EAC ENERGY SECURITY POLICY FRAMEWORK

United Nations
Economic Commission for Africa

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EAC Energy Security Policy Framework 2018

This energy security policy framework for the East African Community is intended to provide policy guidance towards better understanding, measurement, monitoring, evaluation and management of energy security risks and challenges in the energy sector of the region. The framework develops models for energy security monitoring, evaluation and management in the biomass, oil and gas and electricity sub-sectors through an approach for integrated overall energy security management. It employs both well-known energy security metrics, such as in the oil and gas sub-sector, as well as putting forth new dimensions to energy security management in the biomass and electricity sub-sectors. The framework proposes institutional framework both for the monitoring, evaluation and reporting functions for biomass, electricity and oil and gas supply security and the coordination of decisions and directives for overall energy security management and emergency responses. The energy security policy framework is not a binding policy document for the region but it aims to provide the foundational policy framework so that the Partner States will take action to devise energy security policy, strategy and action plans, along with their institutionalisation. The framework is developed based on consultative processes in the EAC Partner States.

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Acronyms and abbreviations

AAC	Annual Allowable Cut, forest wood
AEC	Atomic Energy Council, Uganda
AMR	Automated Metre Reader
APERC	Asia Pacific Energy Research Centre
Bbl/day	Barrels per day
BPS	Bulk Procurement System (petroleum products), Tanzania
BRICS	Brazil, Russia, India, China and South Africa
CAI	Current Annual Increment, forest wood
CEMAC	Central African Economic and Monetary Community
CFL	Compact fluorescent lights
CNG	Compressed natural gas
COPEC	Commercial Petroleum Company Limited, Tanzania
DHGER	Direction Gènèral de L'Hydraulique et de l'Electrification Rurales, Burundi
EAC	East African Community
EALA	East African Legislative Assembly
EAPP	Eastern African Power Pool
ECOWAS	Economic Community of West African Countries
EDCL	Energy Development Corporation Limited, Rwanda
EE	Energy Efficient
EPPs	Emergency Power Producers
ERA	Electricity Regulatory Authority, Uganda
ERC	Energy Regulatory Commission, Kenya
ESAP	Electricity Security Action Plan
EU	European Union
EUCL	Energy Utility Corporation Limited, Rwanda
EURELECTRIC	Union of the Electricity Industry, EU
EWURA	Energy and Water Utilities Regulatory Authority
FAO	UN Food and Agriculture Organisation
FiT	Feed-in Tariff, electricity
GDC	Geothermal Development Company, Kenya
IEA	International Energy Agency
IMF	International Monetary Fund
IPPs	Independent Power Producers
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electricity Transmission Company Limited
KFS	Kenya Forest Service
KPLC	Kenya Power and Lighting Company

LED	Light-emitting diode
LPG	Liquefied petroleum gas
M3/ha	Cubic metre per hectare
MAI	Mean Annual Increment, forest wood
MEMD	Ministry of Energy and Mineral Development, Uganda
MEET	Management of Energy Emergency Teams
MINIRENA	Ministry of Natural Resources, Rwanda
MMsfd	Million standard cubic feet per day, gas
MW	Mega watts
NAFORMA	National Forest Resources Monitoring and Assessment, Tanzania
NEIPO	Nuclear Energy Programme Implementation Office, Kenya
NELSAP	Nile Equatorial Lakes Subsidiary Action Plan
NEPAD	New Partnership for Africa's Development
NEU	Nuclear Energy Unit, Uganda
NOC	National oil Company, Uganda
NOC	National Oil Company, Uganda
NOCK	National Oil Corporation of Kenya
NPA	National Petroleum Authority, Uganda
OIC	Oil Importation Coordinator, Tanzania
OMCs	Oil Marketing companies
OPEC	Organisation of Petroleum Exporting Countries
OTS	Open Tender System (petroleum products), Kenya
PAI	Petroleum Authority of Uganda
Partner States	Republic of Burundi, Republic of Kenya, Republic of Rwanda, United Republic of Tanzania and the Republic of Uganda
PAU	Petroleum Authority of Uganda
PPAs	Power Purchase Agreements
RECs	Regional Economic Communities
REGIDESO	Régie de Production et Distribution d'Eau et d'Electricité, Burundi
RNRA	Rwanda Natural Resources Authority
RURA	Rwanda Utilities Regulatory Authority
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SE4ALL	Sustainable Energy for All, global energy initiative
SINELAC	La Société Internationale d'Electricité des pays des Grands Lacs
TANESCO	Tanzania Electric Supply Company Limited
TFS	Tanzania Forest Service
TPDC	Tanzania Petroleum Development Corporation

UEB	Uganda Electricity Board
UEDCL	Uganda Electricity Distribution Company Limited
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
UETCL	Uganda Electricity Transmission Company Limited
UMEME	UMEME Company Ltd (electricity distribution), Uganda
UNECA, SRO-EA	United Nations Economic Commission for Africa, Sub-Regional Office for Eastern Africa
ZECO	Zanzibar Electricity Corporation
ZURA	Zanzibar Utility Regulatory Authority

FOREWORD

Partner States of the East African Community (EAC) have collectively experienced rapid economic growth and transformation over the last decade, in spite of an adverse global economic environment. The main drivers of these changes have been the rapid growth of domestic aggregate demand, robust commodity markets, for the most part, better economic management practices, public investment and a generalised improvement in the investment climate. However, limited energy production capacity continues to be a constraint on regional growth. Its development would be an enabler of growth and transformation. Continued economic and social progress in the EAC will require growing energy capacity and access to affordable energy in an environment of improved energy security.

The energy sector of the EAC features energy security challenges in the biomass, electricity and oil and gas sub-sectors. Biomass energy, which provides more than 90 percent of all primary energy, is the mainstay and dominant source of energy. Cooking continues to rely on available and affordable wood and charcoal fuels. Due to increase in biomass energy demand on the one hand, and the limited improvements in biomass energy supply capacity on the other, there is a serious wood and charcoal deficit in all EAC Partner States, with projections of the biomass energy system driven to deepening unsustainable supply. It is, therefore, imperative that the Partner States consider the recommendations from the developed biomass energy security framework in designing national policies and strategies, and in strengthening evaluation, monitoring, and management capacity for supply security of biomass. This regional policy framework provides guidance on targeting actions in key areas to restore the biomass energy system towards long-term sustainability and supply security. To strengthen supply security of biomass, an institutional framework proposal is forwarded for adoption and implementation by the Partner States.

In the electricity sub-sector, the EAC has registered significant progress in policy reform, energy capacity development and, to some extent, power sector integration, compared to the electricity crises and severe insecurity in the preceding years. Investment in electricity generation capacity is increasing, and policy attention on energy sector development is taking shape. However, the electricity sub-sector in the EAC is still under-developed, constraining both industrial development and the middle-income transition aspirations of Partner States. To close the gap between electricity demand and supply, and to end critical electricity shortages, generation, transmission and distributions systems require more efficiency, greater capacity, better integration, more diversification, and system-wide cost minimisation. The developed policy framework puts forward a consolidated approach to evaluate, monitor and manage the security of electricity supply. It also offers policy guidance on the system-wide management of supply security of electricity. It further presents an institutional framework for electricity supply security and emergency management.

Oil and gas supply security policies are pursued particularly by countries within the International Energy Agency (IEA), to deal with the perennial global energy security concern. In the context of the EAC oil and gas is an area where there is excessive exposure to external shocks, with limited energy security management framework and operational preparedness. With no current regional refining capacity, lack of control over global oil and gas prices, limited regional pipeline infrastructure, no strategic petroleum reserve systems in most Partner States and other constraints, the EAC is exposed fully to oil and gas supply security risks, and resulting economic impacts. Recent discoveries of oil and gas are expected to alleviate part of the concern in some Partner States. However, greater regional cooperation is required to extend the energy security gains to the EAC.

The developed policy framework puts forth, in the context of the realities in EAC, mechanisms to monitor, evaluate and manage oil and gas supply security, along with an institutional framework for such monitoring and decision-making, including for supply emergency management.

This comprehensive energy security policy framework is the first of its kind at continental and REC levels in Africa. In addition, when it is implemented at the country level, it will lay the foundation for improving the monitoring, measurement and management of energy security in the context of Africa, and in particular, that of the EAC. By incorporating the often neglected sub-sector of biomass, the policy framework recognises the unique reality of the region and the importance of addressing energy insecurity in an energy source on which the vast majority of the population relies. The electricity and oil and gas policy considerations in the framework also reflect the conditions and sources of energy insecurity in these sub-sectors in the EAC and offer a context-specific approach to managing energy security.

We expect that the energy security policy framework will provide regional guidance to the Partner States in deepening on-going energy security mitigation measures. We also expect that it will offer a wider scope for a comprehensive country-level energy security policy and strategy development and implementation. We expect that the policy framework will also support the identification of key areas for regional harmonisation, standardisation, cooperation and partnership towards mitigating energy insecurity at Partner State and EAC levels. It is a timely contribution to support the Partner States in their pursuit of a resilient and secure energy future.

Ambassador Liberat Mfumukeko
EAC Secretary General

Ms. Vera Songwe
UNECA Executive Secretary

ACKNOWLEDGEMENT

The development of the EAC energy security policy framework is a result of the partnership between the East African Community and the UN Economic Commission for Africa, Sub-Regional Office for Eastern Africa. Its development was initiated by the approval of the EAC Sectoral Council on Energy, which received the finalised policy framework for consideration and adoption. The initiation, guidance, and adoption of the policy framework by the Sectoral Council on Energy were invaluable. A highly consultative process that engaged the EAC Partner States at regional and country levels was at the centre of the framework development. To facilitate consultation and engagement of energy experts and stakeholder at Partner States level, Country Teams were constituted by nominated experts from the ministries responsible for energy, particularly from the biomass, electricity and oil and gas sub-sectors.

The EAC energy security policy framework was developed by Mr. Yohannes G. Hailu (energy policy expert at the UN Economic Commission for Africa, Sub-Regional Office for Eastern Africa), Mr. Peter Kinuthia (former senior energy expert at the EAC) and Mr. Elsam Byempaka Turyahabwe (senior energy expert at the EAC). The development of the policy framework was strongly supported and facilitated by country teams. The country team for the Republic of Burundi, constituted by Mr. Moise Makuwa (coordinator), Mr. Jean Bosco Ndikumana and Ms. Claudine Shurwe, led the country consultative effort. Mr. Justus Mbithi (coordinator), Mr. Issac Kiva, Mr. Eric Mamwalo, Mr. Francis Thiong'o and Mr. Kihara Mungai facilitated the work in the Republic of Kenya. Consultative engagements in the Republic of Rwanda were supported by Ms. Peace Kallisa (coordinator), Mr. Jerome Nsengiyaremye, Mr. Oreste Nyonsaba and Mr. Jean Clement Nshubijeho. The consultative workshop and data gathering efforts in the Republic of Uganda were ably facilitated by Mr. Michael Ahombisibwe (coordinator), Mr. Disan Kiguli and Mr. Julius Wamala. In the United Republic of Tanzania, the consultative and data gathering efforts were supported by Mr. Erick Rugabera (co-coordinator), Mr. Ali Bakar (co-coordinator - Zanzibar), Mr. Abdillah Mataka, Mr. Abdallah Mussa Chikoyo, Mr. Fabian Mwose, Mr. Faraji Yakoub Abbas and Mr. Mgeta Faustine. The country teams were instrumental and valuable in reviewing and validating the inception of the policy framework development process, organising country consultative workshops, engaging energy sector stakeholders from biomass, electricity and oil and gas sub-sectors, in facilitating country data gathering and contributing expert inputs to the validation of the developed policy framework.

During country consultation and engagement workshops, energy experts and stakeholders from the biomass, electricity and oil and gas sub-sectors actively participated and shared country experiences. The contributions of experts and stakeholders from the biomass, electricity and oil and gas sub-sectors at the inception meetings were invaluable. The participation of 54 experts and stakeholders at the Burundi consultative workshop, 63 in Kenya, 47 in Rwanda, 67 in Uganda and over 100 in Tanzania, including the Zanzibar consultative workshop, were immensely invaluable and contributed realism and depth to the policy framework.

Information, data, and insights shared by institutions in the Partner States were equally instrumental. These include energy sector institutions in Burundi facilitated by the Burundi country team and the Ministry of Infrastructure and energy institutions in Rwanda. In the Republic of Kenya, the Ministry of Energy and Petroleum, Energy Regulatory Commission, Kenya Farmers' Federation, Kenya Electricity Generating Company Limited (KenGen), Kenya National Biogas Programme and the Petroleum Institute of East Africa in Kenya provided useful resources. Similarly, in the Republic of Uganda the Ministry of Energy and Mineral Development, Uganda Electricity Generation Company Limited Uganda Electricity Distribution Company Limited,

Electricity Regulatory Authority, National Forest Authority, the Ministry of Water and Environment, the Department of Water Resources Management, Uganda Bureau of Standards, Biomass Energy Efficiency Technology Association, Renewable Energy Alliance Association, Biogas Association, Hydro Power Association, National Biogas Alliance, Solar Energy Association, Uganda National Alliance on Clean Cooking in Uganda, Uganda Liquefied Petroleum Gas Association, Tullow, Uganda Uganda Energy Credit Capitalisation Company, and the Department of Petroleum shared valuable resources and data. In the United Republic of Tanzania, the Ministry of Energy and Minerals, Energy and Water Utilities Regulatory Authority, Ministry of Natural Resources and Tourism, Tanzania Forest Service, TANESCO, Tanzania Petroleum Development Corporation and Petroleum Importation Coordination in Mainland Tanzania; and the Department of Energy, Zanzibar Utilities Regulatory Authority, Zanzibar Electricity Corporation and Ministry of Agriculture and Natural Resources in Zanzibar provided useful inputs and data. Their support is greatly appreciated.

Finally, the technical and institutional support for this initiative from the EAC, including the management of the institutional process for initiation, guidance, consideration by the Sector Council and adoption of the policy framework is fully recognised. The technical and resource support for this initiative from the UN Economic Commission for Africa, including the overall guidance and support for the initiative by the former Director, Mr. Antonio Pedro and the Interim Officer-in-Charge Mr. Andrew Mold are also recognised.

EXECUTIVE SUMMARY

The EAC energy security policy framework focuses on putting forth an approach for conceptualising, measuring, monitoring and managing energy security in the biomass, electricity and oil and gas sub-sectors. It further identifies the institutional and operational arrangements for ensuring energy security.

Biomass energy is the primary energy source in the EAC. In Burundi, over 90% of the population rely on firewood and charcoal as a source of cooking energy. Over 82% of urban and 34% of rural population of Kenya rely on charcoal, and firewood is the preferred source of cooking energy for 89% of the rural population. In Rwanda, 85% of the energy used is in the form of biomass, and over 88% of rural households rely on wood fuel as a major source of energy. All rural households and about 98% of urban households in Uganda rely on biomass energy for cooking. Similarly, wood energy accounts for 90% of Tanzania's overall energy supply, and 75% of cooking energy in Zanzibar. It is, therefore, apparent that ensuring the security of supply of biomass energy remains a crucial challenge in the energy sector of the EAC.

Demand and supply conditions in the EAC indicate that Burundi faces a biomass energy (wood and charcoal) supply deficit ranging from 56%-155%. Kenya's deficit for wood biomass energy is at 70%, and a 122% deficit for charcoal. Mainland Tanzania similarly has annual wood demand and supply imbalance and deficit of 19.5 million m^3, or 20%. In Zanzibar, assessments indicate a supply deficit of 10% for wood and 178% for charcoal. Uganda and Rwanda similarly faced deficits estimated at 69% and 29%, respectively. Based on demand and supply conditions for fuel wood and charcoal in the EAC, and large deficits in available wood supply meeting current demand, the biomass energy sub-sector in the region is in a state of deepening energy insecurity. Biomass energy experts in the Partner States identified numerous impacts of this energy insecurity, including in food and nutrition, health, rising energy costs and overall vulnerability of the population to scarcity of energy. The energy security framework for biomass energy identifies 11 dimensions in which action can restore the system to greater sustainability and security. These are: forest fires and crime management; efficient conversion technologies adoption; improving forest productivity; resource stocking; expanding energy plantations; forest health; alternative biomass access; land use and climate change management; value chain organisation and regulation; improving the efficiency of cooking technology and managing the effects of population and economic growth.

In the oil and gas sub-sector, based on projected 4.6% to 7.5% growth rates in the Partner States for the 2006-2030 period, forecasts for petroleum products demand show significant growth. Between 2015-2025, demand growth expectation stands at 16% in Kenya, 17% in Tanzania, 18% in Uganda and a relatively stable demand for Rwanda and Burundi at 0.2 and 0.1 million metric tons, respectively. Based on conservative economic growth rates of between 2.3% and 3.75% between 2005 and 2025, liquefied petroleum gas (LPG) demand growth expectation are 36% in Kenya, 50% in Tanzania, 94% in Uganda and 41% in Rwanda and Burundi. Based on the recent World Economic Outlook faster economic growth forecast, the demand for petroleum products and LPG is expected to grow faster. Therefore, it is apparent that security of supply of oil and gas will be crucial to minimising the impacts of energy insecurity. The challenges of dependence on imported fuel, oil market volatility and impact, energy import and corridor security, energy use efficiency, pipeline and refining capacity, and strategic petroleum reserve capacity challenges require policy attention. Actions are recommended in all the 11 dimensions based on the developed oil and gas supply security framework to restore oil and gas supplies security. These are: exploration and development

of oil and gas; market volatility and political risks management; reducing import dependence; maritime and inland transit security; conversion technologies and efficiency; domestic production capacity; refinery and distribution networks; strategic petroleum reserves; fuel switching capacity; value chain organisation and regulation and demand restraint measures.

