ICSU Regional Office for Africa

SCIENCE PLAN

# Sustainable Energy in sub-Saharan Africa

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**TITLE:** Sustainable Energy in sub-Saharan Africa

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# Preamble

The International Council for Science (ICSU) is a non-governmental organization with a global membership that includes 112 National Scientific Bodies (23 of which are from sub-Saharan Africa), 29 International Scientific Unions, and affiliated bodies.

The long-term ICSU strategic vision is for a world where science is used for the benefit of all, excellence in science is valued, and scientific knowledge is linked effectively to policy-making.

The ICSU Strategic Plan 2006–2011 shows its contribution in strengthening international science for the benefit of society to be focused on three overlapping areas:

(i) **International research collaboration** – ICSU plans and coordinates major research programmes in key areas such as (a) global environmental change; (b) monitoring and observation of the Earth System; (c) collection, preservation, and dissemination of scientific data and information.

(ii) **Science for policy** – ICSU seeks to ensure that science is integrated into international policy development and that relevant policies take into account both scientific knowledge and the needs of science. Consequently, ICSU represents the science community in important intergovernmental forums, such as the (a) 2002 (Johannesburg) World Summit on Sustainable Development; (b) 2003 (Geneva) and 2005 (Tunis) World Summits on the Information Society; (c) UN Commission on Sustainable Development, and (d) Earth Observation Summits.

(iii) **The universality of science** – The principle of the universality of science is embodied in ICSU's statutes: "The practice of science should be equitable and without discrimination." Thus the primary aim of ICSU is to enhance the pluralism of science and reach out to all countries, by (a) ensuring that scientists can associate and communicate freely; (b) providing equitable access to data and information; (c) enabling equitable access to research materials and facilities; (d) building scientific capacity; and (e) bringing nations and disciplines together.

The ICSU Regional Office for Africa (ICSU ROA) was inaugurated on 1 September 2005 for the purpose of promoting and coordinating the activities of the ICSU family in sub-Saharan Africa. Such an undertaking will always consider the priorities and the specific realities of this region. In April 2006, the ICSU Regional Committee for Africa (ICSU RCA) selected four priority areas on which its Regional Office would focus its activities in the period 2006–2011 (and beyond). These are: (a) sustainable energy; (b) health and human well-being; (c) natural and human-induced hazards and disasters; and (d) global change.

To address numerous challenges that are embodied in the above priority areas, ICSU RCA established four Scoping Groups, consisting wholly of African experts, to prepare four science plans that would be used to implement, with great success, the objectives of each of the four selected priority areas in sub-Saharan Africa. Terms of Reference (ToR) for this exercise were provided to all the Scoping Groups. They include: reviewing the current status of each priority area on the African continent; identifying capacity-building needs; and defining deliverables to be produced to society. Details of the ToR may be found at the end of this report.

In drawing up the science plans, the authors took into consideration the ICSU Strategic Plan 2006–2011, the AU/NEPAD Africa's Science and Technology Consolidated Plan of Action, the UN Millennium Development Goals, reports from the ICSU interdisciplinary bodies, and joint initiatives.

The ICSU ROA convened its 2nd Regional Consultative Forum for Africa in Boksburg, South Africa, on 25–27 September 2006, to provide a platform for the four draft science plans to be evaluated critically by the broader scientific community. Participants from Africa and international partners had in-depth discussions on the proposed flagship projects and/or identified priority research themes for each of the four priority areas. The four Scoping Groups had an opportunity to meet just after the Forum to incorporate the suggestions provided by the Forum's participants as well as comments received electronically, and to make improvements to the documents. The final science plans were presented for approval by the ICSU ROA on 5–6 March 2007 in the Seychelles.

Some of the proposed flagship projects cut across the four priority areas, and therefore a multi- and interdisciplinary approach is absolutely essential for achieving the objectives of the four science plans of the ICSU ROA.

ICSU believes that science provides the critical underpinning for innovation and technological development. It offers necessary, although not sufficient, input to ensure sustainable socio-economic development of societies. At the same time, it gives a vital base for rational and prudent public policy formulation and decision-making. Accelerated development of scientific knowledge and skills are therefore key factors in the reduction of poverty and improvement of the quality of people's lives in Africa. The great achievements recorded by ICSU in the developed countries should inspire African scientists to apply science, technology, and innovation (STI) in solving Africa's socio-economic problems.

*Sospeter Muhongo*

**Director**

**ICSU Regional Office for Africa**

30 March 2007

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## 1. ENERGY FOR SUSTAINABLE DEVELOPMENT

Historically, energy continues to be the pivot of economic and social development of all countries around the world. Though it has brought great economic prosperity, the way it is produced and used is inefficient and has adversely affected local, regional, and global environments, hence the ongoing debate about making energy systems more sustainable. This debate has largely centred on detailed discussions round the different energy sources and their likely emissions during thermochemical and biological operations. Support has been expressed for renewable energy systems, owing to their more favourable environmental qualities.

These discussions have led to different definitions for the term 'sustainable energy'. In this document, however, sustainable energy is taken in a broader context to include important factors such as resource endowment, existing energy infrastructure, and development needs. The debate on sustainable energy led to the agreement at the 9th session of the UN Commission on Sustainable Development (CSD-9), which was further endorsed at the 2002 World Summit for Sustainable Development (WSSD) held in Johannesburg, South Africa, that 'sustainable energy' be regarded as 'energy for sustainable development'. It is aptly covered by the following definition (Davidson, 2002):

> Sustainable energy is defined as energy providing affordable, accessible and reliable energy services that meet economic, social and environmental needs within the overall developmental context of the society for which the services are intended, while recognizing equitable distribution in meeting those needs.

## 2. ICSU ACTIVITIES IN THE ENERGY SECTOR

Recent major ICSU efforts relating to sustainable energy include the following: an assessment report from the International Union of Pure and Applied Physics (ICSU-IUPAP), the establishment of the International Science Panel on Renewable Energy (ICSU-ISPRE), and an advisory report from the ICSU Working Group on Energy and Sustainable Societies.

### 2.1 ICSU-IUPAP Energy Activities

In October 2004, in a report entitled *Report on Research and Development of Energy Technologies*, ICSU-IUPAP (www.iupap.org) completed an assessment of the status of all energy systems that have the potential to reduce carbon emissions significantly. The results of this assessment will be very useful to the energy community in its search for plausible energy options to cope with global climate change.

### 2.2 ICSU-ISPRE

The 2004 Renewable Energy Summit in Bonn, Germany, called for the establishment of ISPRE as a new mechanism to foster interaction among national, regional, and international research and development (R&D) efforts in the energy sector, and to provide leadership and guidance in developing coherent global strategies for advancing energy systems. Working with the Fraunhöfer Institute for Solar Energy Systems in Germany, ICSU convened a Planning Group to develop a proposal for ISPRE. This proposal was approved by ICSU's Executive Board, and by two other international organizations that will serve as co-sponsors of the effort: the Renewable Energy Policy Network (www.REN21.net) and the International Council of Academies of Engineering and Technological Sciences (www.CAETS.org). The ISPRE membership has recently been established, and the group held their first meeting in January 2007.

ISPRE will help to strengthen the links between science and policy by developing and promoting sound strategies for energy R&D. The primary ISPRE tasks include some or all of the following:

- to compile and analyse the best available scientific, technical, and socio- economic information on renewable energy technologies and, based on this information, to compile assessment reports and focused advisory briefs that present these analyses in a policy-relevant manner
- to develop recommendations for R&D priorities and strategies, based on a thorough analysis of existing efforts and capabilities worldwide
- to recommend actions for enhancing synergies and R&D collaborations among public, private, and academic sectors

- to identify key needs for new/enhanced educational and technical training efforts worldwide
- to convince international financial institutions to invest more in renewable energy R&D efforts and to link targeted R&D efforts to existing economic development and technology demonstration projects.

### 2.3 ICSU Working Group on Energy and Sustainable Societies

During the 2002 WSSD, ICSU played an important role in identifying and promoting the role of S&T in meeting sustainable development goals. As a follow-up to the WSSD, the creation of a major new interdisciplinary programme focused on sustainable energy issues was proposed and endorsed at the 27th ICSU General Assembly in Rio de Janeiro, Brazil, in 2002.

