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"Enhancing Energy Access and Security in the Eastern Africa Sub-Region"

Draft Summary Report

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Enhancing Energy Access and Security in Eastern Africa (Summary)

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EXECUTIVE SUMMARY

The 2011 World Energy Outlook indicates that globally over 1.3 billion people lack access to electricity, 2.7 billion people lack clean cooking facilities, concentrated largely (95%) in Africa and developing Asia, and 84% in rural areas. The International Energy Agency stipulates that even with $14 billion per year investment between 2010 and 2030 to on-grid electricity connections, 1 billion people will still be without electricity, and with population growth billions will still live without access to clean cooking facilities by 2030. Some $48 billion per year during 2010 to 2030 will needed to be invested for universal access to modern energy, with majority of the investment going to Africa.

In the Eastern African sub-Region, most countries have population biomass reliance in excess of 90%. In comparison with developing Asian countries (54%), Latin American countries (19%) and the Middle East (0%), reliance on biomass is still quite high. Electricity access rates range from 1% in the new State of South Sudan (leaving 9.3 million people without access), to 11% in D.R. Congo (leaving nearly 59 million people without access), 12% in Uganda (leaving more than 30 million people without access), 13.9% in Tanzania (leaving nearly 38 million people without access), 16.1% in Kenya (leaving more than 33 million people without access) and 17% in Ethiopia (leaving nearly 69 million people without access). Africa, and particularly the Eastern Africa sub-Region, therefore represents the most significant challenge to addressing the global energy access problem.

With dwindling forest biomass resources due to rapid growth in demand for wood and charcoal, affordability and reliability of electricity supply and rising petroleum consumption in the Eastern Africa sub-Region have also raised concerns about energy security. In terms of percentage changes in forest cover based on 1990 forest resources as a base reference, nearly 20% stock decline is observed in Somalia, Ethiopia and Tanzania, nearly 40% decline in Uganda and Burundi, and 75% decline in Comoros. Between 4 to 8% forest stock declines are observed in Madagascar, Kenya, Eritrea and D.R. Congo. In the D.R. Congo, while a 4% decline seems marginal, given the size of the stock reaching 160 million hectares in 1990, one of the largest in the world, the magnitude of deforestation is quite large. Rwanda is the only country managing its forest resources quite well, showing forest resource recovery by 117,000 hectares between 1990 and 2010. In absolute figures, the losses were highest in Tanzania, with more than 8 million hectares of forest lost; over 6.2 million hectares in D.R. Congo; 2.8 million hectares in Ethiopia; and between 1.3 million – 1.7 million hectares in Madagascar, Somalia and Uganda. The state of forest resources, and biomass energy production capacity, in the Eastern Africa sub-region is skidding towards greater insecurity, with potential consequences of rising wood and charcoal prices, and greater concern about the long-term ability to sustain biomass supply. The state of household energy security, under current trends, is likely to worsen.

In terms of the energy security impacts form the electricity sub-sector, it is noted that the legacy of electricity in the Eastern Africa sub-region was predominantly hydroelectricity. Lack of, or insufficient, energy planning and growing energy demand have pushed the region to technology choices that brought more thermal generation, growing overtime as a share of total electricity generation. The shift in energy conversion technology of the sub-Region to thermal options has energy security implications. In terms of all-round dependency on imported fuels consumption, the global share of petroleum consumption in Africa has gradually increased from around 3.25% to about 4% over the last decade. In the same period, the share of the Eastern African sub-Region in Africa's petroleum consumption increased from about 8% to close to 10%. While the shares seem to have increased only gradually, comparison of absolute consumption levels of petroleum from 2000-2011 shows that while consumption at the continental level increased by slightly more than 40%, the rise in the Eastern African sub-region was 67%.

This constitutes a significant increase in exposure to global energy markets and associated sources of energy insecurity. A decade-by-decade analysis of the price shifts reveal that oil prices were indeed declining before the 1970s oil crisis, only to increase by nearly 3,000% in the 1980s, but receding in the 1990s, and slightly increasing from 1990 to 2000. In the 2000s, though the price hike is not as detrimental as the 1970-1980 decade, has nonetheless broke from norm and increased sharply, by nearly 170%. Dominant growth prospects in China, India, Brazil and Russia (BRICs) and global growth in per capita income are likely to put further pressure on energy prices, with energy security impacts on fuel importing countries.

The World Summit on Sustainable Development in 2002 promoted the role of energy, and through the Johannesburg Plan of Implementation solidified the importance of considering energy in promoting development and reducing poverty. The UN Rio+20 Outcome of Conference of 2012 passes that since 1992, insufficient progress in sustainable development was aggravated by the global energy crisis, particularly in developing countries, and urged countries to address challenges of access to sustainable modern energy services. The Conference further outlined that energy is crucial component to development, as access to modern energy contributes to poverty reduction, improvement of health, and provision of basic human needs, making "reliable, affordable, economically viable and socially and environmentally acceptable energy" crucial in developing countries. The UN Secretary General, Mr. Ban Ki-moon, declared that he "made Sustainable Energy for All a top priority because it is central to all aspects of sustainable development."

Despite numerous challenges in the energy sector of Eastern Africa, opportunities abound. Member States are endowed with significant clean energy resources, development potential of trans-boundary hydropower systems is ripe, energy trade is barely leveraged in the sub-region, private sector participation and capital infusion is a real possibility, and institutional and policy reforms can address the pent-up demand for rapid energy development. Discovery of oil and gas resources in the sub-region, and growing interest in biofuel development also offer pathways to meeting energy insecurity through regional frameworks. These, and other opportunities, constitute the possibility of an *energy transformation and revolution* in the sub-Region.

Recognizing that energy access and security are indispensable to economic transformation, member States of the Eastern Africa sub-region are advised to consider: strong commitment to energy sector development consistent with their socioeconomic development aspirations; increasing private sector engagement, and private-public partnerships to enhance investment resources in the energy sector; pursuing regional opportunities to engage in energy trade and benefit from lower energy costs and economies of scale; pursue renewable energy initiatives aggressively; commit to energy access sub-regional and country targets and strive to achieve Sustainable Energy for All objectives by 2030; strengthen energy planning while synergizing with economic planning; institute and stock strategic reserves of petroleum to lower the economic costs of energy disruptions while developing partnerships for a regional procurement framework; strengthen regional cooperation on development of strategic energy resources such as oil and gas; engage in exchange of information and experiences pertaining to enhancing energy access and security and ultimately addressing the energy constraint to resilient economic transformation through workable strategies implemented in the Eastern Africa sub-region and beyond.

1 INTRODUCTION

1.1 Objective of the Report

The objective of this report is to inform Eastern African energy policymakers, regulators, regional energy development partners, Regional Economic Communities and energy stakeholders - at regional, national and local levels - about the state of Energy Access and Security in the fourteen[1] Eastern African States, existing barriers to enhancing energy access and security in the sub-region and regional and country opportunities and pathways to improving on energy access and security. By raising key issues related to energy access and security in the sub-region, by measuring and evaluating in-depth the state of energy access and security and by engaging possible pathways to enhancing access and security, including regional frameworks, the report further aims to deepen the policy discussion among stakeholders, increasing greater awareness about the issues and encouraging consideration of policy opportunities to enhance energy access and security in the sub-region, as well as in each member State.

1.2 Scope of the Report

Eastern Africa constitutes fourteen countries. The study will offer sub-regional analysis on energy access and security. This analysis is supplemented, in the full report, by review of cases from Ethiopia, South Sudan, Tanzania and Uganda. The case of Ethiopia will enable looking at the role of countries with energy potential, yet internal energy development constraints, in enhancing sub-regional energy access and security. The case of South Sudan will enable discussion of challenges a new State with energy potential but poor access faces. The case of Uganda and Tanzania will feature the role of energy-constrained countries with new found potential, and the implication of energy development in the gas and oil sector to sub-regional energy access and security.

1.3 Energy Access

1.3.1 The Global Energy Access Challenge

Access to modern forms of energy has been a structural constraint to socioeconomic development in the developing world for decades. Recently, *energy access* has entered the global policy priority agenda. This policy prioritization seems to be informed by the realization that achievement of development milestones are related to access to energy services. The International Energy Agency (IEA) stipulates that to meet Millennium Development Goals (MDGs) by 2015, it will be necessary to expand access to clean energy to 395 million more people, and clean cooking facilities to over 1 billion people worldwide, perhaps requiring additional investment of $41 billion per year between 2010 and 2015 (WEO, 2010).

Globally, over 1.3 billion people lack access to electricity, 2.7 billion people lack clean cooking facilities, concentrated largely (95%) in Africa and developing Asia, particularly (84%) in rural areas (WEO, 2011). IEA stipulates that even with $14 billion per year investment between 2010 and 2030 to on-grid electricity connections, 1 billion people will still be without electricity.

[1] The Eastern African sub-region referred to in this report constitutes: Burundi, Comoros, D.R Congo, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Rwanda, Seychelles, Somalia, South Sudan, Tanzania and Uganda.

Some $48 billion/year during 2010 to 2030 will needed to be invested for universal access to modern energy, with majority of the investment going to Africa (WEO, 2011). A joint WHO-UNDP study (2009) suggested that 1.5 billion lack access to electricity, and 9% have access to modern fuels. Within such disparities to access to energy, the urban-rural gap in developing countries is also wide. The study demonstrates that 87% of rural population lack access to electricity, compared with 56% in urban areas in developing countries; and 27% of urban residents have access to modern fuels, compared with 3% of the population in rural areas. Furthermore, penetration of improved cooking stoves is minimal, at about 4% in sub-Saharan Africa.

Energy access is indeed a global challenge. Closer look at the regional disparities on access to energy reveals that much of the *energy access* problem is concentrated in less developed countries, particularly in Africa and southern parts of Asia (see Fig. 1). While access to modern fuels in Africa are slightly better compared with the least developed countries, access to electricity, particularly to rural areas, is however much lower (see Fig. 2). *In essence, the global energy access challenge is intrinsically tied, to a large part, with what will happen to energy sector development in Africa.*

Figure 1: Percent of population without electricity (panel 1) and modern fuels (panel 2) – global view.

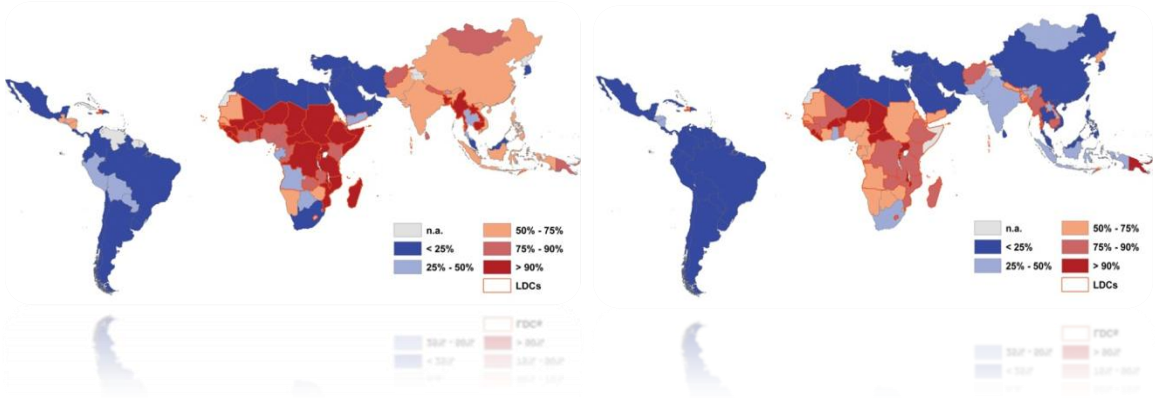
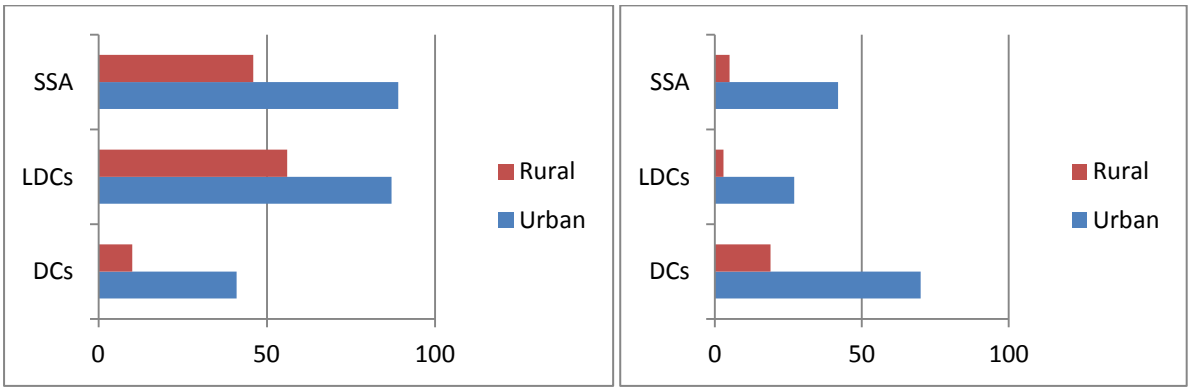


Figure 2: Percent of population without electricity (panel 1) and with access to modern fuels (panel 2) – urban and rural regional variation.

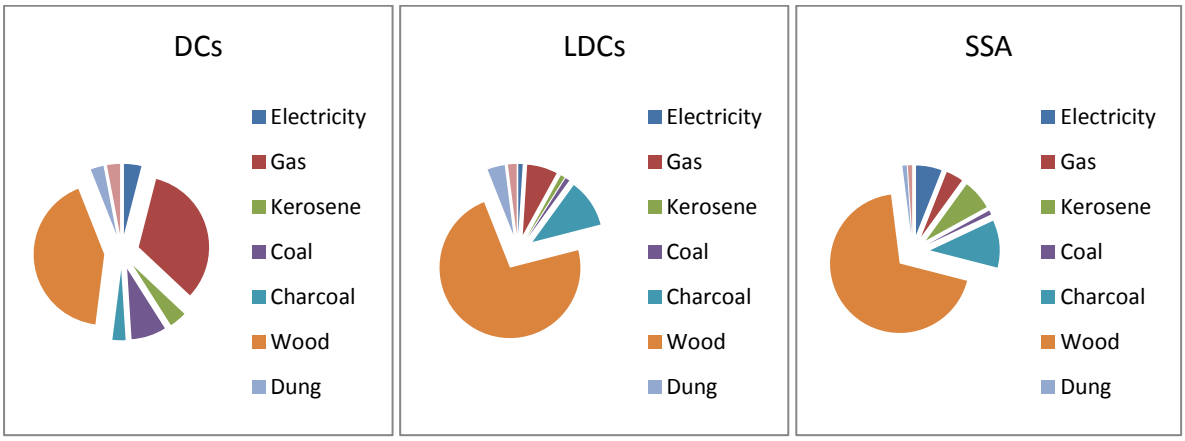


Sources: Adapted from WHO, UNDP (2009).

The global energy access challenge is also reflected in the energy sources portfolio, the degree to which access to modern forms of energy is constrained and transition to the later. In least developed countries, cooking fuels are largely sourced (see Fig. 3) from wood (73%) and charcoal (11%), with minimal access to gas (7%) and electricity (1%).

In sub-Saharan Africa, cooking sources of energy are similarly sourced from wood (69%) and charcoal (11%), with minimal, but slightly higher, shares of kerosene (7%) and electricity (6%). There is therefore excessive dependence on biomass as the major source of energy, signifying the profound structural challenge.

Figure 3: Percent of population using different types of cooking fuels.

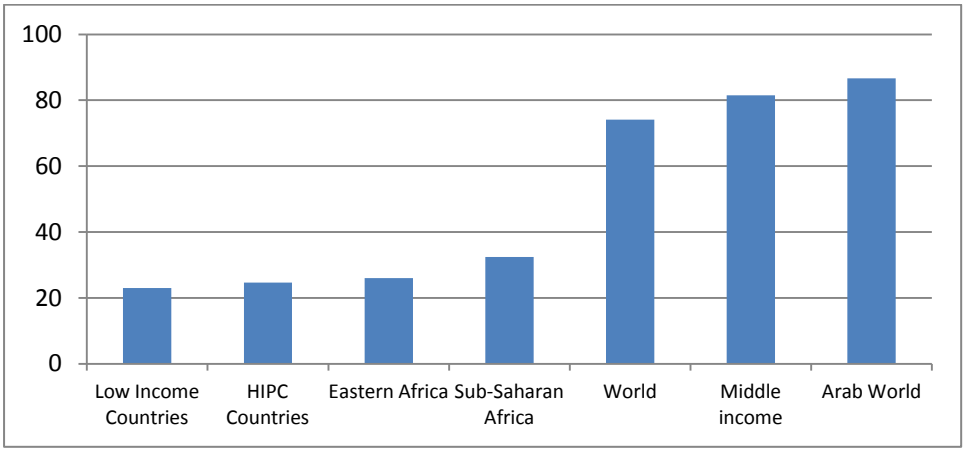


Source: Based on data from WHO, UNDP (2009).

1.3.2 The Energy Access Challenge in Eastern Africa sub-Region

Electricity access rate in the Eastern Africa sub-region ranges from 1% in the new state of South Sudan (leaving 9.3 million people without access), to 9% in Uganda (leaving more than 28 million people without access) (some reports show the level at 12%), 11% in D.R. Congo (leaving nearly 59 million people without access), 13.9% in Tanzania (leaving nearly 38 million people without access), 16.1% in Kenya (leaving more than 33 million people without access) and 17% in Ethiopia (leaving nearly 69 million people without access). Eastern African countries also under-perform in energy access (at around 23%) compared with the sub-Saharan average of 30.5%. Comparison of energy access in Eastern Africa with other regions can put the picture in perspective. Particularly, comparison with access rates in Middle Income countries of over 80% (see Fig. 4) is note worthy, as one central goal in the economic development agenda in Eastern African countries is the transition to Middle Income status. There is ample optimism as economic growth in Eastern African member States demonstrated strong performance, bringing Middle Income status within policy sight. If energy development does not take a rapid pace, this economic agenda will like face an energy road block. *If urgent solutions to rapid expansion of energy access are globally needed, they are particular timely in the Eastern Africa sub-region.*

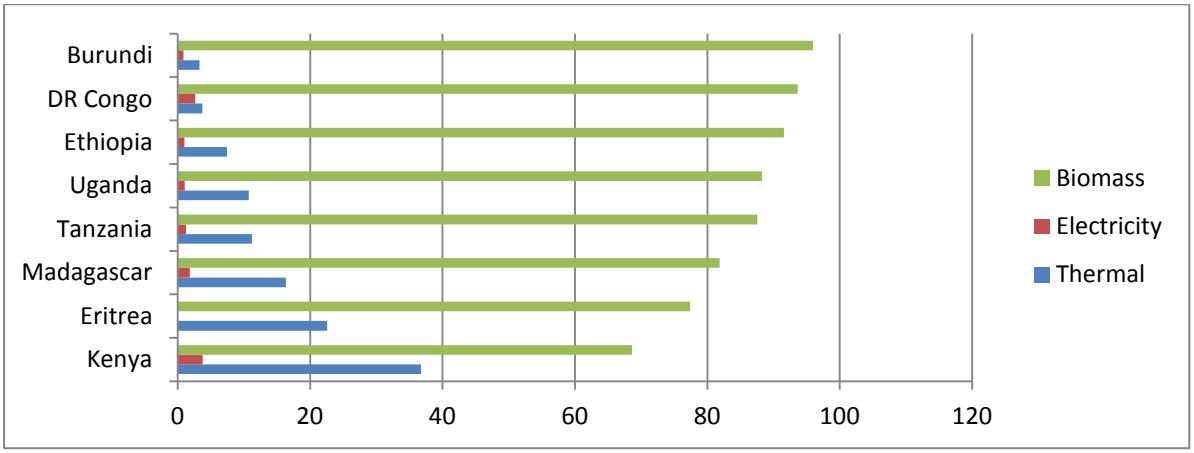
Figure 4: Comparison of electricity access in Eastern Africa with other regions.



Source: Based on data from World Energy Outlook, 2010.

The sources of energy production and energy consumed in Eastern Africa have similar structural composition as in most developing countries – excessive reliance on biomass as a source of energy. Biomass supports 60-70% of the energy consumption in Kenya and Eritrea, and above 80-90% in most Eastern Africa member States (see Fig. 5). Electricity and other forms of modern energy sources are relatively minimally utilized. A growing concern for continuing dependence on biomass for energy, with limited transition to modern energy sources, is the unsustainability of the status quo.

Figure 5: Sources of energy in consumption in select countries.



Source: Based on UN Statistics, *Energy Balances and Electricity Profiles, 2009*.

1.3.3 The Global and sub-Regional Energy Access Agenda

Elevating the energy agenda at the global stage has rested on the efforts preceding it. The Commission on Sustainable Development has recognized the role of energy in sustainable development, particularly at the 11th session, where a multi-year programme of work considered the role of energy in sustainable development (TERI, 2007).

The World Summit on Sustainable Development in 2002 further promoted the role of energy, and through the Johannesburg Plan of Implementation solidified the importance of considering energy in promoting development and reducing poverty. The development of regional power pools in Africa built momentum on the energy access agenda in the continent with charting action plans to implement the energy agenda.

Regional Economic Communities (RECs), such as EAC[2] in East Africa (launched the East Africa Power Master Plan, the Regional Strategy on Scaling up Access to Modern Energy Services, and a regional energy access strategy (adopted by EAC council of Ministers in 2006)) actively engaged in the energy access policy vision.

The EAC strategy seeks ambitious goals of: access to modern cooking energy for 50% of biomass users; access to *reliable* electricity for all urban and peri-urban poor; access to energy to all schools, clinics, hospitals and community centres; and access to mechanical power for productive use for all communities. Moreover, the mainstreaming of energy planning into budgetary processes, building national capacity, developing pro-poor energy policies and promotion of suitable business models were anchored as national intervention opportunities.

These ambitious regional energy vision and strategies are also spearheaded at the continental level, through the promotion of the energy agenda through NEPAD. The NEPAD continental vision advocates for increasing access to *reliable* and *affordable* energy supply for 35% of the population by 2015 and access to modern energy for cooking to 50% of the population. The vision and goals also call for improving the cost of energy supply to enable economic growth (of 6% per annum), improve the distribution of unevenly distributed energy resources, enhance renewable energy development, reverse the negative impact of traditional biomass reliance on the environment, integrate energy infrastructure and reform and harmonize regulations and legislations.

The UN Secretary General, Mr. Ban Ki-moon, declared that he "made Sustainable Energy for All a top priority because it is central to all aspects of sustainable development." As the debate on a post-2015 development agenda has intensified at the UN, member States and development policy and implementations stakeholders, the issue of access to energy is likely to enter the post-2015 agenda.

1.3.3.1 The Sustainable Energy for All (SEFA) Global Agenda

Building on the momentum of the energy access agenda at global, regional and sub-regional levels, Mr. Ban Ki-moon launched an ambitious global vision for energy access, targeting major achievements by 2030, at the opening of the UN General Assembly in September 2011. The year 2012 is named "Year of Sustainable Energy for All" to promote the energy access global vision. The core tenets of the SEFA vision are: (1) ensuring universal access to modern energy services by 2030; (2) doubling the share of renewable energy in the global energy mix; and (3) doubling global rate of improvement in energy efficiency.

It is recognized that to achieve these objectives, *business as usual* will not deliver these results. Instead, four enabling action areas are recommended: (1) energy planning and policies at all levels; (2) business model and technology innovations; (3) finance and risk management; and (4) capacity building and knowledge sharing.

[2] EAC is the East African Community.

Many developing countries have expressed interest in participating in the SEFA initiative (The UN Secretary General's High-level Group on SEFA, 2012), including Ghana developing a national energy plan and programme of action, and in the Eastern Africa sub-regional Uganda, developing a national strategy for SEFA. The agenda of energy access has come to the global policy center, and it is expected that much progress will follow.

