


Scaling up Renewable Energy in Africa

12th Ordinary Session
of Heads of State and Governments
of the AFRICAN UNION

Addis Ababa, Ethiopia

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INDUSTRIAL DEVELOPMENT ORGANIZATION

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FOREWORD

The energy challenges Africa faces are urgent and seem daunting. Encouraging progress is however being made in a number of countries to address these challenges. There remains, however, much more to be done if we are to ensure that the continent will increase access to sustainable and reliable energy supplies. Compelling evidence from different countries in Africa and elsewhere now show that renewable energy systems, both small and large-scale are part of the energy solution of the continent. Policy makers therefore need to send strong signal to all development partners of their commitment to the development of renewable energy resources as part of the process of developing the continent. Likewise, the international community is equally called upon to rise to the challenge and ensure that renewable energy resource on the continent significantly contribute to the energy mix.

H.E. Dr. Jean Ping
Chairperson of the African Union Commission

FOREWORD

There is no doubt that, if properly exploited, renewable energy resources in Africa can make a significant contribution to the continent's energy supply. In particular, the potential of biofuels on the continent is huge. Within the context of the current financial crisis, stakeholders including policy makers, international partners and the UN should lead the debate on and collectively seek strategies for scaling up renewable energy use so as to increase access to energy and enhance energy security among the many potential benefits of these technologies.

Dr. Kandeh K. Yumkella
Director-General, UNIDO

Acronyms

AfDB	African Development Bank
CDM	Clean Development Mechanism
CO2	Carbon Dioxide
EAC	East African Community
ECOWAS	Economic Community of West African States
EE	Energy Efficiency
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gases
GW	Giga Watts
FDI	Foreign Direct Investment
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
kW / kWh	Kilo Watts / Kilo Watt Hours
MDGs	Millennium Development Goals
MHP	Micro Hydropower System
MW / MWh	Mega Watts / Mega Watt Hours
NSI	National System of Innovation
PRSP	Poverty Reduction Strategy Paper
PV	Photo Voltaic
RE	Renewable Energy
REC	Regional Economic Community
REN21	Renewable Energy Policy Network for the 21st century
RETs	Renewable Energy Technologies
SADC	Southern African Development Community
SHP	Small Hydropower System
SHS	Solar Home System
TOE	Tonne of Oil Equivalent
TWh	Terra Watt Hours
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
WB	World Bank

SUMMARY

There is consensus that energy is directly linked to the key global challenges that the world faces today. As such, the development of sustainable and long-term solutions to meet these growing, diverse and urgent energy challenges assumes special significance for developing countries in general and countries in Africa in particular.

Africa continues to face critical challenges related to its energy sector. The current energy policies and systems have failed to provide the platform needed to support the economic development of the majority of Africa's poor. In fact, energy has been supplied in insufficient quantity, at a cost, form and quality that has limited its consumption by the majority of Africa's population, making the continent the lowest per capita consumer averaging about 0.66 Tons of Oil Equivalent (TOE) compared to the global average of 1.8 toe in 2008[1]. Over the past four decades, the gap between energy supply and demand in Africa has actually widened, while it has narrowed in other developing countries. Unless drastic interventions are made, recent trends indicate that this gap will continue to grow, and a majority in Africa will continue to lack access to basic energy services and hence would have limited chances of realizing any meaningful social and economic development.

It is widely acknowledged that while the ongoing global credit and financial crisis would have a major impact on infrastructural financing in general and energy financing in particular, it also offers a huge opportunity to re-direct future investments into "green energy" and "green growth" opportunities that will provide a new driving force for the revival of economic growth , and promote investments in clean, efficient and renewable technologies.

In light of recent high and volatile oil prices, renewable energy has emerged as a viable option at most places that can effectively contribute towards addressing the continent's energy challenges. Efforts to develop renewable energy in Africa have, so far, focused on removing barriers, and much more still needs to be done. What is also now clear is that sufficient good lessons learned from projects implemented across the continent and elsewhere can be instructive in defining a more proactive, concerted and continent-wide effort to scale up the deployment of renewable energy technologies.

This paper proposes that the scaling up of renewable energy to levels that would have a significant impact on the continental energy scene could be achieved through deliberate interventions on policy and institutional environment; technology acquisition, development and integration; investment mobilization; and regional integration, networking, and capacity building. Policy makers in Africa are recommended to recognize the potential role of renewable energy in meeting the energy challenges being faced by the region, and assume a proactive role in implementing the recommendations of this paper. There is an urgent need to assume an integrated and coordinated approach at a regional level to scale up the deployment of renewable energy technologies so as to increase access to modern energy services and increase energy security to support economic and social development.

1 International Energy Agency, 2008, Key World Energy Statistics 2008.

I. INTRODUCTION

A. The Energy sector: status and challenges

1. Africa is endowed with vast renewable and non-renewable sources of energy. It is estimated that the continent has 1,750TWh potential of hydropower and 14,000 MW of geothermal potential. The continent receives abundant solar radiation through the year, and recent studies have confirmed the availability of abundant wind energy resources along some of the coastal and specific inland areas of Africa. With respect to non-renewable energy, coal resources are available in abundance in Southern Africa. At the end of 2007, the continent had over 117 billion barrels of oil of proven oil reserves and over 14.6 trillion cubic meters of proven gas reserves.

2. However, these energy endowments remain largely underutilized. For instance, only 5% of the continent's potential of hydropower has been exploited[2], while the same figure for geothermal is 0.6%[3]. In 2007, the continent contributed to 12.5% of global oil production but only consumed 3.5% of the oil consumed globally[4], thereby effectively making Africa a net exporter of oil. The resulting energy poverty remains a serious impediment to economic and human development in most parts of the continent. As a region, Africa continues to face critical challenges related to its energy sector, which is characterized by lack of access to modern energy services (especially in rural areas), poor infrastructure, low purchasing power, low investments and over-dependence on traditional biomass to meet basic energy needs. Furthermore, energy use across the different sectors remains quite inefficient, with the continent still having the highest energy intensity per unit of GDP.

3. Compared to other parts of the world, energy deprivation or the lack of access to energy is most prevalent by far in Africa. Access to the electricity grid in many Sub-Saharan countries is less than 1%[5]. Recent trends indicate that over 60% of Sub-Saharan Africans will still not have access to electricity by 2020. Traditional biomass[6], despite the environmental, social and health problems associated with it, still remains the main source of energy for the majority of the poor. It accounts for 70-90% of primary energy supply in some countries, and as much as 86% of energy consumption. In some countries biomass energy contributes as much as 97% of total energy supply. Distinct variations exist within Africa, with biomass accounting for only 5% of energy consumption in Northern Africa and 15% in South Africa[7]. Unless significant measures are taken, the status quo is not likely to change; current projections show that the absolute number of people relying on biomass energy in Africa is expected to increase from 583 million in 2000 to 823 million in 2030, an increase of about 27%[8].

4. Some of these resources are unevenly distributed. For instance, over 80% of the oil resources in Africa are located in four countries i.e. Algeria, Libya, Nigeria and Angola. , This in itself is not necessarily a problem, but there is minimal interstate energy trade. Most African countries (39 countries) are net oil importers, including some oil producing countries. Northern Africa and South Africa account for 30% and 45% respectively of the to-

2 OECD,2003/2004 African Economic Outlook, www.oecd.org.

3 United Nations, 2003, Renewable Energy in Africa: Prospects and Limits , www.un.org.

4 United Nations, 2003, Renewable Energy in Africa: Prospects and Limits , www.un.org.

5 Karekezi, S, 2002b. 'Renewables in Africa – Poverty Alleviation Instrument' First World Renewable Energy Forum: Policies and Strategies. Papers and Documents of the International Conference of the World Council for Renewable Energy

6 Traditional biofuels refers to direct combustion of wood, charcoal, leaves, agricultural residue, animal/human waste and urban waste, for cooking, drying and charcoal production

7 International Conference on Renewable Energy 2004, Traditional Biomass Energy, Improving its Use and Moving to Modern Energy Use, 2004 Karekezi S. et al., www.renewables2004.de.

