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Hydropower resource assessment in Africa

Water for agriculture and energy in Africa: The challenges of climate change

Report of the ministerial conference - 15-17 December 2008 - Sirte, Libyan Arab Jamahiriya

Executive summary

Hydropower is one of the cleanest and most reliable sources of energy. Environmentally conscious countries such as Canada, New Zealand, Norway and Sweden have chosen hydropower as their main source of electricity generation.

Compared to other developing countries the level of access to electricity in Africa is low, despite the continent s rich resources. Over 90 percent of the rural population relies on traditional biomass energy sources such as wood, charcoal, crop waste, manure, etc. for cooking and heating, and candles and kerosene for lighting.

The African continent is endowed with enormous hydropower potential that needs to be harnessed. Despite this huge potential, which is enough to meet all the electricity needs of the continent, only a small fraction has been exploited. This may be related to the major technical, financial and environmental challenges that need to be overcome to develop of this resource base.

Energy security and access challenges are the main issues to address in terms of the developmental agenda of Africa to attain the Millennium Development Goals (MDGs). Hydropower has a great role to play in solving Africa s energy security and access issues.

NEPAD s vision for the energy sector has targeted the exploitation of Africa s vast hydropower potential in order to address the socio-economic problems of the continent. The total installed capacity of Africa is about 20.3 GW with a total generation of 76 000 GW/year. A comparison with the gross theoretical hydropower potential of about 4 000 000 GWh/year indicates that the current production from hydropower plants in Africa is about 20 percent of the total potential.

The focus over the years in many African countries has been on large-scale hydropower schemes. Recent studies have shown that electricity generation through small hydropower (SHP) is gaining ground due to its short gestation period, low investment and lowest environmental impacts. Also, economically viable and proven small-scale hydropower technologies have been commercially developed and are available for generating both electrical and mechanical power for rural industrialization and development. This report is an attempt to compile available information on large and small hydropower (SHP) capacities for currently installed, potential, ongoing and pipe-line projects in Africa.

Introduction

Global overview of hydropower

Rising oil prices, increasing global energy consumption and concern for the environment has led to a renewed interest in alternative energy sources such as renewable energy. Renewable energy currently constitutes about 17 percent of the global energy mix with hydropower making up about 90 percent of this. Most renewable energy sources are clean and environmentally benign and would contribute towards mitigating the effects of greenhouses gas emissions and global warming.

Hydropower currently contributes about 20 percent to the global electricity supply, second to fossil fuel. It is anticipated that the global demand for electricity will increase steadily and the growth for hydroelectricity is projected at 2.4 to 3.6 percent from 1990 to 2020. A large number of hydropower development projects with a total capacity of 100 000 MW are ongoing globally. The greatest contribution to current hydropower development is from Asia (84 000 MW). Contributions from other regions are: South America (14 800 MW), Africa (2 403 MW), Europe (2 211 MW), North and Central America (1 236 MW) (Bartel, 2002).

The technical hydropower potential of Africa is around 1 750 TWh which is about 12 percent of the global capacity. Only 5 percent of this technically feasible potential is exploited.

Small hydropower (SHP) development is poor throughout Africa. It is anticipated SHP will form part of the solution to the growing demand for rural electrification programmes in Africa.

Hydropower and poverty

A number of research studies have indicated a strong correlation between energy consumption and economic growth. Access to modern energy services directly contributes to economic growth and poverty reduction through the creation of income-generating activities. Contributions to poverty reduction may arise from time being freed for more productive activities.

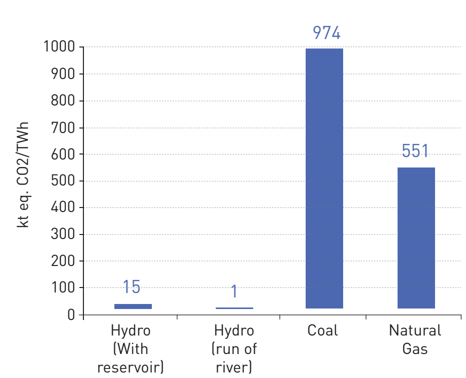
The Millennium Development Goals (MDGs) are the international community s commitment to halving poverty in the world s poorest countries by the year 2015. Whilst some of these countries have seen tremendous success in poverty reduction over the past decade, others, especially in the sub-Saharan African region, are lagging behind. Electricity is essential for the provision of basic social services, including education and health, and also for powering machines that support income-generating activities to reduce poverty. Harnessing hydropower to generate electricity can ensure energy security, which can be an effective way to reduce poverty in Africa.