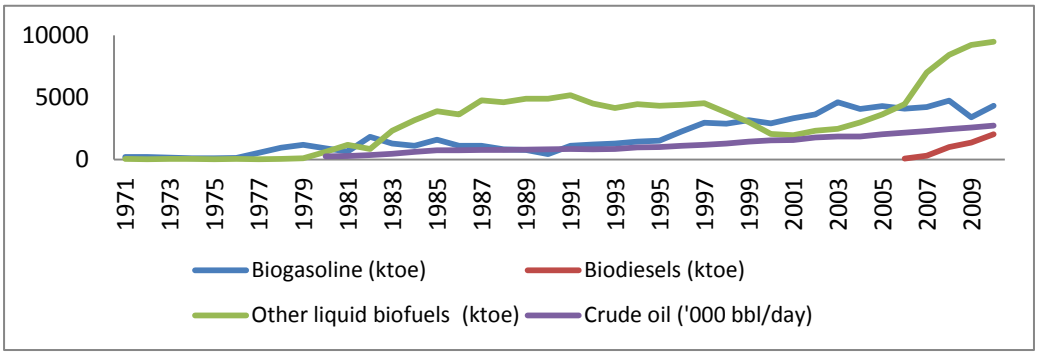
1.4 Energy Security

1.4.1 The Global Energy Security Challenge

Since the Arab-Israeli wars of the late 1960s (the Six Day War) and in the early 1970s (Yom Kippur War), embargo from OPEC countries and resulting price hike, in the range of quadrupling, left the global economy descending into recession between 1973-75. The consequences of the recession were far reaching, as sluggish economic growth in the 1970s and inflation (or *stagflation*) left economic and social damage. Soon after the oil embargo and price hike, energy security, particularly *availability* and *affordability* of crude oil, has dominated the global energy security and macroeconomic stability agenda, posing a serious policy question – *how can global energy security be managed to shield the impact of oil shock on the economy*?

Early efforts at advancing the goal of energy security around oil led to the creation of the International Energy Agency (IEA) in 1974, with the initial central goal of "helping countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks." Countries that did not participate in IEA framework pursued their own energy security strategies. For example, the successful Brazilian model of diversification after the global oil shock brought indigenous sources of energy, particularly in the transportation sector. Review of data from 1971 (pre-crisis) to 2010 for biofuels in Brazil (see Fig. 6) reveals that liquid biofuels increased sharply in the post-crisis period, due to fuel diversification.

Figure 6: Biofuels and crude oil production of Brazil: 1971-2010.

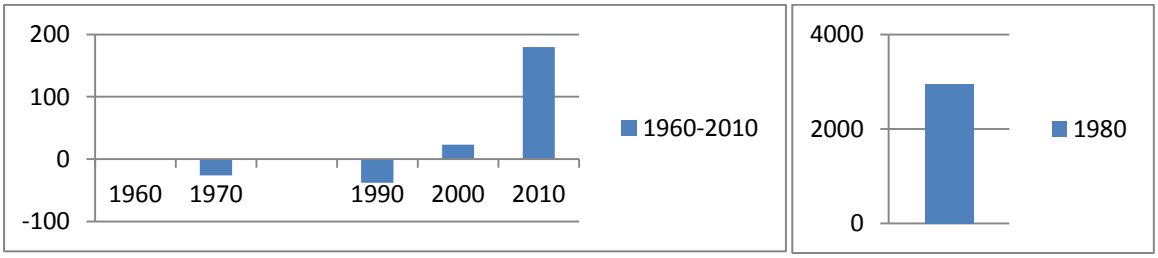


Source: Based on data from IEA. Crude oil data source is US EIA.

More recently, consumption of liquids, natural gas and coal have surged. As a result, the price of crude oil (Petro, Brent, Dubai and WTI[3]) has increased. A decade-by-decade analysis of the price shifts reveal that oil prices in the 2000s broke from norm and rose by 170% (see Fig. 7). Similarly, in the 2000-2011 period, prices for Australian, Colombian and South African coal surged by 361%, 206% and 338%, respectively. Similar pattern is observed for natural gas.

[3] WTI is the West Texas Intermediate crude oil.

Figure 7: Percentage change in crude oil prices by decade.



Source: World Bank Commodity Price Data (Pink Sheet) 1960-2010.

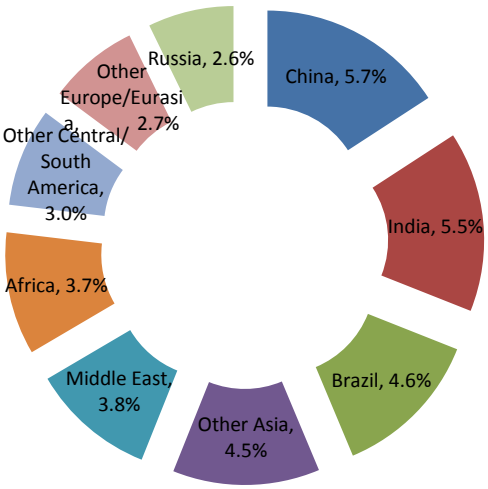
1.4.2 New Sources of Global Energy Insecurity

Traditional sources of energy insecurity, stemming from supply and demand conditions, speculation, market dependence, political instability, diversity of supply sources and other factors are widely discussed in the energy security literature (see for example IEA, 2007; Toman, 2002; Jenny, 2007; Scheepers et al., 2007; Jansen et al., 2004; Awerbuch, 2006; Frondel and Schmidt, 2008; Grubb et al., 2006). But long-term structural changes are introducing a new dynamics in the global energy market. One such factor is a structural shift in the origin of global growth. The global economy is growing, largely due to strong performance in emerging economies and growth in BRIC[4] economies. The growth rate projection from 2008 through 2035 (see Fig. 8) demonstrates robust global economy uptake over the next three decades. Africa is peaking, at what seems to be a conservative growth projection of 3.7%. The Middle East at 3.8%, Central and South America at 3% and much of Asia at 4.5%, among others, the global economy is in an expansion mode, increasing the global demand for energy commodities, particularly hydrocarbons.

Dominant growth prospects are expected in China, India, Brazil and Russia (BRICs) (see Fig. 8). Except for Russia (projected to grow at 2.6% through 2035), the BIRC countries are projected to experience 4.6% plus growth rates till the mid 2030s. Global growth is accompanied by a rise in income per capita. Personal incomes, particularly in Russia and Brazil, and also in China are expected to increase quite sharply, 2-5 times by 2017 from levels in 2000 (see Fig. 9). Growth in GDP and personal income will put added pressure on energy markets, with likely price response in the short-term, when new supplies are limited. The impact of BRICs on global energy market volatility and oil equity returns depends on the extent that BRICs are net importers or exporters of oil (Bhar and Nikolova, 2009). While the degree of impact depends on net import, export position, Chousa, et al. (2008) find that the rapid economic growth will increase energy consumption, caused by increases in investment, population and trade in energy intensive products.

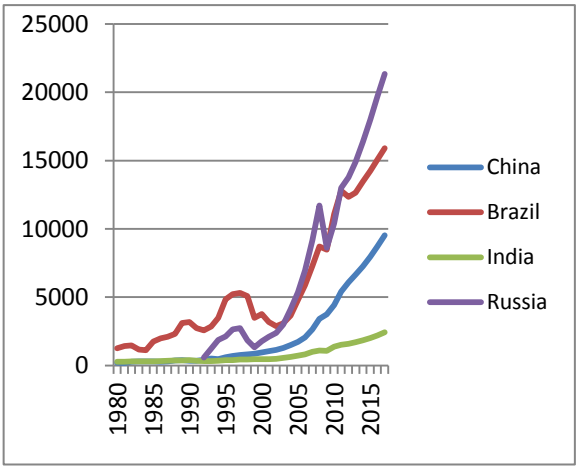
[4] BRIC is reference to Brazil, Russia, India and China, fast growing countries in the global economy.

Figure 8: Projected growth: 2008-2035.



Source: Based on data from US EIA, International Energy Outlook, 2011.

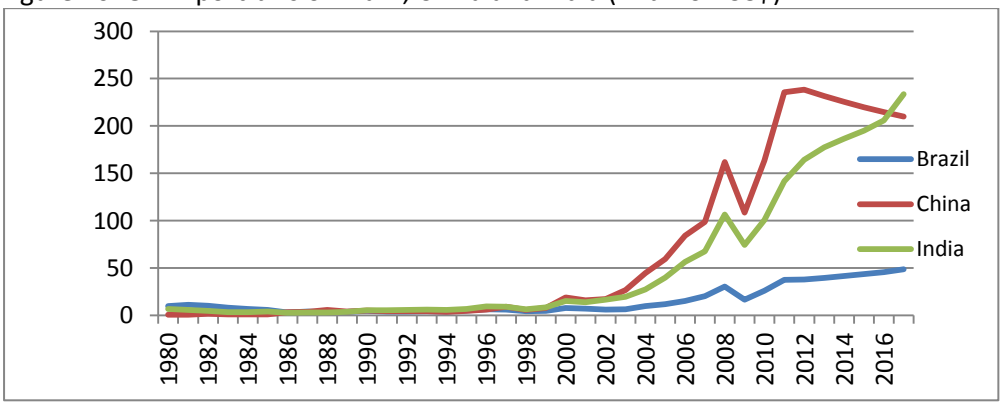
Figure 9: GDP per capita in BRICs: 1980-2017.



Source: Based on IMF, World Economic Outlook data.

While Bhar and Nikolova (2009) advice that the impact of BRICs on global energy prices is dependent on their net trading position. All indications are that BRICs are increasing their presence in global energy markets. The total import bill for China, India and Brazil (Russia is net exporter of energy) from 2000-2012 reveals that their oil import bill increased by 54%, 215% and 164%, respectively, between 2000-2005. In the 2006-2012 period, the oil import bill of China, India and Brazil further grew by 146%, 183% and 192%, respectively. This rapid surge in oil imports is projected to increase rapidly in the foreseeable future (see Fig. 10).

Figure 10: Oil import bills of Brazil, China and India (in billion US$).



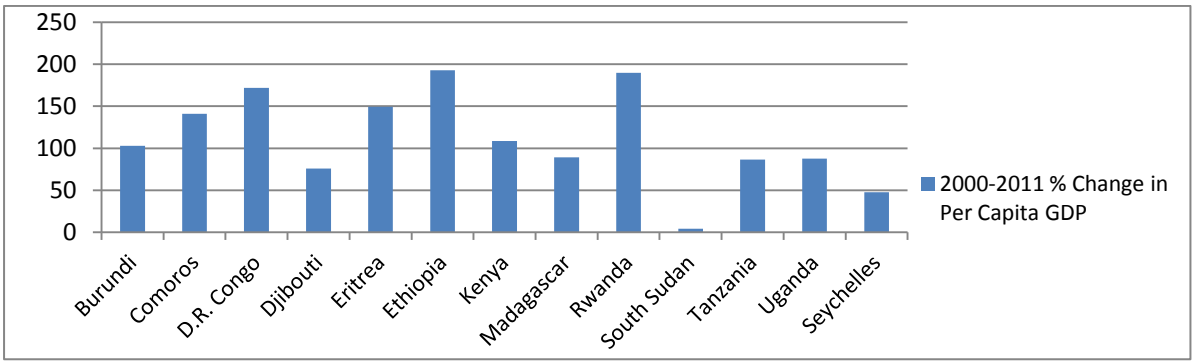
Note: Russia has no oil imports, and is net energy exporter.

1.4.3 Energy Security in Eastern Africa

In the Eastern Africa sub-region, the economic resurgence of member states has given optimism to economic transformation in the region. The fast growth of Rwanda and Ethiopia, and good economic performance in Kenya, Uganda, Tanzania and Burundi has led to positive sub-regional outlook. While concerns remain about the inclusiveness and broad-based nature of such growth in the sub-region, leading to policy focus on *quality of growth*, GDP per capita figures show robust improvement over the last decade (see Fig. 11). Burundi, Comoros, D.R. Congo, Eritrea, Ethiopia, Kenya and Rwanda have seen their per capita GDP more than double during 2000-2011,

with growth rates above 180% in Ethiopia and Rwanda. *Sustaining the economic momentum through energy security is likely to enter the policy debate as robust growth will require increasing supply of energy input.*

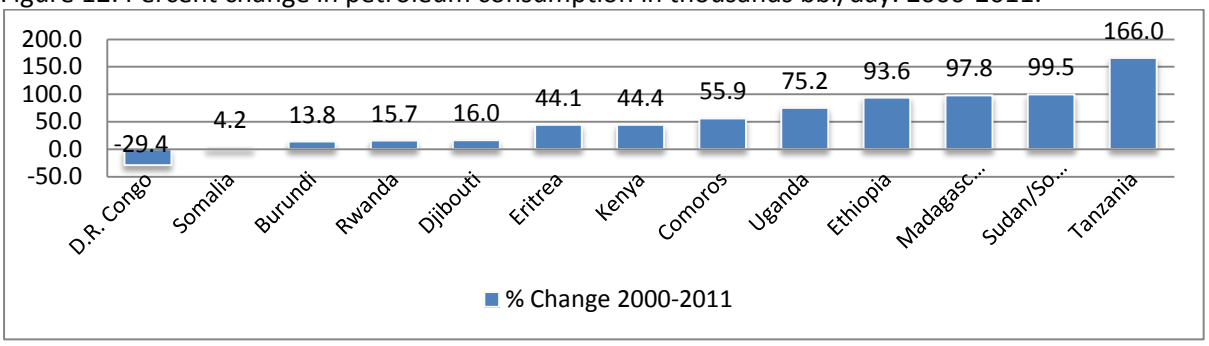
Figure 11 Per capita GDP growth in Eastern African sub-region member states: 2000-2011.



Source: Based on IMF, World Economic Outlook data.
Note: South Sudan growth rate computed from 2010-2011.

Petroleum consumption is already surging in the Eastern Africa sub-region. The global share of petroleum consumption in Africa has gradually increased from around 3.25% to about 4% over a decade. In the same period, the share of the Eastern African sub-region in Africa's petroleum consumption increased from about 8% to close to 10%. While the shares seem to have increased only gradually, comparison of absolute consumption levels of petroleum from 2000-2011 shows that while consumption at the continental level increased by slightly more than 40%, the rise in the Eastern African sub-region was 67%. *This constitutes a significant increase in exposure to global energy markets.* Comparison of percentage changes in petroleum consumption from 2000-2010 further supports the previous proposition. Island States of Comoros and Madagascar saw consumption increases of 56% and 98%, respectively. Larger economies such as Uganda, Ethiopia and Tanzania saw increases in the rage of 75%, 94% and 166%, respectively (see Fig. 12). Smaller economies saw change in the rage of 4.2% in Somalia, 14% in Burundi, 16% in Rwanda and Djibouti, which are modest for a decade change.

Figure 12: Percent change in petroleum consumption in thousands bbl/day: 2000-2011.

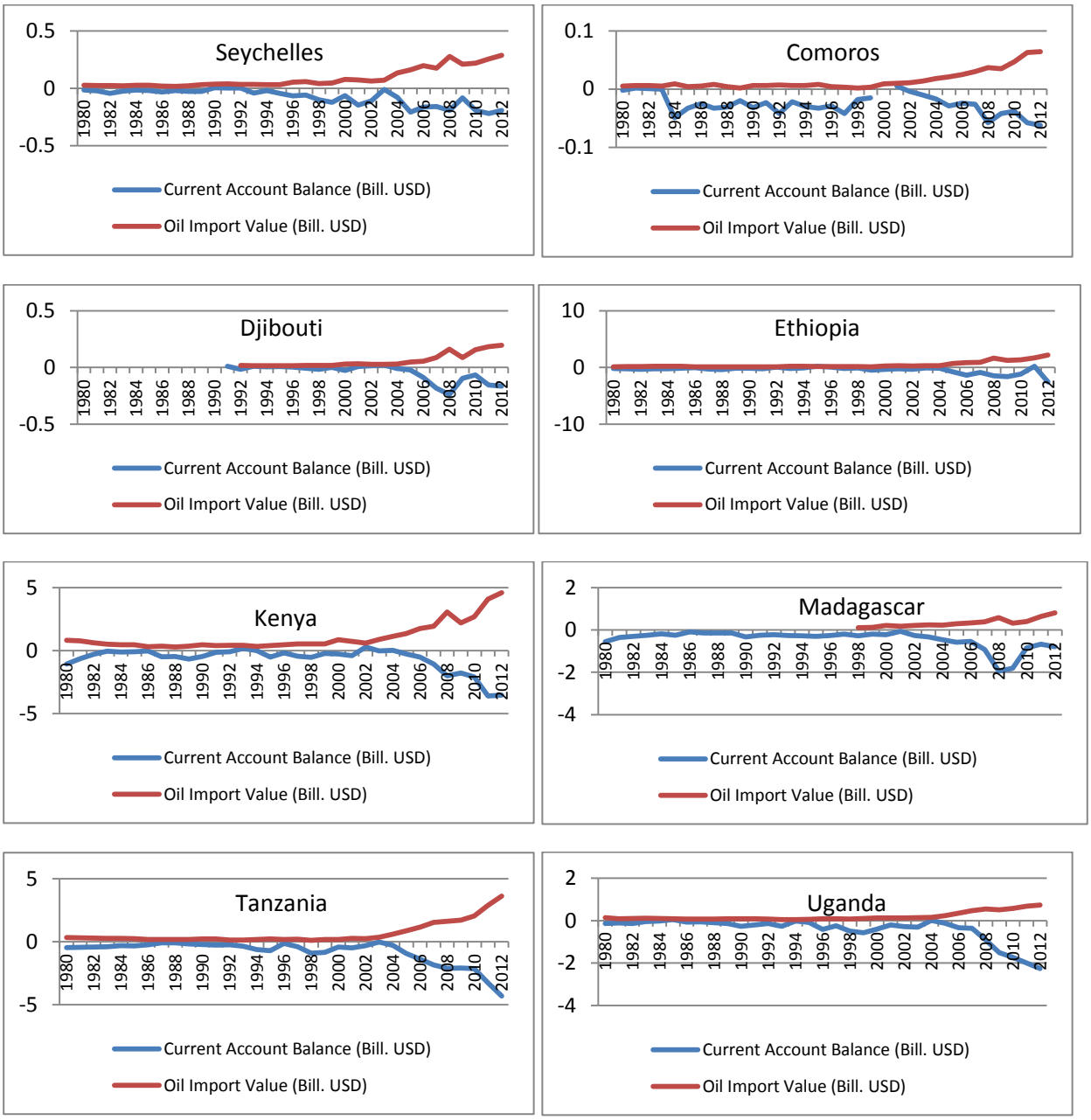


Source: Based on data from US EIA.

The most direct impact of dependence on imported oil is through price hikes in global markets. Comparison of oil import values and current account balance for countries in the sub-region (see Fig. 13) demonstrates the importance of energy security. Increases in oil prices in recent years (post 2008) has led to a drift in current account balance of sub-regional member states from trend. The observation is consistent throughout the region, except in Eritrea (trend reversed due to

kicking-in of mining sector revenues from gold exports in the same time period). Increased negative balances in the current account is likely to lead to drawdown of foreign reserves, or lead to increasing public debt to finance deficits, both posing risk to sustained robust economic growth in the region.

Figure 13: Oil import values and current account balances in select Eastern Africa sub-Regional member States, in billion USUS: 1980-2011.



Source: Analysis conducted based on IMF, World Economic Outlook data.

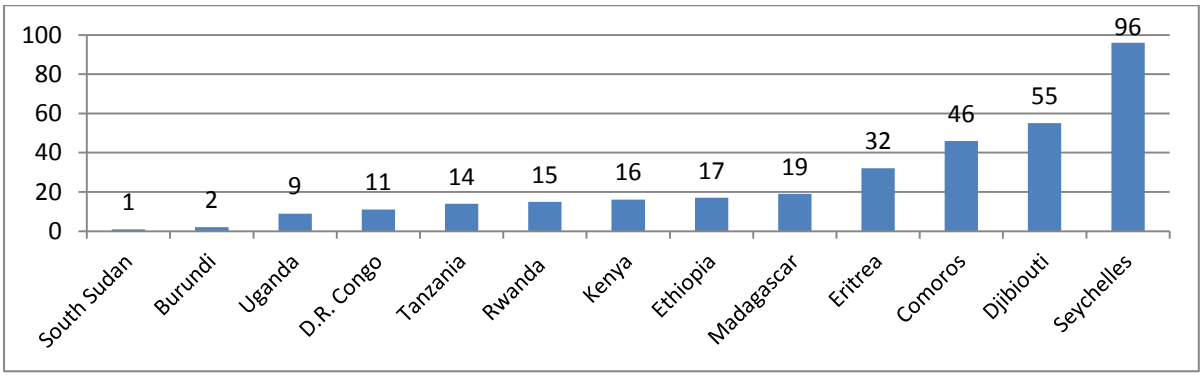
It is evident that managing energy insecurity in the sub-region in itself is a pro-development agenda. Energy insecurity poses risk to economic growth in the sub-region, one that can be mitigated with proper regional energy security management.

2 THE STATUS OF ENERGY ACCESS IN THE EASTERN AFRICA SUB-REGION

2.1 The State of Energy Access in the Eastern Africa Sub-Region

The state of energy access in member States of the Eastern Africa sub-region is generally quite low, ranging from 1% in South Sudan, 2% in Burundi, 9% (also reported 12%) in Uganda and 11% in D.R. Congo to relatively better performance in Comoros (46%), Djibouti (55%) and Seychelles (96%) (see Fig. 14). In eleven of the fourteen member States, electricity access rates are below 20%, with large urban-rural gap. Rural electricity access is rather in single digit in many of the member States. Comparison of access gaps within the Eastern Africa regional average, and with the average for sub-Saharan Africa, middle income countries and the universal access target can reveal the depth of the energy access challenge in the sub-region.

Figure 14: Percent of population in Eastern Africa member States with access to electricity.



Sources: IEA, World Energy Outlook 2010; data from country missions.

Comparison within the sub-region can help map member States with comparative intensity of the energy access challenge. Comparison with sub-Saharan (as North Africa achieved almost universal access) countries on energy access provides a profile of energy access in the sub-region relative to the performance of a wide range of African countries. Comparison with middle income countries on energy access is particularly useful as member States such as Ethiopia, Kenya, Rwanda and Uganda aspire to be middle income within the next decade or so. Comparison with the universal access agenda provides an assessment of the depth of the challenge in member States. Such comparative analysis is summarized in Fig. 15. The assessment includes thirteen of the fourteen member States, leaving Somalia due to lack of accurate access data.

Within the Eastern Africa sub-region, the regional average electricity access level is about 26%, mainly due to the high access rate in Seychelles (96%). The sub-regional average without Seychelles drops to just 20%. Of the thirteen countries depicted in Fig. 26, four have electricity access rates above the sub-regional average of 26%: Eritrea (up 6%), Comoros (up 20%), Djibouti (up 29%) and Seychelles (up 70%). *Sub-regional access rates tend to be higher in coastal small States and Island States*. The relatively small population that is reachable through gird access can be one reason. Relatively large concentration of people in major cities could be another. However, higher access levels are achieved through more expensive generation fuel source.

Thermal generation accounts for nearly all electricity generated in Djibouti (now electricity trade with Ethiopia has improved per unit cost), Eritrea and Seychelles, and to a similar level in Comoros baring the slight contribution from hydropower. On the contrary, in nine of the thirteen countries in the analysis, access levels are below the sub-regional average. The intensity of gap between sub-regional and country access is the largest in South Sudan (down by 25%), Burundi (down by 24%), Uganda (down by 17%) and D.R. Congo (down by 15%). Tanzania, Rwanda, Kenya, Ethiopia and Madagascar have gaps of 12%, 11%, 10%, 9% and 7%, respectively. Countries with access gap from sub-regional average constitute those with vast hydropower potential (D.R. Congo and Ethiopia), small landlocked countries (Burundi and Rwanda), countries with oil and gas potential (Tanzania, Kenya and South Sudan), and a large Island State with indigenous energy resources potential (Madagascar).

In sub-Saharan Africa, the average access rate is around 32%, slightly higher than the Eastern African sub-regional average (26%). Comoros, Djibouti and Seychelles have electricity access levels significantly above the sub-Saharan average, with Eritrea at that average. The rest of the member States in the sub-region underperform compared with the sub-Saharan level, by a margin ranging from 31% to 13%. This reveals the degree to which the sub-region faces an alarming energy access challenge.