8 Energy Agency, 2002a. World Energy Outlook, 2002. IEA, Paris

tal electricity generated in Africa. This leaves Sub-Saharan Africa other than South Africa with about 25% of the total electricity generated, although about 80% of the continental population resides in this region[9] .

5. The performance of the power sector has generally been below expectations. In addition to low levels of access to electricity throughout the region, the sector is dogged by erratic and intermittent supply, low capacity utilization and availability, deficient maintenance and high transmission and distribution losses ranging from 15 percent to 45 percent of electricity distributed[10].

6. Most power utilities in Africa are not commercially viable as they charge tariffs that are below costs to promote access to energy by the poor majority. As a result, the utilities are not able to mobilize external capital for maintenance and expansion projects. Some countries are trying to address this dilemma through innovative cross-subsidies and other similar measures[11] with varying degrees of success. The reforms in the power sector initiated in late 1990s to improve operational and technical performance and ultimately attract private sector investments have not yet yielded the expected results. Attracting private sector involvement has dominated the focus of power sector reform orientation, thereby prioritizing profit while neglecting the need to electrify rural areas and poorer urban neighborhoods[12].

7. The energy sector is now facing new challenges in Africa when seen in the context of the ongoing food and financial crisis, high volatility in oil prices and climate change. World Bank recently estimated that the impact of high food, oil, and other commodity prices since January 2007 have reduced the gross domestic product in African countries by 3 to 10%. With millions living on the margin between subsistence and starvation in Africa, high food and fuel prices are a threat to their survival. The IPCC's 4th Assessment Report has clearly demonstrated that climate change is a more urgent problem than previously thought. It is recognized now that on account of climate change, many African countries will experience increased water scarcity, worsened health, lessened food security, and may even affect Africa's greatest renewable energy resource, hydropower. As a result, the economic and social development of the region could be slowed down or even reversed.

8. It is widely acknowledged that the ongoing global credit and financial crisis could have a major impact on infrastructural financing in general and energy production in particular in Africa[13]. However, it also offers a huge opportunity to target scarce investments into clean, efficient and renewable technologies for ensuring sustainable energy supplies. According to the latest REN 21 Report, global investments in new renewable energy capacity, manufacturing and research and development crossed the US$ 100 billion mark in 2007. However, Africa as a continent could attract only a fraction of these investments (according to recent reports Africa received less than $ 1 billion in investments in renewable energy sector – excluding large hydro).

B. Renewable energy for energy access, poverty reduction and attainment of the MDGs

9. Poverty reduction remains the core issue of Africa's development agenda. For African countries, economic and social development cannot be achieved in the absence of adequate energy supplies. Therefore, access to modern energy services is necessary for productive activities and essential services[14]. While reliable energy

9 Calculation based on data from Africa Energy Database. www.afrepren.org

10 Forum for Energy Ministers in Africa, 2007, Energy Security and Sustainability in Africa.

11 Countries include South Africa, India and Philippines.

12 Renewable Energy in Africa: Challenges and Opportunities, African Ministerial Meeting on Energy, 7-8 May 2004.

13 The World Bank estimates that Sub-Saharan Africa needs an annual addition of 4 GW in order to power its economic growth and keep up with the demand for electricity, which is growing at about 5 per cent per year or more in many countries in the region. So far, only 1 GW is being added annually.

14 UNDP, 2005-08 Energizing the Millennium Development Goals: A Guide to Energy's Role in Reducing Poverty

services, by themselves, are not sufficient to eradicate extreme poverty, they are necessary for creating the conditions for economic growth and improving social equality. Access to modern energy services can help reduce spending; because of the inefficiency of traditional energy forms, the poor often pay higher unit costs for energy than do the rich. In addition, women and girls in most parts of Africa spend large amounts of time fetching wood and water, thereby losing time that they could otherwise devote to schooling and revenue generating activities. Furthermore, indoor air pollution from low quality solid cooking fuels (wood, charcoal, dung, waste) imposes a major health hazard for those who spend time close to the cooking area, again, women and girls.

10. In view of their modular nature and availability at the local level, renewable energy technologies can contribute to sustainable development, and assist in addressing the Millennium Development Goals (MDGs) by increasing access to modern energy services to the majority in rural areas. This is particularly true for small-scale renewable energy systems that provide affordable energy to the poor, and help in creating employment by powering enterprises for both the rural and urban poor. The localized nature of many renewable energy resources makes them attractive for decentralized systems that can be used in remote and rural areas, which currently have no access to grid electricity and pay higher prices for energy services delivery. On the other hand, large-scale renewable energy systems could diversify energy supply, reduce energy imports and help in providing significant local and global environmental gains. Annex 1 shows the importance of modern energy to the attainment of MDGs.

II. RENEWABLE ENERGY RESOURCES AND APPLICATIONS IN AFRICA

The renewable energy systems that contribute to Africa's energy needs fall into two categories: Large-scale and small-scale renewable energy systems.

A. Large-scale renewable energy systems

11. Renewable energy sources most used for large-scale applications are hydropower, modern biomass, geothermal, wind and solar energy sources, with these being usually grid connected.

12. Only about 5% of Africa's hydropower potential of just over 1750 TWh has been exploited. The total hydropower potential for Africa is equivalent to the total electricity consumed in France, Germany, United Kingdom and Italy put together. The Inga River in the Democratic Republic of Congo (DRC) holds great potential for hydropower generation in Africa with an estimated potential of around 40,000 MW. In fact, the DRC alone accounts for over 50% of Africa's hydropower potential while other countries with significant hydropower potential include Angola, Cameroon, Egypt, Ethiopia, Gabon, Madagascar, Mozambique, Niger and Zambia. Despite the low percentage use, large-scale hydropower so far provides over 50% of total power supply for 23 countries in Africa.

13. Biomass energy can be used for such large-scale applications as provision of process heat, liquid fuels production, gasification, heat co-generation, biogas production and solid fuel production. Several agro-based industries in the continent, such as wood-based industries, palm produce, rice mills, sugar, and paper and pulp, use their waste to produce both process heat and power, which in most cases is used locally. Co-generation from agriculture waste holds great potential for Africa. Cogeneration contributes as much as 40% of the total electricity generated in Mauritius[15]. With increased efficiency of use and better technologies, most of such facilities can produce significant power to be used for local demand or sold to the national grid. Presently, several countries in the continent produce sugar and have the potential of generating power for their own needs.

15 UNIDO, 2007, Presentations at the First High-Level Biofuels Seminar in Africa,: http://www.unido.org/index.php?id=068431

14. Geothermal energy is an untapped renewable energy source that is abundantly present in many parts of Africa. It has a potential of generating up to 14,000 MW from geothermal sources[16]. However, only few countries such as Kenya have used it commercially. As of today, Kenya has installed up to 127 MW, amounting to about 17% of the national power supply, followed by Ethiopia with a 7 MW installation. Plans to use potential of geothermal energy in Uganda, Tanzania and Eritrea are at different stages.