Demand and supply conditions for electricity in the EAC indicate that the near-term energy prospects vary in the Partner States. With the implementation of planned energy sector projects from 2016 to 2030 in Burundi, the energy deficit is expected to narrow, and transition to some supply capacity margin, which is expected to once again close in the 2025-2030 period, likely bringing energy deficits again. With the implementation of planned energy projects, including the 5,000+ MW generation expansion national initiative, Kenya is expected to acquire surplus capacity, particularly between 2018-2020. Rwanda, with the implementation of generation expansion, can acquire better supply margin, however, in the current period the margin is narrow. Uganda is expected to have a similar outlook as in Kenya, with power surplus until 2030. Tanzania's power supply margin relative to demand is expected to hold in the 2016-18 period. However, the margin is expected to narrow in the 2018-2020 period. These demand and supply conditions are, however, expected with implementation of generation expansion plans and growth of electricity demand as anticipated in the plans of Partner States.

Action in ten dimensions of the developed framework for supply security of electricity is necessary to increase electricity system resilience and security. These are: fuel and resources input supply stability; diversity of generation technology and entities; generation adequacy; reduction in stranded power capacity; reduction in power not supplied; interconnection capacity; the cost of electricity; planning capacity; market organisation and regulation; and demand side management, including energy efficiency.

To implement measures in the various dimensions of the framework for energy security policy for the EAC, institutionalising the monitoring, evaluation, reporting, advising and decision-making functions are required. In the case of biomass energy, the ministries in charge of energy are advised to create a desk to institutionalise the monitoring, evaluation and reporting functions by the identified pillars relevant for supply security of biomass. The framework recommends the setting-up of an inter-ministerial committee for biomass energy security, with ministerial, agency head and authority executive level representation to coordinate decisions and issue directives to restore biomass energy security and address supply emergencies. The composition of the committee is envisaged to include the ministry mandated with upstream forest resource management, forest service (where available), specialised agencies/authority on forest/natural resources, the ministry in charge of energy, and the energy sector regulator with an expanded mandate over downstream biomass energy supply regulation.

For oil and gas, the ministry in charge of energy is advised to institutionalise tracking and reporting on oil and gas supply security based on the monitoring and evaluation dimensions identified. Related to decision coordination and issuance of directives related to supply security of oil and gas and emergency management, the adoption of the plan developed by EAC through the Petroleum Supply Emergency Plan (2008) is recommended. The Plan calls for the establishment of the management of energy emergency teams (MEET), or to be named inter-ministerial committee for oil and gas supply security, constituted by ministries responsible for energy, finance trade, immigration, infrastructure, internal security, revenue authorities and EAC affairs.

In the case of electricity supply security monitoring, the ministry in charge of energy is envisaged to undertake evaluation and reporting functions, as part of its mandate, through the establishment of a new desk, in tandem with similar functions for biomass and oil and gas supplies security. The identified electricity supply security monitoring and evaluation dimensions are recommended to guide the function. The institutional framework calls for the establishment of committee for electricity supply security, constituted by the ministry in charge of energy, the sector regulator, and generation, transmission and distribution entities, constituted by a minister and executives of the relevant institutions.

Partner States, as a way forward, are advised to pursue:

1. Based on the regional energy security policy framework, develop national energy security policy, strategy and laws for a resilient energy system that ensures biomass, electricity and oil and gas supplies security.
2. Regional cooperation for energy security management based on common challenges faced in biomass, electricity and oil and gas supply security, and shared policy opportunities to address them.
3. Establishment of an institutional framework for energy security monitoring and evaluation, and for coordination of decisions and directives for energy security and emergency management.
4. Expansion of the mandate of energy sector regulator to encompass downstream biomass energy to address the current state of unregulated downstream biomass value chain.
5. Develop and strengthen national capacity in energy sector statistics and energy security monitoring database based on the identified monitoring and evaluation indicators for biomass, electricity and oil and gas supply security.
6. Engagement with the private sector, development partners, donors, civil society organisations, regional and international partners, foundations and other partners to supplement national efforts in supporting policy, strategy and institutional and human capacity development and implementation of measures relevant for improving energy security.

The EAC, as a way forward, is advised to support:

1. Mainstreaming the EAC Energy Security Policy Framework into country policies, strategies and laws as part of EAC mandate under the Treaty to pursue regional harmonisation of policies in the energy sector.
2. Mobilisation of resources for the development of energy security policies, strategies and action plans in the Partner States complementary to efforts at the country level.

3. Capacity development to strengthen energy security monitoring and evaluation in partnership with national, regional and international organisations.

4. Development of regional energy security monitoring and reporting capacity at EAC through strengthening energy statistics capacity in tandem with capacity development efforts in the Partner States.

5. Regional harmonisation of common standards and codes in relevant energy security pillar areas of biomass energy, electricity and oil and gas in support of regional efforts for addressing common energy security challenges and the pursuit of regional mitigation opportunities.

1 INTRODUCTION

1. INTRODUCTION

1.1. Why EAC Energy Security Policy Framework?

The EAC Partner States are pursuing an ambitious economic development agenda, registering the fastest economic growth in Africa. The Uganda Vision 2040 seeks to increase per capita income from USD 506 to USD 9,500 by 2040. Through Vision 2030, Kenya aims to achieve structural transformation towards an industrialised and middle-income country with income rising to above USD 10,000 by 2030. Tanzania's Vision 2025 aims to achieve a competitive and diversified economy which is semi-industrialised, and growing at 8% per annum; while Zanzibar Vision 2020 seeks to eradicate poverty, with per capita income rising from USD 200 to middle-income levels. Through its Vision 2020, Rwanda aims to transform its economy into a knowledge-based middle-income country with accelerated poverty reduction. Through Vision 2025, Burundi aims to be on the path of sustainable development, enabling the achievement of a per capita income of USD 725 by 2025. The achievement of these EAC Partner States' economic visions requires the transformation of the energy sector, from being considered as a constraint to becoming an enabler of development and transformation. Energy sector disruptions in the availability and long-term costs of energy impact on the whole economy, therefore securing development gains and maintaining the momentum on transformation would require energy systems security.

Biomass energy constitutes a predominant energy source in the EAC. Biomass reliance is estimated to be extremely high in the region: Burundi (over 90% of the population); Kenya (82% urban, 34% rural on charcoal, 89% rural on fire wood); Rwanda (88%); Uganda (98% urban) and Tanzania (90%).

The energy security policy framework encompasses biomass, oil and gas and electricity sub-sectors. Biomass energy constitutes a predominant energy source in the EAC. Biomass reliance is estimated to be extremely high in the region: Burundi (over 90% of the population); Kenya (82% urban, 34% rural on charcoal, 89% rural on fire wood); Rwanda (88%); Uganda (98% urban) and Tanzania (90%). Current conditions in the sector indicate that there are major demand and supply imbalances, leading to deficits and unsustainable harvesting. As such energy security policy framework for biomass energy is timely. Related to oil and gas, the EAC is on the cusp of important changes, with the discovery of significant oil and gas resources. However, there are also persistent common regional challenges related to oil and gas supply security, namely the rapid demand growth for oil and gas supplies; the dependence on imported fuels; a lack of domestic policy and a framework for oil and gas energy security; and limited risk mitigation together pose major challenges. A policy framework for managing oil and gas energy security in the region, though Partner States action and regional collaboration, is therefore also timely.

The EAC has suffered major energy constraint and emergencies in the recent past. But it is also important to recognise that the region has made significant progress over recent years with regard to increasing generation capacity, upgrading and extending network infrastructure, expanding energy access and interconnectivity for regional electricity trade. Partner States have also set ambitious development plans prioritising the energy sector. Continued demand and supply difficulties, the need for a rapid upgrade of system capacity, limited diversity in energy generation, system inefficiency and other challenges have affected the availability, adequacy, and affordability of energy in the EAC. The electricity supply security framework aims to provide policy guidance towards restoring energy security in the electricity sub-sector.

To summarise, a comprehensive energy security policy framework will help facilitate support for the ongoing country and regional actions to improve energy security across the EAC.

In this context, with the engagement and input of the Partner States, the EAC Secretariat and the United Nations Economic Commission for Africa (UNECA), Sub-Regional Office for Eastern Africa (SRO-EA) have collaborated in developing the EAC Energy Security Policy Framework. The Framework builds on completed and ongoing efforts at regional and national levels, and the stated commitment of the Partner States expressed through the Treaty for the Establishment of the EAC. This commitment was underscored by the East African Legislative Assembly (EALA) through its resolution on integrated policy on energy security in December 2008, where it:

> urge(d) the Partner States to develop an integrated policy and laws on Energy Security taking into account the potential Regional Energy Resources available; energy utilisation, trading, and management plans; investment financing and transparency; energy efficiency schemes; rural electrification strategies; affordability to people of East Africa and protection of the environment.

Prior contributions by the EAC provide the basis for this policy framework, including the Regional Power Master Plan, the Interconnection Code, Cross-Border Electrification and Scaling Up Energy Access Strategy, the Oil and Gas Infrastructure Development, Refinery Development Strategy and the Emergency Petroleum Supply Plan. The work on the policy framework was under the stewardship of the Decisions and Directives by EAC Organs, particularly the Sectoral Council on Energy.

The developed policy framework aims to establish a regional guidance in support of Partner States' strategic decisions to mitigate energy insecurity. Specifically, it is expected to facilitate:

- A review of prevailing challenges in the biomass, electricity and oil and gas supplies security;
- The development of a regional energy security policy framework to support the Partner States in their regional collaborative efforts to meet energy security challenges; and
- Identification of areas for country action.

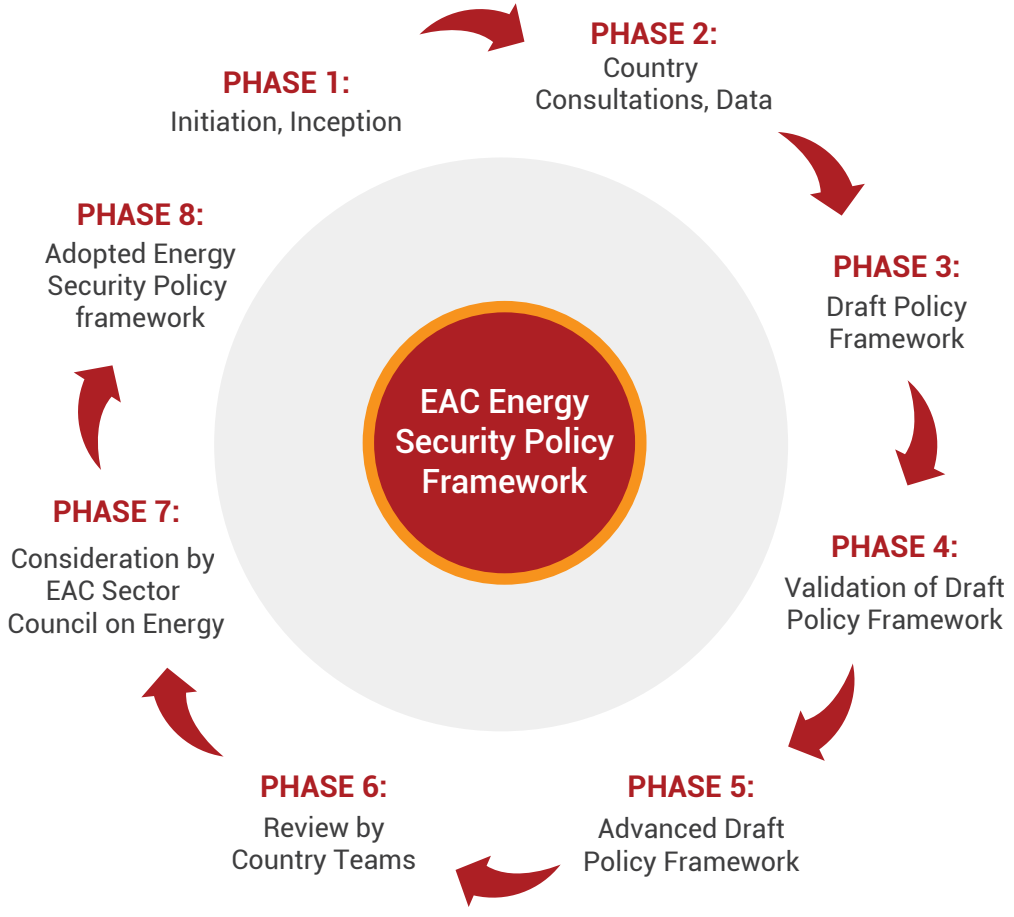
The rationales for the development of the EAC energy security policy framework are:

- Despite energy security policy and coordination in developed regions of the world, no energy security policy framework, or institutional coordination mechanism, is established in the EAC or other regions of Africa;
- By monitoring, measuring and managing energy insecurity, the benefits in the Partner States regarding economic and social well-being will be magnified;
- A comprehensive approach, encompassing biomass, electricity and oil and gas, is lacking;
- Development of a policy framework enables harmonisation of policies and actions towards regional energy security.

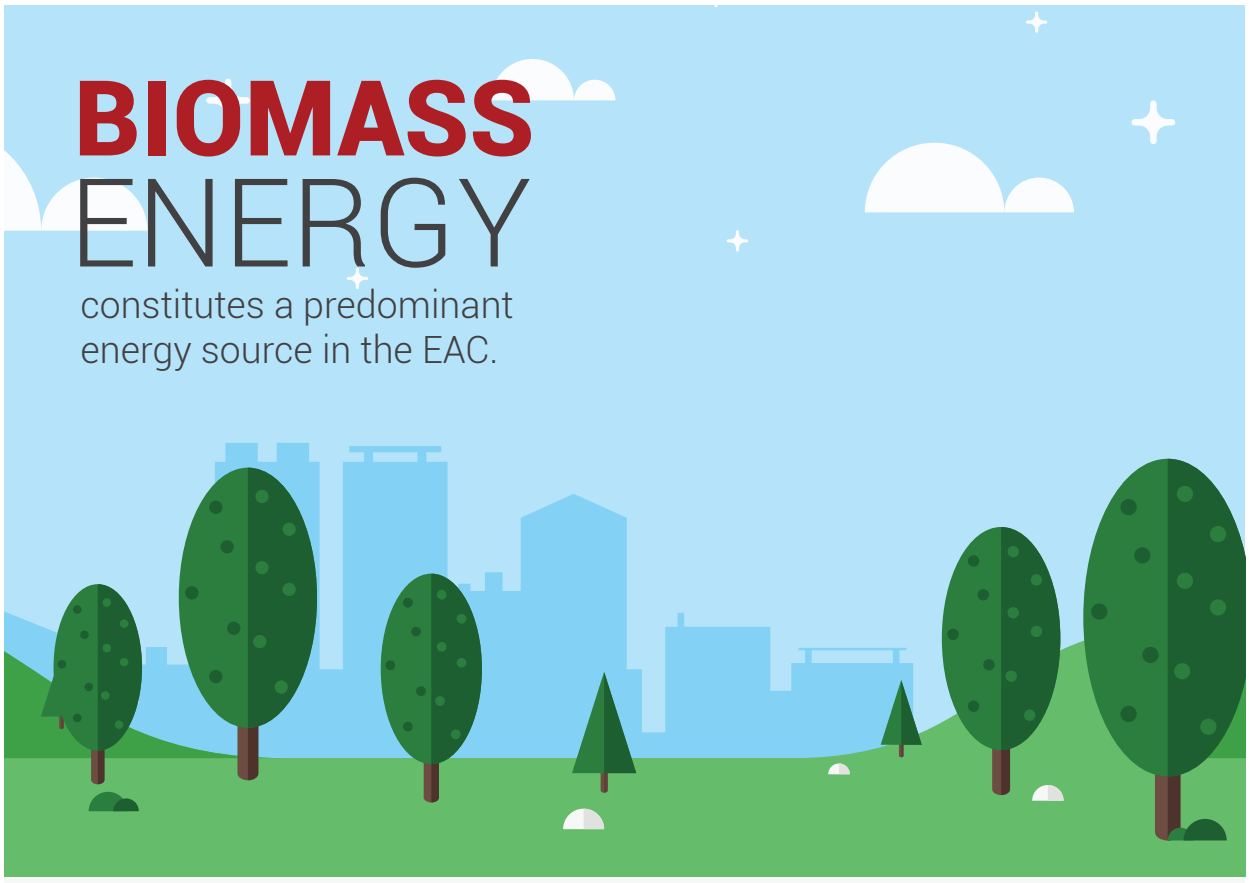
1.2. Development of the framework and engagement of Partner States

The development of the policy framework has been consultative. The drafting of the framework commenced with an inception meeting in 2015 in Kigali, Rwanda, where delegates from the biomass, electricity and oil and gas sub-sectors from the Partner States participated in a review of the scope and nature of the output. Following the inception meeting, subsequent stakeholder consultative workshops were held in Uganda, Kenya, Burundi, and Tanzania (Mainland and Zanzibar). In each of the consultative meetings, a stakeholders' workshop was organised and received participation of experts and stakeholders from the biomass, oil and gas and electricity sub-sectors. Following the consultative workshops, consultations and data gathering were undertaken with the support of national institutions.