A number of sub-regional member States have but transition to a middle income country as a medium- to long-term economic development objective. Transformation will require rapid economic growth, lifting many from poverty. Transformation will also require rapid expansion of energy capacity to sustain economic growth to the middle income post. Middle income countries, on average, have electricity access rate at 82%. With the exception of Seychelles in the sub-region (up 14%), all other member States have significant access deficit from the middle income level. The deficit is 80% and above in South Sudan and Burundi, in the 70% and up in Uganda and D.R. Congo, between 60%-70% in Tanzania, Kenya, Rwanda, Ethiopia and Madagascar, and between 27% - 50% in Eritrea, Comoros and Djibouti.

All member States in the sub-region have gaps compared to “universal access,” of course with targets to be met by 2030, not 2012. But the current gap is reflective. It is in the range of 45% to 99%, with Seychelles just 4% deficit. *The energy access challenge in the sub-region is massive, requiring far-reaching vision, implementation strategy and regional cooperation*.

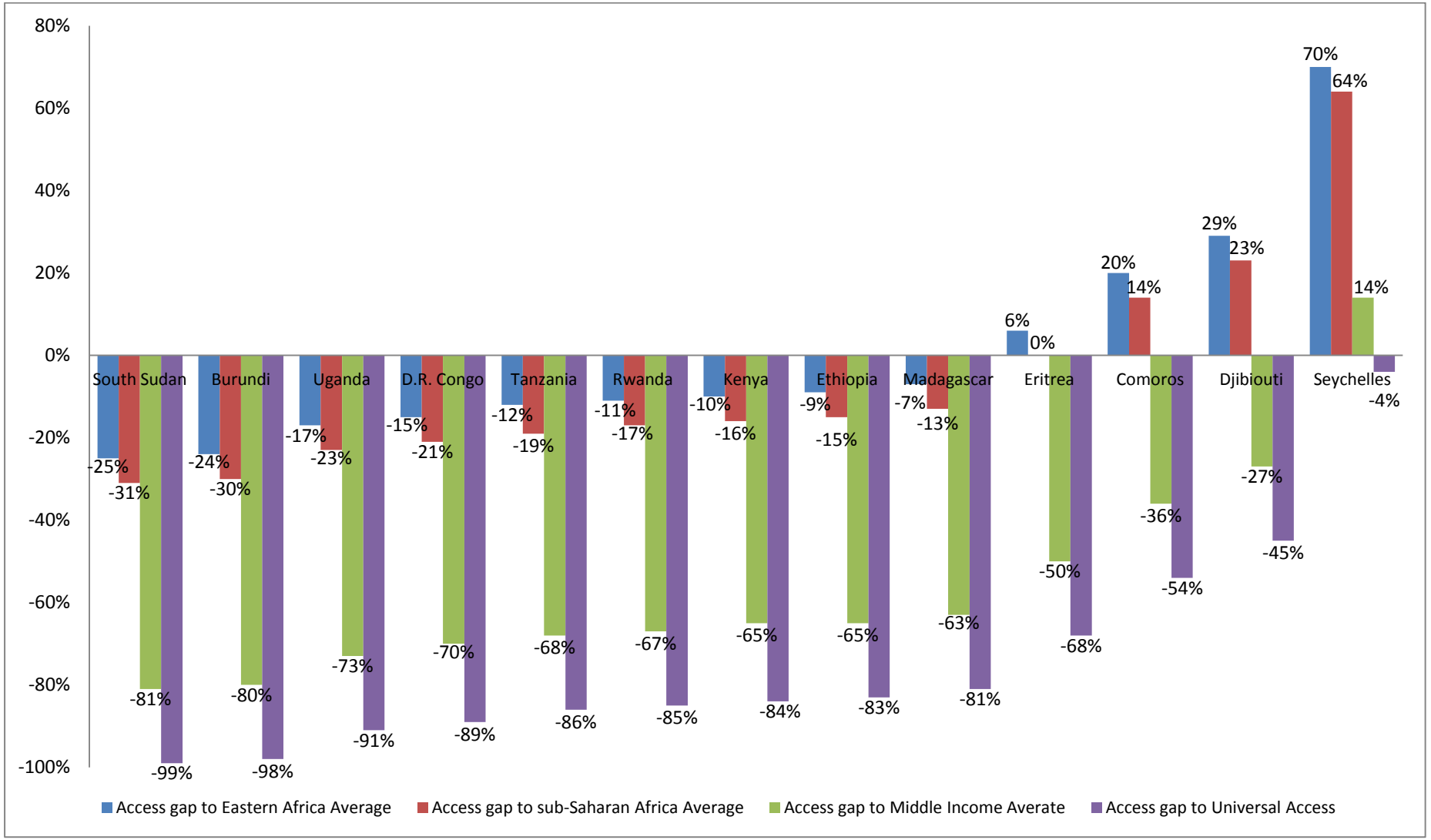
2.2 Contributing Factors to Low Energy Access in the sub-Region

On the demand side, there are a number of constraints. First, the electricity consumption constraining nature of the level of income in countries in the sub-region has implication to access levels. Low income levels lead to lower *effective demand* for energy services, and hence lower levels of energy consumption and access. The relatively lower level of economic development in the sub-region is one reason why observed energy access levels are quite low. *Addressing energy access in the sub-region is interlinked with advancing economic development and enhancing consumer income.* Second, switching to energy technologies, and accessing modern forms of energy away from traditional ones, faces the challenge of culture, attitudes and preferences. Consumers often prefer energy sources they have come to rely and use for a long time, and demonstrate resistance to switch.

Third, settlement of population away from major grid network poses access challenges, given the limited diffusion of off-grid energy systems in many parts of the Eastern Africa sub-region. Illegal settlement and land use patterns pose legal and physical barriers to the urban poor. Illegal tenancy arrangements (largely unrecognized by utilities and city administration) and settlements away from the national grid pose difficulties. Fourth, affordability of energy is a relevant consideration in energy access promotion strategies. Subsidizing energy prices is a common feature in the Eastern Africa sub-region. While costly, these policy efforts reduce the effective price of energy to households, increasing access and consumer welfare.

However, these programs often come at a hefty cost to governments and utilities. The challenge of keeping electricity rates affordable and that of keeping the system financially sustainable is an on-going challenge in the sector. Fifth, the demand for electricity is dependent on how reliable the energy system is over-time. The reliability of the energy system can be observed by consumers based on degree of service interruptions, the cost imposed by such interruptions, and the duration of interruptions when they occur, particularly to industry.

Figure 15: Assessment of the electricity access gap in Eastern African countries relative to sub-regional, sub-Saharan, middle income and “universal access” levels.



On the supply side, there are additional constraining factors. First, the structurally low level of electricity access in the Eastern Africa sub-region is related to existing low power generation capacity. In much of the sub-region, the share of electricity in final consumption is below 5%, and thermal ranging from 3.18% in Burundi to a high of 21.43% in Kenya. The structure of energy production and consumption demonstrates the low contribution of electricity to final consumption, partly due to poor levels of generation. Second, despite low electricity generation capacity, further power shedding from the transmission and distribution lower the available generated power for end users. Transmission and distribution losses are quite high in the sub-region. For example, Tanzania's transmission and distribution loss is in excess of 20% of generated electricity, with 15% or more coming from technical and non-technical losses. In the D.R. Congo, losses are estimated between 20-30%, with significant illegal connections. In Uganda, transmission and distribution losses are also quite high, distribution losses alone accounting to 38% of generated electricity, which in recent years declined to 29%. *Such high levels of* transmission and distribution losses reduce the available energy, curtailing effective supply.

Third, energy sector development has not received adequate attention for much of the period between1980-2000 in many sub-regional countries. Comparison of the total existing capacity with the capacity expansion since 2000 demonstrates that investments were largely marginal, and the last investment year dates back to the 1990s or 1980s. For nearly two decades, energy planning was inadequate, and generation capacity expansion was not at par with the demand pressure. Since 2000, the lagging generation capacity development is met with growing demand for more energy, driving most of the sub-region into emergency generation. In the 2000s, Kenya, Rwanda, Tanzania and Uganda, for example, have added 51%, 45%, 68% and 52% of their total capacity, respectively.

Finally, to public utilities operating the transmission and distribution network, and in some cases the whole chain from generation to distribution, utilities in sub-regional countries are under financial duress. For example, TANESCO has been facing financial insolvency for years, keeping tariff at regulated levels (around $0.13/kWh) even in the face of growing emergency generation from more thermal sources. JIRAMA, the utility in Madagascar, is under similar challenge. While the energy sector is deregulated by reform, JIRAMA operates the transmission and distribution system. The emergence of rapid thermal generation in Madagascar, in the face of regulated tariff (around $0.10/kWh) has exposed JIRAMA to financial insolvency. In D.R. Congo, the public utility company, SNEL, operates from generation to transmission and distribution. It too has faced financial insolvency. Finance-strapped utilities are less likely to invest in grid improvement and quality service delivery, and are largely unable to re-invest in generation capacity expansion. In much of the sub-region, where energy sector reform has taken shape, regulated tariffs with rising generation cost due to rapid integration of thermal technologies, has left utilities ill-equipped to plan for capacity expansion. In Uganda, regulators have already removed part of the subsidy going to keep tariffs low, leading by some estimates to a 42% rise in tariffs. The pressure of keeping tariffs at "socially desirable" levels through regulated tariffs in the face of rising generation costs has created a wedge between keeping tariffs cost-reflective (hence improving the financial solvency of utilities) and keeping rates low to enhance socio-economic development on cheaper energy. This wedge is likely to continue in the foreseeable future.

Generation capacity limits, delayed energy planning and investment, high transmission and distribution losses, limited infrastructure development, integration of thermal generation and technology choice pose supply constraints in the sub-region, but trade potentials and greater attention to indigenous energy resources development by member States represent as a positive shift in the supply side.

3 THE STATUS OF ENERGY SECURITY IN THE EASTERN AFRICA SUB-REGION

3.1 The State of Energy Security in the Eastern Africa Sub-Region

The state of energy security in the sub-region is assessed looking at oil and gas, electricity and biomass systems. Applying energy security measurements and indicators, an overview of the energy security condition and challenges in the sub-region is provided below, based on single indicators and series of indicators informing on the short- and long-term energy security status and *challenges.*

3.1.1 Petroleum Import Dependence and Energy Security in Eastern Africa sub-Region

The consumption of petroleum products in the Eastern Africa sub-region has grown markedly over the last decade. Lager economies of Kenya, Ethiopia and Tanzania saw steeper increases in petroleum consumption. The sub-region as a whole saw an increase from about 200,000 bbl/day to nearly 350,000 bbl/day in a decade, increasing the dependence on imported fuels. Within the sub-region, the share of sub-regional consumption declined in Comoros (by 0.02%), in Burundi (by 0.42%), in Eritrea (.28%), in Somalia (0.89%), in Rwanda (0.79%), in Djibouti (1.69%), in D.R. Congo (4.04%) and in Kenya (by 3.82%) between 2000 and 2001. The sub-regional share increased in Uganda (by 0.2%), Madagascar (1.1%), Ethiopia (1.78%), Tanzania (4.73%) and Sudan/South Sudan (by 4.13%). *Despite these variations, the exclusive reliance of member States on imported fuel, at increasing volume, has raised the level of energy insecurity.* There are indeed new discoveries of oil and gas in Uganda, Tanzania and Kenya, and promising prospects. But until these new found resources are properly integrated into the domestic and sub-regional energy markets, the current exclusive reliance on imported petroleum causes specific concerns.

The level of petroleum import dependence is considered low if it is below 15%, medium in the 40-65% range, and high above 85%. With the exception of Kenya, with 70% reliance on imported motor gasoline, 50% reliance on imported kerosene type jet fuel and 75% reliance on imported diesel (due to domestic refining capacity), all remaining countries in the sub-region rely totally on imported oil products, that is at 100% (see Table 1). In the case of South Sudan, crude oil production and refining capacity at refineries in Khartoum had introduced energy independence for motor gasoline, and significantly alleviated kerosene type jet fuel and diesel import dependence, at just 37% and 16%, respectively. With the independence of South Sudan and the separation of the two States, South Sudan continued to produce crude oil, but entirely for export. This has led to total import dependence on refined petroleum products, making South Sudan as vulnerable as other member States in the sub-region.

The state of oil-import dependence in the sub-region is therefore the most severe, at 100%, exposing the States and their economies to the vagaries of global oil markets.

3.1.2 Oil Market Volatility and Political Instability in Oil-exporting Countries

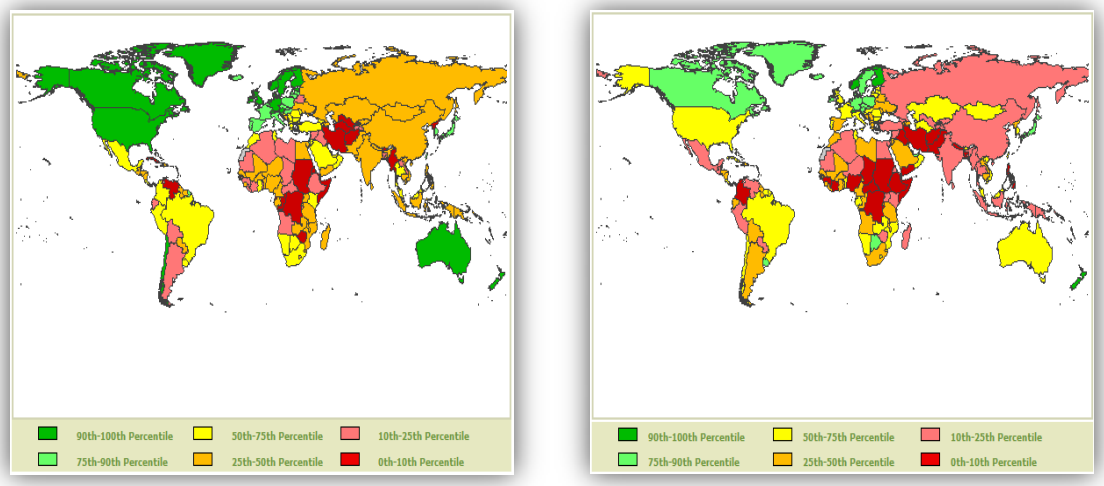
Excessive import dependence poses two immediate risks: *oil market volatility* and *political instability* in oil exporting countries, and additional political risks for land-locked countries emanating from fuel routing States. The political risk in oil exporting countries has traditionally been high, and has increased further in the Middle East and North Africa with the advent of the “Arab Spring”, with rising tension in the Strait of Hmormuz resulting from confrontations about the nuclear program of Iran, and due to conflicts between Sudan and South Sudan.

Table 1. Degrees of refined oils import dependence (%) in the Eastern Africa sub-region.

	Motor Gasoline	Aviation Gasoline	Kerosene Type Jet Fuel	Gas/Diesel
D.R. Congo	100	NA	100	100
Djibouti	100	100	100	100
Eritrea	100	100	100	100
Ethiopia	100	100	100	100
Kenya	69.6	100	50	74.5
Sudan/ South Sudan	0	NA	37	16.2
South Sudan	100	NA	NA	100
Tanzania	100	NA	100	100
Uganda	100	100	100	100
Rwanda	100	100	100	100
Burundi	100	NA	NA	100
Seychelles	100	NA	NA	100
Comoros	100	NA	NA	100
Madagascar	100	NA	NA	100

The World Bank puts forth two indicators of governance that are often utilized as indicators of political stability for short-term energy security assessment: regulatory quality and political stability/absence of violence. The regulatory quality of oil exporting countries is ranked average and below, and their political stability ranking is between 0 – 25% percentile globally (see Fig. 16), making the region politically risky as a source of continual petroleum supply. *Any political instability in oil exporting countries, in the face of almost total sub-regional reliance on imported fuels, will result in maximum energy security exposure of member countries, and their economies.*

Figure 16: Regulatory quality and political stability/absence of violence map.

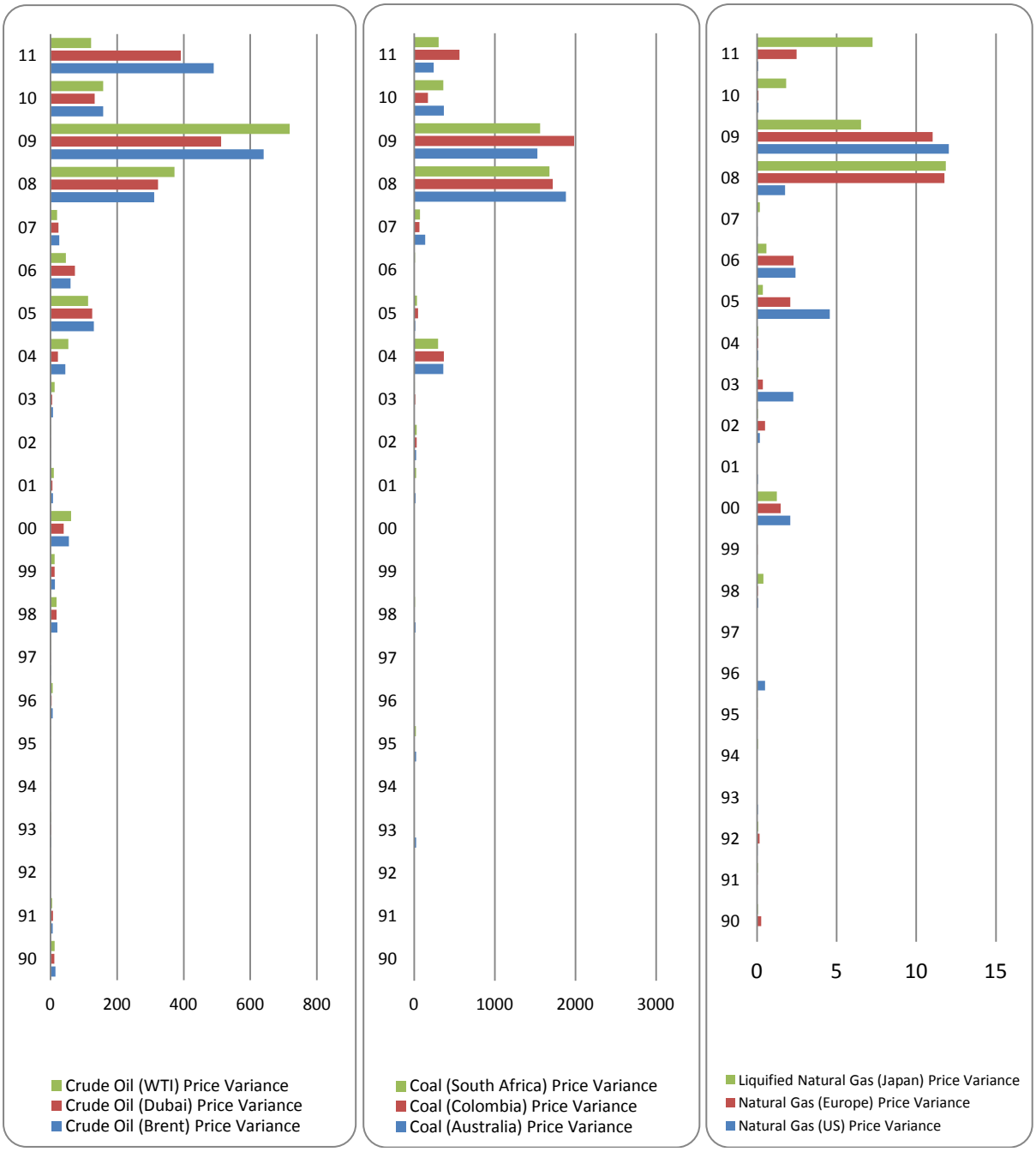


Source: Kaufmann D., A. Kraay and M. Mastruzzi (2010), the Worldwide Governance Indicators: Methodology and Analytical Issues.

The second immediate concern for member States is market risk resulting from unmitigated volatility in the oil market. In the estimated year-to-year price volatility for crude oil, coal and natural gas prices from 1990-2011 (see Fig. 17), from 2005-2011, energy price volatility has taken a structural shift, with sharp volatility particularly in 2008 and 2009, with resurgence of volatility back in 2011. *The brunt of these market volatility, particularly in up-swing prices, are felt by member States, who would now need to commit more resources to meet the same fuel import requirements in an import-dependence energy structure*.

Figure 17: Crude Oil (panel 1), coal (panel 2) and natural gas (panel 3) estimated price volatility:

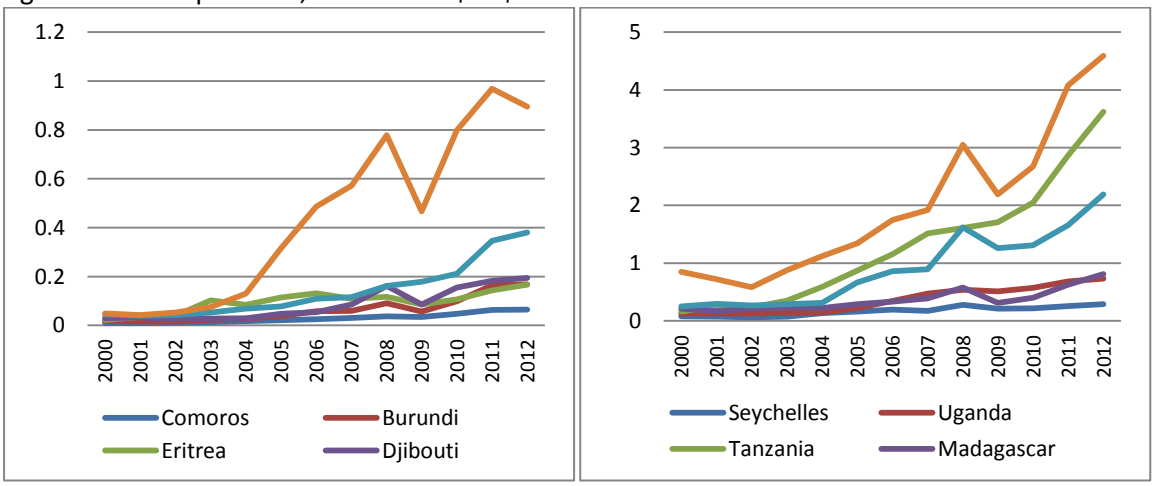
1990- 2011.



3.1.3 Expenditure on Oil Imports and Economy Oil Vulnerability (Oil Vulnerability Index)

The degree of public expenditure on oil imports is a reflection of the exposure to imported forms of energy. This is particularly the case for Eastern African member States where scare foreign exchange reserves can be alternatively utilized for development finance. The oil import bill for 2000-2012 demonstrates increases throughout the member States, but sharply rises for Tanzania, D.R. Congo, Burundi, Ethiopia, Rwanda, Eritrea, Comoros and Djibouti (see Fig. 18). The rise in oil import expenditure is far more than the rate of GDP growth in the sub-region, putting strain on resources.

Figure 18: Oil import bills, in billion USUS: 2000-2012.



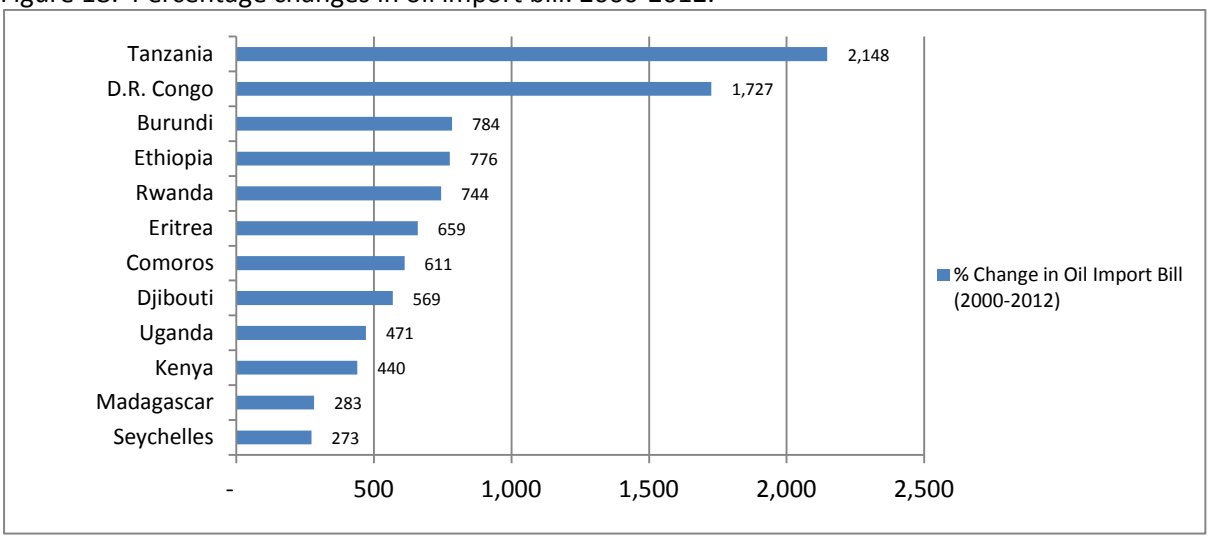
Source: Based on data from IMF World Economic Outlook 2012.