15. Globally, the use of wind energy for large-scale electricity production has been increasing faster than any other renewable energy technologies over past decade. In 2007, new installations were about 21GW, even more than hydropower[17]. Africa still lags behind other regions and the development of wind energy projects is primarily constrained by lack of precise information about wind potential. In terms of installed capacity at the beginning of 2008, Africa only had about 476MW of installed wind energy generation capacity compared to global estimate of 93,900MW[18]. Countries developing large-scale wind energy projects so far include Morocco, Egypt, Tunisia, South Africa, and Ethiopia[19].

16. Most urban areas in Africa face serious problems with disposal of liquid and solid waste, which could be converted to energy. Existing municipality liquid waste handling and treatment systems can be renovated to capture methane produced, which could then be used to generate electricity to power the treatment plants; the excess could be fed into the grid. Organic municipal solid waste could also be incinerated or gasified to produce energy. Urban waste management is a major challenge in many African cities and heaps of rubbish is a common site. High capital costs and lack of conducive institutional frameworks have hindered the development of plants to convert urban waste to energy.

17. Large-scale solar energy projects are very limited in Africa because of cost constraints. Detailed feasibility studies have established that Africa has great potential for concentrated solar thermal power generation from desert areas like the Sahara, Namib etc., with competitive power production costs around 4-6c/kWh. So far, only South Africa operates a solar thermal power system plant, generating 0.5 MW. Egypt plans to install solar thermal plant of 30 MW by 2010 and 300 MW by 2020. Several countries in Northern Africa are planning to develop solar thermal plants of varying capacities buoyed by interest from European countries.

B. Small-scale renewable energy systems

18. In Africa, small-scale renewable energy systems have mainly been used to increase access to modern energy services. These systems are generally modular and decentralized in nature and thereby able to provide energy services to communities that are not accessed by existing conventional energy supply systems such as the electricity grid.

19. Small-scale energy systems are of two types: The first category produces electricity based on photovoltaics (PV) and wind power, for instance, while the second category produces thermal energy for heating, drying and cooking. Solar home systems in the household sector are by far the most common application of this kind of system. South Africa and Kenya have some of the highest documented installed capacities of solar PV systems that stand at over 11,000 and 3,600 kWp respectively. Unfortunately, poor households have not benefited as much as high income households from solar PV systems because of the high upfront costs. Some solar thermal systems have been disseminated for water heating and solar cookers. Presently, solar water heaters are predominantly used in Eastern, Southern and Northern Africa for household application and in the hospitality industry. Solar

16 The Economist, 2008, Geothermal power in Africa; http://www.economist.com/world/mideast-africa/displayStory.cfm?story_id=12821590

17 REN21, 2008, "Renewables 2007 Global Status report"

18 GTZ Website 2009: http://www.gtz.de/en/themen/umwelt-infrastruktur/energie/12124.htm

19 Africa Wind Energy Association, http://www.afriwea.org/

heater systems have shown to have payback periods between 3-5 years, and like solar PV systems, are mainly owned by high income earners due to their high upfront costs, among other reasons.

20. Small Hydropower systems (SHPs, less than 10MW) can supply energy to remote communities and catalyze development in such communities. In comparison to large hydropower systems, the smaller systems require significantly lower capital costs. This allows increased local private sector participation and community involvement. In environmental terms SHPs are more sustainable than large scale systems. Most African countries have a large potential for small hydro systems and some are already exploiting it with a special focus on rural communities. A further option is represented by micro hydropower systems (MHPs), which are already in place in a number of African countries that can provide electricity on a village level

21. Dissemination of biogas digesters for household applications has not been very successful due to high capital costs, insufficient feedstock and water, high labour demand and negative public perception, among other reasons. Countries like Ghana, Kenya, Niger, Burkina Faso, Mali, Ethiopia, Senegal and Rwanda have implemented pilot projects aimed at establishing the technical and socio-economic viability of biogas technology as an alternative source of energy for cooking and decentralized rural electrification.

22. In the case of Ghana, the Appolonia project installed a system that generates 12.5kW electric power, which is fed into a local grid, supplying electricity at 230V for domestic use to 21 houses, street lighting, and five social centres in the community. The biogas is produced from cow dung and human excreta. Two diesel engines of 8kW each were modified to operate on a dual fuel (mixture of biogas and diesel). Project results show that the diesel-biogas system saves 66% in diesel consumption compared to pure diesel generation[20]. The Biogas for Africa Project[21] is mobilizing stakeholders in scaling up biogas digesters. The dissemination of biogas digesters to institutions is quite promising, with the private sector already leading the dissemination of biogas digesters in countries like Ghana, Rwanda and Tanzania.

23. The majority of sub-Saharan households rely primarily on wood fuel for cooking and heating. Wood fuel is the main source of fuel in rural areas while charcoal is commonly used in the poorer urban households. However, shortages of alternative energy sources including electricity blackouts and brownouts often force even the better-off households to use charcoal. As a response to fuel wood shortages, improved biomass cook stoves have been promoted throughout Africa. However, the level of adoption has been limited due to various factors including cost, effectiveness in fuel or money savings and compatibility with user needs.

c. Energy efficiency

24. Countries in Africa have considerable scope for increasing energy efficiency on the energy supply side and reducing energy consumption on the demand side without decreasing economic output, lowering the standards of living, or diminishing the quantity and quality of social services provided. Studies by the International Energy Agency show that in Africa energy intensity, i.e. total energy consumed per GDP, is at least twice the global average[22]. However, energy efficiency continues to be a peripheral issue in the overall energy sector planning and development in Africa. So far, energy efficiency has been vigorously pursued mainly in Northern Africa and South Africa and a few selected countries in sub-Saharan Africa. Experiences so far shows that the adoption of energy efficiency is inhibited by barriers including lack of appreciation of the benefits, initial capital requirements, resistance to change, absence of policy and regulatory frameworks, and subsidized energy costs. To ensure economic competitiveness, Africa needs to systematically integrate energy efficiency into existing energy generation and use systems as well as new major infrastructure projects. This could be achieved through the

20 Renewable Energy in Africa: Challenges and Opportunities, Africa Ministerial Meeting on Energy, 2004.

21 Biogas For Better Africa, www.biogasafrica.org

22 Energy Agency, 2008, Key World Energy Statistics 2008.

establishment of policy and regulatory frameworks that would promote energy efficiency with appropriate policy instruments to ensure success and effectiveness.

25. Energy efficiency offers multiple benefits to countries in Africa. Since reducing CO2 and other greenhouse gas emissions from the burning of fossil fuels is at the heart of current efforts to address the climate change, accelerated use of renewables and more efficient technologies can provide 'win-win' options to tackle global environmental and local development challenges. With over 75%[23] of the power generation capacity in Africa based on thermal sources, efficiency improvements in the existing power systems could translate into substantial monetary savings for many countries and increased competitiveness of local industries.

III. BIOFUELS AND THEIR IMPLICATIONS FOR AFRICA'S DEVELOPMENT

A. Status and prospects

26. It is widely recognized that biofuels have the potential to play a significant role in the future energy mix of the continent. The increased excitement for biofuels is driven by several factors that include: the recent surge and volatility in oil prices; the process of phasing out leaded petrol by using ethanol; diversification of product portfolios by sugar industries due to volatile world sugar markets; the withdrawal of preferential raw sugar pricing; the need to boost rural socio-economic development; and opportunities created by the potential reduction of agricultural subsidies by developed countries.