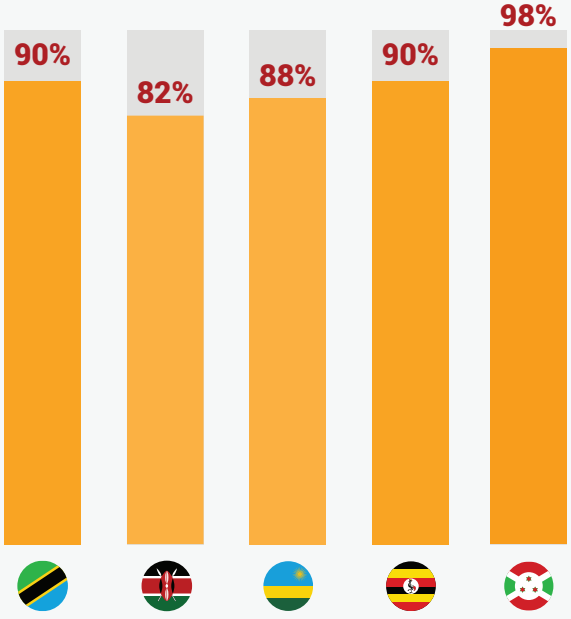
Figure 1. **Phases for developing the EAC Energy Security Policy Framework**



After the country consultative workshops, stakeholders validated the draft EAC energy policy framework. Delegates from the EAC Partner States and energy sector stakeholders in Rwanda participated in the validation meeting. The policy framework afterward is reviewed by the EAC Sector Council on Energy for consideration and adoption.



Biomass reliance is estimated to be extremely high in the region:



Energy situation in the EAC

Current conditions in the sector indicate that there are major demand and supply imbalances, leading to deficits and unsustainable harvesting. As such energy security policy framework for biomass energy is timely. Related to oil and gas, the EAC is on the cusp of important changes, with the discovery of significant oil and gas resources. However, there are also persistent common regional challenges related to oil and gas supply security, namely the rapid demand growth for oil and gas supplies; the dependence on imported fuels; a lack of domestic policy and a framework for oil and gas energy security; and limited risk mitigation together pose major challenges. A policy framework for managing oil and gas energy security in the region, though Partner States action and regional collaboration, is therefore also timely.

● BURUNDI	90%
● KENYA	82%
● RWANDA	88%
● UGANDA	98%
● TANZANIA	90%

2 ENERGY SECURITY IN THE BIOMASS SUB-SECTOR

2. ENERGY SECURITY IN THE BIOMASS SUB-SECTOR

Biomass refers to organic matter, often from plants, with a potential for conversion into useful energy. The BIOMASS Energy Centre[1] states that biomass is a "biological material derived from living, or recently living organisms." Relating it to biomass energy, the Centre further states that it is "often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material" based on which useful energy can be acquired. The most common form of biomass energy in the EAC is forest wood products for cooking. Alternative biomass sources also include agricultural waste (residues), energy crops, liquid biofuels, biogas and municipal waste.

Biomass energy security refers to the continual availability, in a sustainable manner, and affordability of biomass energy sources to households and institutional, commercial and industrial end users. In this regard, biomass energy security has two key components: the ability to supply biomass energy sources through sustainable and efficient production methods; and commitment to balance the demand and supply gap that will contribute towards affordability. In the subsequent sections, these two components of biomass energy security are reviewed in the context of the EAC.

2.1. The state of woody biomass resources in the EAC

Biomass is the leading source of primary energy in the EAC, and a predominant source of household cooking energy, in the forms of firewood (mainly rural) and charcoal (mainly urban) forms. The degree of reliance on biomass energy in the EAC shows its significance. In Burundi, over 90% of the population rely on firewood and charcoal as a source of cooking energy.[2] Over 82% of urban and 34% of rural population of Kenya rely on charcoal,[3] and firewood is the preferred source of cooking energy for 89% of the rural population.[4] In Rwanda, 85% of the energy used is in the form of biomass,[5] and over 88% of rural households rely on firewood as a major source of energy.[6] All rural households and about 98% of urban households in Uganda rely on biomass energy for cooking.[7] Similarly, wood energy accounts for 90% of Tanzania's overall energy supply,[8] and 75% of cooking energy in Zanzibar.[9] It is therefore apparent that the security of supply and affordability of biomass energy will remain key features of the energy sector of the EAC.

1 Available [Online] at http://www.biomassenergycentre.org.uk/portal/page?_pageid=73,1&_dad=portal&_schema=PORTAL.
2 Ministère De L'Energies et des Mines Direction Gènèral de L'Energie et de l'Eau, Rèpublique du Burundi. Janvier 2011. "Lettre de Politique Energetique. "
3 Practical Action Consulting East Africa. June 2011. "The Kenya Charcoal Policy Handbook: Current Regulations for a Sustainable Charcoal Sector."
4 Practical Action Consulting. October 2010. "Biomass Energy Use in Kenya."
5 European Union Energy Initiative, Partnership Dialogue Facility. June 2009. "Biomass Energy Strategy (BEST) Rwanda: Summary."
6 The Department of Forestry and Nature Conservation, Rwanda Natural Resources Authority, Ministry of Natural Resources, Republic of Rwanda. July 2013. "Update and upgrade of WISDOM Rwanda and Woodfuels Value Chain Analysis as a Basis for the Rwanda Supply Master Plan for Fuelwood and Charcoal."
7 Ministry of Finance, Planning and Economic Development, the Republic of Uganda. May 2015. "Biomass Technology in Uganda: the Unexploited Energy Potential."
8 European Union Energy Initiative, Partnership Dialogue Facility. April 2014. "Biomass Energy Strategy (BEST) Tanzania - Tanzania Biomass Energy Strategy and Action Plan."
9 Care International. September 2011. "Tackling the Energy Drivers of Deforestation and Forest Degradation in Zanzibar."

It is important to assess the state of biomass resources. Firstly, the composition of woody biomass resource differs across countries, particularly with regard to patterns of ownership. In Burundi, the forest resource is in over 200,000 Ha of land mostly in public, or community, plantations, and nearly a quarter of the forest resources are natural. Forest on agricultural lands is also prominent. Uganda has a different forest resource composition - private forest lands account for more than 45% of forest lands. Since 24.6% of the forest land is in a central forest reserve, and 29.6% is under the Uganda Wildlife Authority, private forest resources play a lead role in providing fuelwood and charcoal supply.

It is important to assess the state of biomass resources. Firstly, the composition of woody biomass resource differs across countries, particularly with regard to patterns of ownership.

In Rwanda, natural forests account for 39% of total forest resources, and woodlots and trees outside forest areas provide 40% of biomass resources. About 21% of forest resources come from plantations. In the United Republic of Tanzania, privately owned forest land constitutes 55% of Zanzibar's forest resources, with a sizable (45%) public forest resources. In Mainland Tanzania, other than forest and wildlife reserves (35%) and general land under the Tanzania Forest Service (TFS) (5%), decentralised forest management structure is the main feature. Village level forest cover is predominant, and accounts for 45% of forest cover, along with 7% local government forests. Private forest land accounts only for 7%.

Figure 2. Forest resources management and ownership distribution in the EAC

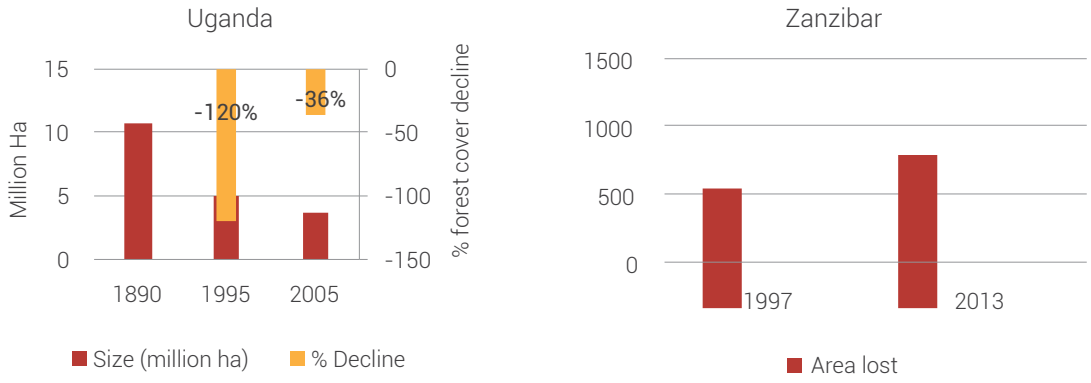
Similarly, of the total forest cover of Kenya, 95% is in natural forests in pubic natural forests (19% of natural forests) and community natural forests (81%) constituting community forest and national parks. Public, community or private plantations are not widespread (0.05% of total forest cover).

The second important characteristic of woody biomass energy resources across the EAC that they are in a condition of continual decline. The acuteness of decline differs across the EAC Partner States, but each State is facing a gap between the sustainable supply of wood and the demand placed on it. The state of deforestation and decline in available woody biomass resources indicate the level of strain placed on the resource.

Burundi is losing forest cover at 2% per year,[10] which would imply a forest cover loss between 1990-2007 of 34%. Other sources estimate the loss at 54%.[11] Analysis of satellite imagery of forest cover in Kenya indicated a moderate loss of 7,000 Ha between 2000-2003. FAO data also indicated a gradual deforestation with 3% loss between 1990-2000 and 2% loss between 2000-2005. Rwanda suffered a rapid deforestation from 1960-1990 (32%). However, the rate between 1990-2001 slowed to 8%.[12] Uganda is experiencing rather a rapid deforestation, in the range of 36% between 1995-2005. Between 2005-2010, deforestation continued unabated by 11% of tropical high forests (well stocked) and 32.9% (low stocked), 42.3% loss of woodlands, and a 35.3% reduction in overall forest cover.[13] A report on Tanzania indicated that it had lost forest cover by an average of 372,816 Ha/year between 1995-2010,[14] and FAO data indicates forest cover loss of nearly 10% between 1990-2000 and nearly 11% between 2000-2010. In Zanzibar, the rate of loss between 1990-2012 was relatively modest, at 0.9% for coral rag forests, 0.3% of agroforestry, 2.9% of plantations and 0.4% of mangroves. The overall picture on the state of forest resources is thus one of concern. There is a rapid decline in the forest resources of the EAC, compromising the short, medium and long-term biomass energy security of the region.

Figure 3. Rate of deforestation in the EAC

10 Ministère de L'Energies et des Mines, Direction Gènèral de L'Energie et de l'Eau, Rèpubique du Burundi. Janvier 2011. "Lettre de Politique Energetique."
11 Based on World Bank forest cover data.
12 Rwanda Environmental Management Authority, Ministry of Natural Resources, Republic of Rwanda. May 2009. "Fourth National Report to the Convention on Biological Diversity."
13 Ministry of Energy and Mineral Development, Republic of Uganda. 2013. "Biomass Energy Strategy (BEST) Uganda.".
14 UNEP. 2015. "Forest Ecosystem in the Transition to a Green Economy and the Role of REDD+ in the United Republic of Tanzania."

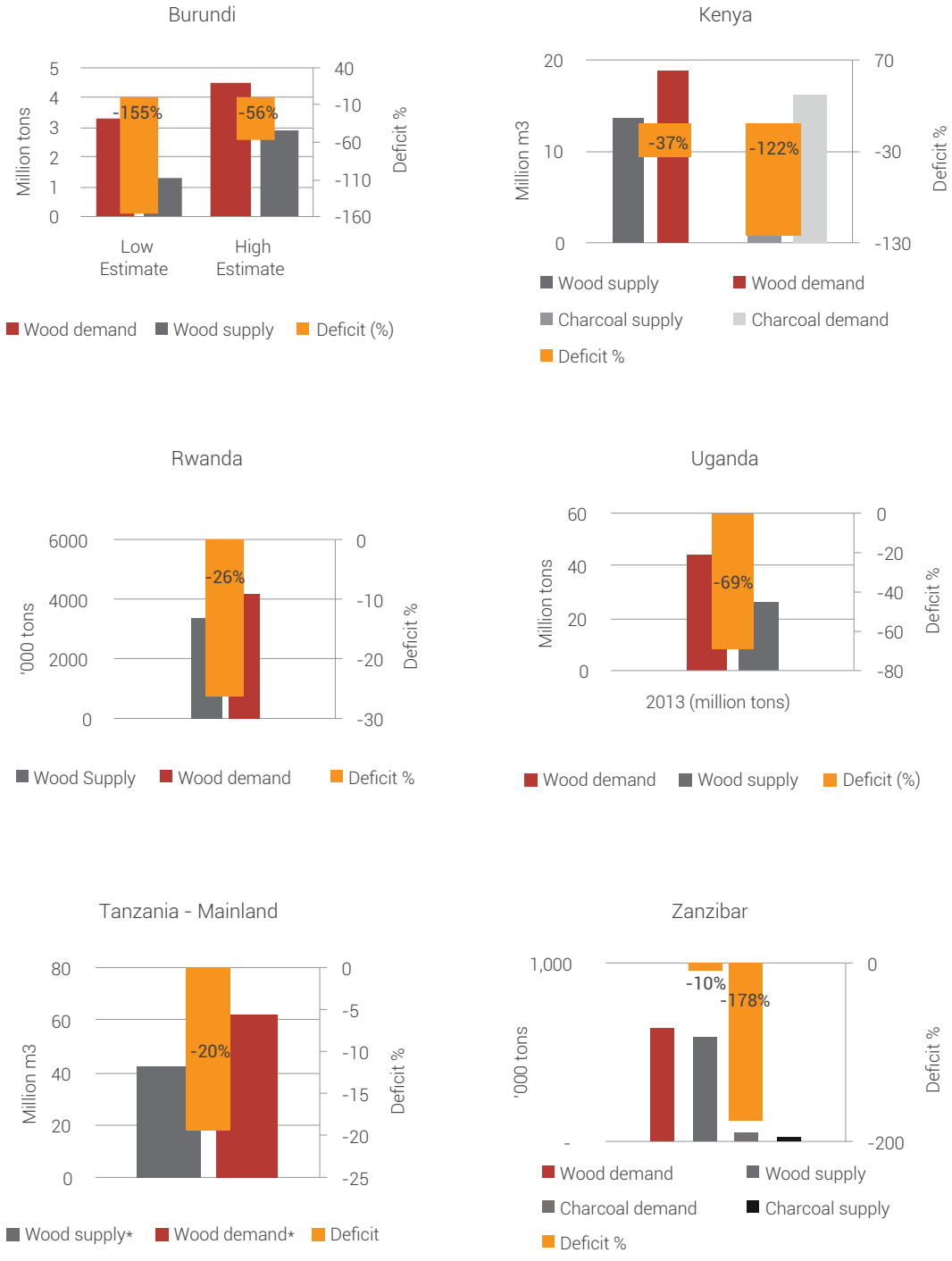


2.2. Biomass energy demand and supply conditions

A better overview of the state of biomass energy in the EAC emerges when considering the biomass market, and demand and supply conditions in the region. The biomass energy market is in distress with demand surpassing sustainable supply of wood and charcoal from forest resources. In Burundi, where biomass statistics are limited, country assessments indicate a demand-supply imbalance for energy wood resources ranging from 56% - 155% deficit.[15] The Ministère de l'Energie et des Mines (Ministry of Energy and Mines) conducted its assessment and established that there is a 70% deficit in current wood biomass energy resources in meeting demand.[16] In Kenya, fuelwood supply, relative to demand, has a 37% deficit, and an acute deficit in available wood for charcoal, at 122%. In mainland Tanzania, demand side studies have established the pattern of demand growth. Supply side analysis through the National Forest Resources Monitoring and Assessment of Tanzania Mainland (NAFORMA), under the Ministry of Natural Resources and Tourism (May 2015) indicate that mainland Tanzania has an annual wood supply capacity of 83.7 million m^3, of which 42.8 million m^3 is legally available for harvest. Due to household sector demand (43 million m^3), industrial wood demand (2.3 million m^3), a deforestation adjustment (14.9 million m^3), illegal harvesting (2 million m^3), and an import-export balance (0.1 million m^3) amounting to wood losses of 62.3 million m^3, the wood balance as of 2013 displayed a deficit of 19.5 million m^3, or 20%.[17] In Zanzibar, while wood supply deficit was 10%, the deficit for charcoal was 178% of available supply. Demand and supply imbalances in Uganda and Rwanda led to deficits equivalent to 69% and 26% of available supply in Uganda and Rwanda, respectively. To sum up, based on demand and supply conditions for fuelwood and charcoal in the EAC, and large deficits in the supply of wood to meet current demand, the biomass energy sub-sector in the region is in a state of deepening energy insecurity.