Note: The 2011 and 2012 values are estimates for Comoros, Rwanda, Uganda, Tanzania, Madagascar, and Kenya. The 2012 values are estimates for Djibouti, D.R. Congo, Seychelles and Ethiopia. For Burundi, data is estimate for 2010 to 2012. For Eritrea, data is estimate from 2009-2012.

To provide a frame of reference, the percentage change in oil import bill in the last decade is depicted in Fig. 19. The slowest growth in the sub-region in public spending on imported oil is in Seychelles, which grew by an estimated 273% and in Madagascar by 283%! Import bills grew 4.4 and 4.7 folds in Kenya and Uganda, 5 times in Djibouti, more than 6 times in Comoros and Eritrea, between 7 and close to 8 fold in Rwanda, Ethiopia and Burundi, and by a whopping 17 times in the D.R. Congo and 21 times in Tanzania! The result has been a sub-regional current account deficit rise.

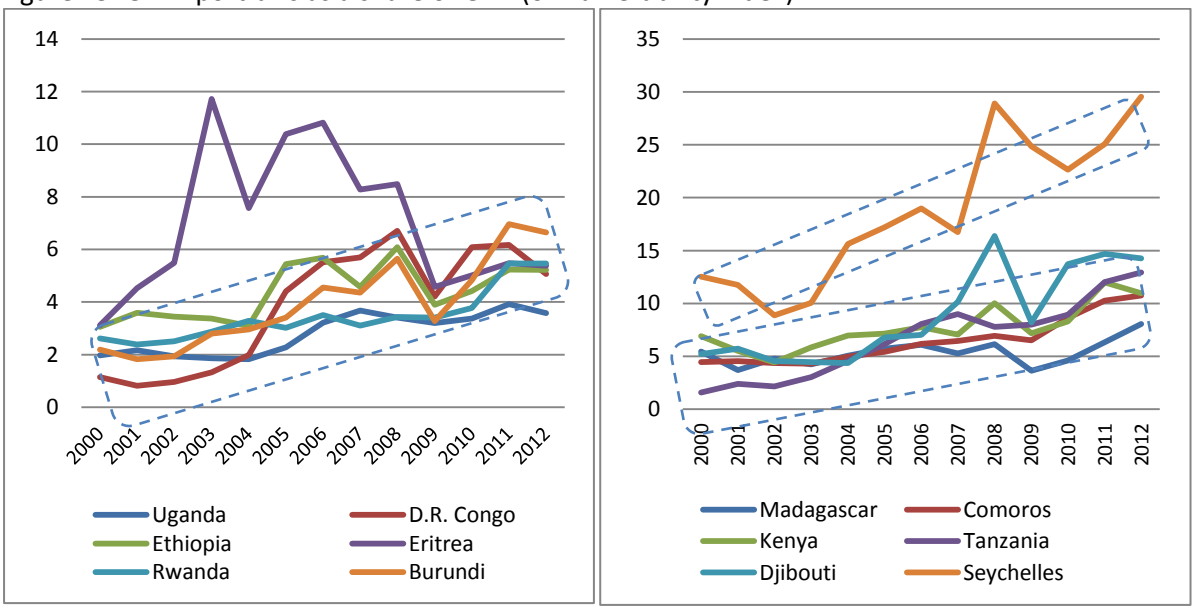
The rapid rise in public expenditure on imported oil in a decade, by a margin between 273% to 2,148%, demonstrates the state of growing energy insecurity in the Eastern Africa sub-region.

Figure 18: Percentage changes in oil import bill: 2000-2012.



The share of oil import expenditure in GDP is also a measure of oil vulnerability, and short-term energy insecurity. In all of the member States in the Eastern Africa sub-region, the GDP share of oil import bills has increased, and the slope of increase overtime is significant (see Fig. 20). The sub-region is devoting a growing share of its GDP on fuel imports, not only transferring wealth to oil-producing countries, but continuing to expose their economies to the energy insecurity impacts.

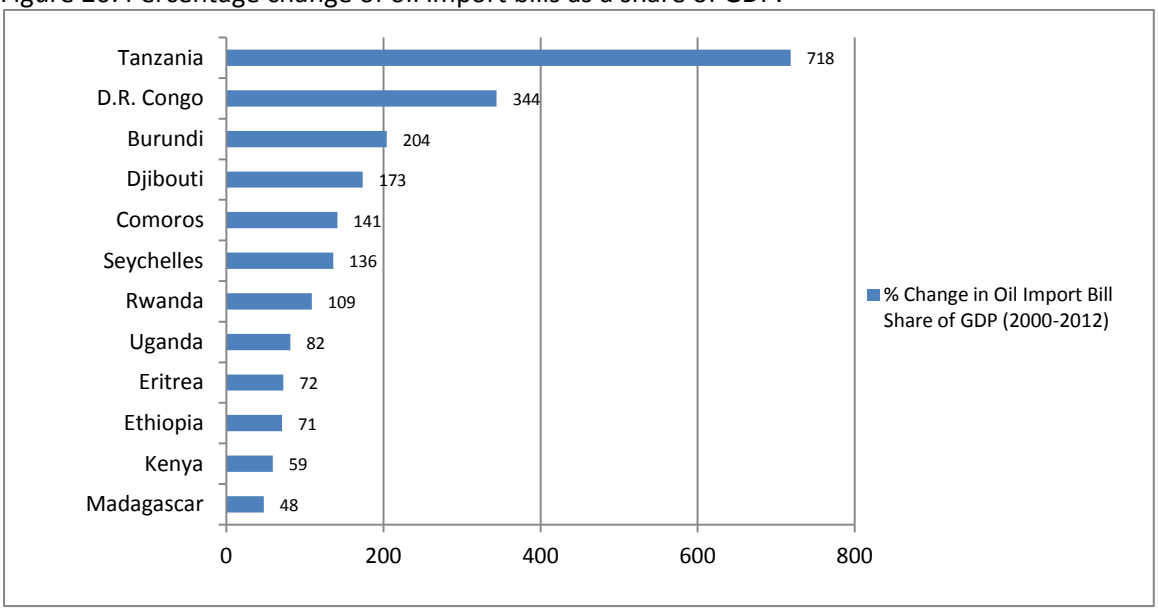
Figure 19: Oil import bills as a share of GDP (oil vulnerability index).



Source: Based on data from IMF World Economic Outlook 2012.

The change in oil import share of GDP from 2000-2012 (see Fig. 21) similarly demonstrates the energy security challenge of member States. The GDP share increased from a low of 48% in Madagascar, to between 100%-200% in Rwanda, Seychelles, Comoros, Djibouti and Burundi. In D.R. Congo and Tanzania, the increase was by 344% and 718%, respectively. *By this measure, energy security vulnerability has increased throughout the sub-region, in small, large and Island States.*

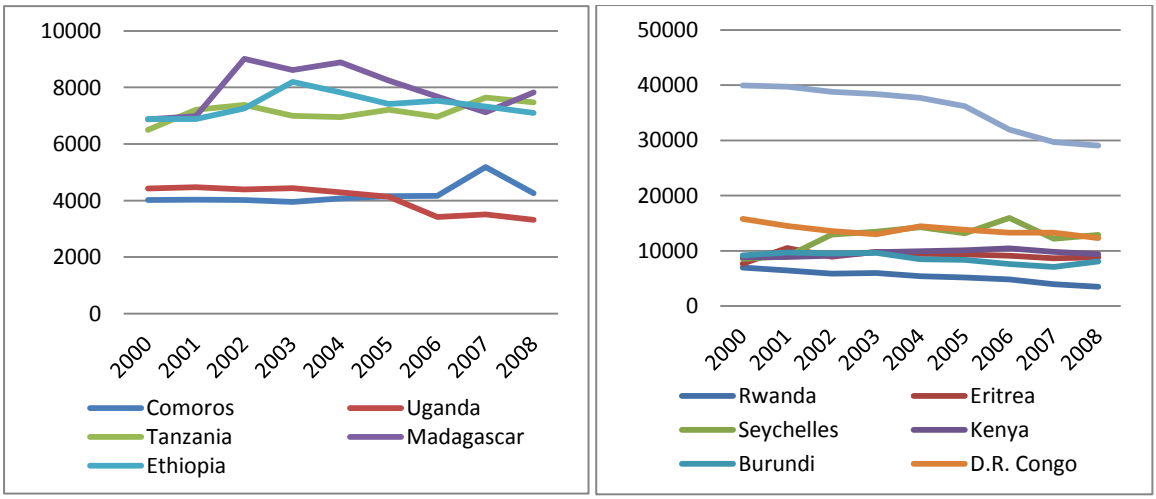
Figure 20: Percentage change of oil import bills as a share of GDP.



3.1.4 Energy Intensity

Another indicator of short-term energy security is the state of energy intensity in the economy. The value of goods and services generated per unit use of energy is important information to evaluate the energy-efficiency and dependence of the economy. Energy consumption (in BTU) per unit of GDP (in US$) is taken as an energy intensity measure. Review of energy intensity from 2000-2008 shows that for most countries in the sub-region, energy intensity has remained more or less similar, or showed marginal change. However, significant improvements in energy intensity are shown in 2008, compared with 2001, in Uganda, D.R Congo, Djibouti and Rwanda. *In most of the sub-region, however, energy intensities have remained more or less the same, utilizing similar level of energy input per unit of GDP generated, therefore limited progress in aggregate energy efficiency per unit of growth generated.*

Figure 21: Energy intensity: energy consumption per dollar of GDP (BTU/2005 US$ GDP).



Source: Based on data from the US EIA.

3.1.5 Energy Crisis Management Capability

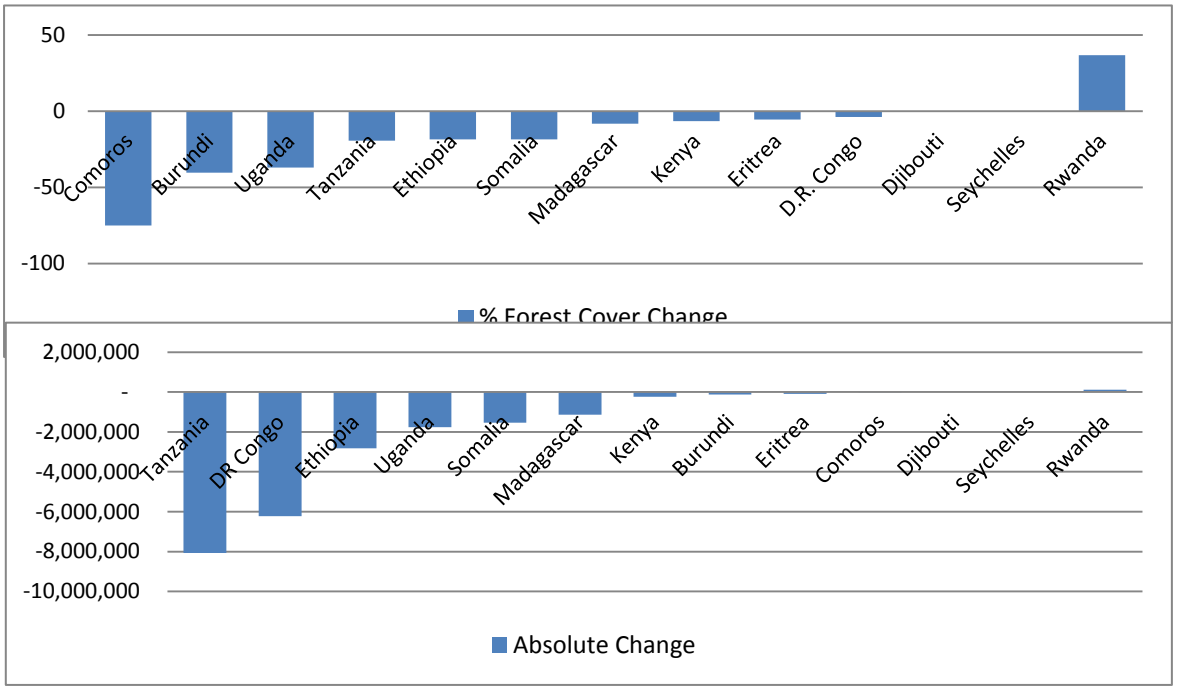
The energy crisis management capacity of a country depends on risk factors. The risk factors relate to: the production capacity of primary energy; energy conversion capacity through power plants; refineries; improved cookstoves; inland and import transportation safety and energy import possibilities, particularly for electricity.

3.1.5.1 *Production Capacity Risks*

The production capacity risk relates to oil, gas, coal, renewable energy and biomass production. With the exception of South Sudan, and limited oil production activities in D.R. Congo, the emerging gas production activity in Tanzania, the Eastern Africa sub-region relies on biomass and imported energy for a large share of primary energy supply. About 87% of primary energy source in the sub-region is biomass, 11% from thermal energy largely depending on imported fuels and just 2% sourced from electricity. Therefore, production capacity currently will largely depend on the management of biomass resources. Assessment of the state of forest resources in the sub-region reveals major concerns, as forest resources show sign of unsustainable and rapid decline. In terms of percentage changes in forest cover based on 1990 forest resources as a base reference, nearly 20% stock decline is observed in Somalia, Ethiopia and Tanzania, nearly 40% decline in Uganda and Burundi, and 75% decline in Comoros (see Fig. 23). Between 4 to 8% forest stock declines are observed in Madagascar, Kenya, Eritrea and D.R. Congo. In the D.R. Congo, while a 4% decline seems marginal, given the size of the stock reaching 160 million hectares in 1990, one of the largest in the world, the magnitude of deforestation is quite large. Rwanda is the only country managing its forest resources quite well, showing forest resource recovery by 117,000 hectares between 1990 and 2010. In absolute figures, the losses were highest in Tanzania, with more than 8 million hectares of forest lost; over 6.2 million hectares in D.R. Congo; 2.8 million hectares in Ethiopia; and between 1.3 million – 1.7 million hectares in Madagascar, Somalia and Uganda.

The state of forest resources, and biomass energy production capacity, in the Eastern Africa sub-region is skidding towards greater insecurity, with potential consequences of rising wood and charcoal prices, and greater concern about the long-term ability to sustain biomass supply. The state of household energy security, under current trends, is likely to worsen.

Figure 22:Absolute and percentage change in forest cover: 1990-2010 (in %, hectares).

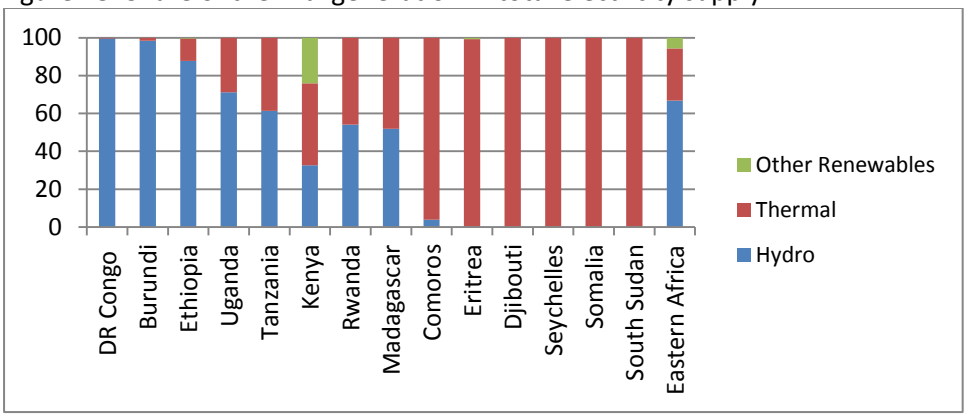


3.1.5.2 *Energy Conversion Capacity through Power Plants*

These characteristics of the electricity sector demonstrate key energy conversion capacity challenges affecting *energy crisis management capacity*. New generation capacity addition efforts, anticipated energy trade in the sub-region and anticipated expanded regional grid interconnection schemes will help enhance energy conversion capacities and accessing energy locally and regionally and improve on *electricity crisis management*. It is noteworthy to bring attention to the technology shift in electricity conversion. The legacy of electricity in the Eastern Africa sub-region was predominantly hydroelectricity. Lack of energy planning and growing energy demand have pushed the region to technology switches that brought more thermal generation, growing overtime as a share of total electricity generation. As shown in Fig. 24, energy conversion in the region, in terms of technology, comes from thermal generation entirely in South Sudan, Somalia, Seychelles, Djibouti[5], and almost entire in Eritrea and Comoros. The thermal generation share of Madagascar, Rwanda, Kenya and Uganda are also sizable.

The shift in energy conversion technology of the sub-region to thermal options has energy security implications: generation is becoming increasingly based on imported fuel, which has increased energy insecurity and reduced the energy crisis management capability of member States.

Figure 23: Share of thermal generation in total electricity supply.



Source: Energy Information Administration and country mission data.

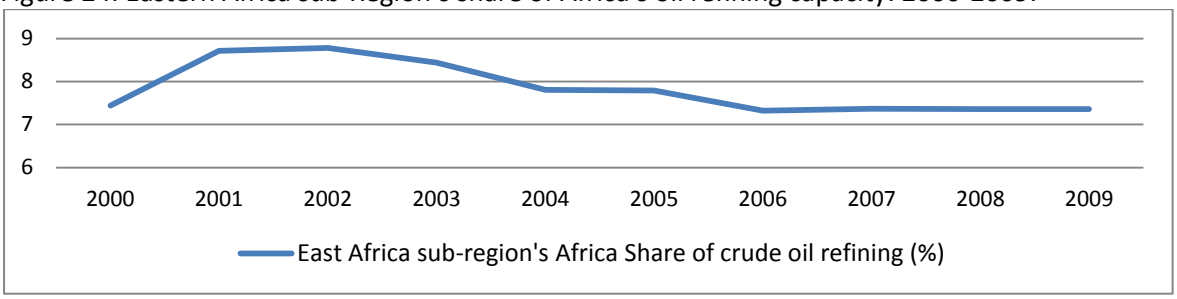
3.1.5.3 Oil Refinery and Natural Gas Distribution Capacity

Capacity to refine crude oil offers a layer of crisis management capacity by increasing domestic refined oil products output. The state of refinery operation in the Eastern Africa sub-region has actually declined. Refinery operations in Eritrea, Madagascar, D. R. Congo and Tanzania have closed down, leaving Kenya the only member state with significant refining activity. As a result, the share of Eastern Africa sub-regions total refinery capacity as a share of Africa's capacity has declined from close to 8.8% in 2001 to below 7.5% by 2006 and remained at that level till 2009 (see Fig. 25). New efforts to increase investment in oil refining capacity in Kenya, and possibility to refine South Sudan crude oil offer new hopes for the region to mitigate energy insecurity. The most promising and heated debate is in Uganda, with the government long-term plan to refining Uganda's crude oil found at Lake Albert. The government plan envisages first starting refining crude oil locally at 20,000 bbl/day, gradually increasing the capacity to 60,000 bbl/day and beyond to meet regional refined oil-products demand. Disputes about refining or raw export are not yet resolved with oil companies. Tanzania's natural gas find, the largest in the region, also has the potential to alter the nature of energy security in the sub-region. Natural gas pipeline infrastructure schemes in Tanzania to evaluate the gas off-shore and in southern deep water rigs to electricity production site and sites of industrial activity will certainly improve the energy security profile of Tanzania in the near future.

[5] Djibouti's electricity profile changed with resumption of hydropower imports from Ethiopia in recent years.

However, the sub-regional natural gas distribution scheme of Tanzania will face constraints emanating from *economics* and *contract negotiation*.

Figure 24: Eastern Africa sub-Region's share of Africa's oil refining capacity: 2000-2009.



Source: Based on data from the US EIA.

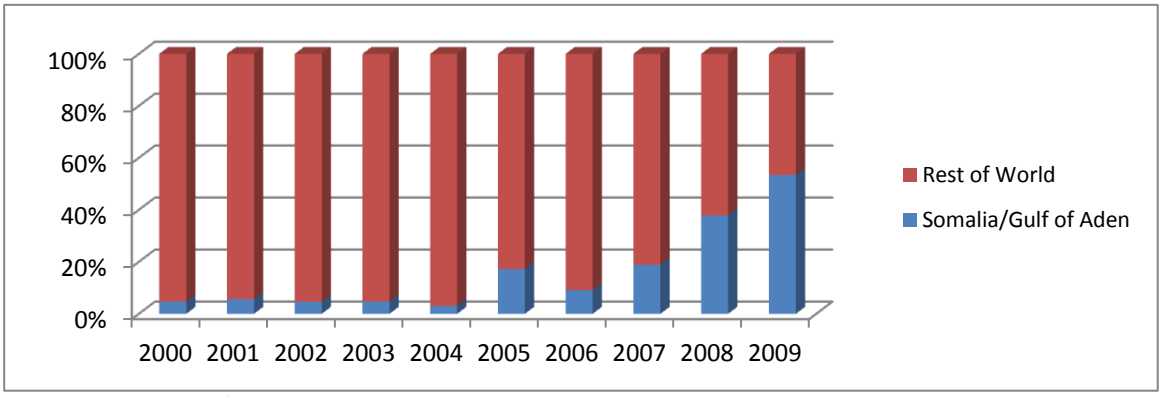
3.1.5.4 Energy Imports Transportation Safety

Another risk factor affecting the energy crisis management capability is exposure to energy import risks emanating from import corridor safety: sea transportation safety and the added risk for land transportation through third countries for land-locked States. Land transportation for land-locked countries in the EAC countries has largely been open, facing no major sustained disruption due to political instability. However, the risk level is demonstrated during the post-election violence in Kenya after the 2007 presidential elections that halted land transportation and disrupted fuel deliveries over pipelines. Uganda has attempted to diversify to Tanzanian road transportation route to deal with such risks by offering subsidy of USh 150/litre of fuel routed through the *Southern Corridor*. Road restrictions in Tanzania, including limits on the wheel capacity of trucks, remain a concern to Uganda. Similarly, Rwanda and Burundi are affected by their land-locked status. South Sudan also relies on oil import routes through Kenya. Due to the state of poor road conditions, particularly during raining seasons, supplies are frequently disrupted. Connections through the Uganda corridor are being pursued.

Ethiopia is also impacted by road transportation. The dispute with Eritrea has led to the shut-down of road transportation routes to all portal cities of Eritrea since 1998, and its use of the Assab oil refinery in Eritrea has been severed since then (the refinery also stopped operation in 1997/1998). This has forced Ethiopia to rely on the Djibouti route. The railway connection between Djibouti and Addis Ababa has largely been ruled out for oil transportation due to the narrow width rail lines insufficient to accommodate oil tanker rails. Transportation over land is also exposed to risks of sabotage by rebel groups. Plans to build a parallel new railway line that can accommodate oil shipments is in the works.