27. Assessing the biofuels potential for Africa is an extremely complex process because there are so many factors at play, some of which, such as demographic trends, can be predicted while others, like climate change effects, are far more difficult to predict. Various scientific studies have estimated that the potential for sustainable biofuels production (production that preserves biodiversity, rainforests and water resources, and does not endanger food security) in 2050 for Sub-Saharan Africa ranges from 41 to 410 Exajoules[24]. The lower range of this estimate is more than twice the total amount of energy that was consumed in Africa in 2008, which is about 19Exajoules. While much research is still required to estimate the exact biofuels potential of Africa with increased certainty, the current figures adequately demonstrate that Africa has the potential to become a major biofuels producer. Realizing this potential means overcoming several challenges related to costs, environment, technologies and others that are specific to Africa's context. Annex 2 outlines some of these challenges.

28. About 39 countries in Africa are net oil importers. Therefore, the development of biofuels will reduce dependency on imported fuels. As an example, studies show that from 1976 to 2004, Brazil's ethanol production substituted oil imports worth $60.7 billion. Agriculture is the mainstay of most countries in Africa, so the development of biofuels in Africa, especially in rural areas that have the land to use, could bring in many potential benefits including increased access to electricity, transformation of the rural economy due to the availability of reliable energy supplies, and new employment opportunities.

29. On the other hand, some stakeholders are raising serious concerns about the potential risks and trade-offs of developing biofuels that include, among other things, food security, biodiversity loss, competition for land and water resources, the use of genetically modified organisms, greenhouse gas emissions, soil erosion and other soil degradation, water contamination, human health impacts, labour conditions, and rights of children.

23 EDRC, 2002. A new sustainable energy path for African Development: Think big act faster by Ogunlade Davidson and Youba Sokona,

24 Progress in Energy and Combustion Science, 2006, A quick scan of global bioenergy potentials to 2050, E.Smeets, A Faaj and I Lewandowski.

Of particular concern are recent trends where vast tracks of land are being allocated for biofuels production in some countries in Africa, yet there is no evidence that any detailed analysis has been carried out of the overall impact of these agreements on land-use, local communities and food production systems, technology transfer and acquisition etc. Given these concerns, there are concerted efforts at the global level to develop sustainability criteria and certification schemes for biofuels production and trade. Therefore, the development of biofuels in Africa will need to be guided by globally accepted sustainability standards so as to minimize negative impacts.

30. The recent high food prices led to even greater debate on biofuels development, mostly focusing on the balance between food and fuel and the potential environmental impacts of increased crop production for fuel purposes. As a result, various developed countries are considering changes in their policies and targets on biofuels. While there is a link between the development of biofuels and food prices, the extent of the impact of the current biofuels development on food prices still needs further research. To date, different reports have estimated impacts of biofuels development on food prices ranging from 10% to 80%. It should be noted that only 1.3% of global area harvested in 2007 supplied biofuels feedstock.

31. Large-scale biofuels production in Africa has been limited so far. Only Zimbabwe, Kenya and Malawi have ethanol programmes in which ethanol produced as a by-product from sugar industries has been blended with petrol and used as transport fuel. Such programmes have resulted in economic gains that include reduction in levels of imported petrol. Zimbabwe is the only one of the three countries, however, to mandate that ethanol be blended with all gasoline sold and produced up to 40 million litres of ethanol per year[25]. Although Zimbabwe's programme was established as a way of responding to economic sanctions, several other gains were achieved such as development of local manpower. The Kenya plant was closed in 1992 due to lack of viability. At its peak, it produced up to 45,000litres and some rural employment was achieved.

32. Other recent efforts to develop large-scale biofuels include Palm oil and Cassava based ethanol in West Africa, jatropha based biodiesel in Mali, Tanzania etc. Small-scale biofuels production in Africa is so far primarily based on jatropha biodiesel. Most countries in Africa have ongoing programmes to grow Jatropha in rural areas to produce biodiesel.

B. Strategic focus

33. There are ongoing discussions on Africa's biofuels potential and how to realize this potential in a sustainable manner. The First High-level Biofuels Seminar in Africa[26] was one such event where various stakeholders discussed this issue in detail. Based on the outcomes of this and other discussions, participants agreed that Africa should focus on the following set of issues so as to realize its biofuels potential.

34. Feedstock availability and sustainability are central to the success of the biofuels industry. As such, there is need to closely assess Africa's feedstock production capacities and comply with emerging global sustainability guidelines. The AU could lead the process of compiling specific sustainability guidelines, which must be informed by the continent's priority development needs. As such, efforts to develop biofuels should initially focus on the use of existing agricultural waste and then gradually shift towards expansion of existing agricultural systems once agreed sustainability guidelines are in place.

35. Africa needs to promote biofuels by developing conducive policy instruments such as blending targets, tax benefits, smart subsidies and loan guarantees. These policies should be developed considering the cross-sectoral nature of biofuels and the need to comply with agreed sustainability criteria and resource availability.

25 IPCC, 2001, Methodological and Technological issues in Technology Transfer.

26 UNIDO, 2007. The First High-Level Biofuels Seminar in Africa : http://www.unido.org/index.php?id=068431

36. Biofuel conversion technologies are central to the success of the biofuels industry in Africa. Africa needs to develop mutually beneficial partnerships with technology leaders with a view to acquiring and mastering biofuel technologies. Existing South-South Centres could be instrumental in this process. Africa should take part in the research in next generation biofuels through existing regional institutions.

37. Biofuels development will also have direct implications on land use patterns across Africa. In particular, the adoption of national and international targets will create assured markets and hence increase demand for land for biofuel production. A recent study led by researchers at the University of Illinois in USA confirmed that biofuel targets might cause a shift from conventional crops to biofuel feedstock and bring about attendant changes in crop rotation and tillage practices. In fact, biofuel markets will influence agricultural activities and trade-offs in terms of climate change mitigation. As an example, the production of one type of feedstock could reduce the emission of GHG but could also simultaneously increase nitrogen use through increased fertilizer demand. Life cycle assessment studies of cellulosic biofuels show on the other hand that they offer greater potential for carbon emissions reduction with minimal nitrogen applications. Therefore, there is need for similar work in the context of Africa to ensure that biofuel production will not cause unacceptable tradeoffs.

38. As an emerging industry, the biofuel sector will need support that is typical for industries in such stages of development. As such, there is a need for capacity building activities for stakeholders along the biofuels value change, knowledge generation and management as well as for mobilizing financing.

39. The economic viability of investment in liquid biofuels hinges on the potential of biofuels to replace petroleum based fuels. Therefore, investment in biofuels faces risks related to low oil prices. In order to mitigate this risk, there is a need to develop technologies and other response mechanisms that would ensure timely switch to other crops or products should the price of oil fall below viable levels. For instance, in the case of the production of ethanol from sugar, when ethanol production becomes unviable because oil prices are too low, the same processing technology should be able to focus on maximizing sugar production.

40. Biofuels are very context–specific, and replicating success stories is complex. Many African countries have potential to produce biofuels for their domestic market and even for export. Some countries already have well-established industries to build on, such as the sugarcane industries in Kenya, Malawi, Zimbabwe and Mauritius. However, African countries need to carefully examine their national circumstances to ensure that biofuel production will not compromise food production, degrade existing ecosystems, or create land disputes, among other things. As a first step, the development of biofuels should initially focus on ensuring energy access for the local market and only turn to international markets once local capacities and sustainability standards are in place.

