised for industry, mining, hydropower generation, infrastructure and transport purposes providing national economies with export earnings. Needed employment was created through subsistence and commercial agriculture, livestock production, fisheries and tourism. The provision of safe water supply and sanitation is a social good – necessary for reducing morbidity and mortality rates caused by waterborne and water-related diseases such as cholera, diarrhoea and malaria. Safe water is a precondition both for health and for success in the fight against poverty and hunger. Unfortunately, in most developing countries access of poor communities to water is still problematic.

47. In order to provide economic security and social well-being, the water resource base requires protection. Environmental degradation is inextricably and causally linked to problems of poverty, hunger, gender equality and health. Provision of water needs to take place within the context of sustaining healthy functional ecosystems. Integrated resource management (IWRM) framework approaches are required that allow water resources to be managed as ecosystems.

48. Climate change and variability, population growth and increasing water demand, over-exploitation and environmental degradation will continue to contribute to complexity of water resource management. Extreme events may have an impact not only on human society but also on the aquatic and terrestrial environments. Conflicts, misuses of water resources and poor water management practices have often resulted in depleted supplies, falling water tables, shrinking inland lakes, destruction of ecosystems, human and ecological disasters and pollution of water. Also many human (industrial) activities cause even more frequently and in widespread manner water pollution, thus even further decreasing the quantity of water suitable for life sustaining purposes.

49. Research has generated new knowledge to remedy some of the above issues in recent years. Good progress has been achieved in better understanding the role and function of the ecosystem as carrier of all life, as supplier of water and absorber of wastewater, and as purifying agent, but many questions remain to be answered. Water is managed in a too fragmented way. Surface water and groundwater are often considered separately in development activities without due recognition of their interdependence. Water resources in many places are still not managed in conjunction with land resources. Water supply schemes, eventually generating large amounts of wastewater in consumer areas, are usually designed and built, especially in developing countries, without the required matching drainage networks and wastewater treatment facilities. Quantity is generally managed separately from quality, as is water science and water policy. Clearly, the need for improved, more efficient management of water resources and the more accurate knowledge of the hydrological cycle for better water resources assessment underlines the need to implement a system approach, which includes the social and economic dimension for a sustainable development.

4.1.3 Strategy for international cooperation

50. Bearing in mind that water resources are often one of the primary limiting factors for harmonious development in many regions and countries of the world, in particular developing countries, more emphasis should be given to stronger interrelations between scientific research, application and capacity building. Filling the gap between policies and alleviation of poverty, science and the transfer of knowledge, is at the centre of achieving sustainable development in many developing as well as industrialised countries.

51. In particular, capacity building and international cooperation is required to address issues such as developing:

- Scientific understanding of the water cycle (and the inter-linkages) in order to promote a systematic assessment of the quantity and quality of water available for development,
- Tools and methodologies for managing the impacts of climate change and human interventions in the hydrological cycle,
- Appropriate technologies for water treatment, and sanitation systems and applying these
- Appropriate technologies for water conservation including the application of enhanced agricultural technologies and applying these.
- Good practice models of linking the above S&T applications to appropriate institutional mechanisms, in particular catchment-level agencies that monitor the resource, allocate water rights and potentially facilitate the trading of such rights, and applying these.

52. Partnering activities are increasingly seen as a means of fostering international cooperation. These partnering networks are products of complex inter-linkages among a wide range of enterprises, links that are designed to reduce the risks associated with the development of new products and facilitate the exchange of information. These partnering arrangements help provide sources of financing through licensing and upfront fees for R&D expenses, reimbursement of expenses for partnered products and services, royalties, profits, and other “success fees” associated with the achievement of certain milestones (UN Millenium Project Task Force on Science Technology and Innovation 2005). Increasingly South-South collaboration is also creating opportunities for partnering activities.

4.1.4 Focal issues

53. As a follow-up to CSD 13, the water session in this workshop will explore north/south and south/south interaction and best practices for (regional) strategic planning, technology options and methodologies in the area of water science and technology. The workshop will aim at debating in a fair and equitable manner the sharing of good practices in order to find solutions for addressing water management for developing countries. These solutions should ensure sufficient water supply, good water quality, adequate water (hazards) management, efficient water use and sustainable access to safe water and sanitation, in particular for the poor. The workshop will put forward proposals for successful research collaboration, including north/south partnerships, in pursuit of increased knowledge, capacity building and technological innovation in developing countries. The break-out session on water will focus on IWRM, from supply to waste water treatment; water hazards management; and capacity building for water management.