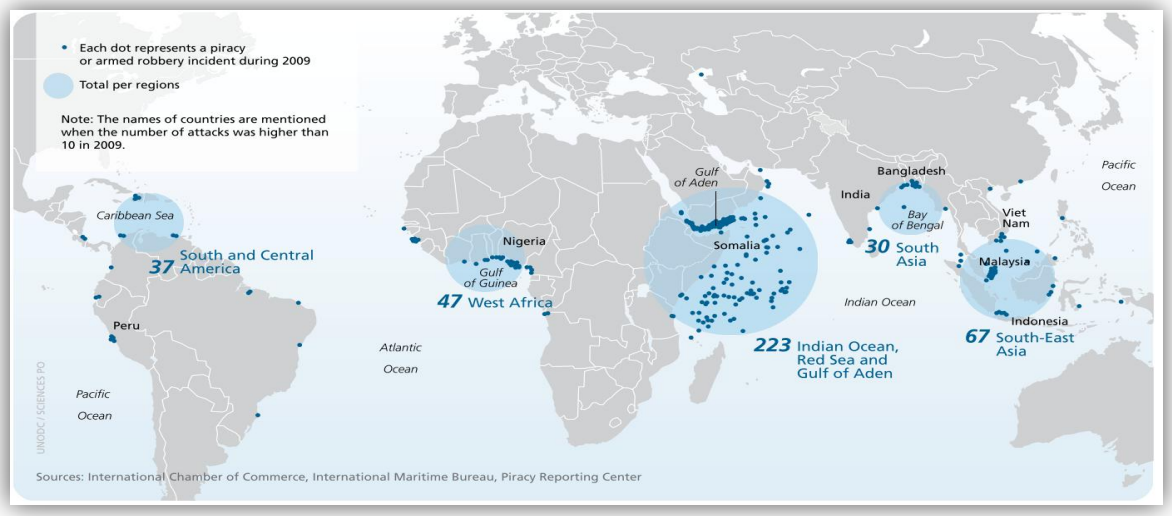
Fuel import transportation is particularly impacted by the surge of Red Sea and Indian Ocean piracy activity emanating from the crisis in Somalia. The incidence of piracy activity in the Gulf of Aden, compared to global total incidents, has increased from 4.7% in 2000 to 17.2% by 2005, reaching 53.4% in 2009 (see Fig. 26). Seizure of oil tankers by Somali pirates have caused fuel supply disruptions in Kenya and Uganda, and threatened deliveries to Red Sea States of Eritrea and Djibouti as piracy threats spread northwards. The geographic distribution of piracy activity is concentrated mainly around the Somali territory around Gulf of Aden. But the *piracy risk* has gradually shifted as far north as the Eritrean waters in the Red Sea, as far south as the Indian Ocean territories of Mozambique and as far as the Arabian Sea and Gulf of Oman (see Fig. 27). *In essence, the wider geographic distribution of the Somali piracy problem from the Red Sea and the Gulf of Eden to the Indian Ocean, the Arabian Sea and the Gulf of Oman has severely undercut energy security of the Eastern Africa sub-region, emanating from unsafe sea transport routes for imported fuels and rising cost of insuring shipments.*

Figure 25:Incidence of piracy in the Gulf of Aden: 2000-2009.



Source: IMB-ICC annual reports, 2003-2009.

Figure 26: Geographic distribution of piracy activity in Eastern Africa, 2009.



Source: International Chamber of Commerce, International Maritime Bureau, Piracy Reporting Center.

The total economic cost of the Somali piracy reaches close to US$7 billion in 2011, with 635 million insurance premium costs, involving 15% of the oil tankers. Its wide geographic coverage, change of involving nearly 1 in 9 oil tankers and the prevalence of attack has driven the Eastern Africa sub-region to greater fuel import cost, undercutting affordability, and posing greater physical disruption risk, meaning from unsafe sea fuel transportation.

3.1.5.5 *Strategic reserves/Emergency Stocks*

Fuel disruptions can occur due to the materialisation of any of the risk factors. The resiliency of the energy security status of a country, in such occasions, depends on built-in mitigation strategies, frameworks and implementation efficiencies. Maintaining a strategic reserves, or emergency fuel stock, is one effective mitigation mechanism. The state of strategic reserve policy and implementation is observed for Ethiopia, Eritrea, South Sudan, Tanzania and Uganda (see Table2).

Table 2. Strategic reserve policy and implementation in select countries.

Country	Strategic Reserves
Ethiopia	90 days policy, at around 1 month supply due to price hike
Eritrea	Signs of stock depletion
South Sudan	No policy, no strategic reserve
Tanzania	2 weeks policy, no public strategic reserve
Uganda	Stock depleted, restocking in the works

Source: Country mission and secondary data, 2012.

Emergency stocks in biomass are largely disregarded, and such a system is nearly non-existent, expect for households stocking their own supplies. The practice of energy security in the biomass area requires further look, and designing proper frameworks to manage its continual supply and disruption management scheme.

3.1.5.6 Demand Restraints

Demand restraints assist in mitigating the widespread manifestation of fuel shortages. Rationing is the most commonly utilized approach in demand restraint in times of energy shortages. In the Eastern Africa sub-region, demand restraints are often exercised to deal with fuel supply disruptions. In recent years, the sub-region has been exposed to numerous fuels supply disruptions. The 2008 post-election violence in Kenya was widespread, and affected fuel shipments to neighbouring countries, undermining short-term fuel supply. In Uganda, following the violence and unrest, fuel stocks dwindled, triggering oil distribution companies, such as Total and Engen to exercise fuel rationing. Uganda also saw fuel shortages in 2010, due to devaluation of the Shilling, delays in Mombasa port, Nairobi-Eldoret pipeline constraints and rising global oil price, leading to price increases from Shs 10,000 for 4.5 litres down to 3 litres.[6] Uganda also faces other sources of supply disruptions, such as Kenya's three-axle rule that reduced the amount of fuel trucks can carry on the road, Mombasa-Eldoret pipeline condition and other delays in clearing shipments. Timing of oil procurement can also introduce risks, such as in July 2008 when oil companies procured at higher prices, though prices receded subsequently, the stock was acquired at high prices (Kojima, et al., 2010).

In Rwanda, similar fuel rationing was put immediately in place following post-election violence in Kenya, due to disruptions to fuel supply from the port of Mombasa and declared a 10 litres petrol cap for small cars and 20 litres cap for SUVs. It has also engaged Tanzanian authorities to facilitate the routing of fuel trucks through Tanzania, up to 4 million litres and to lift non-tariff barriers to reduce fuel shipment delays. Rwanda also released state petrol reserves to distributors who run out of fuel. Prices were also kept frozen with tax incentives of 68% for diesel and 78% for petrol[7]. Rwanda's coordinated response was well targeted, and the then Minister of Commerce, Mr. Protais Mitalli, assured markets by stating "there should not be panic. There are adequate fuel reserves to take the country through the crisis, but contracts are currently on to have the first delivery of four million litres of fuel to be on standby."[8] Similar shortages were experienced in Burundi, resulting in fuel rationing. Burundi also faced its own oil supply shortages in August 2007, and started fuel rationing, after the General Prosecutor ordered the impounding of fuel trucks and tankers of the Interpetrol Company. Later the Company's bank accounts were frozen.

[6] See Adrew Nkurunziza's article in *The Monitor*, April 16, 2010.
[7] See Eddie Mugaaya's article in *Sunday Times*, December 21, 2008.
[8] Ibid.

Since the company supplied 50% of fuel supplies in Burundi, supply shortages were quickly felt, necessitating smuggling of fuel from Rwanda in Ngozi Province, and leading to fuel price hikes, and in the case of Rumenge town almost doubled.[9] Eritrea also faced fuel supply disruptions, including in 2004 where fuel rationing was imposed. Later, Eritrea banned sale of petrol to the public, conserving it for "essential uses." Petrol prices went up 40%, and diesel 25%. Rationing continued to 2005, and for the most part through 2012. Priority of petrol use is provided to public services and development programs. In Ethiopia, 2006 saw fuel shortages and rationing resulting for timely transportation and distribution of fuel stocks. Cities of Dire Dawa, Jimma and Addis Ababa experienced disruptions, which were resolved by replenishments.

Shortages in electricity similarly are handled through rationing of powe. *Demand restraints in times of fuel and electricity shortages are common in the sub-region, but in the case of fuels are often not sufficiently complemented by strategic reserve stock releases.*

3.1.5.7 Reserve Capacity

Existence of sizeable reserve capacity in the energy system can help mitigate the impact of short-term energy disruptions. Dependence on imported fuel of the sub-region, and lack of local production of fuels, limits the exercise of reserves to manage fuel shortages. Kenya is the only country in the sub-region with sizeable refinery capacity, offering it domestic capacity to refine and supply fuel, reducing imports by sizeable margins. Limited existing capacity to import and quickly distribute fuel through pipelines (capacity is limited) and road transportation introduce challenges. In the electricity sector, there is often limited power, and power shortage is the norm, not surplus. The fact that the sub-region is poorly interconnected limits the potential of electricity imports to deal with peak-demand shortfalls. *Expanding reserve capacity in electricity and fuels stocking and transportation will assist in managing short-term energy disruptions.*

3.1.5.8 Fuel Switching Capacity

A long-term strategy to mitigate the impact of dependence on imported fuel is switching to alternative fuel sources. In the transportation sector, fuel switching is pursued through policy and program in Ethiopia, where the only fuel blending mandate of the sub-region is exercised. The plan, which is an experimental program for Addis Ababa, requires a 10% ethanol blending, with a plan to raise it to 20% by 2015. New sugar factories are opened, generating more supplies of ethanol, potentially meeting higher blending mandates. A blending factory is set-up in Sululta, just outside Addis Ababa, to produce standardized blended fuel. By 2010, 314,000 tons of ethanol were produced, with a goal to increase production to 2.2 million tons by 2015. Some 2.5 million hectare of land is set aside for biofuels, for both local consumption and exports. Ethiopia's blending program is the only in the sub-region that puts a tangible plan to switch fuel, and mitigate imports. It is claimed that the program is saving US$ $20 million in fuel import bills.

In electricity sector, fuel switching is either in the plans or implementation in the sub-region. Tanzania has successfully expanded the share of its indigenous gas resources in electricity generation, and plans to expand integration of gas and coal in the generation portfolio. Uganda and South Sudan plan to divert some crude oil to generate electricity from crude-driven thermal generation systems. The possibility of small-scale nuclear energy use is considered in Kenya and Tanzania. Fuel switching for cooking is also widely pursued in Rwanda where 50% of households already have improved stoves by 2008, with a plan to increase coverage to 100% of households by 2012.

[9] See Jean Pierre Nkunzimana's article in *NewVision*, Uganda daily newspaper, August 28, 2007.

Through its national Domestic Biogas Programme, it aims to install at least 15,000 biogas digesters in rural households owning 2-3 cows by 2011, and expanding biogas services to public institutions such as schools, hospitals and the prison system.

Fuel switching in the transportation sector is limited in the sub-region, but the electricity sector and household cooking is in a transition to integration of indigenous energy sources, such as gas, coal, crude oil and biogas. Supporting and expanding such programs will enhance energy security in the sub-region.

4 GOVERNANCE OF TRANS-BOUNDARY WATER RESOURCES FOR HYDROPOWER DEVELOPMENT IN EASTERN AFRICA

4.1 Water Resources and Energy Development in Eastern Africa

The Eastern Africa sub-region has a number of rivers with excellent potential for hydropower development. The hydropower resources in sub-Saharan countries account for about 12% of the world's hydropower potential, but only 17.6% of these resources had been harnessed - one of the world's lowest figures (FAO, 2008). The continent has a technically exploitable capability of 1,888 TWh/yr of which 41% (or 774 TWh/yr) is in one country, the D. R. Congo, thanks to the mighty Congo River. Ethiopia has a technically exploitable capacity of 260 TWh/yr. Madagascar also has substantial potential capacity at 180 TWh/yr. The current geographic distribution of hydropower in Africa demonstrates the following pattern: North Africa (23%), West Africa (25%) and South/Central/Eastern Africa (51%). Despite this potential, which is enough to meet all the electricity needs of the continent, only a small fraction has been exploited and Africa has one of the lowest electricity utilization rates in the world. Presently, 20% of this potential has been harnessed. Hydropower has long been the pillar of Eastern Africa's energy production capabilities. Indeed, the majority of electricity produced in the sub-region comes from hydropower, and it is expected to provide 79% of East Africa's total new additional generation capacity (REEP, 2010). However, environmental and institutional challenges to harnessing the region's hydropower production potential remain, including drought, carbon issues relating to reservoirs, the need for capital investment, a lack of technical expertise in formulating energy plans and feasible projects, and perhaps a focus on large-scale projects.

4.2 Major Sub-Regional Water Systems and Hydropower Development in Eastern Africa

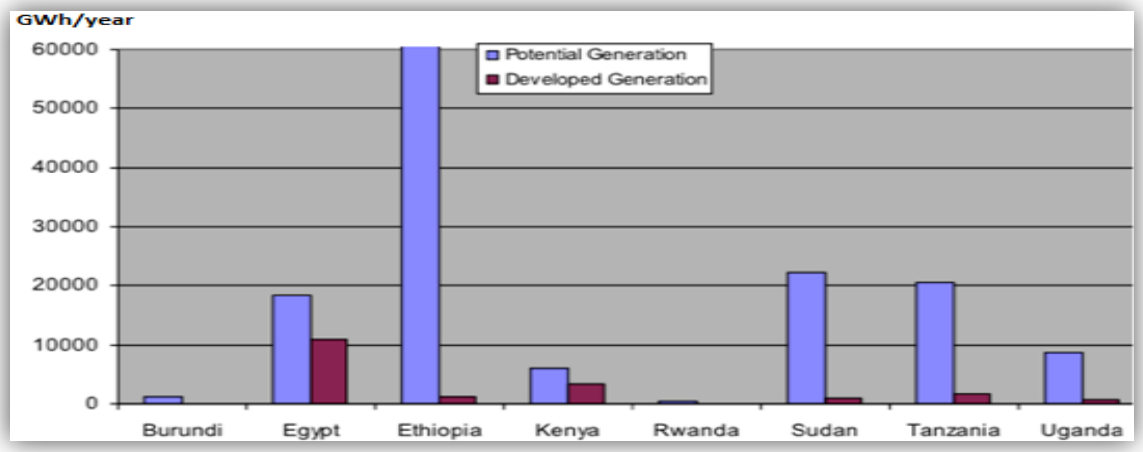
4.2.1 Nile River and Hydropower Development

The Nile, the world's longest river, flows for 6,850 Km, and covers ten countries: Burundi, the D.R. Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, the Sudan, Tanzania and Uganda. The Nile, due to its length and climatic variety, is one of the most complex river systems in the world. Its main sources are the Blue Nile, which arises from Lake Tana in Ethiopia, and the White Nile, which arises from Lake Victoria in Uganda. Some countries, such as Burundi, Rwanda, Uganda, Sudan and Egypt are highly-dependent on the river, while for others, such as D.R. Congo the Nile's water constitutes only a small part of their resources. Egypt and the Sudan use the Nile's water mainly for agriculture purposes; 80% of water in Egypt is directed to this sector. The Nile is not only a water reserve for its riparian States, it is also a fundamental waterway. In the Sudan, it is the only practicable way to navigate across regions during the flood season from May to November. Nile water is also used for production of hydroelectric power, especially in Ethiopia (Sinnona, 2007).

If all the Nile Basin Countries are taken into account, their hydropower potential is estimated at 140,000 MW. The D.R. Congo alone is considered to have a potential of 100,000 MW, with approximately is 40,000 MW concentrated in the INGA complex from the Congo River; Ethiopia has a hydropower potential of 45,000 MW.

Figure 28 shows the energy from hydropower for the Nile basin countries, excluding D.R. Congo. While the sub-regional hydropower potential is considerable, especially for D.R. Congo and Ethiopia, the current approach is that each country is attempting to develop its hydropower resources autonomously. Whereas they face challenges for collaboration, there are examples of countries jointly building hydropower plants such as Burundi, Rwanda and D.R. Congo on the Ruzizi through collaborated, despite the challenges.

Figure 27: Energy generation potential and realized for the Nile basin countries.



Source: Kanangire, 2008.

The central water and energy management challenge for the Nile River Basin, as in many other river basins throughout the world, is sustainability of water supply in the context of population growth, recurring drought and increasing competition for water. The issues get complicated as a result of global climate change. As a result, the demand for the Nile water is expected to increase significantly. Some of the basin states, such as Ethiopia, Kenya, Tanzania and Uganda have already experienced critical water shortages due to extreme events such as recurring droughts. Considering a threshold value of 1,000 cu m per person per year, it is projected that some of the Nile Basin countries: Burundi, Rwanda, Egypt, Ethiopia and Kenya will be considered as water "scarce" by 2025. If the present trend continues, water shortage is likely to materialize and impacting socio-economic development and increasing the potential for water conflict (Yitayew and Melesse, 2010). The main strain on the Nile water resource comes from Egypt's unilateral development of new areas such as the Toshca project to expand irrigated areas to establish claims for prior appropriation rights. Equally, Ethiopia's unilateral decision to build the Renaissance Dam is a challenge for water governance.

The 1990s has been one where substantial effort has been invested by the riparian States themselves and by the donor agencies to develop confidence and vision for the future which is based on cooperation, consideration for the environment and the efficient use of water. Despite the intense pressure for cooperation driven by demographics, sustainable development needs, water and food security, economic integration and climate change, there is no reliable established framework for governance of the water and energy resource of the Nile basin to *attain a shared vision.*

4.2.2 The Congo River and Hydropower Development

The Congo River is the ninth largest river in the world at 3,100 km. It originates in Zambia, flows north into Lake Bangwelu and then Lake Mweru. The Luvua flows north out of Lake Mweru and joins the Lualabu, which is a major tributary of the Congo. The Congo flows southeast into the Atlantic Ocean.

It has the highest potential for hydropower of any river in the world. The basin contains 30% of the fresh surface water in Africa, and the discharge at Kinshasa and Brazzaville is 1,269 km^3/y (UNECA, 2000). There are many tributaries on both sides of the Equator, therefore the rainy season alternates in different parts of the basin, providing a fairly constant yearly flow in the Congo. The Congo River basin is the second largest in the world with an area of 3.7 million km^2. Nine countries make the Congo River basin: the D. R. Congo, the Central African Republic, Angola, the Republic of Congo, Tanzania, Zambia, Cameroon, Burundi and Rwanda. Approximately 29 million people live in the basin, which includes 250 indigenous groups.

The Congo River has tremendous potential to provide electricity, and in terms of ecological and power wealth, as well as its rain forests, is rated second in the world after the Amazon (Fairley, 2010). Since its tributaries are on both sides of the equator, the Congo is swamped with rain water in all seasons. This consistent flow translates into a hydropower potential that knows no equal in scale, concentrating at a natural pinch point 225 km upstream from Kinshasa. The Congo River drops some 102 meters over a distance of 15 km within the valley. Total flows range from a low of 30,000 m^3/s in the dry season from June until September to up to 55,000 m^3/s at the peak of the wet season in November. Two channel diversion power projects, Inga I and II, take a portion of the flow off the main channel and divert it 9 km through a canal to the hydroelectric plants. After powering the turbines the water rejoins the main channel (Fairley, 2010).

The Inga valley 250km west of Kinshasa is the site of the most important hydroelectric projects and proposals in all of Africa. The existing installation already power Kinshasa and western D.R. Congo and provide critical export revenue, and expansions could see the site develop into a clean energy provider of global importance. These developments however will not be without localized impacts and risks which need to be mitigated. Inga I was built in 1972 and Inga II in 1982, and have a design capacity of 351 MW and 1,424 MW, respectively. Nevertheless, due to old installations and lack of maintenance, the output is now considerably reduced. An internationally funded $US 500 million rehabilitation project is in progress to restore some of that capacity to over 70% and to modernize the generating facility, the distribution network and the electricity authority SNEL (Société Nationale d'Electricité) (UNEP, 2012).

In 2002, there was an attempt to obtain more power from Inga through international cooperation. A major new project, Inga III, is at the design level with a proposed total capacity of 3.5 to 5 GW. High voltage lines are intended to transmit the power generated to Zambia, Zimbabwe, South Africa and the Republic of Congo (Brazzaville). Much of the anticipated project cost (up to US$8 to 10 billion) faces tough technical choices including that of optimal design (IRENA, 2012). The Grand Inga project is at the feasibility stage and plans are to generate 39 GW, which is the largest energy-generating project ever-built. The project is expected to cost as much as US$ 80 billion and significant amounts of electricity could be exported. The D.R. Congo and South Africa have signed a Memorandum of Understanding to establish partnership between the two countries of the development of Grand Inga.

4.3 Governance of Trans-boundary Water Resources in Easter Africa for Hydropower Development: Challenges and Opportunities

4.3.1 The African Context

Trans-boundary water resources management in Africa is addressed in various international documents with guideline characters; including the G8 Africa Action Plan, the New Partnership for Africa's Development (NEPAD) Action Plan, and the Abuja Declaration of the African Ministers Council on Water (AMCOW). These efforts also have reference to the work of the UN Secretary-General's Advisory Board on Water and Sanitation and the International Water for Life Decade proclaimed by the UN General Assembly (2005–2015).

Trans-boundary water resources management provides for governance of water resources shared between two or more riparian neighboring countries. The Nile Basin with 10 riparian countries and complex upstream/downstream issues is one such example. In the South African Development Community (SADC) alone, there are 13 trans-boundary rivers shared by two or more riparian states. As many local, national and international stakeholders are involved, Trans-boundary Water Resources Management (TWRM) cannot be conducted purely on a state-by state basis. Multi-national dialogue and negotiations are the basis of wide-ranging agreements between riparian states. The need for cooperation and information sharing is an essential element. This can be facilitated by the creation of trans-boundary-basin institutions or agreements – such as the Congo-Oubangui-Sangha International Basin Commission (CICOS), the still-born Zambezi Basin Commission, or the Nile Basin Initiative – established to monitor the policies of riparian states and ensure equitable utilization of water resources, create development strategies and monitor the implementation of national Integrated Water Resource Management (IWRM) plans. In most cases, however, such institutions have faced severe challenges impeding their ability to get off the ground (Schmeier, 2010).

Governance of trans-boundary water resources in riparian countries along the Nile present both challenges and opportunities. While at the national-level different institutions have been created to settle disputes over water allocation, at the regional-level institutional structure with authority to enforce water agreements are rather absent. Governments often have preference for bilateral agreements to settle disputes over trans-boundary water resources. Internationally, there exist two multilateral agreements, the UNECE “Convention on the protection and use of trans-boundary watercourse and international lakes”, signed in Helsinki in 1992 and in force from 1996, and the UN “Convention on the Law of the Non-Navigational Uses of International Watercourses”, adopted in 1997, but still not in force (Sinnona, 2007).

4.3.2 The Political Economy of the Nile and Implications for Water Governance

Trans-boundary water management is mainly a political process. This is the reason why cooperation and conflicts on water resources are determined by asymmetries in power among riparian states. It is not without good reason that the example of the Nile is often cited in the popular discourse on "water wars." Egypt is wholly dependent on the waters of the Nile for its economic development, and hence it has declared a secure supply of water from the areas beyond its border to be a vital national security interest. In the past there have been repeated conflicts between Egypt and the upstream Nile riparian states over the allocation of the waters of the Nile, and these conflicts have even led to threats of war in times of particular stress (i.e. in periods of drought). It is important to point out that while there are ten riparian countries, only three of these are in the most critical position for peaceful, cooperative sharing of Nile water—Ethiopia as the primary supplier, and Egypt and Sudan as the dominant consumers.

Among riparian states, Egypt has the highest Nile water share, subject to water management of the upstream riparian states. In 1979 it was declared that at the beginning of 2000 Egypt would have faced a water deficit of 4 billion m^3 due to its alarming population growth (one million every nine months) and agricultural water uses. Still in 1990s, Lake Nasser, because of the high evaporation, could not meet the population's water demand, thus 50% of food was imported from abroad (Swain, 1997). These occurrences caused high internal instability and a strong political and economic dependence on other countries' policies, threatening Egyptian national security. In order to face these political problems, Egyptian diplomacy has strongly promoted water allocation based on old treaties, basically attempting to maintain the *status quo*. North and South Sudan (secession with the referendum of 9th of January 2011), as well, are strongly dependent on the river.

After the Second World War, with independence of riparian states, the challenge of water governance has gotten more complex. In 1956, when the Sudan obtained independence, it requested a renegotiation of the 1929 Water Agreements with Egypt. Sudan accepted the Aswan High Dam construction by Egypt, in exchange for sharing the water of the dam. The two countries signed in 1959 Nile water agreements to allocate the resource and to share costs and benefits of future projects on the river. From then on, cooperation between the Sudan and Egypt more or less continued (Sinnona, 2007).