Hydropower and climate change

Energy derived from moving water is environmentally benign as compared to that obtained from burning fossil fuels. Hydroenergy does not lead to the emission of greenhouse gases (GHG) and therefore do not contribute significantly to global warming. It was previously held that dam reservoirs does not emit any greenhouse gases. This view is changing due to clean development mechanism (CDM) studies which were undertaken.

Under the Kyoto Protocol industrialized nations are committed to reducing their greenhouse gas emissions, including carbon dioxide and methane. One mechanism for achieving emission reductions is the CDM approach, where countries can reduce emissions by purchasing emission credits from other countries that invest in projects and programmes that avoid GHG emissions and produce a net global reduction in emissions. CDM depends on the ability to assess accurately the emissions avoided so that a net reduction can be verified and evaluated. Studies carried out on dams to verify their suitability for CDM projects have

Figure 1: Greenhouse gas emissions of selected power generation technologies



shown that dam reservoirs produce small quantities of greenhouse gases. Figure 1 shows GHG emissions from selected power generation technologies. Hydropower from run-of-river shows the least GHG emission.

Hydroelectric power development in Africa

Energy supply is the main economic challenge facing the African continent. Electricity production is mainly from hydropower and fossil fuels. Access is very low in most countries, the lowest per capita consumption being 80 KWh as compared to a continental average of 359 KWh. This is very low when compared with the EU average of 3 750 KWh. New research indicates a direct correlation between energy usage and economic development. China, for example, has moved 300 million of its people out of poverty since 1990 due to increased access to energy.

Hydroelectric power potential in Africa

Africa has 14 percent of the world s population but only four percent of the global energy. The majority of Africans live in rural areas using traditional biomass for cooking. Africa has enormous potential for hydropower development due to adequate water resources both perennial and non-perennial which need to be harnessed for socio-economic development. It has about 10 percent of the world s hydropower potential but less than 10 percent is utilized. Hydropower potential of the continent is estimated at 100 000 MW, the bulk of which can be found in the Inga in the Congo basin. The Inga rapids which is one site that has an estimated hydropower potential of 40 000 MW.

Large hydropower/SHP development in Africa

Current status of large hydropower

Africa has one of the biggest hydropower potentials in the world but currently uses only a fraction. The total installed capacity is 21 000 MW, 90 percent of which is concentrated in eight countries (DR Congo, Egypt, Gabon, Ethiopia, Nigeria, Zambia, Madagascar and Mozambique). Figure 2 shows the hydropower potential for selected countries. The highest installed capacity is found in DR Congo. Figure 3 shows the contribution of hydropower to net electricity generation and Figure 4 shows the hydropower potential by region. All regions of the world are experiencing increases in the world installed capacity with China showing the greatest increase.

The potential for exploitable hydropower in Africa is high but only 7 percent is exploited. Table 1 shows the summary of Africa s hydropower development. It indicates that the installed hydropower capacity is about 20.3 GW with a total generation from hydroplants of about 76 000 GWh/year. Comparison with the gross theoretical hydropower potential of 4 000 000 indicates that the current production of hydropower in Africa is about 20 percent of the total potential. Table 2 shows the installed large hydropower by region. Countries with installed capacity of more than 1 000 MW have a total installed capacity of about 13 GW comprising 65 percent of the total hydropower installed capacity of Africa. The remaining 45 countries account for 35 percent of the total installed hydro capacity.