Based on this, an ad hoc Working Group of 13 members worldwide was convened to evaluate the potential opportunities for ICSU involvement. After two meetings of this Working Group, held in Tokyo (Japan) and Paris (France) in December 2003 and April 2004, respectively, specific recommendations were made to ICSU for possible incorporation into the broader strategic planning efforts of ICSU. The general recommendations, along with some examples of specific types of projects that could be pursued, are summarized as follows:

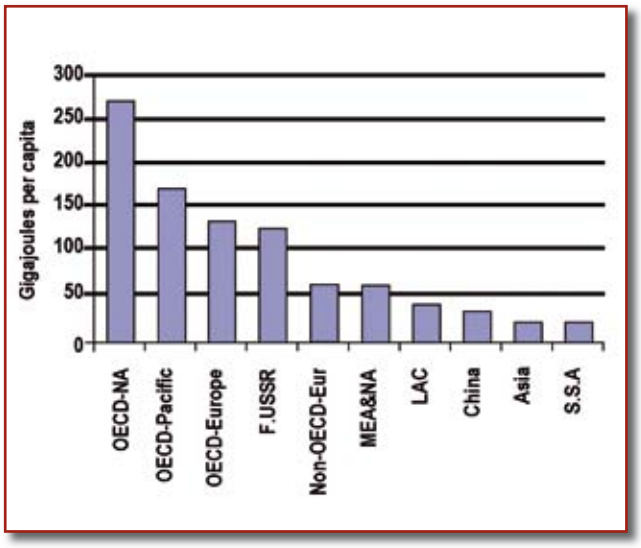
- Removing barriers among different disciplines involved in energy research development and design (RD&D) with the following project:
  - End-use energy RD&D: Exploring efficiency improvements with a focus on energy services.
- Removing barriers to the wider use of existing energy technologies with the following projects:
  - An international scientific dialogue on the concerns of nuclear power generation.
  - Facilitating technology adoption and diffusion in developing countries.
  - Advancing techniques for production of alternative transportation fuels (i.e. ethanol) from cellulose materials.
- Networking and integrating existing energy RD&D activities with the following project:
  - Building global networks to advance technologies for carbon capture and storage, hydrogen storage, and renewable hydrogen sources.

Although the ICSU Secretariat is not currently pursuing any of the specific projects listed above, the activities mentioned will be useful to consider for the ICSU ROA Science Plan initiative, as most of the global challenges that ICSU seeks to address also apply to the energy sector in Africa.

## 3. OVERVIEW OF THE ENERGY SITUATION IN AFRICA

Africa has a landmass of just over 30.3 million km$^2$, an area equivalent to the United States of America, Europe, Australia, Brazil, and Japan combined. As of 2004, Africa housed 885 million people (World Bank, 2005) in 53 countries of varied and diverse sizes, socio-cultural entities, and resource endowments, including fossil and renewable energy resources. Most of these energy resources are yet to be exploited, which is a contributing factor in making the continent the lowest consumer of energy, as illustrated in Figure 1. An African uses only one eleventh, one sixth, and one half of the energy used by a North American, a European, and a Latin American, respectively. There is an urgent need for substantial increases in energy consumption in Africa as a whole if Africa is to be competitive with other developing regions of the world.

**Figure 1: Per capita energy use (commercial and non-commercial) by world region, 2000**




Source: IEA, 2002

According to BP statistics, about 9.5%, 5.6%, and 8% of the world's proven global economic recoverable reserves of oil, coal and natural gas, respectively, are in Africa (BP, 2006). Furthermore, most of the recent new oil and gas discoveries were found in Africa (Davidson, 2002). The majority of the oil and gas reserves are limited to a few countries in northern and western Africa, and Angola. Recently, though, natural gas has been found in eastern and southern African countries. There are coal reserves in southern Africa, mostly in South Africa (>90%). Significant geothermal resources exist along the Rift Valley in eastern Africa, in Djibouti, Eritrea, Kenya, Malawi, Mozambique, Tanzania, and Zambia. The geothermal energy potential in the continent has been estimated to be in the range of 2.5–6.5 GW, but at present only Kenya has exploited this resource with an installed capacity of 129 MW. Plans are at different stages to repeat this Kenyan experience in many African countries in the Rift Valley areas. However,

development of these resources requires large foreign investment. Africa's technically exploitable hydropower capability is estimated to be in excess of 1 917 TWh/year, representing about 13% of the global total (WEC, 2005). The economically exploitable capability is estimated to be at least 1 100 TWh/year. These resources could be exploited in both large and smaller hydropower systems. The smaller ones, which normally have lesser constraints, are proving to be a viable alternative for rural/village power in many countries. Hydropower is common in most countries, but the resource is dominant in eastern and central African regions.

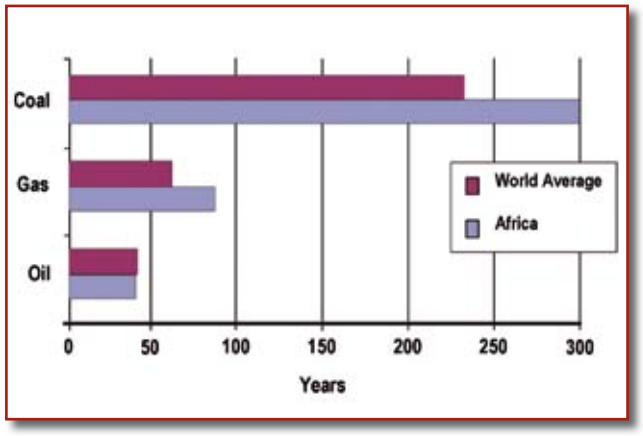
Africa has the world's best solar resources. Several countries in the region have exploited solar energy for water heating, crop drying, medical applications, and telecommunications, amongst other things. The wind potential estimated for Africa is 10 600 TWh per year, assuming that 10% of the land area has average wind speeds exceeding 5.1 m/s at a height of 10 m. However, useable wind energy occurs in highly localized areas and therefore requires detailed assessment.

Traditional biomass in the form of firewood and charcoal is widely used in Africa for providing heat energy in households. This use is inefficient and in some areas puts pressure on biomass resources. Residues from agriculture and forestry can provide major opportunities for modern biomass energy in the region. Mauritius, Kenya, Tanzania, and Egypt are exploiting bagasse for the generation of electricity. Ethanol from sugar cane is also produced as an additive to gasoline in some African countries. There is also potential for biodiesel production and use.

Despite the continent having about 14% of the world's population and producing 7% of the world's commercial energy, it consumes only 3% and exports more than half of its production (Davidson & Sokona, 2002). Furthermore, the current reserves-to-production ratio for natural gas and coal are above the world average, as shown in Figure 2 (Davidson, 2004). While the population of Africa has grown by more than 3% annually for some years now, its global share of total primary energy supply has only increased from 3.5% to 5.2% between 1973 and 2003 (IEA, 2005), indicating a reduction in energy access on a per capita basis.

Over 70% of oil consumed in Africa is used in four countries, namely Egypt, Algeria, Libya, and South Africa, and over 60% of the natural gas consumed in Africa is used in Algeria, Libya, Egypt, and Nigeria. South Africa uses about 93% of the coal produced on the continent. Electricity in Africa comes mainly from fossil fuels and hydropower, but the average electricity consumption is the lowest in the world, namely 515 kWh/year compared to a world average of 2 326 kWh/year (Karekezi, 2006). Furthermore, consumption is skewed: about 40% is consumed in the northern region, 40% in South Africa, and the remaining 20% by all the other African countries (Davidson & Sokona, 2002).