The Hydromet Agreement was signed in 1967, originally among Egypt, Kenya, Tanzania, Uganda and the Sudan with the collaboration of the United Nations Development Programme and the World Meteorological Organization, and later joined by Rwanda, Burundi, D.R. Congo and Ethiopia, increasing cooperation. Hydromet lasted for 25 years, terminating in 1992. The same year the water resource ministers from Egypt, the Sudan, Rwanda, Tanzania, Uganda and D.R. Congo created a new organization, the Technical Committee for the Promotion of the Development and Environmental Protection of the Nile Basin (TECCONILE). The rest of the four riparian states participated as observers. In February 1999, the Nile Basin Initiative (NBI) was launched by all riparian countries, except Eritrea. In September 1999, the NBI Secretariat replaced TECCONILE in Entebbe, Uganda. The NBI is considered a transitional arrangement until the member countries agree on a permanent Nile River Basin Commission for sustainable development of the river basin (Sinnona, 2007).

Cooperation is often extended to other benefits. The UNDP Report (2006) claims that more than 40% of transnational water treaties include provisions on financial investments, energy commerce and peace negotiations. This approach could facilitate agreements, because it provides governments national justifications and it promotes financial flows, capable of opening cooperation on a variety of matters. Moreover, it offers a bargaining power to weaker states that could grant something in return to an equitable water management.

4.3.3 Public Participation in Water Governance

In many respects, civil society participation in water resources management and water supply and sanitation is the key to successful sector governance, encompassing management, quality service provision and sustainability. This has been recognized in the Dublin-Rio principles, which are clear in their statements that water development and management should be based on a participatory approach, involving users, planners, policy-makers at all levels and that women play a central part in the provision, management and safeguarding of water.

4.4 The Congo River: Challenges and Opportunities for Efficient Use

The D.R. Congo government identified restoration of its war-ravaged electrical system as an early priority for national recovery. The World Bank intervened to support the rehabilitation of the power stations installed under Mobutu to generate electricity from the water flowing into the Inga Dams. The original 1972 station known as Inga 1 had reduced capacity and Inga 2, added in 1982, was neglected. Power output was barely a third of Inga 1 and 2's original capacity, according to the World Bank. An African program was also created to realize Inga's further potential under the encouragement of the African Union and its New Partnership for Africa's Development (NEPAD). The proposed Grand Inga Dam, which is to be constructed in western D. R. Congo will build on the existing dams, Inga I and Inga II, and a yet to be constructed Inga III. It has been proclaimed that upon construction, 500 million of Africa's 900 million people currently without electricity will be able to benefit.

4.5 Best Practices in Governance of Water Resources

The Mekong River Commission (MRC), an inter-governmental agency that works directly with the governments of Cambodia, Laos, Thailand and Viet Nam, established under the 1995 Agreement on Cooperation for the Sustainable Development of the Mekong Basin, provides one of the most highly developed examples of an international river basin organization founded to facilitate trans-boundary water cooperation. Currently the MRC Secretariat administers a range of joint programmes, including: the Basin Development Plan; the Water Utilisation Programme; the Environment Programme; the Flood Management and Mitigation Programme; the Fisheries Programme; the Agriculture, Irrigation and Forestry Programme; the navigation Programme; the Hydropower Programme; the Information and Knowledge Management Programme; and the Integrated Capacity Building Programme.

As one of the world's largest and most complex efforts at TWRM, the Nile Basin Initiative (NBI) could be considered as best practice as its objective is to develop water resources in a sustainable and equitable way, and to ensure efficient water management and optimal use of the Nile's water resources. Major achievements have been to facilitate cooperative action, build confidence and capacity in riparian states, and pursue cooperative development opportunities.

In the SADC Region, the SADC Water Protocol was prepared in 1995 to encourage the establishment of appropriate institutions for monitoring and ensuring equitable utilization and strategizing for water resources development. The Protocol also provides for essential data and information exchange between riparian states. Progress has been made in forging agreements in some shared basins, such as the Zambezi, Orange-Senqu and Incomati basins, and some water monitoring networks have been established that are now providing information to riparian states. Efforts to get the Zambezi Watercourse Commission (ZAMCOM) up and running five years after an agreement was signed by seven of eight riparian states to do so continue to be bogged down by political disputes.

Civil Society Participation in Practice: Burkina Faso, Senegal and South Africa use decentralization approaches to ensure the enhanced participation of target communities in program design and implementation and come closest to what could be defined as best practice. Benefiting from decentralization and democratic systems that avail responsive representation and local governments, these approaches center on participatory planning in the development of Local Development Plans (LDPs) and, commensurate with them, Local Water and Sanitation Plans (LWSPs). The LDPs and LWSPs constitute a useful framework for sector planning that is based on community and community organization participation.

The way forward, one Eastern Africa states are encouraged to consider, is to establish effective water governance based on the principles of equity and efficiency in water use and energy resources production and distribution. The countries in the sub-region need to formulate, establish and implement water and energy policies with appropriate legislative and institutional frameworks. There has to be clearly defined roles of governments, civil society and the private sector in terms of their responsibilities regarding ownership, management and administration of the water and energy resources. Transnational dialogue, co-ordination and conflict resolution must be clearly defined and agreed upon by all parties. Also, the sub-region has to focus on benefit-sharing rather than water-sharing, multilateralism instead of unilateralism and enhancing more cooperative approaches. Establishing effective water governance and the NBI legal and institutional framework agreement with full consideration of the hydro-politics of the region is urgently needed if the countries are to overcome their differences and attain a sustainable water and energy development.

5 ENERGY TCHNOLOGY AND ENERGY ACCESS IN EASTERN AFRICA

5.1 Energy Technologies and Energy Services

Energy technologies offer a potential for diversification in energy supply, thus strengthening energy security by broadening the energy generation portfolio used within a country and can play an important and cost-effective role in rural electrification, particularly in areas that are costly to connect to existing grid systems. Innovation and technology in the energy sector offer opportunity to reach to the majority of the sub-region's population, especially the rural communities and the urban poor. Technologies like solar panels and wind turbines require many parts and services to develop projects, install and run them in the most efficient way, creating collateral economic opportunities. Renewable energy generation options such as wind, small hydropower bagasse-based cogeneration and geothermal help reduce adverse local, regional and global environmental impacts of increased reliance on conventional energy options.

In 2008, about 18% of global energy consumption came from renewable (Zobaa and Bose, 2011). Wind power installed capacity grew at 30% worldwide in 2009: at 158 GW and cumulative global PV installations exceeds 21 GW. Africa has massive hydro-power capacity, 9,000 MW of geothermal (hot water and steam based) potential (Karekezi and Kithyoma, 2003), abundant biomass and significant solar and wind potential. Proper integration and application of innovation and technology in the energy sector can help release these renewables potential into expanded access and enhanced energy security.

In Eastern African countries, innovation and technologies are characterised by small systems, as governments often invest substantially more in conventional large-scale energy sources rather than in renewable energy sources (RES). However, distributing, installing, operating and maintaining RETs in rural areas have the potential for substantial power generation and expanding economic opportunities. A number of RETs offer viable potential and options for both off-grid and mini-grid solutions for energy access in rural areas (see Table 3). These technologies leverage local resources and can often be sited close to load centers, reducing the need for costly grid extension (UN Foundation, 2012) and helping to lessen the need to import expensive diesel fuel. Aside from renewable energy technologies' commercial benefits, these technologies enhance energy security by decreasing dependency on fossil fuel imports, provide a number of benefits: improve human health, greater energy security, provide environmental services, and promote forest conservation. Their introduction also helps initiate gender- sensitive dialogue in local communities (SGP, 2011).

In the Eastern Africa sub-region, targets to increase renewable energy are set in many countries. Uganda targets integration of renewable energy to 61% of total energy consumption by 2017, through the development of 188 MW small-scale hydro electricity, biomass and geothermal capacity, the use of 30,000 solar water heaters and 100,000 biogas digesters. Ethiopia is looking at expansion of its energy capacity by 760 MW from wind power, 450 MW from geothermal and 5,600 MW from hydro power. Kenya focuses on doubling installed renewable energy capacity by 2012, and integrating 5,000 MW additional capacity from geothermal by 2030. Rwanda is targeting a 90% of renewable integration in electricity generation by 2012, and 42 MW small hydro capacity by 2015.

Djibouti is targeting a 30% solar energy-based rural electrification by 2017. Similarly Eritrea aims a 50% electricity generation from wind, while Madagascar is aiming a 54% final energy coming from renewables by 2020, and 75% of electricity generation from renewable by 2020. In Seychelles, the plan is a 5% electricity generation from renewable by 2020 and increasing it to 15% by 2030. Burundi similarly targets 2.1% of final energy to come from renewable by 2020. These policy prioritization of renewable energy integration into the energy portfolio will require accelerated technology adaptation and local innovation.

Table 3. Renewable energy sources in Eastern Africa.

	Wind	Solar	Hydro	Biomass	Geothermal	Ocean
Burundi	Medium	High	High	Medium	Unknown	N/A
Comoros	Medium	High	High	Unknown	High	Unknown
Djibouti	Medium	High	Unknown	Unknown	High	N/A
D.R. Congo	High	High	High	High	High	Medium
Eritrea	High	High	Unknown	Low	Medium	N/A
Ethiopia	High	High	High	High	High	N/A
Kenya	High	High	High	Medium	High	N/A
Madagascar	High	High	High	Medium	Low	High
Rwanda	High	High	Medium	Low	High	N/A
Seychelles	N/A	High	N/A	N/A	N/A	N/A
Somalia	High	High	High	Unknown	Unknown	High
South Sudan	N/A	N/A	N/A	N/A	N/A	N/A
Tanzania	High	High	High	High	High	N/A
Uganda	Medium	High	High	Medium	High	N/A

5.2 **Renewable Energy Adoption in Eastern Africa**

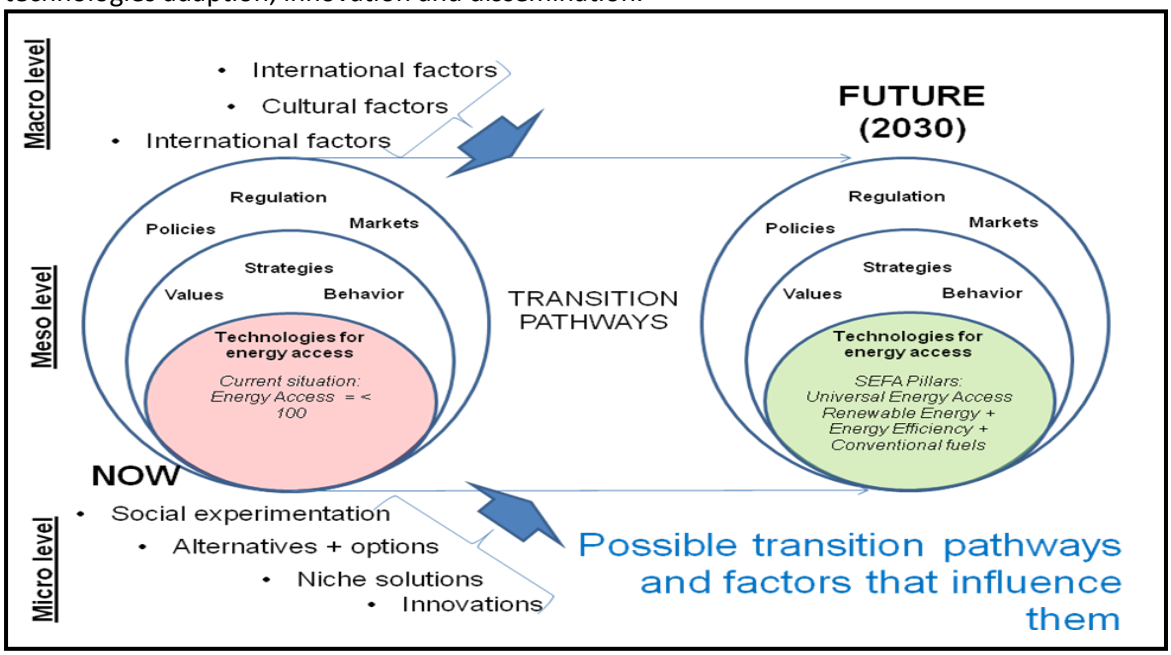
The adoption and diffusion of energy technologies are influenced by a set of micro, meso and macro factors. At the macro level, the global agenda of Sustainable Energy for All (SEFA) is on key policy prioritization of the energy agenda which calls for doubling the use of renewable energy globally. It also sets expansion of energy access to all by 2030. The SEFA initiative will pave the way for countries to set ambitious targets and receive technical and financial assistance in pursuing universal energy access. Uganda is one of the first countries to participate in the SEFA framework, and has already developed a country SEFA strategy that aligns its universal access goal by 2030, close to its original target of 2034. Such ambitious initiatives will induce rapid integration and diffusion of energy technologies, particularly off-grid applications.

Global energy innovation and technological improvements, at small and large-scale, in all areas of energy services (motive, cooking, electricity, etc) will also be a factor in determining the pace at which such technologies will be globally diffused.

At the meso level, energy technology adoption and diffusion are determined by a set of country factors, including the nature of regulation, policies, markets, values and behavior (see Fig. 98). Renewable energy policies and strategies are in place in the sub-region, such as in Kenya, Uganda, Rwanda, Ethiopia and Tanzania, some including feed-in tariff, power purchase agreements and fiscal incentives to put in place strong incentives for rapid energy technology diffusion. Markets also play a role on how successful technology diffusion will be. Particularly on the demand side, a set of consumer attitudes towards untested new technology, the relative price of traditional fuels compared with improved technology based energy supplies, the initial cost of technology adoption, and other factors are important considerations. The collective valuation of risk, and risk-taking or risk-averse behavior can also play a role in technology diffusion.

At the micro level, the options available to households and their economic values are also important. In Eritrea, for example, the meager forest resources have increased wood and charcoal prices, and encouraged the use of alternative fuels for cooking (in urban areas including electricity). The options available to households, and the gradual value of options will have impact on the pathways of technology adoption. Niche markets and technologies in niche markets and the extent to which local innovation have access to such niche markets are also technology challenges at the micro level.

Figure 28: Global, sub-regional and country energy transition pathways and impact on energy technologies adaption, innovation and dissemination.



Source: SEFA workshop, May 2012, Africa Climate Policy Center.

Within these macro, meso and micro systems that filter technology adoption rate and pace, a set of renewable energy technologies offer promising potential to harness sub-regional green energy potential into actual integration in the energy portfolio and end use.

5.3 Constraints on Energy Technology and Innovation

Creating links between knowledge generation and enterprises is a challenge. Particularly in countries where technology and innovation support infrastructure is inadequate, development and integration of innovation with business enterprises can be constrained. South Africa is currently creating a Technology and Innovation Agency to promote innovation and integrate technology into its economy, partly through the identification of gaps and linking sectors where resources can be shared. Innovative energy technologies are relatively new and are largely small-scale technologies that do not require large amounts of capital. Most of the challenges facing energy technologies exploitation are not specific for one technology but generic for all types of energy technologies. General constraints for access to innovative energy technologies include: the absence of clear policies to promote energy technologies; financial shortfalls for R&D; lack of conducive environment for resource mobilization from the private sector; lack of awareness about renewable energy technologies (RET); and lack of long-term framework for consumers of renewable energy to receive products at affordable prices and in a sustainable manner.

Beyond innovation and energy technology development, there are barriers to dissemination of new technology and energy products. In the context of rural areas, Deutch Bank identifies the following (see Table 4).

Table 4. Potential barriers of RETs deployment in rural areas.

Market Customer	Constraints
Legal issues, regulations and administrative barriers	Lack of information about potential markets/customer needs and preferences
	Consumers lack awareness of RET products and their benefits
Remoteness, Physical infrastructures	Lack of land title or title uncertainties, which can limit ability to sign contracts
	Lack of regulatory predictability and long term vision concerning rural electrification strategies and planning
	Approval processes for RET projects may take a considerable amount of time
	Unfair competition from conventional energy sources (subsidies)
	Import tariffs increase cost RETs and could make them prohibitively expensive
Skills and training	Difficult to recruit and retain staff with adequate technical skills to install , maintain and repair RETs
	Limited business skill (literacy, book-keeping, computer-related)
	Customers lack information/skills needed to properly operate RETs
Cost and access to financial services	Up-front costs can be high compared cash flows
	Lack of access to credit)for entrepreneurs and end users); local banks need

	experience and greater awareness of how to finance RETs
	Customers do not have access to financial services to make payments (bank accounts)
Supply Chains and services Delivery Channels	Insufficient development of supply chains
	Retail and logistics services are limited low-income communities
	Geographical mismatch of sources and centre of energy consumption
	Private companies face high costs of going to rural areas, often preferring donor contracts and capital cities
Performance of the RETs	Power quality products can undetermine reputation of RETs and diminish customer trust
	If promised economic (payback period, etc.) fails to materialize, customer trust may suffer
Gender	The fact that men are responsible of household investment in many rural developing regions but not for lighting and cooking energy often hinders investment in RET

Source: Deutch Bank, 2011.

5.4 **The Way Forward**

The Eastern Africa sub-region requires a revolution in energy technology innovation and adoption to meet the profound economic, environmental and social challenges energy poses in the 21st century. The G8 Summit in Heiligendamm (Germany 6-8 June 2007) Declaration states the aim to promote major emerging and developing economic participation in international technology partnerships in the energy sector and to scale-up national, regional and international research and innovation activities.

It is evident that without an energy policy based on technology-supported sustainability, Africa and other developing countries may not achieve strong sustainable development outcomes. Collaboration on science and technology within a South-South framework and with technology and innovation robust countries is an ideal partnership for the sub-region to develop and obtain the necessary capacity to boost indigenous energy technologies capacity that will allow sustainable economic growth. Having a Europe-Africa energy partnership would respond to the challenges identified at the G8 Summit addressing energy security, climate protection, development and the achievements of the MDGs.

Based on these considerations, the following options are put forth for policymakers, decision-makers and stakeholders in the Eastern Africa sub-Region to consider:

- Establishment of science and technology policies;
- Strengthening innovation systems through innovation policy frameworks;
- Accelerating energy innovation and public research, development and demonstration;
- Developing human capital to support indigenous energy technologies development;
- Promotion of appropriate (environmentally sound) energy technologies for mechanized agriculture, water pumping, agro-processing, educational, health facilities, and in other sectors;
- Enhancing the ; utilization of indigenous and renewable energy sources and technologies;
- Capacity building in terms of skills for managing appropriate energy technologies;
- Information and awareness creation on the available options in increasing energy services;
- Encouraging firms to develop and share technology;
- Encouraging private sector participation in technology diffusion;
- Better linkages between the research and enterprise in specific sectors of energy.

6 ENERGY ACCESS, ENERGY SECURITY AND THE ENVIRONMENT IN THE EASTERN AFRICA SUB-REGION

6.1 Promotion of Renewable Energy and Energy Access and Security

The Eastern Africa sub-region is significantly endowed with a wide range of renewable energy resources, including hydro-power, geothermal, biomass, solar, wind, and other renewables, most of which are currently under-exploited. Member States can opt for an alternative path to the 'business as usual' scenario by prioritizing fulfillment of their renewable energy potential. This approach will support the development of green economies anchored into green growth diagnostics and implementation of equitable solutions, in phasing out for example inefficient use of traditional biomass and pursue alternatives such as improved cookstoves. There is an urgent need for policy makers to recognize the potential role of renewable energy in meeting the energy challenges of the sub-region and assume an integrated and coordinated approach at a sub-regional level to scale-up the deployment of renewable energy technologies.

The share of renewable energy in electricity generation remains marginal in some countries of the sub-region. Some countries have a sizable renewable energy share such as Madagascar (25% ADER 2012, REN 21 has a different data - 57%), Tanzania (59% EIA, 46% REN 21), Uganda (54% REN 21) and Kenya (56% EIA; 66%, REN 21). Countries such as D.R. Congo (99%, EIA) and Ethiopia (88% - average between REN 21, 2012 and EIA 2009) produce almost all their electricity from hydro. Kenya's energy mix is somewhat diversified. In September 2011, the Governing Bodies of the Climate Investment Funds (CIF) endorsed Kenya's investment plan for funding under its Scaling Up of Renewable Energy Program in Low Income Countries (SREP). Developed under the leadership of the Kenyan Government with support from the African Development Bank (AfDB), World Bank Group and inputs from private sector, civil society and community representatives, Kenya has produced a plan outlining development of its multiple renewable energy resources to enhance energy security, improve access to electricity, reduce the cost of supply, and bring substantial economic, social, and environmental co-benefits to local communities. SREP aims to scale-up the deployment of renewable energy solutions and expand their markets in the world's poorest countries. It is a program under the CIFs, a USUS 6.5 billion financing instrument designed to channel scaled up climate change financing to developing countries through multinational banks like the AfDB.

Electric power based on renewable energy sources is a fundamental enabler of green growth, powering green cities, industrial operations, and crop irrigation. More than 85% of GHG emissions in Ethiopia come from forestry (37%) and agriculture (50%). Ethiopia is endowed with ample natural resources to meet these demands and already generates 90% of its electricity from renewable sources. It has a master plan to exploit its vast potential for hydro, geothermal, solar, and wind power to increase supply capacity fivefold over the next five years – and then to double it again, to 67 TWh, by 2030, and achieve zero emissions even sooner. Furthermore, due to the expected impact of energy-saving measures, Ethiopia foresees having a surplus of clean power, which it could export. In 2030, such exports could replace up to 19 Mt CO_2e per year of neighboring countries' generation from fossil fuels while contributing positively to Ethiopia's trade balance (national source).

6.2 Biomass: First Source of Energy in the Sub-Region

Nearly half the world's population and about 81% of Sub-Saharan African (SSA) households rely on wood-based biomass energy (fuelwood and charcoal) for cooking.

This proportion is much higher in Eastern Africa with 83% of the population relying on traditional biomass for cooking in Kenya, 94% in Tanzania, 94% in D.R. Congo and 93 % in Ethiopia (REN 21, 2012). This degree of reliance is far greater than in any other region of the world and will remain at high levels (or even grow) over the next few decades because: (a) electricity is still not considered as a suitable alternative given high costs of equipment and use; (b) rapid population growth; and (c) accelerated urbanization. The number of wood-based biomass energy consumers in Sub-Saharan Africa will reach almost one billion by 2030 (IEA, 2010). The economic value of the charcoal industry in Sub-Saharan Africa may exceed US$12 billion by 2030, employing almost 12 million people (AFREA, 2011).

Wood-based biomass consumption is occurring in both rural and urban areas (fuelwood, predominantly used by rural population and traditionally characterized by subsistence collection, and charcoal, the major cooking fuel for urban population and with associated commercialization and value-chain involving many stakeholders). This preference is essentially motivated by: (a) availability of wood (though the distance to forests and woodlands increases year after year and negatively reflects back on sale prices; for example up to 200 kms to servce Kinshasa); (b) affordability compared to other modern sources (though retail prices of charcoal have doubled in the last five years in most countries, for example from US$ 15-20 to US$ 50-60 for a bag of 50kgs in Kinshasa; US$ 15 for a bag of 50kgs in Addis Ababa; Euros 5 for a bag of 50 kgs in Madagascar); (c) simplicity of use (cultural features are key in traditional ways of cooking, easy to transport, distribute and store).

The sector remains informal with unclear regulations though its estimated total annual value can exceed agriculture crops for export (World Bank, 2009). The sector also provides employment and income. In Kenya, it is estimated that about 700,000 people work in the sector (Sepp, 2008a) for a total annual income estimated at US$450 million, equal to the country's tea industry (World Bank, 2007). In Uganda, around 200,000 people permanently earn money from charcoal (World Bank, 2007). Another study for Uganda found that if households are involved in charcoal production, it reduces their likelihood of falling below a poverty line by approximately 14% (Khundi et al., 2010). In Rwanda, where 95% (national source) of the population rely on solid wood-based fuels, the charcoal sector is estimated to account for an annual volume of US$77 million (van der Plas, 2008). In D.R. Congo, the charcoal sector employs 270,000 people for an annual income between USUS 75 and 100 million for Kinshasa (country report).