15 Ministère de L'Energie et des Mines, Direction Gènèral de L'Energie et de L'Eau, Rèpublique du Burundi,. Janvier 2011. "Elaboration de la Stratègie Sectorielle pour le Secteur de l'Energie au Burundi."
16 Ibid.
17 Ministry of Natural Resources and Tourism, the United Republic of Tanzania. May 2015. "National Forest Resources Monitoring and Assessment of Tanzania Mainland."

Figure 4. Demand and supply conditions in the EAC



2.3. Biomass energy security challenges and their impacts

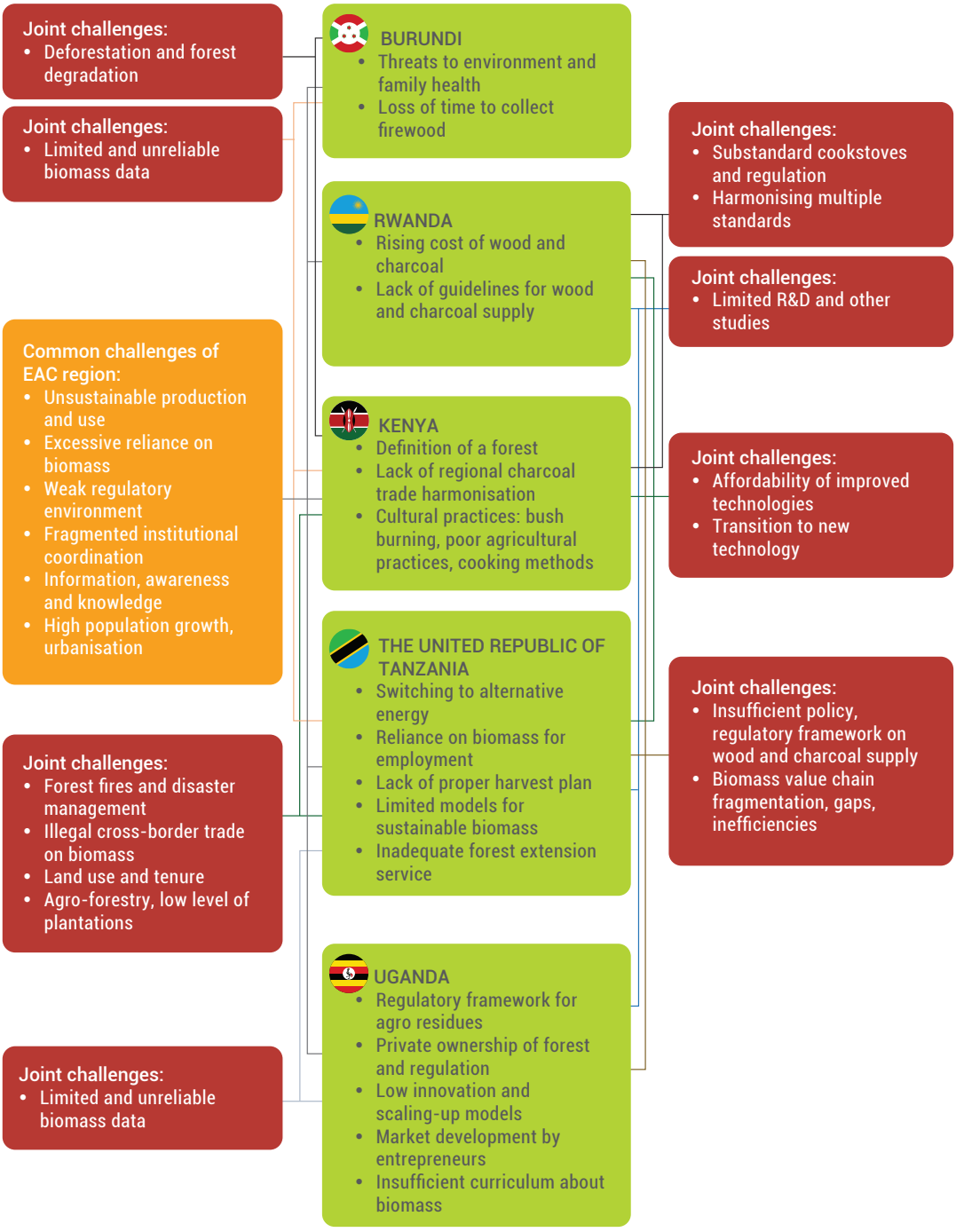
In the management of biomass energy, EAC Partner States face numerous challenges, some of which are common to all. In Burundi, environmental challenges from the continued biomass energy imbalance are experienced. Rwanda faces rising wood and charcoal prices, and experts view gaps in wood and charcoal supply among the key challenges. In Kenya, the definition of what constitutes a forest itself is a challenge. A revision in the definition of a forest recently seen national forest cover increased from 1.7% to 6.99%. Traditional practices of bush burning and poor agricultural practices contributed to biomass energy insecurity. In Tanzania, switching to alternative energy technologies is among the challenges flagged by experts, along with reliance on the forest for employment and economic benefits, the lack of proper forest harvest plans, the lack of successful models to scale-up nationally on sustainable biomass management and inadequate forest extension service capacity. Experts raise some challenges to sustainable biomass energy in Uganda, including the predominantly private ownership of forest lands and the difficulty of regulating private lands. A limited degree of innovation in the sub-sector, together with a weak regulatory framework and insufficient attention to the promotion of alternative biomass energy sources (such as agricultural residues) continue to constrain the development of the sector.

Some of the challenges identified during stakeholder consultations are cross-country in nature. These include, among others, rapid deforestation and forest degradation, inadequate statistical capacity and data, inadequate regulatory frameworks and weak enforcement, a limited capacity to deal with forest fires and disasters, a fragmented value chain, a limited transition to alternative technologies and a failure to set up technological standards and regulations.

Outlined in Table 1 are impacts from biomass energy insecurity as identified and mapped by biomass energy experts in each Partner State during stakeholder consultative workshops. Some of the identified impacts are limited to within the energy sector itself. However, a number of the identified negative effects are far reaching, such as the impact on food security, climate change, water cycles, socio-economy, education, gender, the destruction of infrastructure, a decline in soil fertility, environmental stress, rising unemployment levels, and health. It is therefore crucial that broad-based awareness of these impacts be promoted to facilitate action towards strengthening energy security in the biomass sub-sector.

Traditional practices of bush burning and poor agricultural practices contributed to biomass energy insecurity. In Tanzania, switching to alternative energy technologies is among the challenges flagged by experts, along with reliance on the forest for employment and economic benefits, the lack of proper forest harvest plans, the lack of successful models to scale-up nationally on sustainable biomass management and inadequate forest extension service capacity. Experts raise some challenges to sustainable biomass energy in Uganda, including the predominantly private ownership of forest lands and the difficulty of regulating private lands.

Figure 5. Biomass energy challenges in the EAC



Source: Based on inputs from country consultative meetings on energy security in the Partner States.

Table 1. Expected impacts of biomass energy insecurity in the EAC

Partner State	Experienced and/or Anticipated Impacts
Uganda	▪ The shift of woody biomass energy prices towards expensive and unaffordable levels ▪ Continued depletion of biomass stock, mainly forest cover ▪ Negative impact of climate change on biomass stock ▪ Increased poverty resulting from energy insecurity ▪ Malnutrition and hunger from energy poverty ▪ Increased health impacts ▪ Increased rural to urban migration in search of better services
Burundi	▪ Increases in the price of wood ▪ Family health impact (fatigue in firewood collection) ▪ School drop-outs for girls ▪ Climatic change, reduced rainfall and food insecurity ▪ Degradation of ecosystem and natural biodiversity ▪ Destruction of public and private infrastructure (roads, houses, bridges, et cetera) ▪ Reduction of the water table resulting in the scarcity of drinking water ▪ Reduced hydroelectric potential ▪ Budgetary impact
Rwanda	▪ Considerable increase in biomass prices ▪ Availability of poor quality woody biomass ▪ Lack of access to products by end users ▪ Socio-economic impacts such as health, education, livelihood, gender, et cetera ▪ Forest resources degradation, reduced soil fertility ▪ Gap between demand and supply will widen ▪ Vulnerability of the population
The United Republic of Tanzania	**Mainland** ▪ Increased poverty ▪ Increased forest degradation, depletion and deforestation ▪ Inadequate human and financial resources capacity ▪ Increased social and environmental stress ▪ Time consumed during searching for wood would increase ▪ Higher prices for charcoal and fuelwood ▪ Unsustainable wood sector supply ▪ Suitable tree species for charcoal production will diminish, replaced by poor quality wood ▪ Drying of water sources and increased vulnerability to climate change ▪ Reduced income for dealers in the charcoal supply chain ▪ Increased social and environmental stress **Zanzibar** ▪ Malnutrition, especially in rural areas ▪ Higher unemployment rate ▪ Higher demand for other sources of energy ▪ Households economic welfare effect ▪ Rise in resources use conflicts
Kenya	▪ Health effects of indoor pollution ▪ Dwindling forest resources and inaccessibility of bio-energy ▪ Higher wood and charcoal prices ▪ Disruption of food preferences and diet due to availability and cost of biomass energy ▪ Deforestation and degradation of land and ecosystem and energy resources conflict ▪ Destruction of water catchments and contribution to rising food insecurity ▪ Increased effects of climate change

Source: Based on biomass energy sub-sector country experts' feedback during country consultative workshops in the EAC Partner States.

2.4. Tracking energy security in the biomass sub-sector: key factors

Energy security in the biomass sector is underpinned by key drivers on the demand and supply sides, and external factors bearing on biomass availability and affordability.

2.4.1. Supply side factors

Supply side drivers relate to factors that directly, or indirectly, determine the availability and flow of wood and charcoal supply to markets at any given time.

Size of harvest-grade forest land

The size of the forest land determines the supply capacity of wood and charcoal. Available forest resources change over time, particularly due to deforestation and resource degradation. In Tanzania, for example, between 2000 and 2010 about 4 million Ha of forest land was deforested. 50 m^3/ha of forest stock, an equivalent of 201.7 million m^3 of wood, or 141 million tons, will therefore be lost. In comparative terms, this loss is far greater than the annual wood demand collectively in Burundi (4.5 million tons), Rwanda (4.2 million tons), Kenya (41.7 million m^3, or 29 million tons) and Uganda (28 million tons).

Forest productivity

For existing forestry resources, the supply of wood and charcoal supply to markets will be affected by forest productivity. There is wide variation in the productivity of forests, measured by volume output per hectare. The EAC Partner States have low and, in some cases, declining forest productivity. Private and public plantations have significantly higher productivity than natural and other types of forests.[18] FAO estimates that the average forest productivity in Africa stands at 72 m^3/Ha.

The declining productivity of non-plantation forest lands is demonstrated by the Mean Annual Increment (MAI) (average growth of tree stands over a period of rotation) reported in the EAC.

The declining productivity of non-plantation forest lands is demonstrated by the *Mean Annual Increment* (MAI) (average growth of tree stands over a period of rotation) reported in the EAC. The MAI of Tanzania, for example, has dropped by 2 m^3/Ha/year.[19] Tanzania's production forest (based on NAFORMA 2013) is evaluated to assess the impact of this drop in forest productivity. Productive forests account nearly 24% or 20.9 million Ha. A 2% drop in MAI, therefore, corresponds to lost wood supply potential of nearly 42 million m^3/year. Similarly, due to pressure on forestlands, including from deforestation, the Current Annual Increment (CAI) (forest wood stand increment in a current year) in Uganda has declined to 4.2 t/ha/year.[20] The Annual Allowable Cut (AAC) (the wood volume harvested per year at a sustainable level) has also declined. In 2013, an assessment of the AAC indicated that 19.5 million m^3 could be harvested sustainably. However, actual harvest was much more.[21]

18 The Tanzania Forest Service Agency assesses, in 2013, that forest productivity varies by specie, and stands at 50 m3/Ha for production forests, 57 m3/Ha for protection forests, 20 m3/Ha for grasing land and 31 m3/Ha for other lands. The Ministry of Environment, Water and Natural Resources of Kenya assessed demand and supply condition of wood products in 2013 and indicated that forest productivity in Kenya are 0.9 m3/Ha for public natural forests, 1.5 m3/Ha for community natural forests, and 407.5 m3/Ha and 17.58 m3/Ha for pubic and community/private plantations, respectively. The Ministry of Energy and Mineral Development of Uganda, under its 2013 Biomass Energy Strategy, states that tropical high forest on private land have productivity of 133 t/Ha, and that productivity varies to 27.9 t/Ha in woodland, 11.9 t/Ha in bush land and 10.7 t/Ha in farmlands. The Biomass Energy Strategy of Rwanda reports that closed natural forests have 1.66-1.98 t/Ha productivity, and forest plantations and farms and agro-forestry have productivities of 6.6-12.4 t/Ha and 0.28-0.48 t/Ha. Forest productivity data in Burundi is scant, and no recent data is available. Biomass sector strategies utilise productivity estimates from Rwanda where forest characteristics are considered comparable. As a result, natural forests in Burundi are believed to have productivity of 5 m3/Ha, and 7-10 m3/Ha for plantations, 3-5 m3/Ha for protected forests and 1-5 m3/Ha for other woodlands.

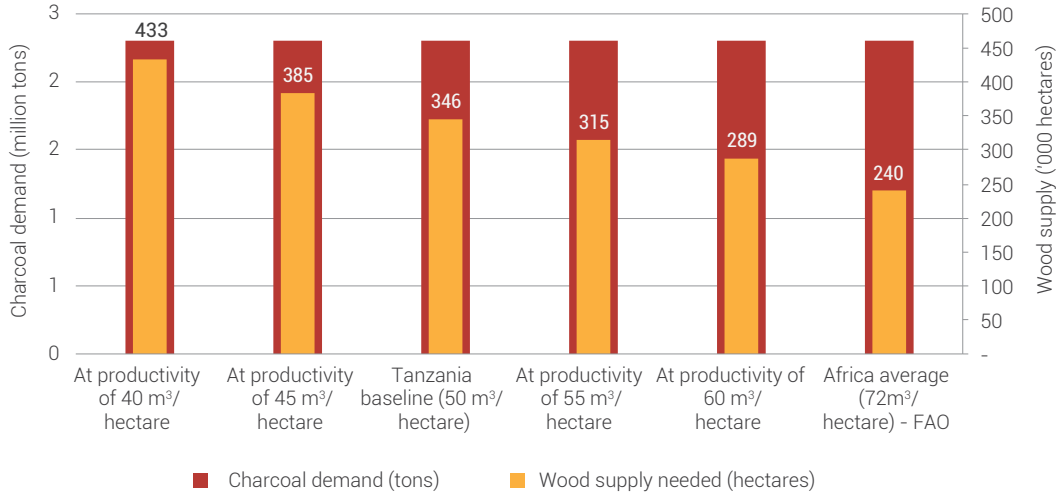
19 EU Energy Initiative, Partnership Dialogue Facility. April 2014. "Biomass Energy Strategy (BEST) Tanzania - Tanzania Biomass Energy Strategy and Action Plan, Final Report."

20 Ministry of Energy and Mineral Development, Republic of Uganda. 2013. "Biomass Energy Strategy (BEST) Uganda."

21 Tanzania Forest Services Agency, Ministry of Natural Resources and Tourism, United Republic of Tanzania. July 2015. "Business Plan and Associated Budget for Financial Year 2015-16."

The case of Tanzania demonstrates the importance of forest productivity. If average forest productivity in Tanzania is to increase from the baseline of 50 m^3/ha to the Africa average of 72 m^3/Ha, 106,000 fewer forestlands would have been required to meet current national charcoal demand, or 7.6 million m^3 of wood would be saved at Africa average level of productivity.