54. The participation and contributions of representatives of developing countries and upcoming (emerging) market countries/economies will ensure focusing on the needs and scope for country/region specific action. The workshop should specifically seek to identify possible joint research efforts between

developed and less developed countries, and strengthen research outcomes with stake-holder training and activities that raise awareness of the need for capacity building. Furthermore, it should seek to improve access to data, information and sources of knowledge and involve the public at large. Hence, the transfer of knowledge, information and technology will be more beneficial for both the water specialists and the general public.

4.2. Issues in energy efficiency, climate change and sustainable industrial production

4.2.1. Introduction

55. The WSSD highlighted the centrality of water and energy service delivery to the goals of sustainable development. In both of the two formal outcomes, the negotiated text (JPOI) and the public-private partnerships, these two themes were prominent as being necessary for economic and social development throughout the developing world. Their importance was formalized in the UNCSD work plan, which focused on water in 2004-2005, and will focus on energy, industrial development and climate change in 2006-2007. To date, work fulfilling the objectives of the JPOI has neglected the value of energy efficiency in science and technology collaboration. This workshop will fill that void by linking efficiency programmes to climate change and industrial development and by demonstrating their contributions to sustainable development.

4.2.2. Endowment opportunities and threats regarding energy supply:

56. Demand for energy is growing worldwide and the projected rate of growth in developing countries far exceeds that of the industrialized nations over the next 15 years. The Energy Information Administration estimates the developing world's energy consumption will increase from over 100 quadrillion BTUs in 1999 to just over 264 quadrillion BTUs by 2020. Further, by 2020 it is expected that the developing world will overtake the industrialized world in carbon dioxide emissions with over 4.6 billion metric tons of carbon equivalent in 2020 for the developing countries and over 4.0 billion for the industrialized countries (EIA 1999, 2001). Further increases in energy demand projections are expected if the goal of expanding access to modern energy services to the more than 1.6 billion people unserved is to be realized. While additional supply sources will form an essential component of the solution to this exploding demand, energy efficiency in end-use applications must also be a critical element to ensure a cost-effective, long-term sustainable development path that reduces greenhouse gas (GHG) emissions and contributes to sustainable industrial production.

57. The way in which we generate our energy also relates to energy efficiency. An alternative to investing money in the construction of new power stations and, at the same time, producing harmful emissions is to improve the efficiencies of current production of energy sources. Therefore, energy efficiency technologies and practices are warranted both on the supply side and the demand side of the energy equation. It makes little economic sense to increase the generation capacity of electricity if that increased capacity isn't generated efficiently.

58. The inefficient use of energy degrades the environment, slows economic growth and wastes precious natural resources. Improving the efficiency with which we generate, transmit, distribute and use energy can be the surest way to ensure the sustainability of a country's energy system and in turn, catalyze economic and social development. Improving energy efficiency throughout the economy reduces infrastructure bottlenecks and future investment requirements, reduces the need for fuel imports thereby enhancing energy security, frees up capital for other social and economic development needs, increases a company's and country's competitiveness through more sustainable industrial production, and reduces both local air pollution and greenhouse gas emissions. Energy efficiency has been determined to be among

the most cost-effective options to address climate change from greenhouse gas accumulation in the atmosphere.

59. Energy, environmental, and industrial policies and programs have traditionally undervalued the contributions energy efficiency practices and technologies can make in these sectors. The World Bank has recently recognized the need to scale-up energy efficiency investments and policy dialogue in order to overcome these global trends and articulated a commitment to (i) reduce the average energy consumption per unit of GDP in developing countries to 0.24 toe/$1000 compared to 0.27 toe/$1000 in 2001; and (ii) reduce CO_2 emission intensity of energy use to 2.75 tons/tons of oil equivalent (t/toe) compared to 2.90 t/toe in 2001 (Saghir 2003).