Figure 2: African hydropower potential

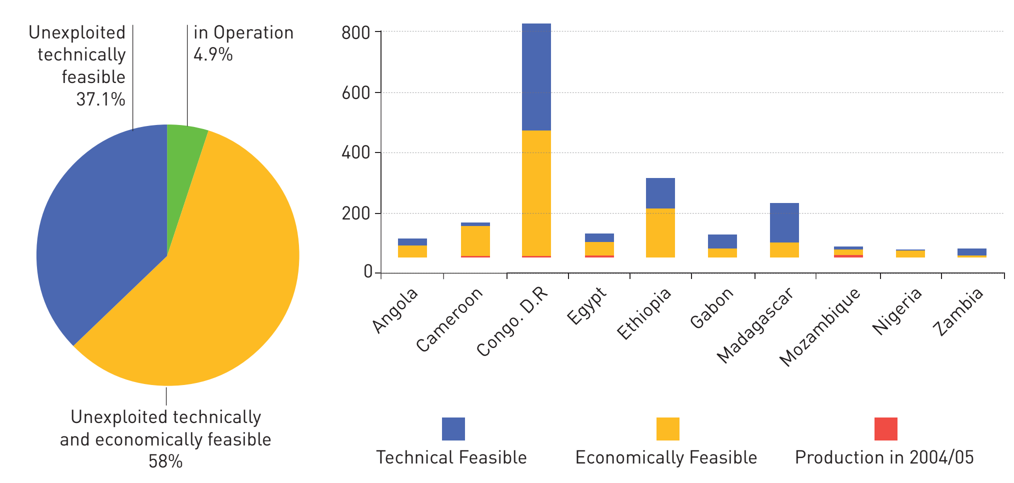
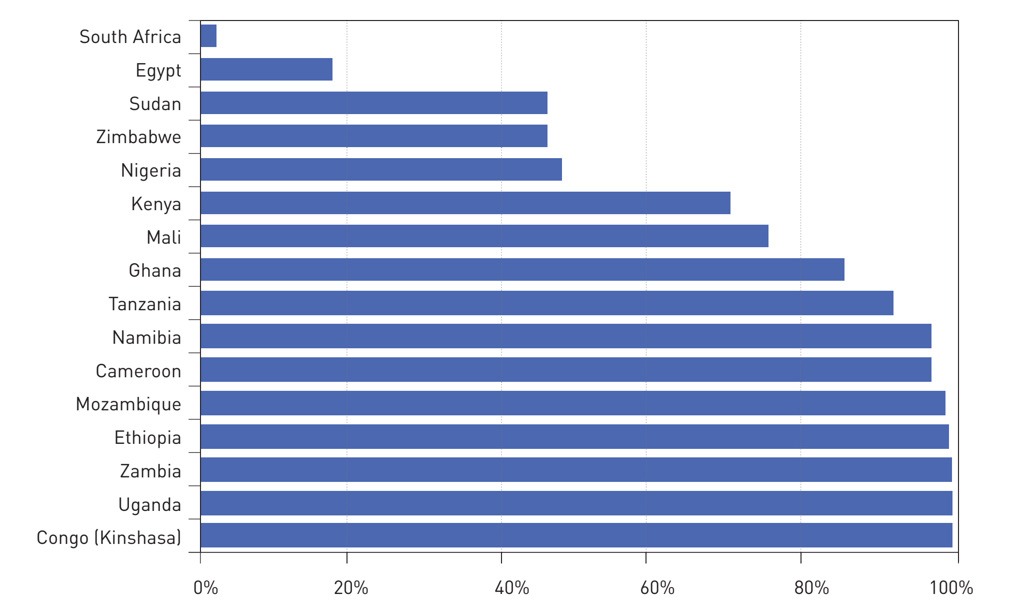


Figure 3: Contribution of hydropower to net electricity generation (2002)