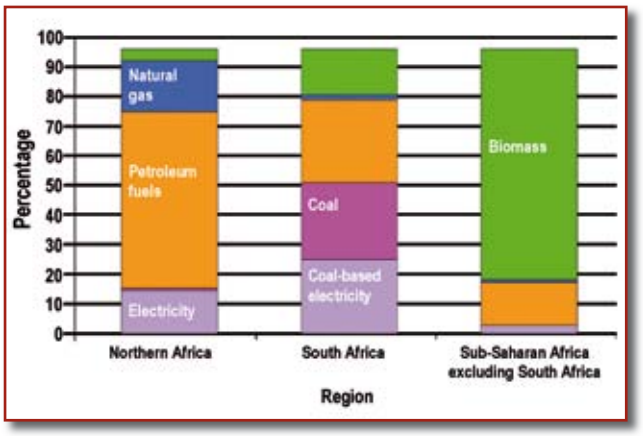
**Figure 2: Reserves-to-production ratio for fossil sources (Africa and the world)**




Source: Davidson, 2004

In addition, northern Africa, in general, can be described as petroleum-fuels dominated, as oil and gas account for 62% and 18%, respectively, of the total demand. South Africa, which is also fossil-fuel dominated, is more dependent on coal and nuclear energy for industrial and power production, with coal accounting for over 50% of the total. The situation in sub-Saharan Africa is substantially different because this region depends heavily on inefficient traditional biomass (used in particular for cooking in households), which accounts for over 80% of primary energy demand (as shown in Figure 3).

**Figure 3: Percentage energy demand in Africa by region, 2001**




Source: IEA, 2004

Large increases in modern energy consumption are required for coping with the key challenges in the energy sector. These challenges include the extremely low generation, transformation, and transportation capacities; low access to and supply of modern energy, particularly poor in rural areas; weak human and institutional capacities, especially related to governance in the energy sector; lack of adequate tools for effective energy planning and policy formulation; and a weak energy demand base. Overcoming these challenges will need intensive and

organized R&D activities to facilitate informed energy decision-making. However, energy R&D is also weak in Africa, especially in sub-Saharan Africa, despite existing capacity building efforts by various universities in the region and some coordinating networks such as the Environmental Development Action (ENDA) and the African Energy Policy Research Network (AFREPREN).

Since the aftermath of the oil crisis in the early 1980s, energy R&D in sub-Saharan Africa has largely concentrated on renewable energy resources as alternatives to fossil fuels, except for a few countries that have significant projects on fossil fuels. These R&D efforts are, to a great extent, externally funded, small-scale and uncoordinated in nature, and generally have weak economic and policy links. Hence, these activities failed to cope with the identified energy challenges, as the need was for local innovative thinking through intense R&D activity. For the region to improve its developmental status, its energy R&D must be strengthened and integrated. Therefore, this science plan will discuss some proposals for energy R&D in sub-Saharan Africa that are intended to address the key challenges in the energy sector. As a background, these challenges are enumerated below, along with a brief discussion of relevant energy projects in the region and a review of some of the progress made so far in the energy sector.

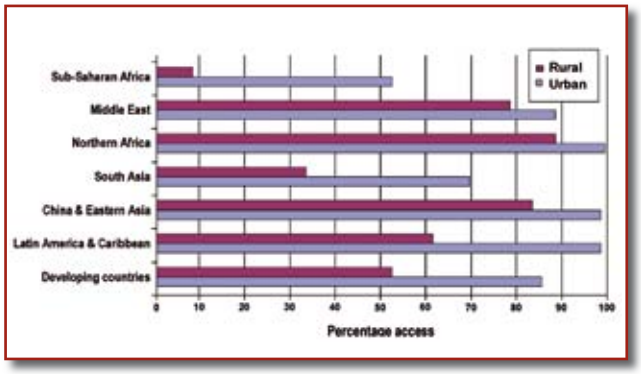
## 4. KEY ENERGY CHALLENGES IN SUB-SAHARAN AFRICA

The energy challenges in sub-Saharan Africa are many, and they impact seriously on the overall performance of the region's social and economic indicators. The region's relatively poor health and education indicators can be greatly improved with the provision of modern energy services. Increased availability of and access to electricity for health facilities can lead to better health care. Modern educational facilities depend largely on the availability of modern energy services, which can facilitate improved student performance.

Improving the added value of African products will require modern energy provision for manufacturing, processing, storage, and transportation. Energy is also needed for the development of small-scale enterprises, which can contribute to the region's economic survival and growth. Improved access to modern energy services, therefore, is crucial for the overall socio-economic development of the region, but certain key challenges need to be overcome.

Access to electricity, a generally accepted indicator for overall socio-economic development of any country or region, is low in sub-Saharan Africa. Only 53% and 8% of urban and rural populations, respectively, have access to electricity as compared to 99% and 88%, respectively, in northern Africa (Figure 4) (IEA, 2004). A few countries in the region, such as Ghana, Mauritius, South Africa, and Zimbabwe, are above the average. All the developing regions of the world, apart from South Asia and sub-Saharan Africa, have managed to narrow the gap between urban and rural areas in terms of accessibility to electricity. The rural areas of sub-Saharan Africa pose specific challenges, mainly because of their low population density and remoteness, both of which result in high costs of production, transmission, and distribution of electricity.

**Figure 4: Rural and urban access to electricity in developing countries, 2002**




Source: IEA, 2004

The energy production-to-consumption ratio is high in Africa, largely due to poor regional and sub-regional networks, as well as to the heavy reliance on external financing. The poor energy demand base due primarily to Africa's low level of industrialization is also a contributing factor. Most countries have not mobilized local finances for energy resource development, though external private investments and official development assistance (ODA) are declining. Hence, energy investments are far below the required level to satisfy the region's needs. Unfortunately, though foreign direct investment (FDI) to the region has shown some increase, it is mainly confined to upstream oil extraction development and limited to less than 10% of the countries in the region (Davidson & Conteh, 2006). There is an urgent need to identify innovative means of financing fossil and renewable energy development.

Furthermore, investigating means of reducing the burden of the up-front cost of renewable energy sources is particularly important, especially when they are intended to be used by poor and vulnerable groups of people. Special efforts are needed to mobilize sustainable local funding for energy projects, so as to reduce reliance on external sources. Other areas that need special attention to reduce the cost of energy projects include: investigating ways of reducing the long lead times between project/programme conceptualization to implementation; and developing the downstream energy sector. Increasing energy demand in the industrial and commercial sectors is crucial to ensure that a large share of energy produced will be used within the continent, as that will yield associated economic benefits.

The sustainable development of a viable energy sector will require decisions and actions by multiple institutions and stakeholders including the public and private sectors, non-governmental organizations, international bodies, and user groups. The effective participation of all these groups will need a strong and adequate policy, and firm legal, regulatory, and institutional frameworks. Such frameworks should be conducive to both domestic and foreign investors, ensuring that policies, strategies, and regulations incorporate the specifics of the sub-Saharan African energy context, especially those of the rural areas.

In promoting access to affordable sustainable energy services, issues such as integrating off-grid systems with overall national energy programmes, implementation strategies, and lessons learnt from past projects and programmes should be considered. Lack of clearly defined institutional roles has led to poor implementation of energy projects and programmes. The absence of adequate frameworks has led to high costs in implementing energy programmes and projects in the region, hence the energy burden to GDP growth. One area that needs urgent attention is the development of capacity so as to negotiate effectively with the private sector, bilateral and multilateral organizations, and international agencies. In particular, the growing interest in the oil and gas resources of the region will require the development of new negotiating skills to cope with experienced external investors. The current inadequacies further increase the transaction costs of energy projects and programmes.

The continued high urbanization rate, which has led to the emergence of informal settlements around urban areas, creates serious problems for energy planning in these locations. Coping with the transportation problems linked to urban development has exacerbated the problem. Developing new energy planning paradigms that will involve participation from local governments, regional councils, and cities as well as community-level organizations, is urgently required.

With the exception of South Africa, where only 16% of the population depends on traditional biomass energy, almost 80% of the population in sub-Saharan Africa depends on biomass resources for cooking (see Figure 3) (Karakezi, 2006). Firewood and charcoal burn inefficiently, resulting in major energy losses (up to 15%). Furthermore, when burned indoors, they emit pollutants such as carbon monoxide, small particulates, nitrogen oxides, benzene, butadiene, formaldehyde, poly-aromatic hydrocarbons, and many other health-damaging substances. It is estimated that 393 000 deaths in sub-Saharan Africa in 2002 were due to indoor air pollution from the burning of biomass fuels (WHO, 2006). It is particularly dangerous to women and children as they do most of the cooking.