41. Undertaken properly, the development of biofuels can contribute significantly to solving energy security concerns, improve rural livelihoods and mitigate considerable environmental and socio-economic impacts of current lifestyles. There are real opportunities for rural farmers to produce biofuel feedstock and supply national, regional or even international biofuel commodity markets. The African continent is ideal for the expanded competitive production of biofuels and biofuel feedstock because of its climate and resource endowment. Many potential biofuel feedstocks are already being grown successfully in the region and new varieties and technologies promise to enhance the resource base and result in higher yields. Furthermore, biofuels are not a new phenomenon in the region as sugarcane based bioethanol production and use as a transport fuel has been practiced since the early 1980s.

IV. BARRIERS TO RENEWABLE ENERGY DEVELOPMENT IN AFRICA

42. The extent to which renewable energy can contribute to efforts to address the energy challenges facing Africa needs to be closely analyzed. In general, the role of renewable energy in meeting Africa's energy demand has been undermined by bad experiences, misinformation, technology push, and consequent negative perceptions[27]. The balance between energy services for meaningful economic growth, on the one hand, and general welfare gains, on the other, continues to be a source of unnecessary conflict among stakeholders, as both are essential and complementary. So far, certain technologies have been disseminated in circumstances that compromise their further adoption, as beneficiaries have been dissatisfied. The mismatch between energy service provision and income generation to meet the cost of services has been particularly disadvantageous for the promotion of renewable energy.

43. Although major technical and financial breakthroughs have been achieved internationally with respect to renewable energy, besides large hydropower their contribution to Africa's energy problems remains minimal. To increase their contribution using market-based approaches, major barriers to the wider dissemination of renewable energy on the African continent will need to be overcome. These barriers can be categorized as being policy, regulation and institutional; information and technical capacity; and financial. They are discussed below.

44. An obstacle to development in general in Africa, which also affects renewable energy, is the extremely low levels of both local and international investments in comparison to those in other developing regions. In 2007, Africa's share of FDI was about 10.6% of the over US$500 billion inflows into developing countries[28]. Investments from local sources are hampered by the relatively low savings potential in the region, while external investments are seriously affected by the image of the continent. Changing the image of Africa is crucial for investments especially for the energy sector, and more particularly for renewable energy.

A. Policy, regulatory, and institutional frameworks

45. Coherent, consistent and conducive policy and regulatory frameworks are central to the successful dissemination of renewable energy in Africa, yet such frameworks are generally absent. A clear direction and leadership from the government in the form policies and regulations is generally missing. Their absence makes it difficult for the private and industrial sector to operate effectively and expand their investments in the development and use of renewable energy in the continent, especially when it is as weak as it is in Africa.

46. Recently, some countries have instituted some ad hoc policies on renewable energy; for instance, Kenya and Zimbabwe removed excise tax on PV systems. Though these efforts are laudable, they are not widespread and in some cases not consistent and well coordinated. More worrisome is the absence of energy and renewable energy in most development plans at national and sub-regional levels. A recent review of the World Bank's Poverty Reduction Strategy Papers (PRSPs)for countries in Africa shows that only very few mentioned the energy sector, let alone the renewable energy sector, as priority. Consequently, despite the importance of this sector to the economic and social development of any country, it does not receive adequate policy attention.

27 Renewable Energy in Africa: Challenges and Opportunities, Africa Ministerial Meeting on Energy, 2004.

28 UNCTAD. World Investment Report 2008.

47. One result of the lack of policy attention to the development of renewable energy is the relatively low budgetary allocations or other dedicated funds for the promotion of renewable energy in many African countries. Generally, the majority of energy projects are externally financed, and where they do exist dedicated funds for renewable are less than 3% of total public expenditure. Despite the recent development of several renewable energy policies in many developing countries, only a few have been developed in Africa, and only then in Northern Africa and South Africa. Where suitable policies for promoting renewable energy do exist, their impact is weakened by a lack of enforcement mechanisms.

48. The successful development and deployment of any technology, especially relatively new ones such as renewable energy technology, need several institutions covering the different technical, economic to market aspects. Unfortunately, this institutional capacity is not always available in most parts of Africa, and this puts renewable energy in a disadvantaged position. Power utilities do not easily accept power produced by solar, biomass and wind technologies because of their smaller size, on the one hand, and the normal resistance to change in any well established institution, on the other. They normally find it difficult to match such power with their usual peak load due to problems of intermittency in renewable supply.

49. Deficiencies of ancillary technical institutions for testing, operation and maintenance of technologies also affect development of renewable energy markets. One area in which Africa suffers the most in technology development and transfer is the absence of National Systems of Innovation (NSI). Such systems have proved to be crucial in increasing technological receptivity in most developed and emerging economies[29]. Only Egypt and South Africa have attempted to put systems that foster technology incubation and commercialization into place. The wider use of renewable energy using market based approaches will call for NSI if manufacturing capacities have to be increased.

B. Information and technical capacity

50. A major technical barrier is the unavailability of accurate and well organized renewable energy resource data. The data on renewable energy, especially for solar and wind, are very scanty. The ones that are available in selected countries are not linked with modern methods such as satellites. Biomass data as it relates to land availability, competing uses, water availability and processing is one such example. Also the poor technical skills in the continent affect the development of renewable technologies.

51. Inadequate domestic technical skills account for poor maintenance of imported systems and lack of provision of adequate after-sales service. Hence, there is need for high and middle level technical manpower in business development, manufacturing and overall management. The public sector also lacks adequate personnel to undertake effective monitoring and evaluation. Ensuring secure sustainable commercial success of renewable energy depends on institutional and human capacities as well as business and market capabilities.

C. Financing and investments

52. The African Development Bank has estimated at US$ 547 billion the total investment required to implement its scenario of universal access to reliable and increasingly cleaner electric power in all the 53 countries in Africa by 2030[30]. This averages out at over US$ 27 billion per year, yet total funding to the energy sector in Sub-Saharan African has averaged only about US$ 2 billion every year. Therefore, the energy sector in general faces serious challenges with respect to mobilizing financing. Many economies in Africa are performing badly and this only makes the situation more difficult when seen in the context of ongoing financial crisis. Due to weak government

29 IPCC, 2000

30 African Development Bank 2008, Clean Energy Investment Framework, www.afdb.org

support, the private sector, banks and lending facilities are not yet interested in enhancing their investments in renewable energy systems.

53. The private sector remains a small player overall, and more prevalent in small-scale renewable energy systems. The bulk of the private sector financing is non-local and mostly on-led from international financing organizations and thus guaranteed by beneficiary governments. It is therefore critical that experiences from international financing organizations in dealing with private sector be used to catalyze local private sector participation in renewable energy projects.

54. Closely related is the lack of support from financial institutions that promote the business and market environment of technologies. These include insurance companies and broker institutions that assist to reduce the very high transaction costs of clean technologies in African countries. Lack of suitable advertising media also affects the marketing of renewable technologies.

V. RECOMMENDATIONS FOR SCALING UP RENEWABLE ENERGY IN AFRICA

55. Major technical progress and policy development along with financial and institutional innovations are needed to scale up the use of renewable energy in Africa. Lessons learnt from different renewable energy projects and programmes in Africa and elsewhere are instructive in defining Africa's strategy to scale up renewable energy in line with its sustainable development needs. In defining such a strategy, it should be recognized that renewable energy technologies are at different stages of development and deployment. Whereas technologies like hydropower and wind energy are fully mature, others like solar energy technologies are not yet developed enough to realize their economic and market potentials. Other technologies are still in the research stage and have yet to establish their technical potential. Therefore, the continent's strategy should give priority to technologies that will deliver on the huge and immediate energy needs of the continent.