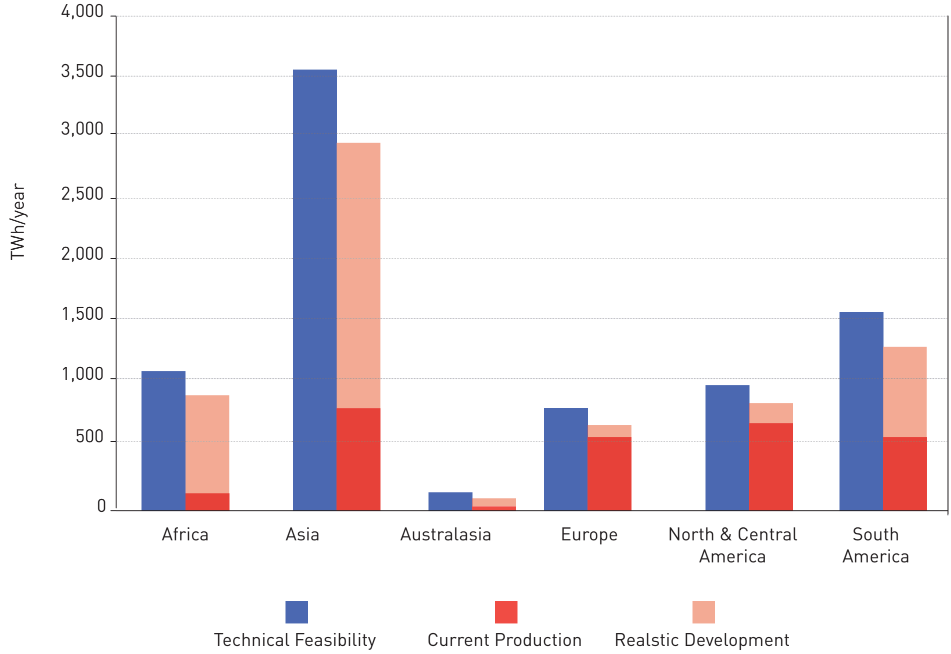


Source: International Energy Agency

Table 1: Summary of Africa s hydropower development

Theoretical hydropower potential (GWh/ year)	Technically Feasible hydropower potential (GWh/ year)	Economically feasible hydropower potential (GWh/ year)	Installed hydropower capacity (MW)	Generation from hydropower plants (GWh/ year)	Hydropower capacity under construction (MW)	Planned hydro capacity (MW)
4 000 000	1 750 000	1 000 000	20 300	76 000	2 403	60 000

Figure 4: Hydropower potential by region



Source: WEC, 2007, Survey of Energy Resources

Table 2: Installed large hydropower by region

Country	Subregion	Capacity
Egypt	North Africa	2 810
DR Congo	Central Africa	2 440
Mozambique	Southern Africa	2 180
Nigeria	West Africa	1 938
Zambia	Southern Africa	1 634
Morocco	North Africa	1 205
Ghana	West Africa	1 072
Total		**13 279**

Current status of SHP

Renewable energy constitutes about 17.9 percent of global energy out of which hydropower forms 16.1 percent. The remaining 1.8 percent comes from wind, geothermal, bioenergy and solar. This means that hydropower forms 90 percent of total renewable energy.

Small hydropower plays a dominant role in rural renewable energy markets. SHP plays a great role in remote off-grid communities with typical applications in areas such as rural residential community lighting, television, radio and telephony, rural small industry (agriculture and other uses) as well as grid-based power generation. SHP can serve two main purposes, namely, social and commercial. The social SHP supplies electricity in stand alone mode characterized by small capacity and poor load factor; often used in distribution and normally government supported. Overheads and maintenance costs are recovered through collection of user charges. Commercial SHP, on the other hand, have larger capacities, sell power to power-distribution or trading companies, are grid connected and have higher load factor.

Table 3 shows the regional contribution to global SHP installed capacity. It indicates that Africa has one of the lowest SHP installed capacities despite the enormous potential for SHP development. Table 4 shows the installed capacities for some selected countries in Africa. Nigeria, for instance, has an installed SHP capacity of 33 MW and a potential of 3 500 MW. This indicates only 1 percent of the SHP potential.

Table 3: Regional contribution to global SHP installed capacity

Region	Installed capacity	Percentage of total
Asia	32 642	68
Africa	228	0.5
South America	1 280	2.7
North & Central America	2 929	6.1
Europe	10 723	22.3
Australasia-Oceania	198	0.4
Total	**47 997**	

Source: Taylor et al. 2006

Table 4: SHP capacities for selected countries

Country	Installed capacity	Country	Installed capacity
Algeria	42	Lesotho	3.54
Morocco	30	Mali	5.0
Tunisia	15	Ghana	10
Egypt	10	Nigeria	33.18
Uganda	0.5	Malawi	1.52
Mauritius	6.7	Botswana	1.0
Kenya	6.28	Rwanda	1.0
Burundi	5.17	South Africa	0.4
Somalia	4.60	Swaziland	0.3
Zambia	4.50	Mozambique	0.1
Tanzania	4.00		

Barriers

The key barriers to the development of SHP in Africa are summarized below:

1. Lack of infrastructure in the design and manufacture of turbines, installation and operation.
2. Lack of access to appropriate technologies pico, micro, mini and small hydropower. Networking, sharing of best practices and information dissemination through fora and conferences.
3. Lack of local capacity (local skills and know-how) in developing SHP projects. There is the need for technical assistance in the planning, development and implementation.
4. Lack of information about potential sites (hydrological data).
5. Lack of SHP awareness, incentives and motivation.
6. Lack of national governments investment and policies in energy technologies.