Developing a competitive energy sector requires large numbers of highly skilled people in many specialized areas. Unfortunately, many of the functions that are needed in sub-Saharan Africa are carried out by foreign personnel, resulting in significant financial drain. Areas in which this is a problem include oil and gas exploration and development; power generation, transmission, and distribution; and financial investment decision-making related to energy. These areas encompass energy planning, analysis, and modelling based on national, sub-regional, and regional data. Some skills do exist in sub-Saharan

Africa, but not in sufficient quantities to meet the demand. Improving skills to achieve optimal human resource capacity, and strengthening institutions to compete internationally, are urgent concerns. A further serious problem is the retention of human capacity.

As sub-Saharan Africa is fragmented, with countries of different sizes, and bestowed with an uneven distribution of energy resources, building cooperative mechanisms among countries and sub-regions is crucial for optimal benefits. In the region, some countries such as South Africa, Cote d'Ivoire, and Kenya, which do not produce oil, have more efficient refineries than oil-producing countries such as Nigeria, Angola, and Gabon. As a result, these countries with more efficient refineries have become regional suppliers of oil products. There is need to create a more rational basis for oil production, refining, and use. Joint procurement of oil and gas will result in gains from the benefits of large supplies and elimination or reduction of expensive third-party financing. Greater use of joint oil refining will reduce losses and improve the continent's overall refining capacity. Several power interconnection facilities exist within the region, but improving these and introducing more of them will improve the region's power supply. However, to benefit from the gains of energy cooperation and trade, standards and policies need to be harmonized and economic cooperation enhanced. Furthermore, greater cooperation for sharing relevant experience among the various sub-regions of sub-Saharan Africa will lead to optimal benefits.

Africa's contribution to global greenhouse gas (GHG) emissions is about 3%, but the continent is the one most vulnerable to the impacts of climate change, a global threat that is primarily due to the concentration of such gases in the atmosphere. African countries need to embark on energy development paradigms that are less carbon intensive than those of the past. Such ventures will need innovative thought. Furthermore, most African countries depend on international financing arrangements, which often stipulate certain environmental criteria to which these countries must adhere, if they wish to access these finances. Hence, reconciling global and/or local environmental concerns with Africa's energy development needs will require new thinking.

## 5. ENERGY PROJECTS IN SUB-SAHARAN AFRICA

Since the late 1970s, several energy projects have been undertaken and others planned for both direct developmental purposes and for R&D. These projects are carried out by external as well as internal organizations on either a regional, sub-regional, or national scale, though some overlaps occur among the projects. These projects will be discussed along regional, sub-regional, and national lines.

### 5.1 Regional Projects

The African Union (AU) is premised on African states making commitments to good governance, democracy, and the preservation of human rights. The AU has an energy initiative that aims at developing vast African energy resources in a sustainable manner to ensure increased productivity, wealth creation, and improved quality of life for all Africans. This initiative is articulated in the New Partnership for Africa's Development (NEPAD), which is a holistic and comprehensive strategic framework for the continent's socio-economic development.

AU/NEPAD is based on self development and reliance using collective means to exploit African opportunities, and it involves facilitating and ensuring constructive partnerships between African countries and the developed world, based on mutual interest and benefits, and shared commitment – driven by African ownership and leadership. Among the energy projects and plans within AU/NEPAD are: the formulation of suitable energy policies aimed at cooperation for sub-regional development; electricity grid interconnection among countries and a possible pan-African electricity grid; oil and gas pipeline projects; resource development (especially major hydropower sites); and the energy information development project. All these projects are at different levels of development, but the Energy Information Project is well advanced and collaborating with the World Energy Council (WEC) and the

International Energy Agency (IEA). It is being run by the Energy Commission of AU/NEPAD, that is, the African Energy Commission (AFREC). Another project that is relatively advanced is the study of regional energy integration.

The Forum for Energy Ministers in Africa (FEMA), which advocates for major energy infrastructure projects, has undertaken two situation analysis studies. One focused on identifying the key challenges facing the continent and possible policies to overcome them. The other looked at energy and poverty reduction with the hope of identifying key energy targets for achieving the Millennium Development Goals (MDGs). FEMA is presently considering a study on energy security in Africa. The African Ministerial Conference on the Environment (AMCEN) is interested in the environmental challenges facing the African energy sector and searching for and investigating ways to overcome them.

### 5.2 Sub-Regional Projects

Several sub-regional economic bodies are conducting numerous energy initiatives. In the western sub-region, the Economic Community of West African States (ECOWAS) has two main ongoing energy projects: the West African Power Pool (WAPP) that aims at connecting all the electricity grids of member countries, and the West African Gas Pipeline Project (WAGPP) that aims at connecting three countries to Nigeria's natural gas supply. In addition, the West African Solar Energy Project (CILES) undertakes several renewable energy projects in nearly all the countries in the Sahel.

The Economic Community of Central African States (ECCAS) has also set up a power pool, the Pool Energétique d'Afrique Centrale (PEAC) that connects the various countries in the sub-region. There is also a mini-pool connecting Burundi, the Democratic Republic of Congo (DRC), and Rwanda. The countries in Eastern Africa have also formed a pool known as the East Africa Power Pool (EAPP). An oil pipeline connecting Tanzania to Zambia was constructed, and crude oil flows from Dar Es Salaam harbour to Zambia.

The inter-connection in Southern Africa (SADC) is far advanced. The Southern African Power Pool (SAPP) is well established and some countries are now benefiting from optimization of power sharing. They have also embarked on a sub-regional project in energy efficiency and a biofuels programme, which aim to promote efficient technologies and reduce reliance on petroleum fuels. The gas pipeline between Mozambique and South Africa has been commissioned and is fully operational. There is also the Nile Basin Initiative (NBI) involving Burundi, DRC, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda.

### 5.3 National Projects

All countries in sub-Saharan Africa have initiated national energy projects. Prominent among these are the following.

- The reduction of natural gas flaring in Nigeria along with demand stimulation projects to utilize the gas.
- Capacity building projects with formal training ranging from short courses to undergraduate and postgraduate programmes. Ghana, Nigeria, and South Africa are among those involved.
- The South Africa/Botswana methane gas pipeline project.
- Biofuels as alternative fuel projects in several countries.

### 5.4 Multi- and Bi-Lateral Projects

Various United Nations bodies have energy projects on the continent. The United Nations Development Programme (UNDP) has projects in several countries. These include the promotion of liquefied petroleum gas (LPG) as alternative cooking fuel in some countries. The UNDP is assisting rural women in Mali to produce biofuel for productive activities. The United Nations Environment Programme (UNEP) is working with several countries to study the relationship between energy systems and the environment. The United Nations Economic Commission for Africa (UNECA) is coordinating a UN system-wide collaborative mechanism involving other African regional organizations, such as the African Development Bank (AfDB), the AU, AU/NEPAD, and others, in support of NEPAD programmes including the energy programme.

The World Bank has several energy projects in its member countries. They fall mainly into three groups: power sector reform; development of energy infrastructure and energy services provision; and poverty reduction. The World Bank recently joined other donors to form an Energy Infrastructure Consortium that could jointly fund energy infrastructure in Africa.

Energy development and R&D projects feature among the several bilateral programs with Development Assistance Countries (DAC) in the region.

- The German government, through its funding agency GTZ, is running energy projects in selected countries. These include energy advisory services in Uganda, rural electrification and household fuel management in Senegal, renewable energy development in Tanzania, household energy in Ethiopia, promotion of biomass conservation in eight SADC countries, and sustainable biomass energy supply in Madagascar.
- France has several energy projects with its former colonies, mostly in West Africa. These projects involve power and renewable energy projects.

- Denmark has renewable energy projects in Burkina Faso, Ghana, Kenya, and some countries in southern Africa. The projects range from power plants to renewable energy projects.
- Norway is working with a few countries on oil development projects.
- Sweden, through the Stockholm Environment Institute, is working on several renewable energy projects in selected countries in southern Africa, Zambia, and Tanzania.

The above list is not comprehensive and should be considered as illustrative.

In addition to bilateral projects, some regional energy networks undertake energy RD&D work relevant to the projects discussed below. The Global Network on Energy for Sustainable Development (GNESD) Type II initiative from WSSD is working with three energy centres in the region, namely, AFREPREN in the east; the Energy Research Centre (ERC) at the University of Cape Town in the south; and ENDA in the west. They are identifying suitable pro-poor policies for power sector reform and renewable energy development. The Global Village Energy Partnership (GVEP), another Type II initiative, is at present working with Senegal on a rural electrification project; in Ghana on an Energy for Poverty Reduction Action Plan; and in Kenya on energy data collection and analysis. The African Rural Energy Enterprise Development Training Programme (AREED), which is funded by UNEP, is working with Senegal and Zambia to train small and medium-sized enterprises (SMEs) in business development within the energy sector with the aim of increasing their productivity.