56. Experiences in OECD countries and more recently in Brazil, India and China amply demonstrate the central role of policy and institutional innovations in facilitating investments in renewable energy. In particular, the setting of policies with clear targets and the adoption of policy instruments such as quotas, feed-in tariffs, capital subsidies or rebates, investment or other tax credits, tradable renewable energy certificates, and public investment loans or financing have so far been instrumental in promoting the widespread use of renewable energy. Examples include German's Renewable Energy Sources Act, the European Union's target of 20% share of renewable energy by 2020, and China's target of deriving 15% of total energy consumption from renewable energy by 2020 along with reducing their energy intensity substantially by 2010. Between 2005-2007, biofuel tax exemptions, of up to 100% in some cases, were enacted in many countries such as Argentina, France, Germany, Greece, Ireland, Italy, South Africa, Spain, Sweden and the UK, and have spurred significant investments in this sector. In developing countries, feed-in tariffs; capital subsidies, grants or rebates; tax credits and public investment loans or tax credits, have all been applied successfully. Annex 3 summarizes notable policy experiences from different countries and lessons learnt.

57. Of late, the cost of onshore wind energy technologies has reached 4-8 US cents/kWh[31] and is now comparable to traditional fossil fuel systems. If this trend continues, then more renewable energy systems will be competitive even if external costs are not considered. In addition, renewable energy systems in general have modest operation and maintenance costs in comparison with fossil fuel systems. Both large and small hydro systems, as well as solar and wind systems can operate with very little human input as compared to fossil fuel systems.

31 REN21, 2008, Renewables 2007, Global Status Report.

58. A disconcerting feature in many African countries is the price of imported goods and services in the renewable energy sector, including technical equipment and project services. There are very high transaction costs, which arise from several factors including relatively small markets for RETs that result in few suppliers and monopolistic prices, the time lag between project formulation, conceptualization and actual implementation, and the poor manufacturing base that makes the retail price far higher than the cost price. One feature that always seems to favour renewable energy systems is its low external costs and this explains the call by many to internalize the external costs in the total retail price of energy systems. On average, the external cost for fossil fuels in comparison to renewable energy is over 20 times higher. If these costs are included it will make renewable energy more competitive.

59. An important feature that needs attention by African countries is the negotiations for the trade of environmental goods and services including renewable energy. The industrial countries have always emphasized market access but this has done very little for African countries because in 2007, the USA, the EU and Japan accounted for 84% of all trading in environmental goods and services. Very few are by developing countries and these are limited to China, India and Chile. There was some trade in efficient cook stoves from Kenya, but this forms a negligible share of total exports. If this trend continues African countries will only be technology users and not technology developers.

A. Policy and institutional environment

60. Several national and international policies have so far been used to promote the use of renewable energy technologies and it is clear that policy successes are likely to be achieved when used in combination and adapted to the local, regional or national situation. Based on these experiences, policies to be considered for implementation at the national level are: regulation measures (i.e., performance standards, equipment standards, etc); subsidies and financial incentives (feed-in tariffs, rebates, grants, loans, production incentives, government purchasing agreements, insurance) that are targeted and have a clear sunset clause; voluntary agreements (e.g. between government and private sector). At regional and sub-regional levels, policy measures that have been successful and can be considered for development in Africa include focused use emission targets and trading systems; technology co-operation; financial systems (ODA, FDI, commercial bank loans). In selecting appropriate policy options, it is important that these policy options be evaluated for their environmental impacts and cost effectiveness; distributional aspects; institutional feasibility; and suitability to the local context. In addition, renewable energy policy development should be well integrated into policies of other sectors and most importantly into PRSPs.

61. The process of reforming the power sector has created opportunities for Independent Power Producers (IPPs), which if well designed can be a major driver for the diffusion of renewable energy. Another market promotion policy is to develop a strong customer base such as encouraging public procurement. Major purchases of RETs by public schools and hospitals can demonstrate confidence to other possible buyers and assist in bringing down the cost of renewable energy. Setting clear targets as a share of the total energy supply market can assist to develop the RETs market. The renewable energy market can be enhanced by either internalizing external costs into the cost of fossil fuels, or setting up subsidies for RETs, or giving tax incentives to RETs. The use of a quota system for renewable energy can be very useful, as the feed-in tariff systems in European and a number of other countries demonstrates.

62. Using well designed policies and stronger institutions can encourage renewable energy producers to sell their products to the national grid, provided the revenue collected covers the cost and interest payments. However, smaller-scale producers may need special policies such as using dedicated funds or project bundling. Off-grid renewable energy systems need policy attention such as customer financing to protect them from high upfront costs. Renewable energy markets can be promoted if governments take decisions to promote investments in renewable energy for powering social infrastructure such as schools, medical centres, hostels etc. Also, use can be made of modern institutional relationships such as public-private partnerships to promote renewable energy. Smaller African countries that still receive ODA can strategically use these funds to leverage

funds from the private sector or other project funding such as GEF in promoting renewable energy systems. A good example is the recently approved GEF West Africa Energy Programme, which has been developed by UNIDO as a collaborative effort between UN Energy and GEF (GEF funding to the tune of US$ 46 million has already been approved for this programme).

63. Energy markets at the country level tend to be too small and fragmented to attract meaningful investments. As such, there is an increasing drive for integrated energy markets at the sub-regional level, as demonstrated by regional projects such as power pooling and energy access programmes that are led by Regional Economic Communities (RECs). A similar approach of adopting regional policies, regulation and institutions that are particular to the context of a specific sub-region should be used to develop renewable energy markets. As such, RECs should lead the process of developing renewable energy markets through developing policies and regulations, establishing support institutions and mobilizing investment. In addition, there is a need to strengthen already existing national and sub-regional institutions to support such initiatives.

B. Technologies acquisition, development and integration

64. The continent should develop regional, sub-regional and national strategies to acquire renewable technologies by developing their R&D capacity and skills of technology adaptation and development and manufacturing capacity. Technologies are successfully transferred mostly to countries that not only have developed their domestic capacities to operate the transferred technologies but also have the capacity to modify, adapt, and improve the technology through domestic innovation, i.e. the desire to master the technology. Past technology relationships in Africa have mainly been one-way relationships through licensing or commercialization of public sector R&D. African countries should now enter into two-way relationships with technology suppliers using different instruments including co-production, standardization of components across models, modularization and exploring new forms of sub-contracting.

65. Improving domestic capacity to adapt, modify and innovate technology require National Systems of Innovation to be developed, but on a sub-regional basis because of their financial and human resource demand. Policies will be required to foster technology transfer and also assist to build capacities. These will include those that promote and strengthen the domestic knowledge base, stimulate learning and innovation, and create the support structures to sustain these processes. Another set of policies will be those that create facilities for starting up small and medium-sized enterprises, as these will prove useful for sub-contracting.

66. Specific skills are required for operating, modifying, producing and innovating renewable energy and energy efficiency technologies. Although most African countries do have operating skills and some modification skills, they will need both productive and innovative skills to scale up. These capacities will even assist African countries to develop export-oriented skills from RETs, such as acquiring codified knowledge, learning to meet quality standards and delivery times, and skills to react flexibly to cope with changes in products and processes. Many of these skills can be acquired in a technology incubator, which is also useful for the commercialization of technologies.

67. Scaling up RET markets in Africa will need to be guided by market oriented research and development. Whereas developed countries tend to lead in cutting-edge R&D, Africa is better off focusing its R&D on issues that will have immediate impact on its energy situation. In addition, there is need for coordinated R&D at local, sub-regional and regional level so as to maximize comparative advantages and increase specialization. Regional research efforts could be strengthened by creating a regional network of R&D institutions/efforts on renewable energy similar to the global consortium that exists for agriculture.