Table 5: Economic and technical hydropower that have been developed

Country	Installed Capacity
Asia & Eastern Europe	22
Western Europe	75
Africa	7
North America	69
Oceania	49
South America	33

Source: World Atlas of hydropower & dam, 2002

Regulation

There is no single definition of SHP in Africa. In Nigeria, for example, the following definition is used:

Small hydro: 1.001 10.0 MW
Mini hydro: 0.50 1.00 MW
Micro hydro: less or equal 0.5 MW

The regulatory framework in most countries is by Act of parliament. The mission of such Acts will *inter alia* seek to ensure adequate, safe, reliable and affordable power supply. A country s electricity regulatory commission may be tasked with the following responsibilities:

- promotion of competition and fair market practices;
- protecting the interest of consumers;
- ensuring cost recovery and adequate ROI; and
- ensuring best practice in power and service delivery.

The electricity regulatory commission may also perform the following functions:

- issuance of license to operators;
- setting of tariffs;
- arbitration of disputes;
- performing audits; and
- reporting regulatory activities to government.

The above definition indicates that SHP schemes with capacities of less than one MW may not require a license but may still come under regulations of the electricity regulatory commission.

With respect to SHP the regulatory commission s tasks will include licensing/registration, setting of tariffs, performance and customer service standards. The regulation of SHP schemes is found to be problematic due to complexities arising from factors such as the small size, high unit cost and the dispersed nature of SHP projects. The large number of projects involved makes it difficult to adopt a case-by-case treatment. Additional factors such as remoteness of the site, civil works involved (waterways), transmission lines, generating equipment (turbines, generators, etc.) lead to cost variations adding to the complexities of regulation.

The small-scale nature of SHP makes it difficult for operators to carry regulatory burdens such as licensing fees, operating charges, operating standard codes, high technical standards for power supply, service delivery and performance requirements.

For the promotion of SHP in Africa, it is imperative for the above regulations to be reduced in favour of the small player. Such relaxed regulations may include permitting a new entrant to register or receive a permit, flexibility in quality regulation between categories of providers and the use of subsidies to bridge the gap between tariffs and cost recovery levels.

The primary goals of effective SHP regulation will incorporate increased SHP penetration into the electricity market, SHP sustainability, system cost reduction, development of local industry, sound investment climate and simplicity of implementation.

Regional energy integration: the regional power pools

A recent study conducted by the World Energy Council (WEC) members in Africa discovered that the conventional approach of limiting energy planning and provision to the individual nation states is detrimental to energy access issues on the continent. The nation-based planning is not the best in several respects including the:

- cheapest and cleanest source of energy may be found across national boundaries;
- national energy markets are often too small to justify investments;
- cross border energy could contribute towards energy security due to diversification of energy sources.

The study further revealed four major benefits that regional integration could bring. These are: improved security of supply, enhanced environmental quality, wider deployment of RE resources and better economic efficiency.

Proposed regional integration projects include Zambia-DR Congo, South Africa interconnections, Zambia-Tanzania interconnections and West Africa Grid Network and Power Pool.

Access to modern energy services is vital for the socio-economic development of Africa. The problem of low access could be eradicated through projects such as the INGA. The large hydro potential of Africa could be developed as a regional rather than a national project. This would help expand energy markets in the area and secure supply to those who have no access to electricity. In DR Congo INGA could provide sufficient electricity to the African continent and help Africa export energy through possible interconnection links with southern Europe. Three major INGA interconnection projects identified include:

- Northern Highway (between INGA site and Egypt).
- Southern Highway (between INGA site and South Africa).
- Western Highway (between INGA site and Nigeria).

The main objectives of a project such as the INGA are to bring affordable and clean energy to the African continent and to improve the standard of living. The project will lead to cross border cooperation in Africa and beyond. This will bring interdependence and prosperity to Africa.

The Manantali dam on the Senegal River with a capacity of 200 MW is an example of a regional Integration project serving Senegal, Mali and Mauritania. The objectives of the project are to install power generation capacity to generate economic and financial benefits, to minimize the cost of electricity supply to the three countries, and to provide hydropower to help meet the increased electricity demand and reduce costs in Dakar, Bamako and Nouakchott.

Security of supply and accessibility

Security of supply involves ensuring uninterrupted daily operation of power supply systems, at the same time coping with short-term problems such as international price volatility and environmental concerns and industrial action. Security of supply underpins the development of interconnection between countries and regions. In the long term, security of supply involves the depletion of global and national energy resources and the capacity to diversify energy supply options.