60. The primary drivers of energy use in many developing countries will be the growing trends of urbanization, industrialization and rising incomes. Industrial end-use applications account for approximately 40% of global primary energy demand and roughly the same share of CO2 emissions. The technical potential for energy saving ranges from 30% to 50% in existing operations, to as much as 90% in new buildings and operations, with concomitant reductions in greenhouse gas emissions [15]. In many developing country industries, the costs of reducing energy and other input costs through more efficient practices and cleaner production options can be lower than the costs of increasing supply through new production facilities. In addition, by implementing technically advanced energy systems, developing nations have a chance to leapfrog much of the world's existing energy infrastructure in efficiency and sustainability of energy delivery. There is an extensive body of knowledge and history of experience in S&T collaboration in this field that can inform developing country policy makers as they work to design and implement their respective development programs. Unfortunately, barriers such as lack of awareness and expertise, high perceived technical risks, low energy pricing, high upfront and project development costs, underdeveloped markets due to historically low supply/demand for such equipment, and a lack of affordable financing have all contributed to underutilization of efficient technology in energy and industrial development to date.

61. There are a number of international partnerships, initiatives and networks in the energy field that have flourished in the last ten years or more, dealing with clean energy, sustainable development and the way to ensure energy services for the 1.6 billion people that do not have access to them. For example, for more than 30 years, the International Energy Agency (IEA) international technology collaboration framework has offered a structure for governments to leverage and strengthen their national research and deployment programs. There are 40 Implementing Agreements covering all the key new technologies of energy supply and end use. Similarly, there are numerous national bilateral S&T relationships that involve national laboratories and private sector R&D activities that cover the spectrum of energy and development issues from basic research to commercialization of technologies. The workshop in South Africa offers the opportunity to disseminate the results obtained through IEA, bilateral and related international collaboration on energy technologies.

4.2.3 Focal Issues

62. The breakout session will address the two fundamental components of science and technology collaboration: technologies, and the diffusion mechanisms (networks, partnerships, initiatives) of technologies. The goal is to complement the technology issues with the mechanisms of international cooperation and the success/failures of these various efforts.

4.2.4 Session for 2.1 Technologies for Energy Efficiency

63. Discussions will proceed from selected production efficiency and end-use applications (e.g. power plants, industrial motors, commercial building lighting, pulp and paper, appliances), and discuss the

energy use typically required in representative examples. Presentations will then highlight the technological solutions that have been implemented in the selected supply-side and end-use areas that have resulted in measurable efficiency gains with greenhouse gas abatement, environmental and economic benefits, (e.g. industrial process upgrades and optimization, improved lighting systems, codes and standards, motor and drive system improvements). Attention will be paid to the importance of integrating disparate efficiency technologies in a systemic fashion. Presenters will also discuss the policy (e.g., energy pricing, incentives/penalties, standards/benchmarking, energy auditing) and institutional/financial arrangements that facilitated the adoption of the efficiency technology or improvement. Efforts will be made to highlight those solutions that have not only demonstrated their cost-effectiveness and commercial viability within a given market, but also their ability to be adopted on a sustainable, scalable and replicable manner.

64. From a **technology perspective,** presentations will focus on results obtained from various energy efficiency programs that introduce new technologies that have resulted in substantial efficiency gains on either the supply and/or demand side of the energy problem. Technology projects will represent both bilateral and multilateral energy efficiency programs.

4.2.5. Session for 2.2 International Initiatives and Partnerships for Energy Efficiency and Renewable Energy

65. From the point of view of **international cooperation in energy efficiency and renewable energy,** different types of initiatives/organizations will be presented, e.g. partnerships launched at the WSSD such as The Renewable Energy and Energy Efficiency Partnership (REEEP), the US Clean Energy Initiative's Efficient Energy for Sustainable Development, and the Mediterranean Renewable Energy Program (MEDREP). Similarly, specific technology focused partnerships such as the Collaborative Labelling and Appliance Standards Program (CLASP), Watergy, a partnership designed to provide efficiency savings in both water and energy use, and the Climate Technology Initiative (CTI) of the IEA can be discussed to learn of the various diffusion models for energy efficiency, renewable energy and climate related technologies. Finally, given that one of the objectives of the Workshop is to develop criteria and indicators of successful S&T collaboration on energy efficiency as well as renewable energy technology, a presentation of an existing program on this topic supported by the Danish government would be instructive. The Danish International Development Assistance, Energy Management Office and the International Institute for Energy Conservation in South Africa are working together with the South African government to establish a system for monitoring progress toward achieving its energy efficiency targets. The initial output of this work will be an international review of "best practice" monitoring for energy efficiency and a recommendations for how to organize it that could be used by the South African government.