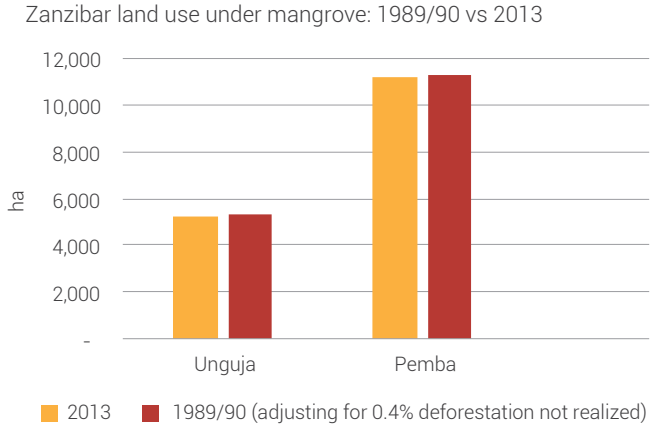
Figure 6. Scenario analysis based on forest productivity change in the EAC

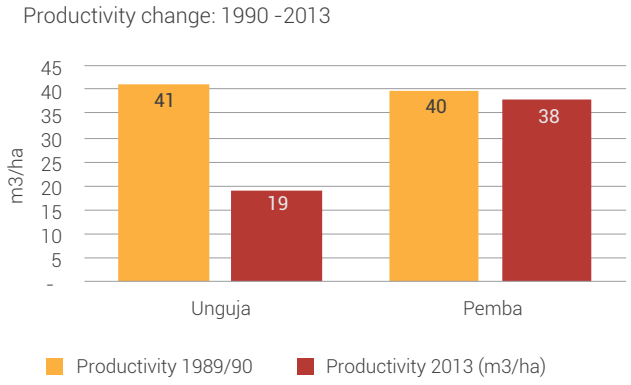


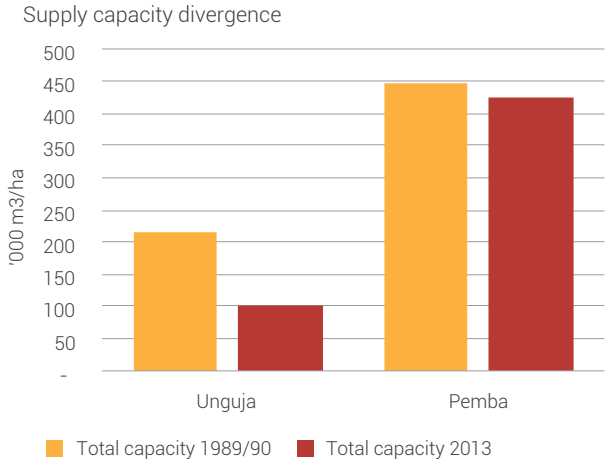
Source: Charcoal production and use in Mozambique, Malawi, Tanzania, and Zambia: historical overview, present situation, and outlook". Falcão, M. P.1

The change of mangrove productivity in Unguja and Pemba islands of Zanzibar between 1989/90 and 2013 further demonstrates the importance of forest productivity (Fig. 7). In 1989/90, Unguja and Pemba had 5,274 ha and 11,214 Ha of mangrove forest land, respectively. By 2013, mangrove productivity in Unguja declined from 41 to 19 m^3/Ha, but in Pemba, it marginally declined from 40 to 38 m^3/Ha. The result has been decline in mangrove wood supply capacity in Unguja by 54%, and a decline of only 5% in Pemba. Thus, the decline in forest productivity impacts on the long-term supply capacity of wood and charcoal, and directly impacts on biomass energy security.

Figure 7. Mangrove productivity change and supply capacity divergence in Zanzibar: 1989/90 - 2013







Source: The Revolutionary Government of Zanzibar, Ministry of Agriculture and natural resources, Department of Forestry and Non-Renewable Natural Resources. November 15, 2013. Biophysical Inventory Report on Preparedness for REDD+ Phase. "Zanzibar Woody Biomass Survey."

Afforestation and energy plantation

The re-stocking of forest resources supplements existing supply. Existing afforestation activities are, however, below the FAO recommendation of 1 Ha/person. In Rwanda, an afforestation rate is 0.029 Ha/person.[22] In Tanzania, there is a reported afforestation activity for 2014-15 of 4.6 million trees, but this is still not sufficient to compensate the rate of forest loss.[23] Afforestation programmes in Uganda, Kenya, and Burundi are similarly below the FAO recommendation. The current rate of afforestation is not sufficient to improve the biomass supply, and therefore energy security in the sub-sector remains insecure.

Plantations have higher forest productivity. In the case of Kenya, while community natural forests have 1.5 m^3/Ha of productivity, public, community, and private plantations have on average 407 m^3/Ha. In the other EAC Partner States, plantations similarly have better productivity than any other form of forestland. There is, therefore, great potential to expand on private and public forest plantations with high productivity to bridge the wood supply deficit. However, current plantation areas in the EAC are marginal at best. In Tanzania, only 7% of forestland is under private management. In Kenya, public and private plantations account for 6% of forestland. Uganda has 48.5% of forestland in privately-owned hands, although a large portion is still not under plantations. Burundi and Rwanda have a relatively

22 Ministry of Infrastructure, Republic of Rwanda. 17 March 2015. "Energy Sector Strategic Plan: 2013/14-2017/18."
23 Ministry of Natural Resources and Tourism, United Republic of Tanzania. August 2014. "Annual Implementation Report July 2014-June 2015."

higher public share of plantations, at 45% and 48%, respectively, albeit with a lower forest productivity. Increasing public and private forest plantations within the EAC could enhance supply significantly.

Efficiency of conversion technologies

Rural households largely use firewood for cooking. However, urban households rely on charcoal, with major cities in the EAC absorbing more than half the demand for charcoal. As such, the efficiency at which wood converts into charcoal through carbonisation matters in the long-term supply of charcoal and its impact on the underlying forest resources. As identified earlier, the current conversion method from wood to charcoal relies predominantly on traditional methods that are largely inefficient. The average efficiency of conversion in Burundi is 8-10% of wood volume,[24] 16% in Kenya,[25] 12% in Rwanda,[26] 19% in Tanzania,[27] and 10-12% in Uganda.[28] The impact of improving the efficiency of wood to charcoal conversion is significant. In the case of Kenya, for example, if the efficiency of conversion is improved from 16% to 30%, the wood requirement to supply current levels of charcoal of 47 million m^3 would decline significantly to 14 million m^3. This would constitute a net saving of 33 million m^3 of wood today (31% of current national demand for charcoal). The large-scale utilisation of traditional carbonisation technology is limiting opportunities to improve on biomass energy security through the adoption of high-efficiency wood-to-charcoal conversion technologies.

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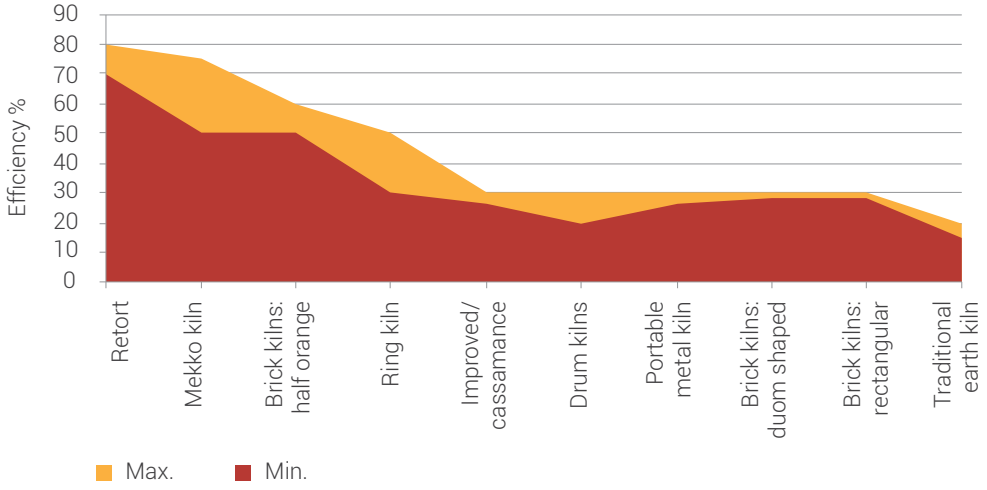
Figure 8. Wood to charcoal conversion technologies and level of efficiency



Source: Based on data from UNDP and Kenya Forest Service (undated). Available Charcoal Production Technologies in Kenya (Draft Copy).

A scenario analysis based on Kenyan data and an existing analysis conducted in Burundi reveal the extent of wood savings from adopting efficient carbonisation technologies. For Kenya, by forecasting the demand and supply of charcoal, the analysis reveals that, with no intervention, there will be a 10.7 million m^3 deficit by 2030. A 30% adoption of more efficient carbonisation technology (with 80% efficiency) could close the deficit and generate a 2 million m^3 charcoal surplus

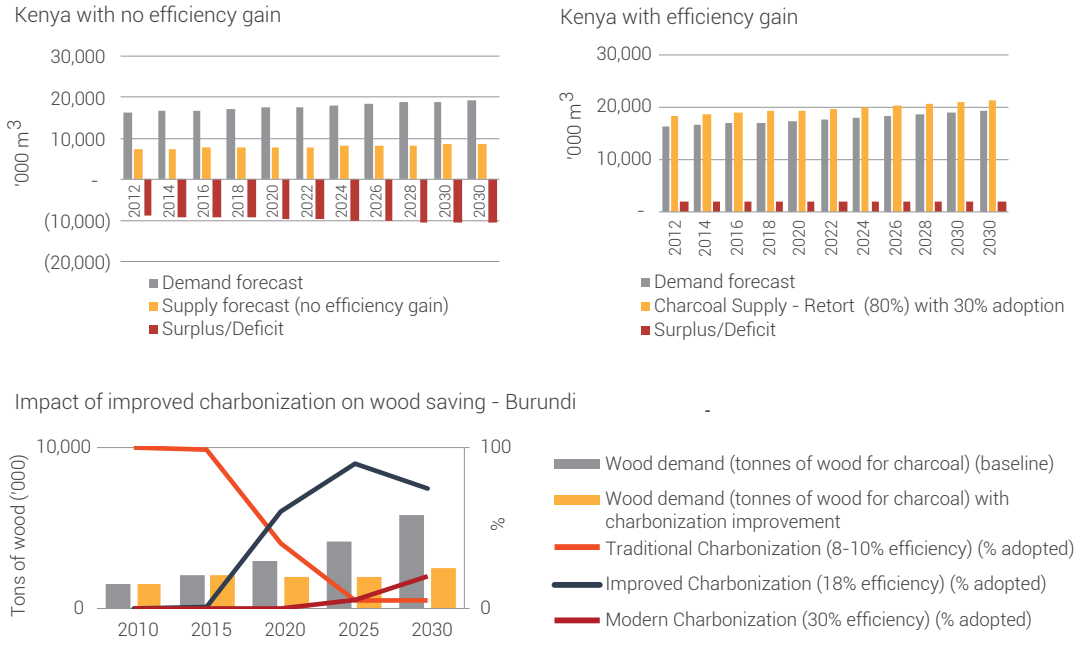
24 Ministère de L'Energie et des Mines, Rèpublique du Burundi. October 2013. "Stratègie National de Developpement des Energies Nouvelles et Renouvelables au Burundi a L'Horizon 2030."
25 Ministry of Environment, Water and Natural Resources, Republic of Kenya. July 2013. "Analysis of Demand and Supply of Wood Products in Kenya."
26 EU Energy Initiative, Partnership Dialogue Facility. June 2009. "Biomass Energy Strategy (BEST) Rwanda."
27 Scenario analysis on the effect of efficiency on wood demand (10 - 25% efficiency) by Okello et al., 2001; Lewise and Kammen, 1997; Falcão, undated. Studies on Mozambique, Malawi, Tanzania and Zambia.
28 Ministry of Energy and Mineral Development, Government of Uganda. 2013. "Biomass Energy Strategy (BEST) Uganda."

by 2030. In Burundi, a similar forecast to 2030 indicates that carbonisation technologies (Fig. 5) could reduce the required wood input from 5.8 million tons to 2.5 million tons by 2030. The adoption of more efficient carbonisation technologies improves the supply potential of charcoal and saves on the required wood input to meet charcoal demand - and thereby significantly improving biomass energy security.

Forest fire and resource crimes

The stock of forest resources, on which wood and charcoal supply rely, are also affected by non-market forces: natural disaster risks and illegal activities. Illegal logging can diminish the sustainable supply of wood and charcoal. In 2007, the Kenya Forest Service reported that illegal logging and forest crimes were widespread, and that illegal charcoal burning and transportation accounted for 50% of the supply, and illegal harvesting of forest products accounted for 15% of total supply.[29] In the case of Tanzania (Mainland), the NAFORMA (2015) report highlights that 2 million m^3/year of wood is illegally harvested, accounting for 4.6% of the allowable legal harvest. Uganda, Burundi, and Rwanda face similar challenges. Illegal and unregulated logging for wood and charcoal constitutes a major risk to a sustainable supply of energy.

Figure 9. Carbonisation technologies efficiency and impact on wood saving

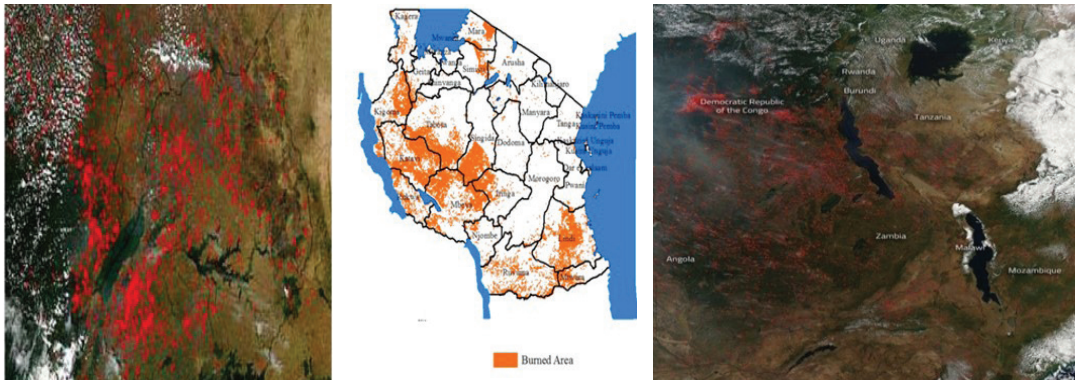


Sources: (1) Ministry of Environment, Water and Natural Resources, Kenya, July 2013. Analysis of Demand and Supply of Wood Products in Kenya. Wanleys Consultancy Services, Nairobi, Kenya. (2) Rèpublique du Burundi, Ministère de L'Energie et des Mines, Octobre 2013. "Stratègie National de Developpement des Energies Nouvelles et Renouvelables au Burundi a L'Horizon 2030."

29 Kenya Forest Service, Ministry of Environment and Natural Resources, Republic of Kenya. July 2007. "Forest Law Enforcement and Governance in Kenya."

A forest fire is an even larger risk to the stock of biomass, with serious implications for short to medium-term supply of wood and charcoal. In the face of limited regional cooperation in combating forest fires, and a similarly limited capacity of Partner State to combat them, the impact of such natural disasters on the available forest stock has been alarming. In its annual performance report for 2014-15, the Tanzania Forest Service Agency indicated that 90,641 km^2 of the forested area was burned, corresponding to 10% of the total landmass of Tanzania. The months of June, July, and August are identified as the riskiest months for a forest fire. At the local level, Ktatavi, Mbeya, and Tabora were reported as having the largest scale incidents, accounting for 44% of the burned area.[30] The Ministry of Energy and Mineral Development (MEMD) of Uganda similarly concluded in 2013 that forest fire in Central Uganda claimed 30% of forestland in the months of January and February.[31] Forest fires similarly plague Burundi, Rwanda, and Kenya. Forest fires pose a major energy security risk to the biomass energy supply.

Figure 10. Incidents of forest fire in Uganda, Tanzania and the EAC



Source: MODIS NASA satellite imagery (red dots are thermal images of fire) and Tanzania Forest Services Agency, September 2015.

Forest health

The health of trees also contributes to the sustenance of the biomass resource base. Risks may emanate from widespread infections, the introduction of invasive species or other communicable means. A recent assessment of forest health in Zanzibar concluded that 96.7% of the forest is in healthy condition, "without any fault," however, that 21% of sweet orange trees are "diseased."[32] It is clear that monitoring and managing forest health contribute to maintaining forest resources, wood, and charcoal supply, contributing to biomass energy security.

Land use and climate change

External factors similarly pose risks to biomass energy security. Various factors on the supply side - land use and climate change – impact on the long-term supply of fuelwood and charcoal. The slashing and burning of forestland to give way to agricultural land are prevalent, particularly in areas where agricultural land fertility has declined. Similarly, human settlement expansion, and the resultant land demand has negatively impacted on forestland. Agricultural and settlement policies thus have a wide-reaching impact on forestland.

30 Ministry of Natural Resources and Tourism, Tanzania Forest Services Agency, United Republic of Tanzania. September 2015. "Annual Performance Report July 2014 - June 2015.".

31 Ministry of Energy and Mineral Development, Republic of Uganda. 2013. "Biomass Energy Strategy (BEST) Uganda."

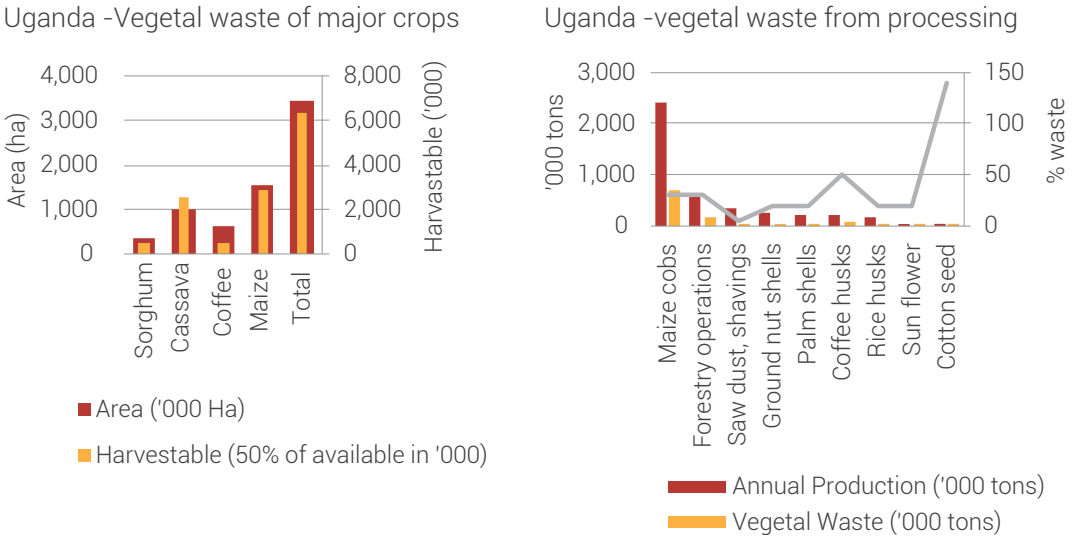
32 Ministry of Agriculture and Natural Resources, Department of Forestry and Non-Renewable Natural Resources, the Revolutionary Government of Zanzibar. November 15, 2013. "Zanzibar Woody Biomass Survey, Preparedness for REDD+ Phase: Biophysical Inventory Report."