Table 5 shows that all countries in the sub-region have considerably increased their production of woodfuels (essentially in rural areas) and charcoal (in urban areas) in the last decade. Burundi has almost doubled its woodfuel consumption (+81.6% increase) whereas Eritrea cut it by half and Seychelles by one fourth (as a result of the implementation of environmental protection measures). With respect to charcoal production, Madagascar (+85,3%), Somalia (+49,2%) and D.R. Congo (+41,5%) are those which have recorded the largest increase during the 2000-2010 period, closely linked to political instability and lack of proper policy frameworks as well as monitoring. Production of charcoal seems to have stabilized in Burundi and Rwanda (which has put into place several forest rehabilitation, reforestation and afforestation programmes). Figures 103 and 104 show that Ethiopia and D.R. Congo are the largest producers of woodfuels and charcoal in terms of quantities in the sub-region (as per FAO data).

Except for Madagascar and Kenya, most countries in the sub-region have lost their primary forests. Though several countries have embarked in ambitious forest rehabilitation and tree planting programmes (Eritrea, Ethiopia, Madagascar, Rwanda, Tanzania and Uganda the overall forest cover in the sub-region has decreased by 9-10% in the last decade.

This implies that afforestation and reforestation efforts at national level were insufficient to offset the continued disappearance of primary forest mostly encroached upon for slash and burn agriculture, grazing land, commercial logging and used for charcoal production resulting in

additional carbon emissions. Other studies[10] show that forests were particularly hard hit near protected areas (46% of East Africa's National Parks having lost forest cover in the last decades). Just outside of protected areas, forests were particularly vulnerable, with buffer zones losing forest at an even faster pace.

Table 5. Wood fuels and charcoal production in Eastern Africa.

Countries	Wood fuels[1] (1000 m3)				Charcoal[2] (1000 tons)			
	2000	2005	2010	Trend (2000-2010)	2000	2005	2010	Trend (2000-2010)
Burundi	5 420	8 542	9 846	+81,6%	60	60	60	0%
Comoros	201	232	266	+32,3%	29	34	40	+37,9%
Djibouti	293	325	356	+21,5%	39	43	48	+23,1%
D.R. Congo	64 903	75 446	76 602	+18%	1 431	1 704	2 025	+41,5%
D.R. Congo*							728	
Eritrea	2 224	1 264	1 264	-43,2%	146	163	183	+25,3%
Eritrea*							135	
Ethiopia	87 471	94 481	101 274	+15,8%	2 908	3 304	3 734	+28,4%
Ethiopia*							1 232	
Kenya	19 658	25 600	26 400	+34,3%	641	18	18	-97,2%
Kenya*							3 109	
Madagascar	9 637	11 055	13 100	+35,9%	645	910	1 195	+85,3%
Rwanda	5 000	5 000	5 000	0%	48	48	48	0%
Seychelles	4	3	3	-25%	-	-	-	-
Somalia	9 228	10 803	12 532	+35,8%	651	797	971	+49,2%
South Sudan	-	-	-	-	-	-	-	-
Tanzania	20 787	21 712	22 836	+9,9%	1 165	1 372	1 609	+38,1%
Tanzania*							1 569	
Uganda	34 090	36 797	39 636	+16,3%	713	814	931	+30,6%
Totals	258 916	291 260	309 115	+19,4%	8 476	9 267	10 862	+28,2%

Source: FAO STAT, FAO website: http://faostat3.fao.org/home/index.html#COMPARE
Wood from main stem and branches, other than logs, used as energy source.
[2] Wood carbonized by partial combustion or application of heat from an external source.
*IEA, 2010.

6.2.1 Policy Options for Promoting Sustainable Biomass Energy Development

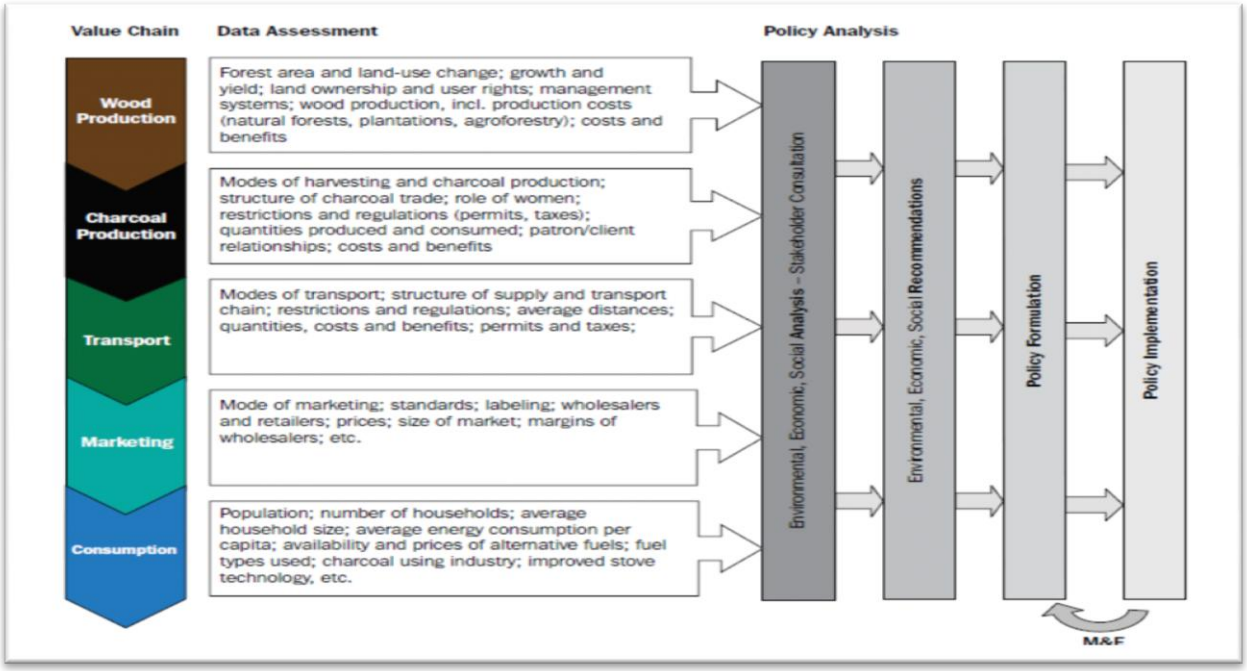
Switching away from wood-based energy will not necessarily be only a matter of improving the economic situation of consumers. In fact, if the price of alternative fuels continues to rise and supply remains erratic, households have little incentive to switch away from biomass energy. Given the often erratic and unreliable income streams to urban households, small quantities of fuel is bought with the cash available even if an ex-post analysis of total fuel expenses per month reveals higher expenses for charcoal compared to alternative fuel, such as LPG. Due to the complexity of the energy decision, a doubling of typical incomes would only reduce the number of those depending on biomass energy for cooking by 16% (World Bank, 2011, forthcoming).

[10] Pfeifer M, Burgess ND, Swetnam RD, Platts PJ, Willcock S, et al. (2012) Protected Areas: Mixed Success in Conserving East Africa's Evergreen Forests. PLoS ONE 7(6): e39337. doi:10.1371/journal.pone.0039337.

Though being the most important source of energy in rural and urban areas of Eastern Africa, wood-based biomass energy has been politically neglected. The charcoal trade is characterized by very weak governance, law enforcement, and other regulatory capacity. Despite its important interactions with development, environment and social welfare, there have only been a few attempts in Africa to include wood-based biomass as a basic sector in planning processes. Further emphasis needs to be put on the promotion of fuel switching, the introduction of fuel-efficient charcoal stoves, improved charcoal production kilns, and afforestation/reforestation measures designed to increase the supply of woody biomass. Increased kiln efficiency would play an important role in achieving a reduction of overall wood quantities needed for charcoal production, while the promotion of fuel switching would mainly buffer against a further increase in demand due to an increase in population.

Forest management plans need to be simple and short and developed in a participatory fashion, so as to remain accessible for communities. The following principles would need to be further embedded: first, no natural forest area should be converted to plantations and second, even for degraded natural forests it is preferable to improve production through enrichment planting rather than full conversion to plantations or woodlots. Plantations should also provide direct pecuniary benefits to rural households in order to divert pressures from primary/natural forests. One of the main reasons for rural households to engage in unsustainable charcoal production is their need for cash income, which is almost exclusively provided by the charcoal business (AFREA, 2011). Figure 30 presents a framework for developing and evaluating various policy options that address the charcoal challenge (Sepp, 2008).

Figure 29: Charcoal value chain.



Source: AFREA, 2011.

6.2.2 Promotion of Improved Cookstoves for Enhanced Energy Efficiency

At present, some sources estimate that cooking with traditional biomass fuels contributes about 18% of current global GHG emissions when forest degradation and deforestation is included (SEI, 2008). Most countries in Eastern Africa have already promoted the development of improved cookstoves in the framework of the charcoal value chain, aimed at reducing in-door pollution, quantities of charcoal produced and GHG emissions, in the framework of country climate resilient green economy strategies. Challenges remain in their design, quality and technical standards and need to be addressed through research and development; monitoring and evaluation (M&E) mechanisms; subsidies and grants; awareness raising, business development, and consumer research; adapting cookstoves and programs to country contexts; and taking account of consumer preferences and behavior.

Madagascar has an ambitious and effective innovation and research programme focusing on the design and fabrication of improved cookstoves-*fatapers* (using rice balls technology for example), which are locally patented (the main challenge remaining on the high annual patents' fees that need to be paid). The population usually opts for them though some initial reluctance (adaptation to new design, cooking time assessment) based on affordability and practicality. In Uganda, a joint venture of private companies aims to provide low-income communities with access to energy-efficient household cookstoves; at an estimated cost of US$ 20 million, this represents one of the largest carbon-finance commitments made to clean cookstoves in the sector's history (REN 21). In D.R. Congo, three million improved cookstoves (*mbambula*) were distributed to the population and the Government has engaged into field tours to Rwanda which is well ahead in the sector, with more than 50% of all households owning improved cookstoves (REN 21) through an Improved Stove Programme.

Ethiopia went through thorough assessments on linkages between wood-based biomass consumption and GHG (a rise in GHG emissions from current 24 Mt CO2e to 41 Mt CO_2e in 2030). As part of the proposed actions, the replacement of open fires and rudimentary stoves for cooking and baking with stoves that need only half as much fuelwood or stoves that use other fuels holds an estimated 20% of Ethiopia's total potential for emission reduction, or about 50 Mt CO_2 annually in 2030. The Government has plans to deploy 9 million more efficient stoves by 2015 corresponding to savings of US$ 270 million in opportunity costs for fuelwood, increasing rural household income by 10%. It would also create many more jobs in making stoves. Using better stoves would not only save energy, hence reducing emissions, but would also reduce severe health risks from smoke inhalation ("black carbon"). The government has identified the following targets: by 2030, fuelwood-efficient stoves for 80% rural population/5% urban (both cooking and baking); LPG stoves: 0%/5%; biogas stoves: 5%/1%; electric stoves: 5%/61% (both cooking and baking). Regarding efficiency improvement, the Ethiopian Ministry of Water and Energy estimates the following potential savings: fuelwood-efficient stoves: 50% (average for both cooking and baking); LPG stoves: 100% (cooking only); Biogas stoves: 100% (cooking only); Electric stoves: 100% (cooking and baking). The effect of overall reduced degradation will result in an abatement potential of 1.6 t CO_2/stove/year.

An ongoing project in Kenya, which is jointly implemented with GIZ and the Ministries of Energy, Agriculture and Education has disseminated approximately 850,000 stoves since it was established in 2005, and provides an example of state-promoted sustainable heating and cooking solutions. Producing cookstoves can provide business opportunities for many entrepreneurs, while other operations— such as formalizing the charcoal sector and creating fuelwood markets—can bring a range of income generating benefits. In Kenya, reports suggest that on average, 337 improved cookstoves were produced each month per producer, who earned an average monthly income of US$120-US$240 (GIZ, 2009). Moreover, fuel, time and money savings can also be a factor for some businesses such as restaurants that would be able to take advantage of newer technologies. For example, households can save an estimated half-ton of fuelwood each year if they own one of the new generation of improved stoves, which substantially affects their income (Adkins et al., 2010).

Countries making charcoal and biomass energy production more sustainable can rely on further support provided by existing initiatives such as the World Bank funded Biomass Energy Initiative for Africa (BEIA) initiated in 2009. The BEIA tests promising approaches to deal with biomass energy that can potentially be incorporated into the World Bank's lending portfolio. It provides small grants to African NGOs, research institutions, universities and private enterprises—selected via a proposal review process—to undertake pilot activities related to the development of biomass energy in Sub-Saharan Africa. The program aims to fund innovative ways to address fundamental problems facing Africa's biomass energy sector.

The recently launched Global Alliance for Clean Cookstoves (GACC)[11] under the United Nations Foundation (2010) has provided an umbrella for many organizations and institutions to work synergistically toward bringing household energy and advanced biomass cookstoves back on the policy agenda of international development agencies and donors. The World Bank has also joined the GACC, as have a number of country governments and other partners. The GACC is a public-private initiative that aims to save lives, improve livelihoods, empower women and combat climate change by creating a thriving global market for clean and efficient household cooking solutions.

6.3 Policy Interventions

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 and 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.

6.4 Energy and Climate Change: Funding Mechanisms for Renewable Energy Policy and Green Growth

6.4.1 UN-REDD, REDD+, FCPC and FIP[12]

The UN-REDD Programme is the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally-led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including Indigenous Peoples and other forest-dependent communities, in national and international REDD+ implementation. The Programme supports national REDD+ readiness efforts in 46 partner countries spanning Africa, Asia-Pacific and Latin America, in two ways: (i) direct support to the design and implementation of UN-REDD National Programmes; and (ii) complementary support to national REDD+ action (REDD+ preparedness strategies) through common approaches, analyses, methodologies, tools, data and best practices developed through the UN-REDD Global Programme. By July 2012, total funding for these two streams of support to countries totaled US$ 117.6 million.

[11] www.cleancookstoves.org.
[12] www.un-redd.org

Another important mechanism for the sub-region is the Forest Investment Programme (FIP), a targeted programme of the Strategic Climate Fund (SCF), which is one of the two funds within the framework of the Climate Investment Funds. The FIP supports developing country efforts to reduce deforestation and forest degradation and promote sustainable forest management that leads to emissions reductions and enhancement of forest carbon stocks (REDD+). Channeled through the Multilateral Development Banks (MDBs) grants and near-zero interest credits, FIP financing complements large-scale investments and leverages additional resources.

6.4.2 The Clean Development Mechanism (CDM): Opportunities for Eastern Africa

Under the Clean Development Mechanism (CDM), emission reduction projects in developing countries can earn certified emission reduction credits. These saleable credits can be used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol. The CDM was quite criticized for its complex procedures, low number of registered African projects and lack of national capacity in developing CDM eligible projects. As early as 2006, Parties to the Kyoto Protocol recognized the importance of a balanced regional distribution of CDM projects and welcomed the establishment of the Nairobi Framework, which brings together UN and regional organizations to support equitable access to the mechanism. In light of the benefits that the CDM can bring to less developed regions, the Nairobi Framework partners and others began funding technical support and capacity-building programmes for the CDM, particularly in Africa[13]. Given the continued importance of wood-based biomass energy in the sub-region, a sustainably designed and operated sector could significantly reduce GHG emissions and help launch low carbon-growth strategies. For example, if charcoal was sustainably produced it would be carbon neutral since this emitted carbon could be sequestered by trees that are planted. In this scenario, one ton of sustainable charcoal would offset one ton of non-sustainable charcoal or nine tons of carbon dioxide (GEF, 2010).

In Eastern Africa, and as per UNFCCC database, Kenya registered four CDM projects (mostly focusing on sustainable forest management, afforestation and reforestation); Rwanda has three registered projects (on energy) and several others under development; Madagascar registered two projects (on small-hydropower); Uganda registered five projects (sustainable forest management, afforestation and reforestation); and Tanzania, one project on energy. Under the CDM, the Programme of Activities (PoA) concept was introduced at the UNFCCC meeting (COP11) in Montreal in 2005. It was developed for simplification of project registration procedures and for expanding the scope of project activities with the aim of allowing the least developing countries to increase their participation in the carbon market PoAs currently being developed across East Africa cover improved cook stoves, demand-side energy efficiency (efficient lighting, new appliances, industrial equipment such as boilers, motors, pumps and also fuel efficient vehicle), small-scale fuel switch measures and small-scale waste management activities, forestry plantations and renewable energy schemes such as hydro, geothermal solar PV and wind. As of July 2012, 325 CDM PoAs (18 projects in Africa, 2.9% of all other CDM projects) had reached the validation stage with 20 being fully registered on the UNFCCC website. PoAs provide a mechanism to create region wide carbon access programmes, so EAC member states could develop a regional PoA for improved cookstoves, hydro power or energy efficiency projects providing access to the carbon markets that would otherwise be impossible to achieve for projects in small countries (Uganda Carbon Bureau, 2012).

[13] The Nairobi Framework Partners are the United Nations Framework Convention on Climate Change, the United Nations Development Programme, the United Nations Environment Programme, the World Bank Group, the African Development Bank, the United Nations Conference on Trade and Development, and the United Nations Institute for Training and Research.

7 ENERGY INFRASTRUCTURE GAPS AND ENERGY TRADE IN THE EASTERN AFRICA SUB-REGION

7.1 Power Systems

7.1.1 Power Generation

As depicted in Table 58, Africa has the lowest electricity capacity per capita in the world (123 MW/million population), as compared with 3,600 for Asia, 515 for Latin America and 1,078 for Eastern Europe and Central Asia. Rosnes and Vennemo (2008)[14] stated that nowhere in the world is the gap between available energy resources and access to electricity greater than in sub-Saharan Africa. They indicated that whereas sub-Saharan Africa as a whole was rich in oil, gas and hydropower potential, 76% of the population lacked access to electricity, with coverage particularly low in rural areas.

Table 6. Generation capacity per capita and per unit GDP, Africa and rest of the world

Continent	Capacity per capita (MW/million population)	Capacity per unit of GDP (MW/billion unit of GDP)
Africa	123	106
Asia	3,600	121
Latin America	515	60
Eastern Europe/Central Asia	1,078	144

Source: PIDA Study by SNC LAVALIN International Inc. in association with PARSONS BRINCKERHOFF (May 2011).

The situation in Eastern Africa is not any different from the above general picture of sub-Saharan Africa and Africa as a whole. Power generation, transmission and distribution infrastructure in the majority of the sub-regional countries is currently inadequate, leading to low access averaging around 23%. Economic recovery and growth in several of the Eastern Africa sub-regional countries is curtailed by lack of adequate supply of power to drive industries. The condition is worse when it comes to meeting domestic electricity needs of the population. Power supply shortages and poor infrastructure often result in several hours, or days, of power outages. Needless to say rural communities in most of the countries have little or no access to electricity. The comparison between Africa and other continents highlight the low levels of installed power generation capacity per capita, and per unit of GDP, clearly pointing to a case of under-investment in Africa in terms of power generation infrastructure.

7.1.2 Power Transmission

Power transmission systems in the sub-region are primarily country focused and tend not to be interconnected; and not designed to facilitate regional energy trade and to enhance energy access and security. It is therefore an imperative that future power generation and

[14] Powering Up: Costing Power Infrastructure Investment Needs in Southern and Eastern Africa – World Bank Africa Infrastructure Country Diagnostic Paper No. 61813

transmission plans in the sub-region should take into account the aspect of regional cooperation and integration, in order to take advantage of scale economies and the comparative advantages of the various countries. In this regard, the efforts of the East African Power Pool and the Regional Economic Communities (RECs), along with close collaboration with member States, are instrumental.

7.1.3 Sub-Regional Power Interconnection

Whereas there are bilateral power exchange agreements, power exchange has been hampered by either supply deficits or inadequate infrastructure to facilitate regional power trade. As a consequence, regional interconnectivity is rather limited. Existing power interconnections include:

- DRC, Burundi, and Rwanda interconnected from a jointly developed hydro power station Ruzizi I, (capacity 45 MW) operated by a joint utility (Societe d'Electricite des Pays des Grand Lacs (SINELAC);
- Kenya – Tanzania interconnection;
- Kenya – Uganda interconnection;
- Ethiopia – Djibouti interconnection;
- Ethiopia – Sudan interconnection.

Within the EAPP/EAC framework, however, a number of power interconnection projects are under development, bearing interconnection results during the next 5 to 10 years (see Table 60). As will be seen later, investments associated with the regional interconnectivity projects are substantial. However, a regional energy infrastructure would significantly expanding electricity access through interconnection-supported trade.

7.2 Natural Gas and Petroleum Pipeline Infrastructure

7.2.1 Natural Gas Pipeline Infrastructure

The African continent's main regional gas pipeline network is in North Africa, where gas is being exported from Algeria and Libya via Morocco to southern Europe. Regional gas pipeline systems also exist in southern Africa between Mozambique and South Africa as well as in West Africa between Nigeria and Ghana, with spur connections to Benin and Togo. There are currently no gas pipelines in the Eastern Africa sub-region. A recent discovery of large gas deposits in Tanzania is, however, bound to alter the gas infrastructure shortfall in the sub-region. Kenya has also reported gas finds in its north eastern coastline near Somalia. The development of gas pipeline systems will depend on markets to be supplied, as at the moment there is virtually no intra-regional trade in oil and gas. But significant discoveries and development of gas resources in the sub-region opens the potential to develop intra-regional gas trade.

7.2.2 Oil Products Pipeline Infrastructure

Existing regional or continental petroleum products pipelines in Africa are very limited, with most of the existing petroleum products pipelines serving national markets. Within the Eastern Africa sub-region, Kenya has an internal products pipeline distribution system, which links the port of Mombasa and its refinery to Nairobi. The system extends through two further pipelines to Eldoret and Kisumu. Plans were underway to extend the Kenya oil pipeline system from Eldoret to Kampala in Uganda and subsequently to Rwanda and beyond. The execution of this project has however been delayed by several factors and recent geopolitical events. The recent discoveries of oil in Uganda and Kenya, as well as the conflict between Sudan and South Sudan have further complicated matters, requiring a total rethink of the oil pipeline infrastructure network in Eastern Africa.

Tanzania is proposing the construction of an oil refinery and a 1,200 km long pipeline from Dar es Salaam to Mwanza on the southern shores of Lake Victoria. If the pipeline project is successful, it could be extended to Uganda, Burundi and Rwanda. There exists a crude oil pipeline between Dar es Salaam (Tanzania) to Ndola (Zambia). The Zambian Government has recently commissioned a study to examine upgrading options. In the case of Southern Sudan, the pipeline network runs from the oil fields in the south to the Port Sudan on the Red Sea.

Recent misunderstandings between the newly independent State of South Sudan with the Sudan have led to renewed interest to pursue an alternative export pipeline(s) to Kenyan port of Lamu and/or the Djibouti port. The agreement signed on September 27, 2012 by Sudan and South Sudan in Addis Ababa to resolve their dispute and return to oil flow through the Sudan pipeline has left uncertainty as to how vigorously South Sudan will continue to pursue alternative export routes. The discovery of commercial quantities of oil and gas in countries of the sub-region offers a great opportunity for planners and policy makers to consider the optimal modal mix for the exploitation and marketing of the products.

7.2.3 Refineries and Storage Infrastructure

The main refinery in Eastern Africa is the Kenya Petroleum Refinery Ltd situated in Mombasa, Kenya. It has the capacity to refine 70,000 barrels (11,000 cubic meters) of crude per day. The refinery is currently jointly owned by the Government of Kenya (50%) and Essar Energy Overseas Ltd (50%). Previously there was a refinery in Dar es Salaam with a capacity of 17,000 barrels per day, but it was closed in 2000 due to high costs of small scale operations. Madagascar also has a refinery, Solina Refinery jointly owned by Galana and the Madagascar government. It has capacity to refine 14,000 barrels a day. The other refinery which has been serving Sudan and South Sudan is the Khartoum Refinery Company Ltd, with capacity to refine 100,000 barrels a day. It is jointly owned by the Sudan Government and China National Petroleum and Gas Corporation. Meanwhile, Uganda is pressing ahead with plans for an oil refinery following the discovery of commercially viable quantities of oil in the Lake Albert region (2.5 billion barrels of crude oil so far confirmed, 2012). The feasibility study recommended a phased approach. Initial plan entails building a facility to process 20,000 barrels a day at an estimated cost of US$600 million. This would then be expanded to a facility that can process 60,000 barrels per day under public private partnership arrangement, which may comprise the Government of Uganda, China National Offshore Oil Corporation (CNOOC) and TOTAL.