66. The breakout session will be organized in such a way to discuss why the project/program was launched; the program goals; how the project/program addresses capacity building, technology transfer, network building; aspects of success/failure; lessons learned; who are the stakeholders/focal points that participate (developed and developing countries).

5. Expected Outputs of the workshop

67. The thematic sessions of the workshop are expected to come up with technology solutions and policy options that address the specific needs of the developing countries in their pursuit of sustainable development, along with specific cases of the institutional and financial arrangements of highly successful (i.e. high impact) programs. The technology solutions would cover those that address energy efficiency as well as integrated water resource management and water hazards management in the developing countries. The energy efficiency solutions will indicate the benefits to reducing greenhouse gas emissions and local

air pollutants, as well as the economic and cost-saving potential to fuel sustainable industrial production through energy savings, cleaner production and use. The technology solutions in water management will include those that facilitate cost-effective access to sufficient and safe water supplies and provide solutions for water hazards management and efficient water use and treatment, especially for those who need them the most. Efforts will also be made to draw up best practices in collaborative relationships and partnerships between country institutions to facilitate technology innovation and transfer.

68. For the workshop as a whole, it is expected that as the outcome of the focused discussion that take up various initiatives in international co-operation, that insights into the following will be gained or deepened:

- Elements of "good" practices in international science and technology co-operation and collaboration. Such good practices should elaborate on the concrete manners and modes in which the general issues such as science and technology capacity building, technology transfer or building knowledge networks should take place.
- Drawing up of possible indicators and criteria of good practices in international science and technology co-operation for sustainable development. Such indicators do not necessarily have to be quantitative, but should include indications of levels of achievement that international co-operation initiatives should aim for.
- Identification of public policies that can enhance the "good practice" international science and technology co-operation. How existing initiatives should be adapted to meet the real needs of the developing countries should be discussed.

69. Plans are in place for the dissemination of the results of the workshop. It is also expected that as a conclusion of the workshop, the participants as well as the organizers will be able to suggest follow-up activities.

REFERENCES

CGIAR (2005) http://www.cgiar.org/

Commission for Africa (2005) *Our Common Interest.*

EIA Office of Energy Markets and End Use(1999), *International Statistics Database and International Energy Annual 1999*, DOE/EIA 0219(99), Washington, DC.

EIA (2001), *World Energy Projection System,* Washington.

G8 Gleneagles (2005), *The Gleneagles Communiqué.*

Government of South Africa, Department of Science and Technology (2002), *South Africa's National Research and Development Strategy*,

Holm-Nielsen, L. (2001), "The World Bank's Role in Science and Technology", in OECD, *International Science and Technology Co-operation towards Sustainable Development*, Paris, OECD.

NEPAD (2001) *The New Partnership for Africa's Development*

NEPAD (2005) *Africa's Science and Technology Consolidated Plan of Action*

OECD (2001a), *Sustainable Development: Critical Issues*, Paris, OECD.

OECD (2001b), *Policies to Enhance Sustainable Development*, Paris, OECD.

OECD (2002) *Dynamising National Innovation Systems,* Paris, OECD.

Saghir, J. (2003), The Role of the World Bank Group in Renewable Energy and Energy Efficiency." A Speech at the Renewable Energy and Energy Efficiency Partnership: Global Network Launch. October.

UNEP (2002) *Global Environment Outlook 3,* London, Earthscan.

UNESCO-WWAP (2003), *Water for People Water for Life: United Nations World Water Development Report* Paris, UNESCO.

UN Millennium Project Task Force on Science, Technology and Innovation (2005) *Innovation: Applying Knowledge in Development*, London, Earthscan.

World Commission on Environment and Development (1987), *Our Common Future,* Oxford, Oxford University Press.

World Summit on Sustainable Development (2002) *Johannesburg Plan of Implementation.*