Climate change also constitutes a long-term risk to forest productivity and wood resources supply. Recent studies estimate the impact of climate change on forest ecosystems. A study by Battles et al. (2008) on the Sierra Nevada, California forest concludes that conifer tree growth "declined under all climate change scenarios" and that under extreme changes in climate, forest productivity, measured by tree volume increment, decreased "in mature stands by 19% by 2100."[33] Climate change, therefore, constitutes a long-term risk to forest supply capacity and productivity.

Alternative biomass

Alternative biomass resources, such as biogas, ethanol, vegetable oil, agricultural waste and municipal waste, constitute untapped resources to generate cooking energy and to reduce the burden on woody biomass. A 2011 study in Burundi found that alternative biomass sources have great potential to supplement woody biomass energy. The study found that 1.38 million tons of crop waste, forest litter and lumber residues, 8.2 million m^3 of biogas, 996,577 tons of ethanol (from molasses, sorghum beer, banana beer and sweet sorghum plantation) and 512,000 m^3 of jatropha oil could be supplied as alternative biomass.[34] Similarly, an alternative biomass assessment in Uganda showed potential, including agricultural waste supply for conversion into energy of 720,000 tons of maize cobs, 168,000 tons of forest operation waste, 17,500 tons of sawdust, and 49,000 tons of ground nut shells. Moreover, there is potential for 42,000 tons of palm shells, 100,000 tons of coffee husks and other potential supply from rice, sun flower, and cotton seed, and municipal waste, which in the context of 2 million people in Kampala can yield 1,000 tons/day.[35] Alternative biomass resources, if widely adopted, could reduce the supply pressure on woody biomass, and improve biomass energy security.

Figure 11. **Alternative biomass energy potentials**



33 Battles, J.J., Robards T., Das A., Waring K., Gilless J.K., Biging G., and Schurr F. 2008. «Climate Change Impacts on Forest Growth and Tree Mortality: a Data-driven Modeling Study in the Mixed Conifer Forest of the Sierra Nevada, California.» Climatic Change 87: 193–213.

34 Ministère de L'Energie et des Mines, Direction Gènèral de L'Energie et de L'Eau, Rèpublique du Burundi. Janvier 2011. "Elaboration de la Stratègie Sectorielle pour le Secteur de l'Energie au Burundi."

35 Ministry of Energy and Mineral Development, Republic of Uganda. 2013. "Biomass Energy Strategy (BEST) Uganda."

Alternative biomass resource: Burundi	Unit	Amount	Potential energy (Ktoe)
Solid fuels	t	1,378,374	569.28
Biogas	1,000 m3	8,257	4,922.98
Ethanol	t	996,577	647.77
Vegetable Oil	1,000 m3	512	422

Sources: (1) Ministry of Energy and Mineral Development (MEMD), Government of Uganda. 2013. Biomass Energy Strategy (BEST) Uganda. (2) Rèpublique du Burundi, Ministère de L'Energie et des Mines Direction Gènèral de L'Energie et de L'Eau, janvier 2011. "Elaboration de la Stratègie Sectorielle pour le Secteur de l'Energie au Burundi." Rapport Final Provisoire.

2.4.2. Demand side drivers

Population and economic growth

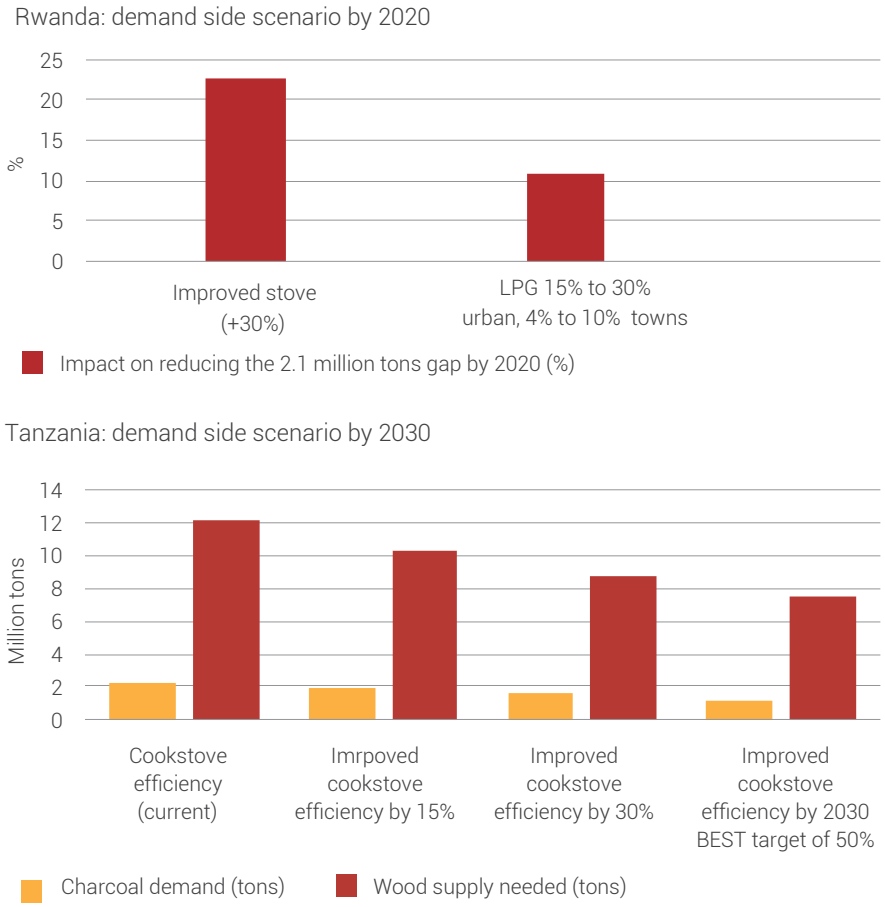
The EAC is experiencing both rapid population and economic growth. Economic growth in Uganda is expected at 5%, with 3% population growth. Kenya expects 5.3% economic and 3% population growth. Rwanda expects 7% economic growth and comparable population growth. Similarly, Tanzania expects a 6.9% economic growth and fast population expansion. Population growth in Burundi is comparable to the region, even though economic growth has slowed.[36] Population and development induced income growth will increase the demand for biomass energy. Analysis conducted in Kenya suggests that there is a one-to-one correspondence between population growth and demand for wood supply at 1 m^3/person/year.[37] Economic growth also places commercial and industrial demand for wood. Population and economic growth thus increase the demand placed on biomass energy which, if unmet, leads to deficits and declines in wood and charcoal affordability, impacting negatively on biomass energy security.

Efficiency of cooking technology

End users of biomass energy often rely on less efficient cooking technologies. The adoption of improved cookstoves changes the energy demand for wood and charcoal. Analysis using baseline data for Tanzania indicates that a 15% improvement in cook stove efficiency across the board will reduce the demand for charcoal from 2.3 million tons/year to 1.95 million tons, and increase the efficiency level by 2030 to 50% will further reduce charcoal demand to 1.1 million tons/year.

36 UNECA Country Profiles, available [Online] at http://www.uneca.org/publications/country-profiles.
37 Ministry of Environment, Water and Natural Resources, Republic of Kenya. July 2013. "Analysis of Demand and Supply of Wood Products in Kenya."

Figure 12. **The impacts of demand side efficient cookstove adoption on wood and charcoal demand in Rwanda and Tanzania**



Sources:(1) Biomass Energy Strategy (BEST) Rwanda. Summary. Partnership Dialogue Facility (EUEI PDF). June 2009. (2) The Republic of Tanzania. April 2014. Biomass Energy Strategy (BEST) Tanzania - Tanzania Biomass Energy Strategy and Action Plan.

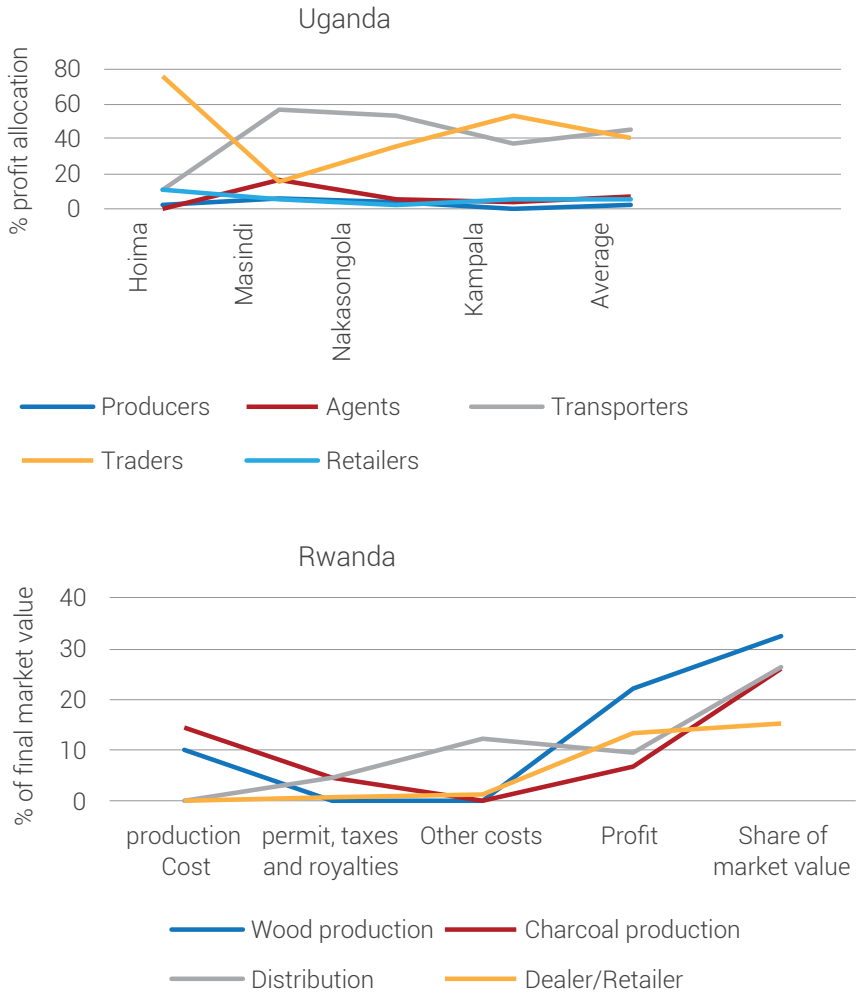
In Burundi, a phased 5% of the population adopting a 40% improved efficiency cookstove in 2010, followed by an additional 7% by 2015, 50% by 2020 and 85% by 2025 would result in wood savings of 2.2 million tons/year by 2025. This is equivalent to 26% of the wood demand if no efficient technologies were adopted. The transition to alternative cooking technology will have a similar effect. The introduction of improved stoves with 30% efficiency in Rwanda is expected to close the demand-supply gap by 22.6%. Efficient cookstoves, therefore, affect the demand for wood and charcoal and impact positively on biomass energy security.

2.4.3. Wood and charcoal value chains organisation and energy security outcomes

Value chains play a key role in determining system costs, allocation of profits and affordability of charcoal and wood supplied to rural and urban markets. Biomass energy security, beyond its supply availability, is anchored in the affordability of biomass energy supply. Ensuring affordability requires efficient and organised value chains and, where appropriate, well-regulated markets, to reduce systemic inefficiency costs in the value chain. Much of the biomass energy market in the EAC is characterised as informal, less organised, and largely unregulated. As such, it is important

to consider the current value chain organisation and the distribution of costs and profits. Based on the analysis of data from Uganda and Rwanda, it is apparent that traders capture much of the biomass energy trade value. In the case of Uganda, although there are regional variations, traders capture from a low of 16% to a high of 76% of profits, and transporters capture from a low of 11% and a high of 57% of profits. In the case of Rwanda, a high share of the cost of production is concentrated on wood and charcoal producers, as well as taxes and permit fees. Profits shares are, however, concentrated on a net basis between distributors and dealers. By concentrating premium value and high profit share in distributors and traders, consumers face prices that are significantly higher than production costs, indicating value chain inefficiency. Organising, regulating and structuring the wood and charcoal value chains, and improving distribution efficiency, increase affordability of biomass energy, and therefore enhances biomass energy security.

Figure 13. Analysis of wood and charcoal value chains in Uganda and Rwanda



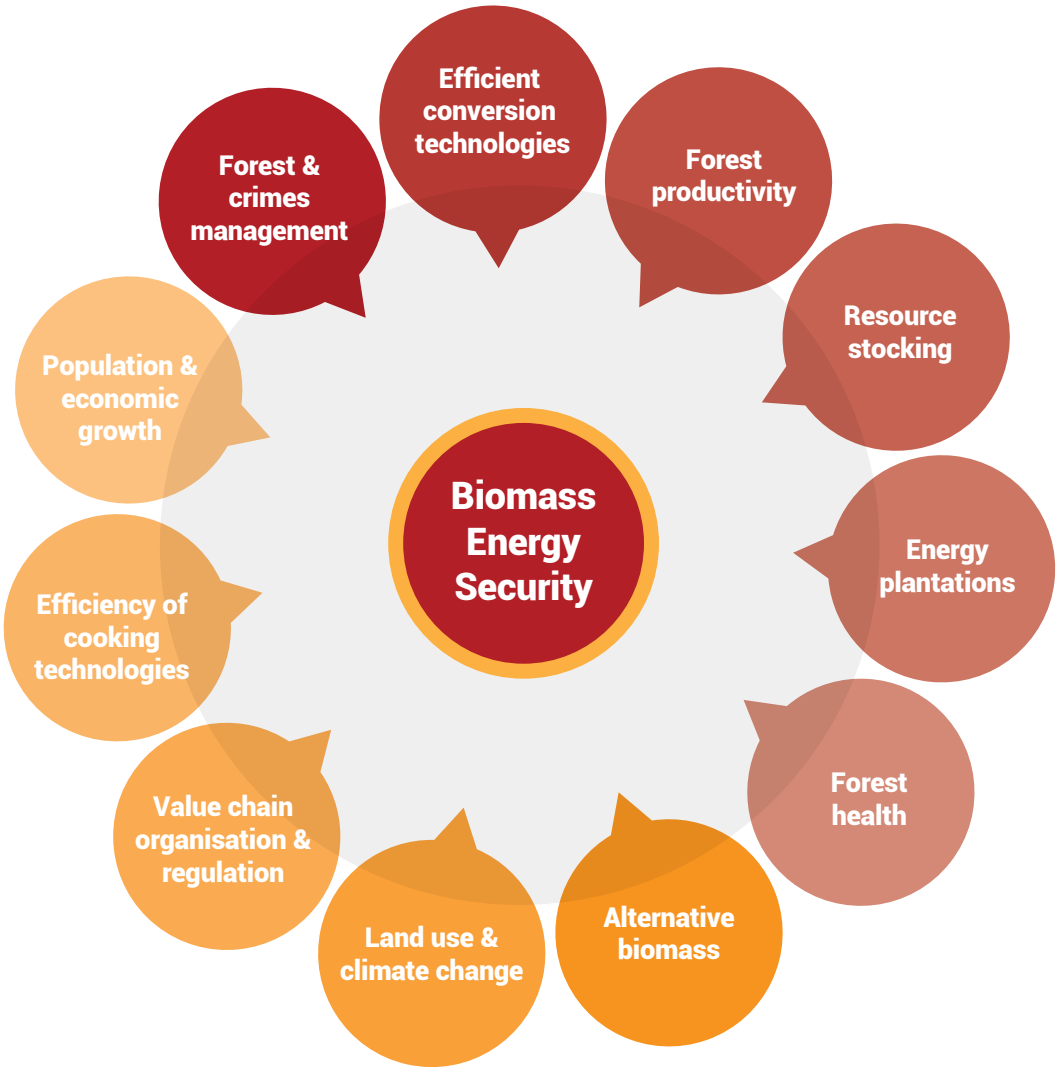
Sources: Based on data from G. Shivly, P Jagger, D. SSerunkiima, A Arinaitwe and C Chibwana. 2010. Profits and margins along Uganda's charcoal value chain. International Forestry Review 12(3): 270-283; and Biomass Energy Strategy (BEST) Rwanda. Summary. Partnership Dialogue Facility (EUEI PDF). June 2009.

Value chains play a key role in determining system costs, allocation of profits and affordability of charcoal and wood supplied to rural and urban markets. Biomass energy security, beyond its supply availability, is anchored in the affordability of biomass energy supply.