There are also regional RD&D centres that are working on a wide range of projects covering power sector development, transport energy, and renewable energy development. These include AFREPREN, which is located in Kenya and works with most of the countries in eastern and southern Africa; ENDA, which is located in Senegal and works with most of the former French countries in West and Central Africa; and the Kumasi Institute of Technology and Environment (KITE), which is located in Ghana and works with selected West African countries.

## 6. PROGRESS IN THE ENERGY SECTOR IN SUB-SAHARAN AFRICA

Modest progress has been made in the energy sector in sub-Saharan Africa. This can be attributed mainly to the internally and externally funded national, regional, and international energy and energy-related initiatives. Access to modern energy services in both rural and urban areas (household and productive sectors) has grown. Recent efforts to improve off-grid energy systems, largely based on renewable energy, have been developed in the rural areas of many countries and are slowly being accepted by authorities as an important option for greater access to energy. The development of indigenous energy resources has increased mainly due to FDI, although this has been essentially on upstream projects. Energy cooperation and trade among African countries, including developments within sub-regional economic groups, have increased significantly. The number of well-trained energy professionals has risen, and the performance of energy decision-making institutions has improved.

Access to modern energy has increased modestly in sub-Saharan Africa in the past few years, from 17% to 24% as whole in the years 2000–2002 and from 3% to 9% in rural areas (IEA, 2004). These increases, which are due to many national initiatives such as the ongoing power sector reform programmes, are still insufficient to improve the region's competitive position compared to other developing regions of the world. However, externally initiated power sector reform programmes have produced mixed results. Improved road and pipeline networks have led to better distribution of petroleum products. Greater attention paid to rural areas, especially by non-governmental and international organizations, has also facilitated access to modern energy services in these areas, though more action is needed to improve the sustainability of such endeavours.

Energy cooperation and trade have grown in many of the sub-regions. SAPP is a clear example of how countries can cooperate effectively to ensure optimal benefits. WAPP, though not as developed as SAPP, has started showing positive results. The other power pools are EAPP in Eastern Africa and PEAC in Central Africa. In addition, several bilateral power agreements among countries have been signed and most of them are now in operation. The pipeline project between Kenya and Burundi through Uganda, and the gas pipeline between South Africa and Mozambique are examples of successful bilateral agreements in the oil and gas sector. The West African Pipeline Project will, on completion, be an example of effective cooperation between four West African countries.

Botswana, Ghana, Senegal, and Sudan have successfully benefited from both locally initiated programmes and externally funded projects to replace the use of traditional fuels with LPG in their urban areas, and to increase the use of this fuel in rural areas. The biofuels programme in Mali, which is being replicated in a few other countries in the region, is a promising case for substituting petroleum fuels for productive activities in land-locked oil importing countries. A few relatively large-scale renewable energy projects in the region have shown some success, such as, for example, the Global Environmental Facility (GEF)-sponsored projects in Zimbabwe, the CILES project in West Africa, and the Eskom/Shell project in South Africa.

There have been advances in the training of energy professionals, within and outside the region, though the retention of staff is still a problem for many countries. Undergraduate and postgraduate energy programmes are on offer at certain universities and other training institutions. Research and development capacity has grown due to many local and international efforts, especially in the postgraduate training domain. Programmes such as that of GNESD and some bilateral assistance projects have contributed to this effort.

In many countries, small and medium-sized energy service enterprises have been established, especially in renewable energy. South Africa, for example, has developed integrated energy centres that are one-stop shops providing energy solutions to rural communities and access to affordable, safe, and sustainable energy services.

National capabilities in energy agencies for energy planning and policy development have improved in many countries through energy projects and related programmes such as national communications for climate change. Capability in energy modelling has increased, though not substantially because of data limitations. In addition, information sharing on modern energy technologies and the services associated with them has improved substantially. The growth of many energy network activities such as GNESD, Renewable Energy and Energy Efficiency Partnership (REEEP), GVEP, and others have, as a result of the WSSD, contributed to greater knowledge and capacity building in several African countries.

Despite all these efforts and modest progress in the region, many gaps remain. Some of them can be filled if the necessary R&D are undertaken, as this will result in providing the information needed for effective policy-making in the energy sector. Among the gaps are the following:

- Substantial increase in guaranteed energy supply
- Sustainable rural and urban access to energy
- Strengthening and retaining human and institutional capacity
- Development of energy models and scenarios for Africa
- Stimulation of timely energy demand growth.

Realizing that progress has been made in some of these areas, however, and also taking into consideration the strength and capability of ICSU ROA in terms of both funding and technical capacity, priority is given to three key areas, namely:

- Development of energy models and scenarios for sub-Saharan Africa
- Increasing the access to high quality, reliable, and affordable energy in a sustainable manner
- The strengthening and retention of human and institutional capacity in the energy sector.

## 7. PROPOSED PROJECTS

Based on the three areas of focus outlined above, three major projects have been proposed within the framework of the ICSU ROA science plan for the period from 2006–2011 and beyond. They are outlined in the sections that follow.

### PROJECT 1
### DEVELOPMENT OF ENERGY MODELS & SCENARIOS FOR SUB-SAHARAN AFRICA

### 1.1 INTRODUCTION

Effective energy management and planning in sub-Saharan Africa is difficult for several reasons. Among these are the lack of much needed energy and energy-related data, and the absence of a coordinated energy planning structure. In addition, the few national and sub-regional efforts in this area are insufficiently organized to be used for conducting a regional activity. It is important, therefore, that an organized data collection and management information system, and a strategy for coordinating development plans and aspirations be established. These are pre-conditions for scientists, engineers, and technologists to apply their analytical skills in mapping out possible energy futures for the region.

At present, many countries in the region lack the adequate and fully developed energy infrastructure needed to provide the foundation for developing future energy perspectives based on sound and up-to-date science and technology. There exists an opportunity for these countries to try out both conventional and bold new options in mapping out their future energy requirements. To embark on such ventures will require them to have the necessary scientific and technological tools in the form of models and scenarios, so that they can visualize their energy futures effectively. This project also allows countries in the region to select from a broad range of models and scenarios now globally available that will ensure a more technically and economically efficient, environmentally sound, climate-friendly, and socially responsible energy future. Repeating the adverse impacts of past paradigms could be avoided with proper selection and adaptation of existing tools.

This type of exercise is already being carried out in many parts of the world, and has resulted in the generation of a range of energy scenarios and models with different levels of scientific and technological sophistication. They range from those based on spreadsheet analysis with minimum data, to third-generation equilibrium models that need detailed techno-econometric information. Despite the high-quality scientific content of these tools, none has the perspectives of Africa as visualized by Africans. Hence, this project creates an opportunity for competent Africans to customize these tools to visualize their energy future in ways that will fully reflect their regional perspectives and realities.

In other developing regions of the world, such teams exist and are working on similar exercises. In Africa, there are a few countries with national activities or ad hoc efforts that are capable of investigating energy futures. This work, however, is far from comprehensive and coherent. There is a need, therefore, to set up a coordinating mechanism that will not only harness existing skills and human resources, but also develop them further to the required standard so that the region becomes more competitive in the energy sector. It will also provide a basis for collaboration with similar structures in developing countries and other parts of the world.

The various sub-regional power pools including the SAPP, the WAPP, and the EAPP demonstrate clearly the region's capacity to coordinate energy development, even though these initiatives are at different stages of development. In addition, there are several cooperating energy activities, such as bilateral and multilateral energy agreements in both the power and the petroleum sectors, which can form the basis for further cooperation. All these efforts demonstrate the willingness to cooperate and investigate the future energy scene of the region.

The development of future energy models and scenarios for sub-Saharan Africa that include national and sub-regional realities and priorities offers substantial opportunities to develop energy and energy-related scenarios, to establish regional energy modelling networks, and to encourage regional and international networking in energy-related modelling. These, in turn, will help to optimize Africa's energy resources and boost both income and human capital development of the member countries.