Hydropower/small hydropower database for Africa

Overview

There is enormous potential exploitable hydropower on the African continent. In spite of this, Africa has one of the lowest electricity utilization rates in the world. Presently, less than 7 percent of this potential has been harnessed. Africa has many rivers running through the Eastern, Western, Central and Southern parts of the continent that provide excellent opportunities for hydropower development. Many countries in Africa do not, however, have coherent data on both large and small hydropower potentials. The UNIDO Regional Centre on SHP (U-RC-SHP) in Abuja is currently collating such information.

Regional contributions

North Africa

Countries like Algeria, Egypt, Libya, Morocco and Tunisia are grouped under this region. Out of the current 20.3 GW about 23 percent is located in North Africa. In terms of large hydropower development, Algeria, Libya and Tunisia are poorly developed. These countries depend more on sources of electricity other than hydropower. Egypt and Morocco have installed capacities of 2 810 and 1 205 MW respectively, making the greatest contribution to the total installed capacity in the region. The potential of North Africa is almost exhausted. The majority of the installed capacity can be traced along the Nile with the Aswan Plant taking about 2 100 MW of Egypt s total capacity.

Southern Africa

The countries that constitute the Southern region are: Botswana, Lesotho, Madagascar, Namibia, South Africa, Swaziland, Zambia and Zimbabwe.

The region exploits about 60 percent of its potential. South Africa has very little potential left to be exploited. Botswana has very little potential and relies on other sources of electricity. Zambia has the greatest potential in the region and has developed 30 percent of it. Much of the potential in Zambia is along the rivers Zambezi and Kariba, shared by Zambia and Zimbabwe. Plans are in place for the exploitation of the potential in the region.

East Africa

East Africa has the second largest potential in Africa with about 20 percent of its capacity developed. It comprises the following countries: Burundi, Kenya, Djibouti, Eritrea, Ethiopia, Kenya, Malawi, Rwanda, Somalia, Sudan, Tanzania and Uganda.

Somalia, Eritrea and Djibouti are poorly developed. Ethiopia has the greatest potential in the region with a capacity of 15 000 MW followed by Kenya with 9 000 MW. Kenya has, however, developed more of its potential (13 percent) than Ethiopia (1 percent).

West Africa

West Africa s contribution to installed large hydropower capacity is about 25 percent. Nigeria and Ghana are the biggest contributors. The potential for large hydropower is enormous in countries such as Guinea (6 100 MW) and Nigeria (11 500 MW). Sierra Leone, Togo, Gambia and Cape Verde are poorly resourced with hydropower potential. The contribution from SHP is very small in West Africa despite the high potential for SHP.

Central Africa

Central Africa has enormous hydropower potential concentrated around the Congo basin. DR Congo contributes the most. The current installed capacity of large hydropower is around 3 816 MW and a potential of 419 000 MW with the highest contribution coming from the INGA sites. This indicates that DR Congo has exploited just 1 percent of its potential capacity.

Africa s hydropower project partners

A number of financial institutions have provided and continue to provide billions of dollars in assistance for large hydropower projects in Africa. This section seeks to highlight a few of these donors and the projects they have funded.

Large hydropower projects

Multilateral banks/World Bank and African Development Bank (AfDB)

Multilateral organizations such as AfDB and the World Bank have financed a number of large hydropower projects in Africa. AfDB, for example, has provided financial support to the following projects:

- US$14 million for part of the INGA II project;
- US$18.7 million grant to finance a hydropower project in Conakry, Guinea; and
- US$16 million for the Bumbuna dam project, 50 MW, in Sierra Leone, West Africa.

World Bank projects:

- US$300 million for the Bujagali Hydropower project on River Nile, Uganda, 250 MW capacity ongoing and to be commissioned in 2011; and
- Uganda, 200 MW Karuma Falls hydropower project.

China

The power sector in Africa attracts the largest amount of financing from China. Much effort is concentrated in hydropower schemes. By the end of 2007 China was involved in ten major hydro-electric power dams in nine African countries with a combined generating capacity of 6 000 MW of electricity. The location, capacities and current status of these projects are:

Country	Capacity (MW)	Status
Mambilla dam, Nigeria	2 600	Under Federal government discussion
Merowe dam, Sudan	1 250	Advanced stage of construction
Katue, Zambia	Over 1 000	Under construction

The projects total cost is around US$5 billion out of which China is financing US$3.3 billion. China uses African natural resources to secure some of the financing; for example, ongoing projects on the Congo River in Congo and Bui dam in Ghana are financed by China Ex-Im Bank loans backed by guarantees of crude oil in Congo and Ghana respectively.