2.5. Biomass energy security: system risks and building resilience

The biomass energy security framework has eleven dimensions. On the supply side, forest fire and crime management, efficient conversion technology, forest productivity, forest re-stocking, energy plantations, forest health, alternative biomass and land use and climate change are relevant shaping factors. On the demand side, population and income growth and utilisation of improved cooking technologies are key factors. Biomass markets, or the value chain, are a bridging factor between demand and supply. Their efficiency, regulation, and organisation also affect biomass energy security. Monitoring and management of all of these dimensions determine b*iomass energy security*, the outcome of which will be visible in the availability and affordability of fuelwood and charcoal over time.

Figure 14. Biomass Energy Security Framework



The table below captures the eleven dimensions of biomass energy security, key indicators, how to measure them, their monitoring and evaluation, as well as the risks and resilience factors for each dimension. While the indicators, their measurement and monitoring and evaluation are discussed in Table 2, the indicated risk and resilience factors require further elucidation.

Risks and resilience factors in the biomass energy security framework

In the identified eleven areas of biomass energy security, the degree of impact depends on the risk factors and the resilience of Partner States in dealing with them. The awareness and management of risks also require the building of resilience in the biomass energy system to help minimise the impact of risks, should they materialise. For example, if forest fire management is effective, forest fires will be contained with relatively less damage. Consequently, while the key indicators and their monitoring and evaluation facilitate the objective assessment of biomass energy security, risk management, and resilience building still need to be fundamental responses to improve biomass energy security in Partner States of the EAC.

Table 2. Biomass energy security framework dimensions, their indicators, measurement, risks and resilience factors

Security Factor	Indicators	Measurement	Risks	Resilience Building
Forest fire and crime 	Number of forest fire incident	Number/year	▪ Unmanaged forest fires and damage to forest resources. ▪ Weak monitoring and enforcement and rampant forest crimes.	▪ Increase forest fire monitoring and management capacity. ▪ Build cross-border forest fire control resource pooling. ▪ Increase the capacity of monitoring forest resources, and enforce the law to contain crimes.
	Intensity of forest fire (loss)	Ha/year		
	Quantity of wood illegally harvested	M^3 wood/year		
Efficient conversion technologies 	Tier 1: > 50% efficient carbonisation adoption	% of registered producers in a given year	▪ Limited progress on scaling-up adoption of efficient conversion technologies. ▪ Entrenchment in traditional conversion technologies.	▪ Identify proven high-efficiency carbonisation technologies and promote their adoption. ▪ Avail sustainable financial and fiscal incentives to accelerate adoption. ▪ Improve research institutions and industry linkages to further enhance efficient practices.
	Tier 2: 26-50% efficient carbonisation adoption	% of registered producers in a given year		
	Tier 3: 1-25% efficient carbonisation adoption	% of registered producers in a given year		
Forest productivity 	Natural forest productivity	M3/Ha	▪ Lack of attention to forest productivity. ▪ Limited action to improve forest productivity. ▪ Continual forest resource degradation and a decline in forest productivity.	▪ Expand lessons from plantation forests to other forest holdings to improve productivity. ▪ Expand forest extension service to build knowledge about forest productivity. ▪ Increase afforestation in degraded forest lands. ▪ Regulate forest harvest in low productivity forest lands.
	Community forest productivity	M^3/Ha		
	Plantation forest productivity	M^3/Ha		
	Agro-forestry productivity	M^3/Ha		
	Other lands forest productivity	M^3/Ha		

Security Factor	Indicators	Measurement	Risks	Resilience Building
Resource stocking 	Afforestation	Ha/year	▪ Afforestation rate much below forest harvest (beyond sustainable forest yield). ▪ Limited seedling preparation capacity.	▪ Increase the number and capacity of seedling centres. ▪ Attract private sector participation in seedling business. ▪ Prioritise afforestation in vulnerable forest lands. ▪ Match afforestation rate over time with that of net trees draw down.
Energy plantation 	Establishment of forest plantation for energy	Ha/year	▪ Lack of dedicated land for energy plantations. ▪ Lack of long-term planning for energy plantation. ▪ Limited scale of energy plantations relative to deficits.	▪ Establish large-scale energy plantations. ▪ Encourage private sector investment in energy plantations. ▪ Establish standing strategic forest reserves for fuel wood and charcoal supply.
Forest health 	% of forestland afflicted by disease	%/year	▪ Limited capacity to periodically review forest health. ▪ Lack of capacity to timely control forest diseases. ▪ Lack of regulation of imported forest species.	▪ Strengthen capacity to periodically review forest health. ▪ Build capacity to provide forest health services. ▪ Regulate importation of invasive forest species.
	% of major fuel wood forest afflicted by disease by species	%/year		
Alternative biomass 	Share of alternative biomass in cooking energy	%	▪ Lack of awareness about alternative biomass energy. ▪ Limited capacity to develop and use alternative biomass. ▪ Lack of investment in alternative biomass development.	▪ Conduct national awareness campaign on alternative biomass energy. ▪ Provide incentive for alternative technologies. ▪ Promote technologies for the use of alternative biomass. ▪ Set a national target for the share of alternative biomass and provide policy guidance.
Land use and climate change 	Forestland converted to other uses	Ha/year	▪ Limited land use management capacity. ▪ Limited attention to the loss of forestland to other uses. ▪ Limited regulation of illegal land use practices. ▪ Limited awareness and adaptive capacity on climate change.	▪ Enhance land use management capacity, and regulate excessive loss of forestland to other uses. ▪ Monitor illegal land use practices on forestland. ▪ Increase awareness about the impact of climate change. ▪ Improve climate change adaptive capacity in the forest sector.
	Assessed impact of climate change on forest lands	Ha/year		

Security Factor	Indicators	Measurement	Risks	Resilience Building
Value chain organisation and regulation 	Assessed total wood and charcoal production by licensed operators	%	▪ Lack of regulation of the wood and charcoal value chain. ▪ Continued high informality. ▪ A sarge share of trade outside regulatory reach. ▪ Poor licensing, permitting and regulation. ▪ Limited capacity of law enforcement. ▪ Corruption and illegal practices. ▪ Lack of market organisation. ▪ Lack of national operators registry.	▪ Formalise and regulate the wood and charcoal industry. ▪ Expand the mandate of energy sector regulator to include a mandate over biomass energy. ▪ Strengthen wood harvest regulation and permitting, and police illegal harvests. ▪ Increase share of trade within formally organised value chains. ▪ Build law enforcement capacity related to forest resources. ▪ Leverage the national police on forest law enforcement. ▪ Reduce distribution inefficiency and price gauging by instituting value chain reform and competition. ▪ Improve data and statistics on value chain operators.
	Assessed total wood and charcoal distribution by registered operators	%		
Efficiency of cooking technologies 	Tier 1: > 50% efficient cookstove adoption	% of households	▪ Low-scale progress on adoption of efficient cookstoves. ▪ Lack of sustained support for adoption of improved cookstoves. ▪ Lack of prioritisation of high-efficiency stoves in support programmes.	▪ Identify high efficiency improved cookstoves and support their rapid adoption. ▪ Sustain promotion of, and support for, improved cookstove adoption. ▪ Prioritise and target high-efficiency cookstove adoption for better impact. ▪ Set a tiered national target for efficient cookstove adoption. ▪ Promote and support domestic production of high-efficiency cookstoves.
	Tier 2: 26-50% efficient cookstove adoption	% of households		
	Tier 3: 1-25% efficient cookstove adoption	% of households		
Population and economic growth 	Population growth	Number of persons	▪ Rapid population growth with continued reliance on biomass energy. ▪ Economic growth and increased demand for biomass energy, with limited alternative energy adoption.	▪ Speed-up alternative biomass and alternative cooking technology adoption. ▪ Fast-track electricity access programmes to displace reliance on biomass energy. ▪ Support dissemination of LPG in urban households.
	Income growth	$/person		

2.6. Policy actions to enhance biomass energy security

Table 3. Policy Actions to enhance biomass energy security in Partner States of the EAC

Energy Security Factor	Key areas	Required Policy Actions
Forest fire and crime 	Forest fire Illegal harvest	▪ Strengthen the capacity of forest services to monitor and manage forest fires. ▪ Establish a regional cooperation agreement, bilateral or multilateral, on forest fire management enabling regional pooling of resources. ▪ Invest in forest resources monitoring and protection programmes and build the capacity of natural resources law enforcement.
Efficient conversion technologies 	Adoption of efficient technologies	▪ Establish, or strengthen, a national programme to fast-track adoption of prioritised high-efficiency carbonisation technologies with targets. ▪ Establish sustainable financial, fiscal and/or technical assistance programmes sensitive to efficiency to accelerate adoption. ▪ Support domestic investment by the private sector in manufacture high-efficiency carbonisation technologies and their distribution.
Forest productivity 	Forest productivity	▪ Initiate a national plan to improve on forest productivity in all forest lands to established guiding targets. ▪ Resource forest services to expand extension service on productivity. ▪ Prioritise national afforestation activities in low productivity forests. ▪ Integrate minimum forest productivity requirement in permitting.
Resource stocking 	Afforestation	▪ Expand private, public or PPP seeding development centres. ▪ Establish annual restocking guidelines to match, overtime, the afforestation rate to that of harvest rate beyond sustainable yield.
Energy plantation 	Establishment of forest plantations for energy	▪ Establish private, pubic and/or PPP large-scale energy wood plantations. ▪ Establish standing strategic forest reserves (SSFR) for fuel wood and charcoal to compensate the gap beyond other policy actions.

Energy Security Factor	Key areas	Required Policy Actions
Forest health 	Forest health	▪ Review the mandate of forest services on forest health management, and increase capacity for early detection and control of plant diseases. ▪ Regulate, or ban, the importation of invasive forest species.
Alternative biomass 	Alternative biomass for cooking energy	▪ Initiate a national programme to promote the adoption and large-scale use of alternative biomass energy sources for cooking to a set national target. ▪ Promote private sector investment in alternative biomass domestic production and distribution to households and businesses.
Land use and climate change 	Land use and climate change	▪ Improve the land use planning and change management capacity, and regulate and enforce the law on illegal land uses in forest lands. ▪ Conduct a national review of the impact of climate change on the forest sector, and invest in climate change adaptive capacity in forest lands.
Value chain organisation and regulation 	Production and distribution organisation and regulation	▪ Reduce informality in wood and charcoal national markets by strengthening regulation and licensing of forest harvest, transport and distribution, and large-scale enforcement against unregulated trade. ▪ Establish national criteria for delineating subsistence versus business grade forest harvest and trade for effective enforcement and formalisation. ▪ Expand the mandate of energy sector regulator to include mandate over biomass energy production and trade, with proposed regulatory mandate over most of the 11 dimensions of biomass energy security. ▪ Reduce wood and charcoal distribution inefficiency and price gauging by instituting value chain reform, formalisation, and competition.
Efficiency of cooking technologies 	Efficient cookstove adoption	▪ Establish, or strengthen, a national programme to fast-track adoption of prioritised high-efficiency cookstoves with targets. ▪ Establish sustainable financial, fiscal and/or technical assistance programmes prioritising efficiency tiers to accelerate adoption. ▪ Promote and support domestic production of high efficiency cookstoves.
Population and economic growth 	Population and income growth	▪ To limit the impact of population and economic growth on forest resources, fast-track adoption of non-biomass alternative cooking technologies. ▪ Fast-track electricity access to displace reliance on biomass energy.

3 ENERGY SECURITY IN THE OIL AND GAS SUB-SECTOR

3. ENERGY SECURITY IN THE OIL AND GAS SUB-SECTOR

Energy security in the oil and gas sub-sector has been a global concern for decades, more so today in an interdependent global economy and with inter-linked global commodity markets. Energy insecurity related to oil and gas is the risk of a shortage of oil and gas supply, either due to shortages arising from demand and supply imbalance, or the physical disruption of supply.[38] Conversely, energy security is viewed as the uninterrupted access to oil and gas, with the absence of over-exposure to particular suppliers.[39] Energy insecurity is alternatively conceptualised as the loss of economic welfare that may result from energy commodity price changes or availability.[40] The Asia Pacific Energy Research Centre (APERC) puts forward four dimensions of energy security applicable to the oil and gas sub-sector: availability of supply (geological); accessibility of oil and gas (geopolitical); acceptability of supplies (social and environmental) and affordability of supplies (economic).[41] The European Commission views long-term energy security to mean the uninterrupted availability of energy supplies at affordable prices to support the economy and well-being.[42] Similarly, the International Energy Agency (IEA) articulates energy security to mean the availability of energy supplies to meet demand at market prices.[43] The common feature in these definitions is the emphasis on both the physical availability of oil and gas and supplies at affordable prices.

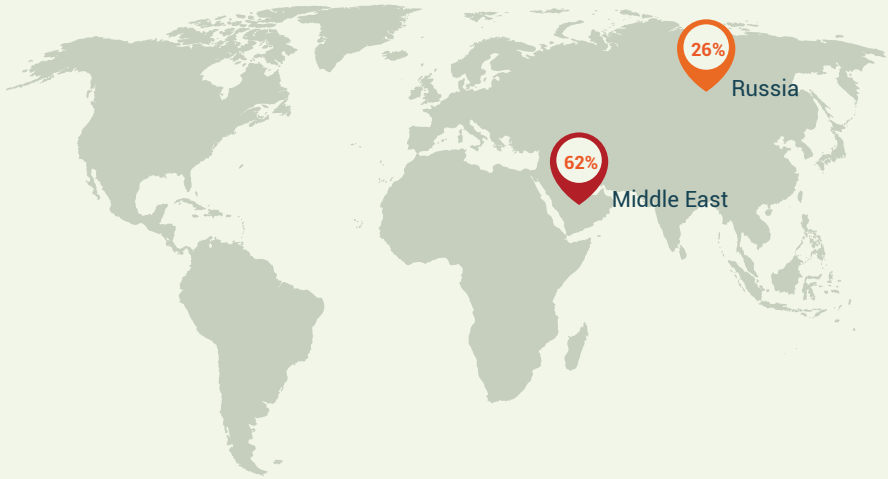
3.1. Global oil and gas energy security

At the global level, energy security in the oil and gas sector has received considerable policy attention for decades. Import-dependence in oil importing countries on a few oil exporting countries is a key feature of the global oil market. The Middle East holds 62% of global reserves, and proven gas reserves are mainly in Russia (26%), Iran (16%) and Qatar (14%).[44] Consequently, concerns exist regarding excessive market concentration on a few major suppliers. Geopolitical events also influence the state of global energy security. The Iraq War of 2003, the gas dispute between Russia and Ukraine in 2005/6, strikes in Venezuela in 2002/3, ethnic and religious violence in Nigeria, Hurricane Katrina in the US in 2005, the Libya Arab Spring uprising, and the Iran-United States confrontation over the Strait of Hormuz are just a few of the recent geopolitical tensions that had direct bearing on energy security. The instability in the Arab world and central Asia continues to be a source of concern for energy supply security.

There is nothing new in these developments. The Arab-Israeli Six Days War of the 1960s and the Yom Kippur War of 1970s led to dramatic increase in oil prices which plunged the global economy into recession, and later stagflation due to oil embargo from exporting countries through

38 Energy Research Center of the Netherlands. 2007. "EU Standards for Energy Security of Supply."
39 Jansen, C.J. and A.J. Seebregts. 2010. "Long-term Energy Services Security: What is it and How Can it be Measured and Valued? Energy Policy 38: 1654-1664.
40 Bohi, D.R. and M.A. Toman, 1996; Lefévre, N. 2010; Toman, M.A. 2002; Jenny, F. 2007 on definition and description of energy security.
41 Asia Pacific Energy Research Center. 2007. "A Quest for Energy Security in the 21st Century: Resources and Constraints."
42 European Commission. 2001. "Towards a European Strategy for the Security of Energy Supply."
43 International Energy Agency. 2007. "Energy Security and Climate Policy: Assessing Interactions."
44 Lefévre, N. 2010. "Measuring the Energy Security Implications of Fossil Fuel Resource Concentration." Energy Policy 38: 1635-1644.

Global Oil and Gas Energy Security



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GLOBAL OIL AND GAS RESERVES

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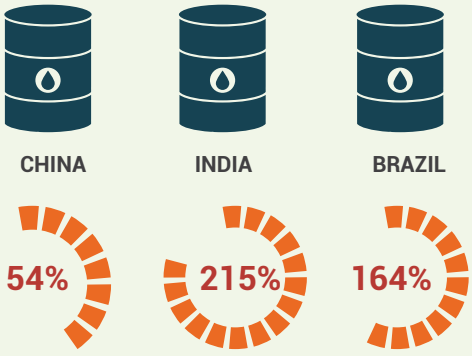
The growth performance of the BRICS (Brazil, Russia, India, China and South Africa) and the strong growth in emerging countries is shifting global demand for energy. BRICS are projected to experience average growth rates of 4.6% through mid-2030.