## 1.2 PROJECT OBJECTIVES

### 1.2.1 General

To develop energy models and scenarios with related activities for optimizing, managing effectively, and planning energy production and energy use in the region.

### 1.2.2 Specific

- To identify capacity needs for effective development of models and scenarios for the region.
- To harmonize national, sub-regional, and regional plans, models, and scenarios in the region.
- To develop a harmonized energy database useful for scenario-building and modelling.
- To strengthen human and institutional capacity in scenario-building and modelling for energy and energy-related sectors.
- To develop knowledge networks and other collaborative links among specialists in energy modelling and scenario-building.
- To keep track of developments in scientific and technological advances in the energy sector.

## 1.3 PROPOSED SCIENTIFIC ACTIVITIES

### *Short-term*

- Identify and assess the capacity needs for effective development of models and scenarios for the region.
- Collect and assess the different national, sub-regional, and regional energy-sector-development sector plans, models, and scenarios for sub-Saharan countries (such as, for example, the African Energy Futures project) and develop common generic variables that will form the basis for establishing consistent storylines reflecting the national, sub-regional, and regional conditions.
- Link with existing initiatives, such as AFREC, AU/NEPAD, and UNECA to develop a robust database for effective modelling and scenario-building in energy and energy-related matters.

### *Medium- to long-term*

- Improve human and institutional capacity in scenario-building and modelling for energy and energy-related sectors.
- Develop detailed scenarios and models for the energy sector in sub-Saharan Africa while considering the introduction of different energy sources as well as new and emerging energy technologies.
- Develop inter-institutional collaborations within and outside the region in energy and energy-related modelling.

### *Ongoing*

Track developments and scientific and technological advances in the energy sector and, where possible, participate in global energy initiatives.

## 1.4 EXPECTED OUTCOMES

- Energy databases suitable for scenario-building and modelling.
- Different energy scenarios and models for various policy testing exercises.
- Trained personnel and enhanced institutional capacity in energy scenario-building and modelling.
- Increased human and institutional collaboration between modelling centres in the region and similar institutions elsewhere.

## 1.5 TIMELINE

This project is envisaged to last for five years, from 2007–2011 in the first phase, and it is hoped that it will be developed into a permanent activity for producing African energy futures.

## 1.6 BUDGET

To undertake the short-term activities would require US$10 million.

## PROJECT 2
## INCREASE IN ACCESS TO HIGH QUALITY, RELIABLE, AND AFFORDABLE ENERGY IN A SUSTAINABLE MANNER IN SUB-SAHARAN AFRICA

### 2.1 INTRODUCTION

Africa currently constitutes 14% of the world's population, but accounts for only 2% of GDP. Although the continent produces 7% of the world's total energy, it consumes only 3% of it. Furthermore, energy intensity[1] in Africa is twice the world average (WEC, 2002). The use of modern energy services is closely linked to economic development, poverty reduction, and the provision of vital services, but consumption of modern energy sources in sub-Saharan Africa is extremely low (WEC, 2005) owing to the region's reliance on traditional biomass.

Electricity, the most important energy source in the delivery of the all-important modern functions such as health, education, lighting, and social services, accounts for only 4% of sub-Saharan Africa's total energy consumption. Moreover, in sub-Saharan Africa, between 1980 and 2000, electricity consumption declined from 132.6 kWh to 112.8 kWh per capita, even as the world average energy consumption increased substantially (World Bank, 2004). For rural sub-Saharan Africa, where the majority of the population lives, the reality is worse. Energy-intensive projects should include improved efficiency for economic activity and production/mobility

Sub-Saharan Africa also has significant amounts of renewable energy yet to be exploited. Furthermore, renewable energy technologies (RETs) have demonstrated a growing potential to meet energy needs where conventional energy supply options have failed. The costs of many RETs are also declining with technology improvements and economies of scale in production. For instance, solar and wind power costs are now half of what they were in the mid-1990s (REN21, 2005). There is also potential to develop modern biomass technologies in Africa such as, amongst others, biogas, ethanol, biodiesel, wood briquetting, wood pelleting, and modern charcoal. Hence there is a need to search for ways that ensure greater use of RETs in sub-Saharan Africa.

The relationship between poverty reduction and energy services provision is complex (Bradley & Baumert, 2005). In order to reduce poverty, governments in sub-Saharan Africa should make a high priority of increased access to modern energy-carriers. To halve poverty by 2015 in accordance with the MDG proclaimed by the UN, it is estimated that the economies of sub-Saharan African countries need to grow at an average rate of at least 8% per year. Such high growth rates need improved access to modern energy services. In addition, lack of access to such services often exacerbates poverty and leads to unacceptable health risks through exposure, for instance, to indoor air pollution resulting from cooking that uses traditional biomass fuels.

Overall improvement in quality of life is needed in both rural and urban communities if the true potential for development is to be realized across sub-Saharan Africa. Energy projects in the region will therefore need to focus on providing secure and reliable energy supplies at affordable prices, while at the same time building up a sustainable demand.

The region is rich in energy resources, however, and needs to use them largely within regional boundaries to create sustainable growth. Such development will be needed by each country, although links among countries will assist in the economic viability of specific development and encourage regional interdependence, trade, and development.

African urban populations are growing at rates about twice their national average population growth rates, thus exacerbating the problem of sustainable urban energy access. Current projections indicate that sub-Saharan Africa will still, in 2030, host the highest percentage of the world's population without access to modern energy services, and that the size of the population without electricity will increase steadily until 2025 (IEA, 2006).

This trend can and must be reversed, and calls for innovative technological and policy approaches. For example, in the case of electrification, it is estimated that, at the rate of power connections of the past decade, it would take more than 80 years to electrify sub-Saharan Africa (IEA, 2002). A model that links the transition to modern fuels with the time when the per capita income reaches US$1 000–1 500 (Toman & Jemelkova, 2003) illustrates this view. Under a business-as-usual scenario, therefore, it will take a long time to realize full access to modern energy technologies in sub-Saharan Africa.

International development partners as well as other energy stakeholders at regional and national levels should therefore view the energy access problem as inseparable from poverty reduction efforts and economic growth strategies. However, two major challenges – namely,

1. **Energy intensity:** The ratio of energy consumption to a measure of the demand for services (e.g. constant dollar value of Gross Domestic Product for services). Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP.

weak policies and inaccessible financing – hamper efforts aimed at accelerating access to reliable and affordable modern energy options in Africa. It is conceivable, therefore, that the role of energy in achieving the MDGs can only be played if these key barriers are eliminated.

Inefficient institutional, regulatory, and policy frameworks characterize the energy sector in most African countries. There is a need for African policy-makers to pay special attention to measures that clarify the roles of various stakeholders, improve investment climate in general through more favourable legal and regulatory reforms, strengthen the role of independent energy regulatory bodies, and remove barriers to the realization of regional integration energy projects (UNECA, 2006).

Since Rio[2], a number of energy projects have been implemented in the region with varying degrees of success. These however, are not well documented and it is therefore unclear what useful lessons exist for scaling up across countries in the region.

The need to urgently and significantly improve access to modern energy services in urban and rural sub-Saharan Africa is thus paramount. The challenge is to determine how this can be achieved.

## 2.2 PROJECT OBJECTIVES

### 2.2.1 General

To provide the information and knowledge for ensuring a substantial increase in the supply of and access to reliable and affordable energy in both rural and urban areas in a timely manner, so as to promote economic growth and sustainable development through stimulating energy demand while maximizing the use of all local energy resources.

### 2.2.2 Specific

- To identify research and knowledge gaps and useful lessons for scaling up and financing strategies for the energy sector.
- To stimulate modern energy demand for both productive and household activities.
- To improve technical and economic efficiency of energy generation, distribution, delivery, and use.
- To recommend policy options for the increase in supply and access to sustainable energy services.
- To identify barriers to modern energy technology access and to scale up both policy and financial commitment through private-public partnerships.

## 2.3 PROPOSED SCIENTIFIC ACTIVITIES

### *Short-term*

- Review existing energy and energy-related production-and-use projects/programmes to identify research gaps and useful lessons for scaling up and financing strategies, flagship energy supply projects (centralized and decentralized systems), energy efficiency programmes, and renewable energy projects.
- Develop standards or sustainability benchmarks for the energy sector.