Others

- East African Development Bank (EADS) partly financed the installation of 150 km high voltage transmission line from the Kiambre power station to Nairobi, Kenya; and
- West African Development Bank (WADB).

Small hydropower projects

World Energy Council (WEC)

The World Energy Council is a multi-international organization covering all types of energy resources with members in 94 countries. WEC s mission is to promote sustainable supply and use of energy for the benefit of people.

Accessibility is one of WEC s millennium energy goals in Africa where the access rate is the lowest in the world. The INGA project offers a unique opportunity to provide affordable and clean electricity access to millions of Africans. In this regard, WEC, to facilitate action on the Grand INGA, organized an International Forum in 2007 on How to make the Grand INGA River hydropower project happen for Africa in Botswana. This was followed up in 2008 by a Workshop organized on Financing INGA Hydropower Projects in London.

WEC s Policy framework for Africa s Hydropower development can be summarized as: improving existing hydropower capacity, advancing the development of regional projects identified, implementing identified projects (INGA, Mepanda Uncua, etc.), identifying and implementing other regional projects and building capacity for small and medium hydropower projects.

Under the WEC/NEPAD policy framework, these policy initiatives were established:

Establish a committee on hydro power development with specific tasks:

- map out the existing facilities and identify opportunities for improving their performance; and
- identify centers of excellence within each subregion to serve as training centers to share experience.

Work with Regional Economic Commissions (REC) and appropriate institutions at the national level to:

- support the development of identified regional projects such as Grand INGA;
- finance facilitation of country projects;
- develop policy at sub-regional levels;
- support African Energy Commission (AFREC) to institutionalize actions mentioned above;
- set up a fund to facilitate the development of small to medium hydro projects to which corporate entities could apply;
- produce annual hydropower publications in Africa to provide information on new projects and status of on-going works; and
- support and collaborate with hydro power research centers and networks.

Africa s hydropower project partners

UNIDO - UNIDO has identified SHP as a tool for rural industrialization and poverty reduction in Africa.

UNIDO-IC-SHP/Lighting up Rural Africa - UNIDO and the International Centre for SHP in 2007 organized the Third Hydropower Potential in China with the theme Lighting up Rural Africa . Under South-South cooperation, UNIDO in collaboration with IC-SHP plan to scale-up SHP production in Africa through the development and production of 100 SHP projects in the next three years.

UNIDO-RC-SHP/Pilot Projects in Africa - UNIDO Regional Centre for SHP (RC-SHP) was established in 2005 in Abuja, Nigeria with the mandate to provide technical assistance to countries within the region. U-RC-SHP hosted the Fourth International Hydropower for Today Forum in Abuja, Nigeria on Small/Mini/Micro hydropower development and management in Africa. UNIDO is currently running a number of pilot projects on SHP in countries such as Tanzania (75 KW), Nigeria (34 KW), Madagascar, Uganda (250 KW) etc. UNIDO-RC-SHP has also carried out SHP refurbishment projects in the following parts of Nigeria: Talata Mafara, Zamfra State (3.4 MW) and Oyam Dam, Ogun State (9 MW). Table 6 is a list of UNIDO projects in selected African countries.

RC-SHP is currently involved in activities such as the collection of data and creation of an SHP database for Africa, organizing workshops and conferences for capacity building and SHP potential site identification.

Table 6: UNIDO Project in Africa

Nigeria	Enugu - Waya	40 kW - 150 kW
Rwanda	Nyamyotsi 1	75 kW
Kenya	4 sites	2 kW
Tanzania	Kinko	12 kW
Mali	Sirakorbougou	3-5 kW

UNIDO-AFREC - Africa Energy Commission (AFREC) has a plan of action that complements U-RC-SHP in Abuja s activities and includes:

- developing information system database for SHP;
- developing a continental master plan for SHP;
- identifying and removing barriers;
- technology transfer;
- capacity building - designing short courses and training sessions; and
- financing, organizing symposiums on strategies for attracting finance for SHP projects.

Impacts

Inter-linkages between agriculture and hydropower

Availability of water is of considerable importance for agriculture. The majority of dams are constructed primarily for irrigation or agricultural purposes, thus contributing to the world food production. Most African staple foods need processing, are conserved and cooked, and these require modern energy for a reasonable quality of life. Paradoxically, most countries in sub-Saharan Africa that suffer from hunger also suffer from major on-farm and off-farm food losses that could be reduced by improving harvesting and storage facilities, by introducing modern energy, in this way large food imports could be reduced.