68. In selecting and prioritizing renewable energy technologies to focus on, Africa needs to consider technological maturity, reliability and financial feasibility. As such Africa is, in the immediate term, better off concentrating on renewable energy technologies that are mature and will have immediate and direct benefits on the energy situation of the continent. There is a need to address the fluctuations and intermittency of energy supply from

renewable energy technologies through integrated systems, pooling of several decentralized renewable energy systems to form energy generating clusters, better integration into national grid systems using multiple connections so that the grid is always supplied with minimum power in case of failure by one system. Equally important is the need to use modern storage technologies to address the intermittency of power generation from renewable energy technologies.

c. Enhanced investments and financing

69. African countries can exploit new financing options to improve investments in renewable energy in the continent. This will be in addition to existing options that are used by a few countries in the region. The new financing options include: mobilizing local financing, aid and grants; foreign direct investments; carbon financing, GEF, etc. Experiences in mobilizing local financing for the conventional energy sector should be used for the renewable energy sector. Local sources of funding that should be considered include public offer of shares by power utilities to implement specific projects, use of pensions funds to leverage local bank financing for new projects, use of emerging local bond markets, local private sector interest in specific projects in countries where business confidence is booming; integrating renewable energy into economic partnerships with countries like China and India which are increasing their investments in Africa, harness foreign remittances within local bond markets for renewable energy, especially in countries where such remittances actually exceeds ODA.

70. There is a need for a deliberate continental drive to leverage financial resources from existing and emerging global funds related to climate change such as GEF and CDM. This will hinge on improved infrastructure and greater involvement by the private sector and banking institutions. FDI flows to Africa are on the rise, buoyed in part by south-south investment from Asia. With the improved performance of the continent and economic growth continuing to rise, it is expected that FDI will rise further. These investments have so far tended to target natural resources, and the challenge for African countries is to discuss with these countries to include renewable energy in south-south investments. China and India could offer great opportunities because they have recently expanded their manufacturing base in renewable energy.

d. Regional integration, networking and capacity building

71. Recognizing limitations of national energy markets, Africa is experiencing a shift towards regionally integrated energy markets. Regional Economic Communities (RECs) like ECOWAS, EAC and SADC are already working on regionally integrated power pooling, policy planning and development and energy access programmes. These efforts need to be strengthened in line with the agenda to scale up renewable energy. In fact, RECs should play a more proactive role in promoting regionally integrated markets for renewable energy technologies that are commercially viable so as to achieve the economies of scale that will attract private sector investments. In parallel, RECs should promote coherence and greater networking among their member states to promote sharing of experiences and best practices in renewable energy. This could be achieved through establishing dedicated regional institutions that will also promote greater partnerships with similar institutions from other parts of the world in promoting research, capacity building, and technology transfer, among other things.

72. To ensure effectiveness, the scaling up of renewable energy in Africa must be supported by reinforcing the capacities and skills of market enablers and players. Policy makers need capacities to develop effective and evidence based policies that would create the market environment for scaling up renewable energy technologies and enforcing such policies. On the other hand, market players like project developers, financiers, equipment manufacturers and so on, will need capacity building. Therefore, there is a need for capacity building both at national and regional levels for both renewable energy market enablers and players.

VI. CONCLUSIONS

73. African countries have significant renewable energy sources which, if exploited, can immensely contribute to the energy needs of the continent. Exploiting these resources faces special challenges, the most important being its ability to contribute to sustainable development. To date, generic barriers have been used to design generic solutions, which are then implemented without sufficient appreciation of the African context. It is, therefore, imperative that the renewable energy technologies, which get promoted in a given market, be those that can provide a level of service that facilitates significant economic growth, i.e. focus on productive activities. Current global efforts to shift to low-carbon economies, calls for a New Green Deal, and valuable international and local experiences with renewable energy technologies presents the continent with a unique opportunity to develop effective and contextualized strategies that would promote the dissemination of renewable energy technologies so as to address existing energy needs.

74. Proper selection of renewable energy technologies is needed to suit the desired needs, and for that it is critical to develop the local markets and domestic capacities to absorb these technologies. Market development strategies should focus on increasing the participation of the private sector within an enabling and conducive environment. Development of human and institutional capacities to cope with the manufacturing, operation, and modification of renewable energy technologies is critical. Equally important is the development of the innovative skills for further development of sustainable markets of renewable energy technologies.

75. Improved and strengthened policies for the scaling up of renewable energy technologies by both public and private sectors are suggested. However, these initiatives will not effectively assist the continent if the business as usual scenario continues. Presently, the continent has the highest rate of return on inward FDI of all developing regions that is over 12%[32] and this feature should be fully exploited for the development of renewable energy. In this connection, policy makers are urged to adopt a modest target on the contribution from renewable energy to the continent's energy mix and invite all development partners to assist the continent to meet such a target. As an example, the recent International Conference on Renewable Energy in Africa[33] noted that current annual estimates of non-large-scale hydropower investment flows to renewable energy development in Africa are consistently below U$ 1 billion, and recommended to increase these investment flows to US$10 billion over the next 5 years (2009-2014)[34]. Policy makers could adopt a similar target, and request the African Union Commission, RECs, and other partners to develop an investment plan on how to realize this target and equally integrate investment programmes into already existing partnerships like the Africa-EU Energy Partnership.

76. Flexible financing mechanisms are needed to enable access to renewable energy technologies. The mechanisms should take into account the local context with respect to sources and patterns of income, attitudes to borrowing, availability of micro-credit agencies, and ability to repay over long and short term periods. These mechanisms should be for both end users and suppliers and should be informed by past experiences. Policy makers should call upon international financing institutions to put in place accessible financing mechanisms to catalyze both local and international private sectors into financing renewable energy projects.

77. Flexibility in planning and policy making is also necessary. Though the least cost option is often identified in planning, it is not always chosen on account of local needs or appropriate technologies needed by planners

32 UNCTAD, World Investment Report 2008: Transnational Corporations and the Infrastructure Challenge

33 http://www.unido.org/index.php?id=076539

34 Investment targets for large-scale hydropower development are also required. More precise continent-wide targets for large-scale hydropower investments can be obtained through a comprehensive analysis of African countries power sector investment plans – a task that can be undertaken by African agencies with a continent-wide mandate such as African Union, NEPAD, African Development Bank, African Regional Energy Commission (AFREC) and Forum for Energy Ministers in Africa (FEMA).

and local policy makers. It is not unusual to find donor funded projects having a predetermined technology. To facilitate integrated resource planning, both donor and local planning and policies need to be flexible and synchronized. As such, policy makers would need to commit themselves to the development of effective policies and strategies for the development of renewable energy in each country. RECs will then make use of the national policies and strategies to develop regionally harmonized and coherent policies. Furthermore, RECs would need to play a more proactive role in promoting regionally integrated markets for renewable energy technologies that are commercially viable so as to achieve the economies of scale to attract private sector investments.

78. Renewable energy technologies should be promoted where a reliable and sustainable form of energy services can support income generation activities and stimulate local growth. Where renewable energy service is a consumer good, the cost is likely to be prohibitive for the majority of the poor and demand for subsidies will remain high. Provision of targeted and smart subsidies that have a clear sunset clause for promoting renewable energy would need to be evaluated on the energy service provided rather than on a technological basis.