### *Medium-term*

- Develop projects for stimulating energy demand as well as creating wealth and employment.
- Undertake an energy policy review to improve energy access, especially for poverty reduction and energy integration, and engage in dialogue with policy-makers, international development partners, and other energy stakeholders.

## 2.4 EXPECTED OUTCOMES

- A report that presents proposals for achieving a substantial increase in sustainable energy supply, energy access, and lessons learnt from energy projects and programmes in the region.
- Strategies and credible projects for integrated energy planning and wealth and employment creation in the region.
- Energy policy options for improved energy access, poverty reduction, expanded energy technology access, and scale-up.
- Compendium of important lessons for scaling up energy technologies in the region.
- Proposals for implementing innovative financing schemes.
- Increased stakeholder awareness of enterprise development.

2. The United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 1992.

## 2.5 RELATION TO ICSU REGIONAL OFFICE FOR AFRICA (ICSU ROA)

This project encompasses several groups of ongoing activities in the region, and the proposal here is to engage in action that will strengthen them. The following will be included.

(a) Electricity grid, and oil and gas pipeline extensions are currently being undertaken by AU/NEPAD, the sub-regional economic bodies, and bilateral agreements among countries. ICSU ROA can support these initiatives, commission evaluation reports, or hold joint conferences in these areas.

(b) Several energy efficiency projects are ongoing, both nationally and sub-regionally. ICSU ROA can join with the relevant bodies in holding conferences and symposia to identify gaps and promote knowledge exchange.

(c) African energy databases are at present being developed by the Alternative Fuels Renewable Energy Council (AFREC) in collaboration with IEA and WEC. These efforts may need to be strengthened by ICSU ROA.

(d) ICSU ROA can commission energy studies and monitor existing energy policies on the continent.

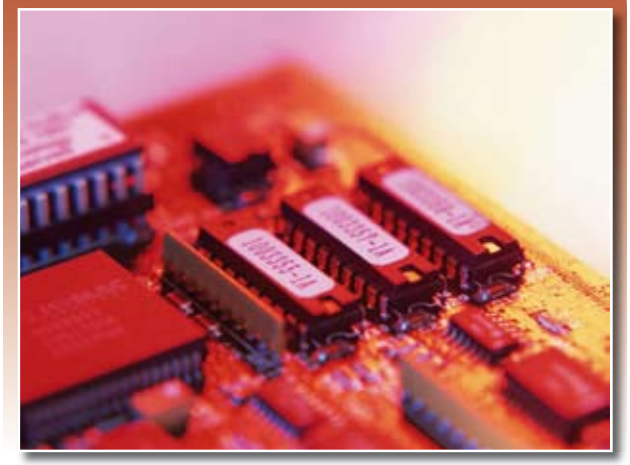
## 2.6 BUDGET

The budget for ICSU ROA activities will vary because proposed activities include 'piggybacking' on commissioned studies. Hence, the following are suggested:

(a) Support for three conferences at US$100 000 per activity, giving a sub-total of US$300 000. This proposal will include support of the activity plus participation.

(b) Support for commission study: US$ 1 000 000 per project.

# PROJECT 3
# THE STRENGTHENING AND RETENTION OF HUMAN AND INSTITUTIONAL CAPACITIES IN THE ENERGY SECTOR IN SUB-SAHARAN AFRICA



## 3.1 INTRODUCTION

Strengthening and retaining human and institutional capacities in the energy sector is of great importance to human well-being, sustainable development, and environmental conservation.

Sub-Saharan Africa currently suffers a high deficiency in human and institutional capacity. Most countries in the region have limited tertiary-level training opportunities in S&T related to the energy sector. Where such capacity exists, the few trained personnel cannot be retained, for several reasons including unfavourable working conditions. Similarly, institutions mandated to build capacity in S&T related to energy are often poorly equipped, and lack the facilities required for training and information access. Furthermore, these institutions have inadequate qualified and experienced teaching and research staff and are often poorly funded by central governments.

The need to provide and improve access to modern energy for people living in both rural and urban areas, and the need to develop alternative energy sources constitute a driving force to the creation of skilled individuals and efficient institutions by strengthening and retaining human and institutional capacities.

Key capacities required include trained researchers, technicians, lecturers, policy-makers, and managers capable of planning and managing programmes in the public and private sectors. Institutional strengths required include, amongst others, analytical instruments, regular funding to sustain programmes, networking capacity (ICT connectivity), and supportive policy frameworks.

The process of strengthening and retaining human and institutional capacities should be contextualised on a broader base, combining activities in diverse countries in the region at governmental and private sector levels. These activities should also promote and stimulate literacy in energy matters at all levels of

education. Furthermore, the exchange of information and knowledge should be prioritized amongst individuals and different African organizations dealing with energy and energy-related matters in the region (for example, AU/NEPAD, SADC, ECOWAS).

The proposed project will endeavour to generate knowledge aimed at informing strategies for strengthening and retaining energy and energy-related human and institutional capacities in the region.

## 3.2 PROJECT OBJECTIVES

### 3.2.1 General

To contribute to the strengthening and retention of energy and energy-related human and institutional capacities in sub-Saharan Africa.

### 3.2.2 Specific

- To identify human and institutional capacity needs in the energy sector of the region.
- To develop a critical mass of skilled people and institutions required in energy and energy-related disciplines in the region.
- To strengthen networks of energy experts and institutions within the region, to enhance collaboration among them, and to strengthen links with those outside the region.
- To stimulate the creation and promotion of centres of excellence in energy.
- To promote expertise in the development of partnerships between the public and private sectors for energy investments, financial negotiations, and technical development and management.
- To improve the development of energy information services and to facilitate access to energy documentation on energy and energy-related matters.
- To identify ways of strengthening entrepreneurial capacity and household access in both rural and urban areas.
- To propose strategies for retaining African energy experts so as to reduce brain drain.

## 3.3 PROPOSED SCIENTIFIC ACTIVITIES

### *Short-term*

- Conduct a review and assessment of the human and institutional capacity needs in the energy sector of the region and propose relevant actions to address these needs.
- Convene specific workshops for discussion and information exchange on energy and energy-related issues, and facilitate the establishment of a network of energy experts in sub-Saharan Africa with links to those in other regions and continents.
- Hold capacity strengthening workshops on enterprise development for selected stakeholders.
- Develop regional task forces around energy sources to investigate specific issues relating to each of these sources.

### *Medium- to long-term*

- Develop a database of regional energy experts, resources, and projects that is easily accessible to governments, the private sector, and relevant organizations, and promote the exchange of human resources in the region.
- Develop new training programmes to complement existing programmes in energy and energy-related sectors for all levels of the educational system, especially in schools.
- Develop mechanisms for retaining trained energy experts and addressing brain drain from the region.

## 3.4 EXPECTED OUTCOMES

- A report on the status of human and institutional capacity needs in the energy sectors, and recommendations for interventions that should be implemented.
- A comprehensive human and institutional capacity database for energy and energy-related issues.
- Enhanced collaborative RD&D programmes amongst individuals and institutions in the energy sectors within and outside Africa.
- Training programmes for all levels of human resource development, especially for schools, researchers, managers, the private sector, policy-makers, and consumers.
- A strategy for retaining energy experts within the region and harnessing the potential of those in the Diaspora.
- Enhanced entrepreneurial capacity within the energy sector.

## 3.5 RELATION TO ICSU ROA

Two types of activities are envisaged in this project.

1. ICSU ROA activities will include hosting workshops to involve existing training institutions and relevant experts to

(a) identify gaps in knowledge, and competence that needs to be developed

(b) estimate the support needed for institutional strengthening

(c) establish human resource needs

(d) form a network in the region with appropriate links to other regions of the world.

2. An activity that involves ICSU ROA in collaboration with existing ICSU (Global) programme initiatives such as that of Global Change SysTem for Analysis, Research and Training (START) on a possible scholarship programme for the energy sector.

### 3.6 BUDGET

The budget for this proposal will include the costs for both activities.

Short-term Activity 1: US$300 000

Short-term Activity 2: US$100 000 per workshop × 4

Short-term Activity 3: US$50 000 per workshop × 4 sub-regions × 2

Short term Activity 4: US$1 million per year × 3

## 8. OVERALL TIMELINE

All projects would run within the timeframe of 2007–2009 for short-term impacts and continue beyond this timeline for broader coverage. The modelling project, in particular, would require at least five years for meaningful outcomes.