On the other hand, the construction of dams affects land use, either directly or indirectly. For example, hydropower projects with reservoirs transform forests and land into aquatic ecosystems, thereby effectively reducing available farmlands. Dams constructed for power generation can also compete in part with the use of water for irrigation since using the energetic potential of hydropower by running turbines means that the water is only available at a lower altitude afterwards. For this reason there has been consensus in most countries that an integrated approach to the management of water resources serves best the exploitation of hydropower resources.

Dam construction assessment

World Commission on Dams Report

The World Commission on Dams (WCD) was established to address the controversial issues associated with large dams. In 2000, the WCD produced a report that made recommendations ensuring the social and environmental aspects of large dams are addressed adequately in the planning, construction and operation phases. The report summarized the lessons learned from a Global Review of experience with large dams and elaborated the development framework within which controversies and underlying issues can be understood and addressed, and proposes a decision-making process based on negotiated outcomes. It offers a set of strategic priorities, principles, criteria and guidelines to address the issues around existing dams to be used in exploring new water and energy development options. The Commission s framework for decision-making is based on five core values: equity, sustainability, efficiency, participatory decision-making and accountability.

International Union for the Conservation of Nature (IUCN)

Many organizations and governments have reacted to the World Commission on Dams Report following its release. For most, the report does not offer a final verdict on dams; instead it provides a new framework for improved decision-making for water and energy development (UNEP, 2001). Several other organizations, however, are in favour of the recommendations and are committed to their dissemination. One such body is the International Union for the Conservation of Nature (IUCN). Founded in 1948, its headquarters is located in Gland, Switzerland; the IUCN brings together 83 states, 108 government agencies, 766 non-governmental organizations and 81 international organizations and 10 000 experts and scientists from around the world. IUCN has many years of experience in ecosystem rehabilitation and participatory management and, more specifically, in field level activities.

Following up from the WCD Report, the IUCN developed a programme that provides a good basis for acting proactively in support of the WCD recommendations. It provides a clear mandate to make full use of the WCD Report through the effective management and restoration of ecosystems, and the assessment of biodiversity and of other related social and economic factors. Furthermore, IUCN aims to demonstrate how the ecosystem approach to water management should be implemented through a new portfolio of 30 projects around the world. At these sites, IUCN will play an important role in fostering implementation, adaptation and testing of the WCD recommendations by working with the main dam stakeholders (UNEP, 2001).

Public and private investors

As seen from the discussion in the previous sections, dams are generally built to generate hydroelectricity, provide irrigation water, or as part of flood control programmes. Depending on the interest group, dam building has brought major benefits; resulted in considerable human suffering; or had a harmful effect on the environment. These factors have had considerable impact on the prospect of building large dams.

Globally, only a handful of private sector hydroelectric projects have managed to attract the investment required, most rely on state involvement in one form or another. One reason is that hydropower is perceived as carrying a number of financial risks that make dams a less attractive investment than other power projects (Hildyard, 1998).

Economic impacts

Hydropower schemes generally involve a huge civil engineering effort and are characterized by high capital costs. The payback on the investment required can be a lengthy process and sometimes has a detrimental effect on a nation s economy. In Africa, where financial resources are scarce, the high up-front costs of hydropower investment are a barrier to the development of this resource (European Union, 2007).

Despite the high upfront costs, hydropower is a well-established and proven technology with low operating and maintenance costs. The economy of countries that depend heavily on fuel imports could benefit from hydropower as it does not depend on energy imports and is unaffected by fluctuating international energy prices.

Conclusions and recommendations

The major conclusions and recommendations are summarized as below:

- Africa is currently using 20 percent of its hydropower potential with non-uniform regional distribution. Some regions are more endowed than others. A few countries with installed capacities of more than 1 000 MW constitute about 65 percent of the total energy installed. The energy imbalance needs to be addressed through regional integration.
- Financing of energy projects is low because of the low level of hydropower technology and the huge cost of power projects in Africa.
- Private-public partnership option to raise capital and share investment risk.
- Reform power sector to attract private sector participation and financial flow.
- Africa is characterized by a low level of technology for hydropower. Hydropower technology is widely available elsewhere worldwide and technology transfer is the immediate option to enhance development.

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