79. While enhanced use of renewable energy technologies help in creating local jobs and saving foreign exchange, compelling evidence from various case studies of both small and large-scale renewable energy projects adequately demonstrate that these projects contribute to increased energy access and security through increased energy supply, and promote low carbon growth paths through reduced greenhouse gas emissions. Pursuing energy security and economic growth in tandem will create greater scope for scaling up the use of renewable energy in Africa to improve access to energy and reduce its dependence on oil and gas imports.

Annex 1: Importance of Energy to Achieving Specific Millennium Development Goals

MDG	Modern Energy Contributes by
1 Cutting Extreme Poverty and Hunger	• Reducing share of household income spent on cooking, lighting, and space heating. • Improving ability to cook staple foods. • Reducing post-harvest losses through better preservation. • Enabling irrigation to increase food production and access to nutrition. • Enabling enterprise development, utilizing locally available resources, and creating jobs. • Generating light to permit income generation beyond daylight. • Powering machinery to increase productivity.
2 Universal Primary Education	• Providing light for reading or studying beyond daylight. • Creating a more child-friendly environment (access to clean water, sanitation, lighting, and space heating/cooling), less time needed for firewood collection, school feeding) which can improve attendance in school and reduce dropout rates. • Providing lighting in schools, which can help retain teachers? • Enabling access to media and communications that increase educational opportunities. • Reducing space
3 Gender Equality and Women's Empowerment	• Freeing women's time from survival activities, allowing opportunities for income generation. • Reducing exposure to indoor air pollution and improving health. • Lighting streets to improve women's safety. • Providing lighting for home study and the possibility of holding evening classes
4, 5, 6. Health	• Reducing exposure to indoor air pollution thus reducing respiratory and eye diseases, less burns, and improving health. • Providing access to better medical facilities for maternal care. • Allowing for medicine refrigeration, equipment sterilization, and safe disposal by incineration. • Facilitating development, manufacture, and distribution of drugs. • Providing access to health education media. • Enabling access to the latest medicines/expertise through renewable-energy based telemedicine systems.
7 Environmental Sustainability	• Boosting agricultural productivity, increasing quality instead of quantity of cultivated land. • Reducing deforestation for traditional fuels, reducing erosion and desertification. • Reducing greenhouse gas emissions. • Restoring ecosystem integrity through land management. • Alleviate environmental poverty

Source: REN21 Renewable Energy Policy Network, 2005

Annex 2: Challenges to biofuels development.

General Challenges	Africa-Specific Challenges
How to make it less costly and environmentally friendly	Availability of technology (big-medium-small scale)
	Infrastructure and logistics
How to balance biofuels needs and food needs	Market demand and trade (local-regional-international level)
How to develop biofuels to a second phase which could overcome the above challenges	How to develop biofuels to a second phase which could overcome the above challenges
	How rural populations and SMEs can benefit

Annex 3: Case examples, key market incentives, tax measures and financing mechanisms used to promote renewable energy in Africa and elsewhere.

Country	Summary of key mechanisms
Mauritius	**Tariffs and Stakeholder Participation:** 30% of the installed capacity is from sugar cane factories. In 1998 the sugar industry exported 195 GWh of excess electricity, nearly 14% of the national power production. The annual sugar production is 600,000 tons with 1.8 million tons of bagasse available principally for electricity generation. To ensure that all stakeholders benefited from the sale of electricity to the grid, the Government established a bagasse transfer price fund and the Sugar Investment Trust, which ensured that the revenues from the cogeneration is equitably shared by all stakeholders. The key lessons are i) the need for clear policies to promote cogeneration, ii) the need to involve local entrepreneurs in IPP initiatives (whereas elsewhere IPPs are foreign owned greenfield projects), iii) the consultation of all the relevant stakeholders to ensure consensus on an equitable revenue sharing mechanism.
Uganda	**Kakira Cogeneration Grid connected IPP – Subsidies and Tariffs:** This project is part of Kakira Sugar Works overall expansion plan and will generate 19MW of electricity through cogeneration using bagasse. 7 MW of the power generated will be used by the factory and the surplus 12 MW will be exported to the national grid. The project received a refinancing facility of US$8.6 million administered by Bank of Uganda and a subsidy of US$3.3 million from the Rural Electrification Agency, both under the Energy for Rural Transformation Programme. The project is now substantially complete feeding 12MW to the national grid. The Power Purchase Agreement states that Uganda Electricity Transmission Company Limited (UETCL), will buy the first 6MW at 4.9 US$ cents per kWh (because of the subsidy) and the rest at 6.15 US$ cents per kWh. This is an example of Public Private Partnerships with feed-in tariffs for promoting renewables.
India	**Wind Energy: Resource Assessment, Feed in Tariffs and Tax Incentives** The state of Tamil Nadu in India assessed its resource potential and the state utility built demonstration projects, provided grid infrastructure and information about good wind sites to potential investors. In 1991, the Indian government opened the electric grid to private producers and allowed them to build and operate power plants as well as enter into long term contracts with state electricity boards. As a result, private companies could produce wind power in remote regions and wheel it over transmission lines for their own needs or to third parties. Grid access, together with combined investment tax credits, financing assistance and accelerated depreciation led to a boom in wind energy in India. Long term and low interest loans that were provided through the Indian Renewable Energy Development Agency, have encouraged banks to fund renewable energy projects and led to the world's largest wind resource assessment program. The private sector has contributed 96% of the investment in wind energy to date.

Country	Summary of key mechanisms
Brazil	**Ethanol: Policies, Infrastructure, Subsidies and Tax Incentives:** More than two thirds of the world's ethanol is consumed by Brazil and modern biomass provides about 20% of Brazil's primary energy supply, mainly due to the use of alcohol fuels. In 1975, the Brazilian National Alcohol Program (PROALCOOL) was established, in response to the petroleum crises, to reduce on petroleum imports and avoid an economic meltdown. The program required that all petroleum products be blended with ethanol between 20% and 24%. The government promoted the manufacture and sale of cars that run on 100% ethanol and provided subsidies to increase sugar cane production together with the construction of distilleries. Infrastructure was also developed to distribute the ethanol to thousands of pumping stations countrywide. The sale of alcohol vehicles rose and reached 96% of the total sales in the mid 1980s. In 1989, the decline in petroleum prices resulted in reduced purchases of all alcohol cars, dropping to 0.03% of total sales. Sales are on the rise again due to new tax breaks and government green fleets. Because of energy security concerns PROACOOL is being revitalized and Brazil now imports 40% to 50% of the petroleum it consumes and is now testing other combinations of fuels for blending, including methane, vegetable oils, and hydrogen. Since the programme started, the cost of producing ethanol has reduced by 4-5% annually and even without subsidies, ethanol is now cheaper than gasoline per unit of energy. This programme created more than a million jobs, reduced the nations CO_2 emissions by 20%, about 4 million cars continue to run on alcohol and the sales doubled in 2002. Brazil is now an exporter of fuel and soon will export technologies.
United States of America	**Quota System:** Massachusetts state in the USA introduced a quota system for all electrical suppliers in 2002 indicating that they should utilize new and renewable sources of energy for at least 1% of their electricity supplies, with an annual increase of 0.5% to increase their share to 4% by 2009. This covered solar, wind, ocean thermal, wave, tidal, fuel cells using renewable fuels, landfill gas and low emission advanced biomass technologies. Verification of the quota system was based on the issuance of a green certificate, which was part of the Generation Information System operated by the New England Power Pool. The GIS system allows for the issuing, transfers, redemption of certificates for electricity, from all sources and technologies including renewables.

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