## 9. PROPOSED FUNDING SOURCES

- African governments: governments should show their interest and commitment by making financial and material support available.
- Bi- and multilateral funding resources: bilateral resources fall within the mandate of many ODA programmes and could be a major source of funding. Multilateral sources are also important in view of the recent trends of forming consortiums and establishing trust funds through multilateral bodies.
- AU/NEPAD and UNECA initiatives.
- African Economic Communities (for example, SADC, ECOWAS, ECCAS, EAC).
- The African Development Bank (AfDB) is increasingly interested in energy development and use, and at present coordinates all energy programmes within AU/NEPAD.
- The European Union Energy Initiative (EUEI) programme, which provides grant funds for sustainable energy activities.
- EU/Africa Collaborative Programmes (for example, FP7).
- Private sector sources.
- Financial resources from joint projects, such as
  - (a) ICSU Unions, for example, IYPE (Geo-Unions), IUGS, INQUA
  - (b) UNESCO
  - (c) GECAFS
  - (d) TWAS/NASAC/AAS.

## 10. THE ROLE OF ICSU ROA IN IMPLEMENTING THE SCIENCE PLAN ON SUSTAINABLE ENERGY

The proposed activities for ICSU ROA are to review existing models and scenarios related to energy services in sub-Saharan Africa, to collect historical analyses of the costs and efficiencies for providing energy services, and to review theoretical studies on the limits of such traditional models and scenarios. On the basis of these reviews, it will be possible to identify obstacles to attaining sustainable energy access, and to foster the technological progresses needed to overcome these challenges.

The proposed studies will enable the development of place-based energy access systems that are high-quality and reliable, affordable, timely, and causing minimal burden to the environment. Participants in these activities must include senior scientists with expertise in energy and energy-related systems analysis, energy and energy-related technology assessment, and the history of technology developments. Participation is also required from energy and energy-related experts in the developed world. Major audiences will be policy-makers, business leaders, universities and training institutions, administrators for technology and innovation management, and related scientists and technologists.

## 11. CONCLUSIONS

The three R&D proposals outlined above are presented to address the key challenges in the energy sector of sub-Saharan Africa. If implemented, they will provide the information needed by African policy-makers and investors to make informed decisions that will lead the region towards satisfying the growing energy demand and catalysing the rapid growth urgently needed in the development and growth of all economic and social sectors in Africa.

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# APPENDIX A

# Abbreviations

| | |
|---|---|
| AAS | African Academy of Sciences |
| AfDB | African Development Bank |
| AFREC | Alternative Fuels Renewable Energy Council |
| AFREPREN | African Energy Policy Research Network |
| AMCEN | African Ministerial Conference on the Environment |
| AREED | African Rural Energy Enterprise Development training programme (UN) |
| AU | The African Union |
| CILES | West African Solar Energy Project |
| CSD | Commission on Sustainable Development (UN) |
| DAC | Development Assistance Countries |
| DRC | Democratic Republic of Congo |
| EAC | East African Community |
| EAPP | East Africa Power Pool |
| ECCAS | Economic Community of Central African States |
| ECOWAS | Economic Community of West African States |
| ENDA | Environmental Development Action |
| ERC | Energy Research Centre |
| EUEI | European Union Energy Initiative |
| FDI | Foreign direct investment |
| FEMA | Forum for Energy Ministers in Africa |
| GDP | Gross domestic product |
| GECAFS | Global Environmental Change and Food Systems |
| GEF | Global Environmental Facility |
| GHG | Greenhouse gas |
| GNESD | Global Network on Energy for Sustainable Development (UNEP) |
| GTZ | Gesellschaft Technische Zusammenarbeit (Germany) |
| GVEP | Global Village Energy Partnership |
| ICSU ROA | International Council for Science Regional Office for Africa |
| ICT | Information and communication technology |
| IEA | International Energy Agency |
| INQUA | International Union for Quaternary Research |
| ISPRE | International Science Panel on Renewable Energy |

| | |
|---|---|
| IUGS | International Union of Geological Sciences |
| IUPAP | International Union of Pure and Applied Physics |
| IYPE | International Year of Planet Earth |
| KITE | Kumasi Institute of Technology and Environment (Ghana) |
| LAC | Latin America and the Caribbean |
| LPG | Liquefied petroleum gas |
| MDG | Millennium Development Goal |
| NA | North America |
| NASAC | Network of African Science Academies |
| NBI | Nile Basin Initiative |
| NEPAD | New Partnership for Africa's Development |
| ODA | Official Development Assistance/Overseas Development Agency |
| OECD | Organisation for Economic Co-operation and Development |
| PEAC | Pool Energétique D'Afrique Centrale |
| R&D | Research and development |
| RD&D | Research development and design |
| REEEP | Renewable Energy and Efficient Energy Partnership |
| REN21 | Renewable Energy policy Network for the 21st century |
| RET | Renewable energy technology |
| S&T | Science and technology |
| SADC | Southern African Development Community |
| SAPP | Southern African Power Pool |
| SME | Small and medium-sized enterprise |
| SSA | Sub-Saharan Africa |
| START | SysTem for Analysis, Research and Training |
| TWAS | Academy of Sciences for the Developing World |
| UNCTAD | United Nations Conference on Trade and Development |
| UNDP | United Nations Development Programme |
| UNECA | United Nations Economic Commission for Africa |
| UNEP | United Nations Environment Programme |
| UNIDO | United Nations International Development Organisation |
| WAGPP | West African Gas Pipeline Project |
| WAPP | West African Pipeline Project |
| WAPP | West African Power Pool |
| WEC | World Energy Council |
| WHO | World Health Organization |
| WSSD | World Summit on Sustainable Development (UN) |

# APPENDIX B

## TERMS OF REFERENCE

### Scientific Planning Groups of the ICSU Regional Office for Africa

Based on the ICSU Strategic Plan 2006–2011, the ICSU Regional Committee for Africa has selected four priority areas for its activities in the period 2006–2009. These are: (a) Health and Human Well-being; (b) Sustainable Energy; (c) Natural and Human-Induced Environmental Hazards and Disasters, and (d) Global Change.

Each priority area will have one Scientific Planning Group, which may need to meet three times: a first meeting to prepare a preliminary report, a second meeting during the Second Consultative Meeting in September, and a third meeting to finalize the report. The generic Terms of Reference (ToR) for the working groups are as follows.

## GENERIC TERMS OF REFERENCE

(1) To review briefly the current status of the priority area in sub-Saharan Africa. This will include taking stock of the major R&D&I activities (that is, ongoing and planned) of the priority area in sub-Saharan Africa. Interests of the ICSU Scientific Unions, Interdisciplinary Bodies, and Joint Initiatives should be incorporated in this exercise.

(2) To formulate a set of detailed objectives for the priority area based on the ICSU Strategic Plan of 2006–2011, taking note of past and ongoing planning efforts by ICSU internationally.

(3) To make proposals on targeted areas of research in the given timeframe, and define milestones that should be reached during the lifespan of the proposed programme of the priority area.

(4) To define capacity building needs.

(5) To define deliverables that they will produce for society.

(6) To propose ways by which the ICSU family and its strategic partners can be involved in implementing the proposed actions.

(7) To identify ways by which the results of the research can be made available to policy-makers and other stakeholders in the region.

(8) To propose a budget for the activities of the programme(s) of the priority area, and to define fund-raising strategies and possible funding sources.

(9) To propose a mechanism for the guidance and oversight of the programmes/projects of the priority area, including the assurance that the activities of the Regional Office are complementary to (not duplicating) the existing activities in the Region.

(10) To submit a preliminary report to the ICSU Regional Committee for Africa by 30 June 2006 and a final report before the end of 2006.

## SPECIFIC TERMS OF REFERENCE FOR SUSTAINABLE ENERGY

**Sustainable energy:** To provide input to the ongoing effort of ICSU to develop plans for an International Science Panel on Renewable Energy (ISPRE); and to build its recommendation on discussions within the Inter-Academy Council study, " Transitions to Sustainable Energy Systems".

ICSU
International Council for Science



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