Uganda's determination to put up a refinery is, however, reported to be facing criticism and skepticism from donors, civil society groups and international oil companies. Donors argue that a world class refinery in a landlocked country like Uganda with undiversified crude supply will face commercial challenges. They further argue that even a small-scale refinery tailored to Uganda's domestic needs will diminish the scale economies of export infrastructure without necessarily reducing domestic fuel prices and that there will be temptation to imbed hidden fuel subsidies within a domestic refinery entity. International oil companies meanwhile are using the reported oil discoveries in Kenya to de-campaign Uganda's refinery project. Uganda's response to the above arguments is premised on value addition and on building additional capacity to strengthen the EAC region. Uganda argues that more discoveries in Kenya, Tanzania, Burundi and Rwanda will provide feedstock to both the Hoima and Mombasa refineries and make them competitive. The EAC region's current total demand for oil is estimated at 164,000 barrels per day. Mombasa refinery has capacity to process 70,000 barrels a day.

With regard to oil storage infrastructure, holding strategic reserves could mitigate the effects of oil prices on the economies of the region. In this regard, cost savings could be possible if countries collaborated in developing regional storage and distribution facilities to mitigate the current inefficiencies in petroleum products procurement and distribution. At the continental level, African ministers responsible for hydrocarbons have proposed the establishment of an African Petroleum Fund. It can be taken that such a concept could be applicable at the regional level through development of proper policy and framework.

7.3 Energy Infrastructure Investment Needs in the Eastern Africa sub-Region

7.3.1 Investment to Expand Access and to Meet Increasing Power Demand

The Programme for Infrastructure Development in Africa (PIDA) anticipates that EAPP's demand will increase by a moderate 6.5% per annum and access rate will increase substantially from 36% to 68% between 2010 and 2040, over the PIDA period, requiring an investment of US$ 44 billion in access over that period. The list of generation projects identified in the EAPP/EAC Regional PSMP & Grid Code Study are shown in Table 7.

Table 7. List of identified regional generation projects.

Country	Plant Name	Type	Installed Capacity (MW)	Date
Eastern	RUZIZI III	Hydro	145	2024
D.R. Congo	RUZIZI IV	Hydro	287	2027
	Mandaya	Hydro	2,000	2031
Ethiopia	Gibe III	Hydro	1,870	2013
	Gibe IV	Hydro	1,468	2016
	Karadobi	Hydro	1,600	2036
Rwanda	Kivu I	Methane	100	2013
	Kivu II	Methane	200	2033
Tanzania	Stieglers Gorge (I, II, III)	Hydro	1,200	2020;2023;2026
	Karuma	Hydro	700	2016
Uganda	Ayago	Hydro	550	2023
	Murchison Falls	Hydro	750	2032

Source: EAPP/EAC Regional PSMP & Grid Code Study (May 2011).

7.3.2 Regional Power Trade

The countries in the Eastern Africa sub-region have different endowments in terms of power generation potential, as well as cost, creating the necessary arbitrage for power trading in the sub-region. Trading with neighboring countries facilitates the development of cheapest forms of energy resources in the sub-region, potentially reducing cost of electricity member States within the trading regime. Stimulating the development of hydropower in countries with the comparative advantage, while expanding regional trade in energy, for example, would lower generation costs in the long run, reduce carbon emission from generating plants and insulate countries from hikes in the price of fossil fuels[15]. Orvika and Haakon pointed out that the existence of regional connectors would make it possible to shave 5-6 percent off annualized power system costs. For the EAPP region, they reckoned that the savings could be in the order of US$ 1 billion per year.

[15] Some countries rely on imported fuel to generate electricity

7.3.3 Investment in Oil and Gas Pipeline Infrastructure

7.3.3.1 Kenya Oil Pipeline

The Kenya oil pipeline, initially linking Nairobi with the Mombasa Port (450km) has been in operation since 1978. The Western Kenya Pipeline Extension (WKPE), which runs from Nairobi to Nakuru and Eldoret, was commissioned in 1994. As a result of regional economic growth, the pipeline has experienced capacity constraints. The short-term solution was to install additional pumping stations to increase the rate of flow. Subsequently, however, it was found necessary to enhance capacity through installation of additional or wider pipes. In this regard the WKPE was expanded from 8-inch to 14-inch pipeline with a flow rate of 378 cubic meters per hour. In a similar manner, there is need to enhance pipeline capacity from Mombasa to Nairobi by installing a parallel line to the existing one. Plans are underway to do just that and tenders were issued for detailed engineering design for the new pipeline.

7.3.3.2 Kenya-Uganda Oil Pipeline Extension

The project to extend the pipeline to Uganda from Eldoret in Kenya had been planned on the basis of a public-private partnership (PPP). Each of the two governments was to take 12.5% of the shares, leaving the 75% to the strategic private investor. However, the project stalled due to the recent political events in Libya since the strategic partner selected happened to be from Libya. The discovery of oil in Uganda has also affected the project. The Eldoret to Kampala extension was meant to be a unidirectional line from Kenya into Uganda and yet the latter may need a pipeline to export oil products in the opposite direction. Uganda is considering the development of a 230km refined fuel products oil pipeline from Hoima to Kampala, with the expectation that it would eventually be linked to Kenya's Mombasa-Eldoret pipeline. Thus, need has therefore arisen to reappraise the project, which is likely to result in a different set-up, costing and financing arrangements.

7.3.3.3 South Sudan Oil Pipeline

South Sudan considers to build a pipeline to Kenya, or Djibouti, to reduce dependency on the Sudan route to the Red Sea port. Although necessary feasibility and engineering design studies have not been undertaken, preliminary estimates indicate a cost of US$ 3 billion and above for such a pipeline. Moreover, through a proposed US$22 billion Lamu-Southern Sudan-Ethiopia Transport (LAPSSET) Corridor project, a joint oil pipeline construction is under consideration.

7.3.3.4 Tanzania Oil and Gas Pipelines

Tanzania already has a gas pipeline from connecting Songo Songo Island with Dar es Salaam. Following further discovery of an estimated 3 trillion cubic feet of gas off Tanzania's southern Indian Ocean coast, the government plans to begin construction of a natural gas pipeline project from Mtwara to Dar es Salaam. China has offered a loan of US$1.2 billion to finance the construction. In addition, a feasibility study was completed for a gas pipeline to run from Ubungu in Dar es Salaam though Tanga to Vipingo in Mombasa. The study report was submitted to the project stakeholders for consideration.

In April 2007, the Tanzania Government signed implementation agreements with a US-based firm Noor Oil and Industry Technology (NOIT) for the construction of Dar es Salaam-Mwnza-Kigoma pipeline and oil refinery. The two projects have however not taken off due to reported failure on the part of NOIT to adhere to the agreements that were stipulated in the contract. It was reported (Tanzania Daily News, 14 August 2012) that the Tanzania Government was reviewing the project.

7.4 Financing Mechanisms

7.4.1 Domestic Resource Mobilization

Domestic resource mobilization takes many forms, with the most common one being the establishment of an Infrastructure Fund or Energy Fund. Countries that are reported to have explored and/or utilized this option are Ethiopia, Kenya and Uganda. The other domestically mobilized resource that could be used to finance energy infrastructure are the Pension Funds. In many countries, the National Social Security Funds are holding billions of dollars in the form of workers savings, which could be used for infrastructure development, provided that credible loan arrangements are entered into so as not to put the pension funds at risk of misappropriation.

7.4.2 Public-Private Partnerships

Perhaps the most common and preferred financing mechanism is the public-private partnerships where publicly owned utilities partner with a strategic private investor in power generation, transmission and distribution. This model works better when power generation, transmission and distribution are run by separate entities. This allows Independent Power Producers (IPPs) to invest in power generation and then sell the power to the distribution company. Uganda is an example where this model is currently in application.

7.4.3 Regional/Cross-border Integrative Projects

Regional or inter-state cross-border projects involving two or more countries tend to be attractive to funding by multilateral funding agencies, such as the World Bank, International Finance Corporation (IFC), African Development Bank (AfDB) and others. There are however challenges during implementation arising from different national laws and regulations. Such challenges could be overcome by adopting common regional investment regulations, norms and practices.

7.4.4 Coordinated Development of Optimum Regional Networks

Development of an optimal regional network would enable the development of the cheapest sources of energy facilitated through regional energy trade. The optimal regional energy network would reduce costs and enhance access. In addition, a strategic framework for cooperation in regional oil procurement, utilization of refineries, storage and distribution facilities, as well as the development of necessary infrastructure is necessary. In this regard, appropriate regional protocols and implementation frameworks and strategies are crucial. Based on the above, some key infrastructure development policy and implementation recommendations are:

- Enhance collaboration in the development of regional power generation and transmission systems;
- Harmonize investment codes and regulations to encourage investment in cross-border projects;
- Adopt a strategic framework for cooperation in regional oil procurement, utilization of refineries, storage and distribution facilities, as well as the development of necessary infrastructure is necessary;

- Collaborate sub-regionally in the development of oil and gas pipelines and regional refinery projects;
- Adopt strategies to counter the negative effects of low country and utility credit worthiness ratings and the perceived political risks.

8 MITIGATING THE ENERGY CONSTRAINT ON ECONOMIC TRANSF ORMATION IN THE EASTERN AFRICA SUB-REGION

8.1 Energy Access and Economic Development

Countries in the sub-region have been fighting poverty and underdevelopment for years. Factors contributing to persistent poverty include conflict, deficient infrastructure, poor access to capital, governance and insufficient institutional capacity (IMF, 2008). For the last two decades, sustained growth, job creation and poverty alleviation have been priority development goals, and these goals can be supported through implementation of broad-based socio-economic development policies. Historically, achievement of these goals has occurred with a corresponding increase in energy use (Jakobsson, 2007). Energy impacts all sectors of the economy and thus access to adequate and reliable energy supplies is central to economic growth. Securing higher living standards implies high rates of economic development. Reliable and affordable energy is a needed to power industry, increase agricultural productivity and boost GDP, to electrify rural areas, and improve quality of life. Thus, availability and reliability of cost-effective energy supplies impact directly many aspects of a country's social and economic development.

It is critical that energy access and supply should not a stumbling block in the way of realizing national potentials. Unfortunately, in the East African sub-region, energy poverty is one of the biggest obstacles to sustainable economic growth and development, hindering efforts to reach the poverty reduction and related MDGs. Power is by far Africa's largest infrastructure challenge, with countries facing regular power shortages and devoting valuable resources to emergency generation. Reliable and accessible electricity supply has emerged as a major bottleneck. Recent studies on the energy consumption–economic growth relationship for countries includes Jumbe (2004), Wolde-Rufael (2006), Akinlo (2008), Odhiambo (2009), Kahsai et.al. (2011) and Nando et al. (2012). They found some form of relationships between energy consumption and economic growth. Furthermore, an IEA study shows that energy consumption is positively related to wealth, while a lack thereof is correlated with people living on less than $2/day (IEA, 2004), providing support for the hypothesis that inadequate energy services impede from achieving their development goals. A study by Chien and Hu (2007) on the effects of renewable energy on GDP for 116 economies also reveals that renewable energy indirectly stimulates GDP through the channel of increasing capital formation. Accordingly, investment in renewable energy might result in the development and expansion of businesses and thus effectively stimulate employment growth and increase earnings.

Therefore, it is imperative that to sustain the gains in socioeconomic development and transformation underway in the Eastern Africa sub-region, the energy constraint to it in terms of low level of access will require to be alleviated.

8.2 Energy Security and Economic Growth

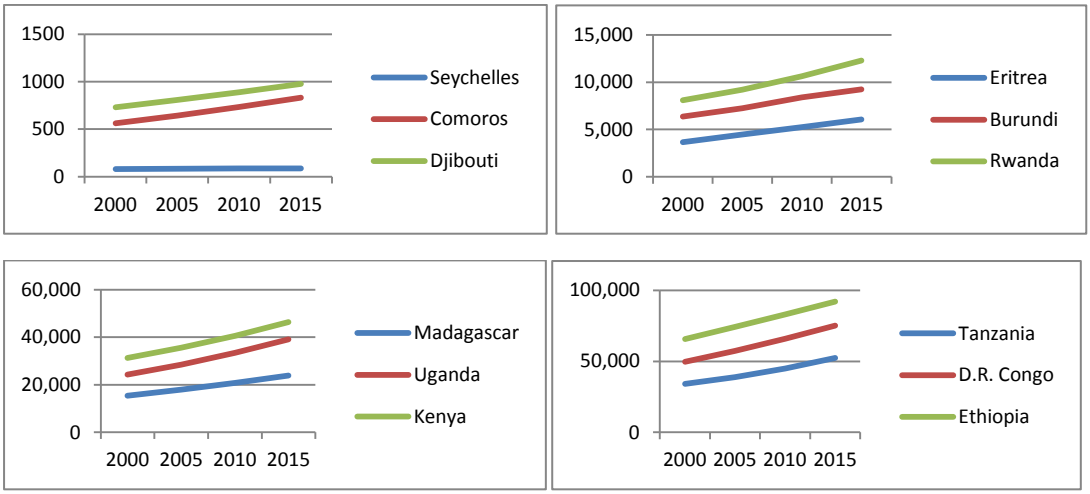
Energy security is a complex theme that relates to the reliability, resilience and sustainability of energy supplies. For policy makers, energy security concerns vary widely and include: the stability of fossil fuel prices; the long-term availability of energy resources; the impact of energy production on the local and global environment and the

susceptibility of energy infrastructure to acts of violence and natural disasters. Further, the availability and reliability of cost-effective energy supplies impact directly many aspects of a country's social and economic development, including poverty alleviation, private sector modernization and balance of trade. Energy security underlies a nation's ability to supply reliable and affordable energy to meet the energy demand and to promote sustainable development.

8.2.1 Increasing Energy Demand and Energy Services

Energy consumption within the sub-region is expected to increase significantly during the coming years. This increase will be triggered mainly by the current low level of energy consumption (3% of world average consumption), rapid population growth (see Fig. 31) and the expansion of the economies of the region. With growing demand comes more pressure on how to provide a secure and reliable energy services at affordable price for current and future needs.

Figure 30: Actual and projected population growth in the Eastern Africa sub-Region.



The key challenge is how to meet the need and obligation to deliver secure and affordable energy services to rural remote areas and the poorest segments of the population and continue to provide reliable services to existing customers and growing demand from the traditional economic sectors. To meet this challenge, a practical and long term plan must be in place to address the issue of national energy portfolio, energy price affordability and demands for expansion of energy infrastructure, conjointly with economic development and transformation strategies.

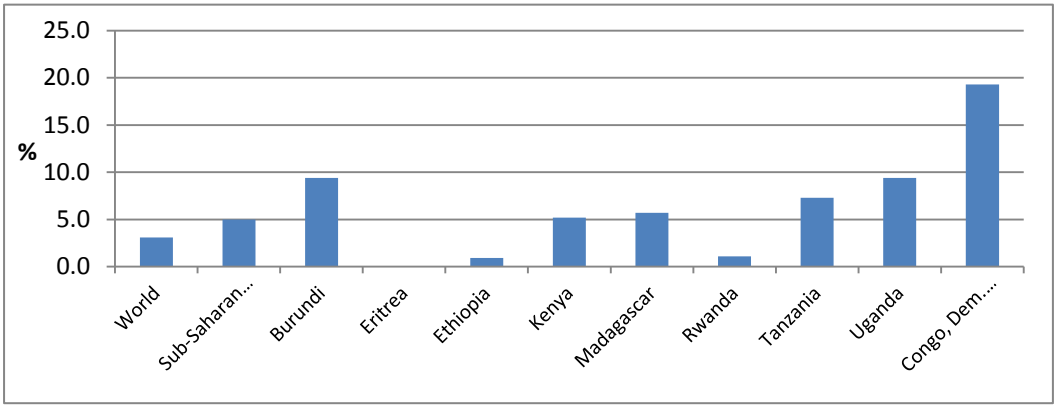
8.2.2 Energy Services Disruption and Economic Impacts

The cost of energy services disruptions due to electricity outage is another major constraint to economic performance and long-term transformation. African manufacturing enterprises experience power outages on average 56 days per year. As a result, firms lose 6% of sales revenues; in the informal sector, where back-up generation is limited, losses can be as high as 20%, and the overall economic costs of power outages can rise to 1–2% of GDP (Khennas, 2012). As shown in Fig. 32, in Eastern Africa, annual sales revenue loss of firms due to electrical outage is one of the (D.R. Congo 19.3%, Uganda and Burundi 9.4% and Tanzania 7.3%). Electricity constraint is identified as a major obstacle for doing business (49.2% of firms in sub-Saharan Africa compared with 39.2% world average, based on World Bank Enterprise Survey).

8.2.3 Oil Price Volatility and Economic Impacts

The adverse economic impact of higher oil prices on oil-importing developing countries is generally more severe than developed countries. This is because their economies are relatively more dependent on imported oil and increasingly energy-intensive, and because energy is used less efficiently. According to IEA (2004), on average, oil-importing developing countries use more than double the oil to produce a unit of economic output as do Organization for Economic Cooperation and Development (OECD) countries. Developing countries are also less able to manage the financial pressure they face by higher oil-import costs. It is estimated that the loss of GDP averages 0.8% in Asia and 1.6% in highly indebted poor countries (HIPC) in the year following a $10 oil-price increase. There are fewer studies on the impact of high oil prices on African economies compared with other continents. However, specific studies have been conducted on the effects in Kenya (Semboja, 1994), Nigeria (Ayadiet al., 2000; Ayadi, 2005), Mali (Kpodar,

Figure 31: Losses due to electrical outages (% of annual sale of firms).



Source: Enterprise Survey database, the World Bank.

2006), Mozambique (Coady and Newhouse, 2005), South African Region (Nkomo, 2006) and Ghana (Coady et al., 2006). The loss of GDP in the sub-Saharan African countries was estimated to be between 3% (IEA, 2004) and 6% (Bouakez and Vencatachellum, 2007). The finding of Bouakez and Vencatachellum (2007) is quite interesting. It indicates that a doubling of the price of oil on world markets with complete pass through to oil consumers would lead to a 6% contraction in the first year. If that country were to adopt a no-pass through strategy, output would not be significantly affected but its budget deficit would increase by 6%. Both ways, whether it follows a pass through strategy or not, the macro-economic stability of the country is affected. *The interconnections between energy security and economic transformation would therefore need careful examination and management strategy.*

8.3 Policy Options to Reducing Energy Constraints to Economic Transformation in the Eastern Africa Sub-Region

8.3.1 Within-Country Strategies

8.3.1.1 Enhancing Energy Efficiency

The sub-region can go a long way in enhancing energy efficient regions, as the average energy intensity (GDP per unit of energy) in Africa of 13,352 is much higher than the global average of 9803 (EIA, 2012). This is 36% above world average which indicates the amount of energy input in production processes wasted that could have been saved for other productive activities. Energy saving reduces strain on generation expansion demand. There are great potential and opportunities in energy efficiency and it needs prioritizing in the strategy for sustainable energy development and constraint alleviation.

8.3.1.2 Joint Economic and Energy Planning

Economic transformation planning has a wide range of anchoring strategies and policy targets. Given the level of influence the energy sector has on the overall economy, and due to the energy input implications for ambitious economic development plans, a joint economic and energy sector planning is quite crucial. Economic transformation requires vast amounts of energy to be available. For example, middle income countries, on average, have 80% population electricity access, compared with 23% in the Eastern Africa sub-region. An ambitious economic transformation agenda to enter middle income status in the sub-region would therefore require an equally ambitious energy access transformation, which necessitates joint economic and energy planning.

8.3.1.3 Shielding the Economy from Energy Insecurity Impacts

Economic transformation can be constrained by energy insecurity, stemming from sustainability of biomass-based energy supply and the availability, quality and affordability of electricity supply. More importantly, petroleum import dependence and disruption management policies and schemes in-country determine the nature of impact on the economy. Efforts at energy diversification and maintenance of strategic reserves would certainly help, so would an information management system that would provide policymakers timely and accurate analysis and information on the risk of energy disruption for timely management decisions that can deter potential spillover effects of energy on the economy.

8.3.2 Sub-Regional Strategies

A sub-regional framework is advantageous for many reasons. It helps bring a whole serious of high-potential energy sources for development, enabling the alleviation of the energy constraint throughout the sub-regional economy. With proper infrastructure development and trade, the sub-regional average cost of energy supply can

be reduced while enhancing supply constraints. Moreover, a regional framework can help pool investment resources together to develop an otherwise costly project. One example is the development plan of Inga III power project in D.R. Congo that is pooling financial resources from countries in the Southern Africa Power Pool (SAPP), particularly South Africa.

On petroleum products, a regional framework on strategic reserves, procurement, distribution infrastructure and coordinate policy response are effective possibilities. Political will of regional governments and policy makers will be required to help building an effective response to the energy constraint to economic development.

9 Conclusion

From basic aspects of everyday life, energy has become an indispensable input. It is widely recognized that achievement of the MDGs and broader social transformation necessitates the availability of modern, affordable and reliable energy, and increasingly needed from cleaner and sustainable energy sources. Despite the strong linkages between energy sector development and socioeconomic transformation, Eastern Africa is one of the few sub-regions with poor energy access. As the sub-region continues to enjoy robust economic growth, sustaining the momentum will require taming energy problems: poor availability of energy; poor population energy access levels; unreliable and insufficient quality energy; generation, transmission and distribution inefficiencies; insufficient policy, institutional and human capacity in the energy sector; energy market structural barriers; limited private sector participation; energy planning lags and emergency generation and others. As part of the overall effort to reduce transaction costs and structural constraints on economic transformation in Eastern Africa, alleviating the energy challenges to growth constitutes a major step. Moreover, the excessive reliance on imported energy, particularly petroleum, has exacerbated energy security in the sub-region, with severe impacts on member States' macroeconomy, including balance of payments impacts. Management of energy security risks to the economy continues to be part of the structural constraints to economic transformation.

Despite numerous challenges in the energy sector of Eastern Africa, opportunities abound. Member States are endowed with significant clean energy resources, development potential of trans-boundary hydropower systems is ripe, energy trade is barely leveraged in the sub-region, private sector participation and capital infusion is a real possibility, and institutional and policy reforms can address the pent-up demand for rapid energy development. Discovery of oil and gas resources in the sub-region, and growing interest in biofuel development also offer pathways to meeting energy insecurity through regional frameworks. These, and other opportunities, constitute the possibility of an *energy transformation and revolution* in the sub-region.

Recognizing that energy access and security are indispensable to economic transformation, member States of the Eastern Africa sub-region are advised to consider: strong commitment to energy sector development consistent with their socioeconomic development aspirations; increasing private sector engagement, and private-public partnerships to enhance investment resources in the energy sector; pursuing regional opportunities to engage in energy trade and benefit from lower energy costs and economies of scale; pursue renewable energy initiatives aggressively; commit to energy access sub-regional and country targets and strive to achieve Sustainable Energy for All objectives by 2030; strengthen energy planning while synergizing with economic planning; institute and stock strategic reserves of petroleum to lower the economic costs of energy disruptions while developing partnerships for a regional procurement

framework; strengthen regional cooperation on development of strategic energy resources such as oil and gas; engage in exchange of information and experiences pertaining to enhancing energy access and security and ultimately addressing the energy constraint to resilient economic transformation through workable strategies implemented in the Eastern Africa sub-region and beyond.

This report offers a sub-regional picture on energy access and security, looks at the environmental, trans-boundary energy resources, infrastructure and trade, technology and energy and economic performance issues. Policymakers, decision-makers and energy sector stakeholders may find it useful as they deliberate, advocate and implement programs and strategies that will collectively enhance the state of energy access and security. For detailed information, refer to the full report.

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