Total oil and gas import bill Percentage increase for the period 2000-2012



Organisation of Petroleum Exporting Countries (OPEC). This experience led to the creation of the IEA in 1974 to enable Western countries to coordinate their actions and devise an energy security policy framework to respond to oil-related crises and the impact to their economies. However, non-IEA countries were left to handle energy security challenges on their own through country actions. At a fundamental level, socio-political factors in oil and gas exporting and importing countries, the growing incidence of terrorism, piracy and transportation challenges have posed energy security threats.[45]

A review of energy security in the oil and gas sub-sector indicates that global demand and supply conditions, market concentration, diversity of supply options, political risks and speculation are among the key factors affecting energy security.[46] However, at the global scale, new dynamics are emerging that are shaping energy commodity markets. The growth performance of the BRICS (Brazil, Russia, India, China and South Africa) and the strong growth in emerging countries is shifting global demand for energy. BRICS are projected to experience average growth rates of 4.6% through mid-2030. If past performance is any judge (and bearing in mind commitments made under the Paris Climate Change Agreement), it can be expected that their import requirements for oil and gas will rise proportionately. Already, for the period 2000-2012, the total import bill for oil for China, India, and Brazil increased by 54%, 215% and 164%, respectively.[47]

While oil and gas supply has faced numerous risks, affordability and volatility of prices have also been frequently problematic. Between 2000 to 2010, average crude oil prices increased annually by 179%, while US average natural gas prices in the same period rose by only 1.9%. Between 2010 to 2014, average annual crude prices rose a further 21.8%, whereas natural gas prices declined by 0.41%. However, between 2014 and April 2016, average crude oil prices declined by 64%, and natural gas by 55%. The long-term affordability and volatility of oil and gas globally is a recurring energy security challenge. The OPEC decision to keep production of oil stable, despite the sharp decline in oil prices, partly due to the desire to maintain market share in the face of new oil and gas supplies, has benefited oil and gas importing countries. However, the long-term cost, including declining investment in new exploration, discovery, and development are lingering concerns.

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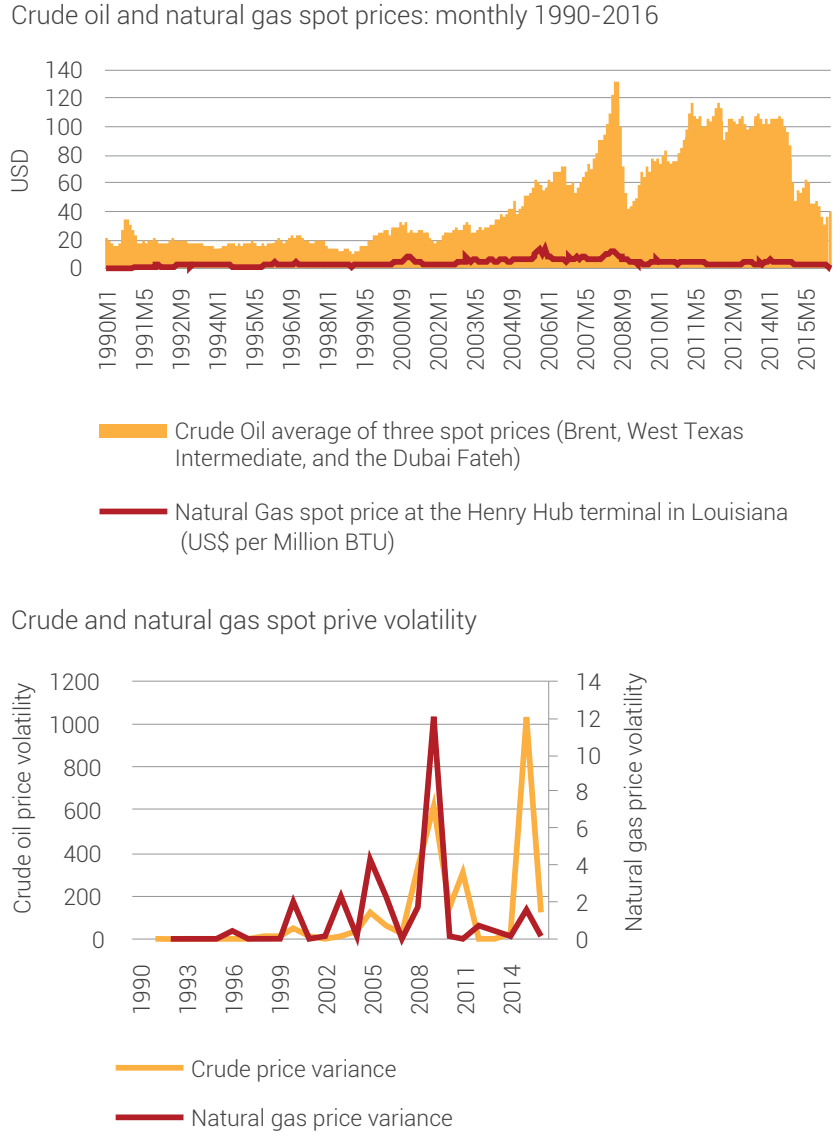
Driven by the necessity of managing such challenges, and to benefit from the current prevailing low oil prices, countries are responding by stocking up their strategic oil reserves, or investing in new reserve infrastructure. For example, China has expanded its strategic oil reserves, including a 19 million barrels facility in Huangdao in Shandong, to expand its strategic reserve capacity, according to the National Statistics Office, by 191 million barrels. The IEA indicates that China is steadily building its oil stock reserves following the completion of a 103 million barrel first phase completion of its Strategic Petroleum Reserve (SPR) plan, and the second phase infrastructure expansion will see a combined 207 million barrels reserve capacity, with expected SPR capacity of 500 million barrels by 2020.[48] India is also expanding its SPR, where IEA reported an expansion of strategic reserves by up to 7 million barrels in 2015, and additional infrastructure development to increase the SPR capacity to 28 million barrels. In the face of global supply conditions and price shifts, strategic responses, therefore, require the presence of energy security policy and action plans.

45 Bohi and Toman, 1996; Greene and Leiby, 2006; Arnold, et al., 2007; Stern, 2002 on energy security threats.
46 IEA, 2007; Toman, 2002; Jenny, 2007; Scheepers, et al., 2007; Jansen and others, 2004; Awerbuch, 2006; Frondel and Schmidt, 2008; Grubb, et al., 2006 on key factors affecting energy security.
47 UNECA. 2014. "Energy Access and Security in Eastern Africa: Status and Enhancement Pathways."
48 IEA Oil and Gas Security: Emergency Response of IEA Countries, available at: https://www.iea.org/publications/freepublications/publication/China_2012.pdf

Figure 15. Oil and gas prices and volatility

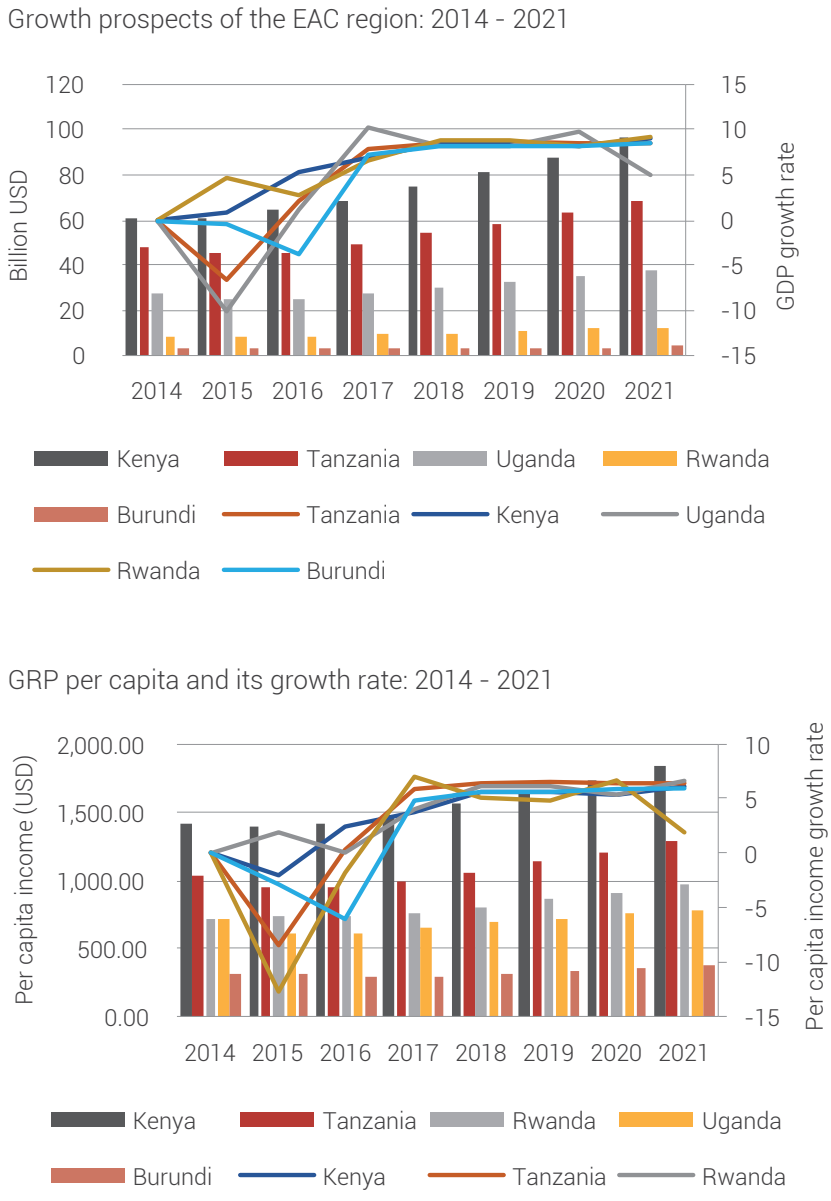


Source: International Monetary Fund, World Economic Outlook Database, April 2016

3.2. Oil and gas consumption in the EAC

The EAC is among the fast-growing Regional Economic Communities (RECs) in Africa. Sustenance of the strong economic performance in the region is expected in the near to medium-term. The IMF World Economic Outlook forecasts show that GDP will grow between 2014-2021 by 57.4% in Kenya, 43.3% in Tanzania, 35% in Uganda, 61% in Rwanda and 41% in Burundi, after factoring-in recent developments in the region and the global commodity market trends. These growth forecasts translate into per capita income growth for 2016-2021 of nearly 69% in Kenya, 286% in Tanzania, 381% in Uganda, 241% in Rwanda and after accounting for the current challenges in Burundi, a 2017-2021 forecast of nearly 16% per capita income growth. These continuing robust and fast economic growth are expected to lead to growing oil and gas demand, therefore making energy security a crucial policy consideration.

Figure 16. GDP per capita income and growth rates of the EAC: 2014-2021

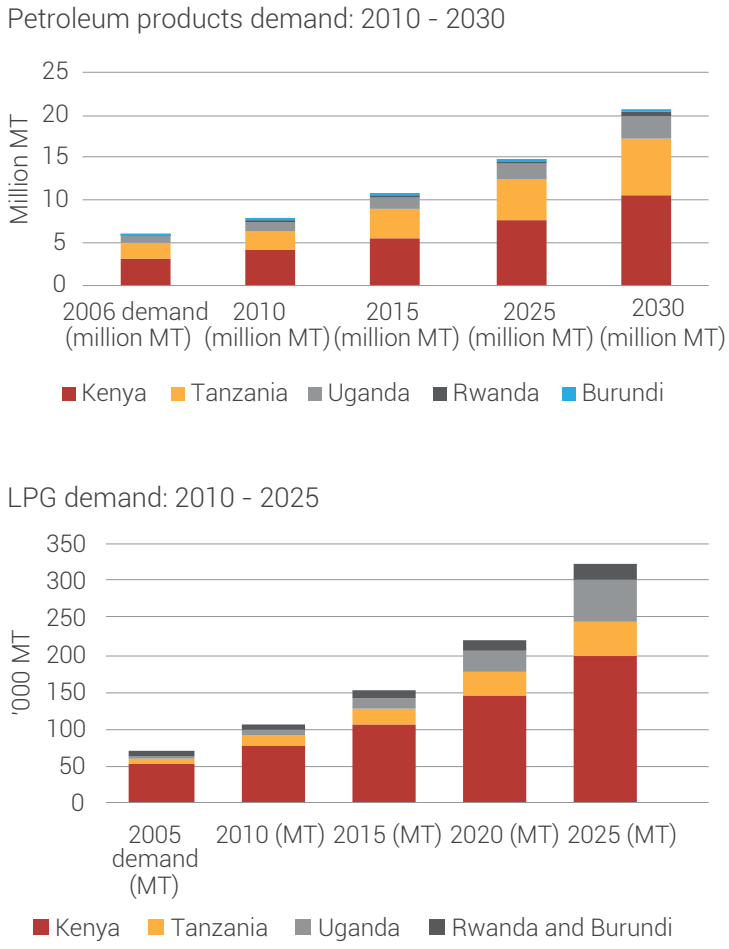


Source: Based on data from International Monetary Fund, World Economic Outlook Database, April 2016

Note: Per Capita Income (PCI) shown by bar graph, and PCI per capita shown by line graph.

Based on 4.6% to 7.5% growth rates in Partner States for the 2006-2030 period, the EAC projects petroleum products demand growth, between 2015-2025, of 16% in Kenya, 17% in Tanzania, 18% in Uganda and a relatively stable demand for Rwanda and Burundi at 0.2 and 0.1 million metric tons, respectively. Based on conservative economic growth rates of between 2.3% and 3.75% within 2005 to 2025, the forecast for LPG demand growth is 36% in Kenya, 50% in Tanzania, 94% in Uganda and 41% in Rwanda and Burundi. However, based on the recent World Economic Outlook faster economic growth rates, the demand for petroleum products and LPG is expected to grow faster. Therefore, it is apparent that security of supply of petroleum products and natural gas will be crucial to minimising the impacts of energy insecurity in the oil and gas sub-sector.

Figure 17. Projected demand for petroleum products and LPG in the EAC



Source: The East African Community Secretariat. February 2008. Strategy for the Development of Regional Refineries.

3.3. Oil and gas energy security challenges and their impacts

The impact of energy insecurity, when it materialises, is often far-reaching, particularly in countries with no, or inadequate, energy security management framework and action plans. Based on expert views during energy security consultative workshops in the Partner States of EAC, a summary of the key energy security challenges in the oil and gas sub-sector are summarised below, along with their expected impacts. At the country level, Burundi faces challenges related to fuel import through tracking, with significant cost markup due to loading and unloading, insurance, taxes and transit-related costs. As a land-locked country, it also shares the challenge of Rwanda in importing fuel from long-distance ports and tracking challenges related to the efficiency of the route, nontariff barriers, and other delays. Rwanda faces the challenge of organising oil marketing companies (OMCs) in importing jointly to benefit from economies of scale. The experience of Kenya through the Open Tender System (OTS) and Tanzania through the Bulk Procurement System (BPS) managed through the Oil Importation Coordinator (OIC) can serve as comparable systems of bulk purchase administration. Product contamination and inadequate storage facilities are also identified as challenges, though Rwanda has already invested in expanding its public storage capacity from 30 million to over 70 million liters.

Country-level challenges for energy security management in Kenya consist of port capacity limits, including the availability of only a single jetty for off-loading petroleum imports at the port of Mombasa. The jetty can only handle ships with capacity of up to 85,000 metric tons, leading to delays resulting in demurrage costs and markup in fuel prices. Storage capacity at port facilities is also a major constraint. The Kipevu oil storage, developed in the 1980s, has storage capacity below the requirements of Kenya and poses a constraint to regional importers. During the transport of petroleum, electricity outages also cause delays in pipeline operations. These challenges are compounded by Kenya's full reliance on the import of refined petroleum products, after the closure of its refinery which became non-competitive due to outdated refining technology and competition from cheaper suppliers.

Experts in the EAC Partner States advise that unaddressed energy security challenges will lead to short to long-term impacts including exposure to external shocks, inflationary pressures, rising cost of energy, unreliable and unaffordable supply (inducing some households to resort back to biomass energy for cooking), deforestation, and market distortions.

The United Republic of Tanzania shares some of the challenges Kenya is experiencing, such as the limited port facility capacity in storage and ship handling, the transport of imported petroleum products, inadequate LPG storage facility, and limitations in handling regional oil and gas imports. Moreover, low levels of investment in natural gas wells, domestic infrastructure and transport network limitations and weak capacity and policy guidance on the use of compressed natural gas (CNG), particularly in the transportation sector, are major challenges. In Zanzibar, pricing policy is a challenge as petroleum products imported from the mainland are distributed at prices below those established in the mainland, causing delays and disruptions to supply. While the Zanzibar Bureau of Standards intends to establish standards on oil imports, the regulatory capacity to monitor fuel quality is limited. Environmental contamination at sites of petroleum import and off-loading are also reported, requiring further attention in environmental monitoring and safety enforcement.

In the case of Uganda, while challenges exist regarding storage facilities, distribution infrastructure, and low LPG capacity, because of the recent oil discoveries and development, Uganda is also facing specific challenges related to upstream oil and gas operation. These include delays in issuing production licenses and the scaling-down of the proposed refining capacity with the regional market in mind. Similarly, under the oil and gas sector reform, the establishment of the National Petroleum Authority of Uganda (NPA) and the National Oil Company (NOC) was delayed. Moreover, the burgeoning oil and gas sectors in the United Republic of Tanzania, Uganda, and Kenya are all facing expertise and human capital constraints. While there are numerous country-specific energy security challenges, the similarity of the challenges offers a window of opportunity to collaborate at the EAC level. The commonalities should buttress the development of a regional energy security policy framework and areas of joint action.

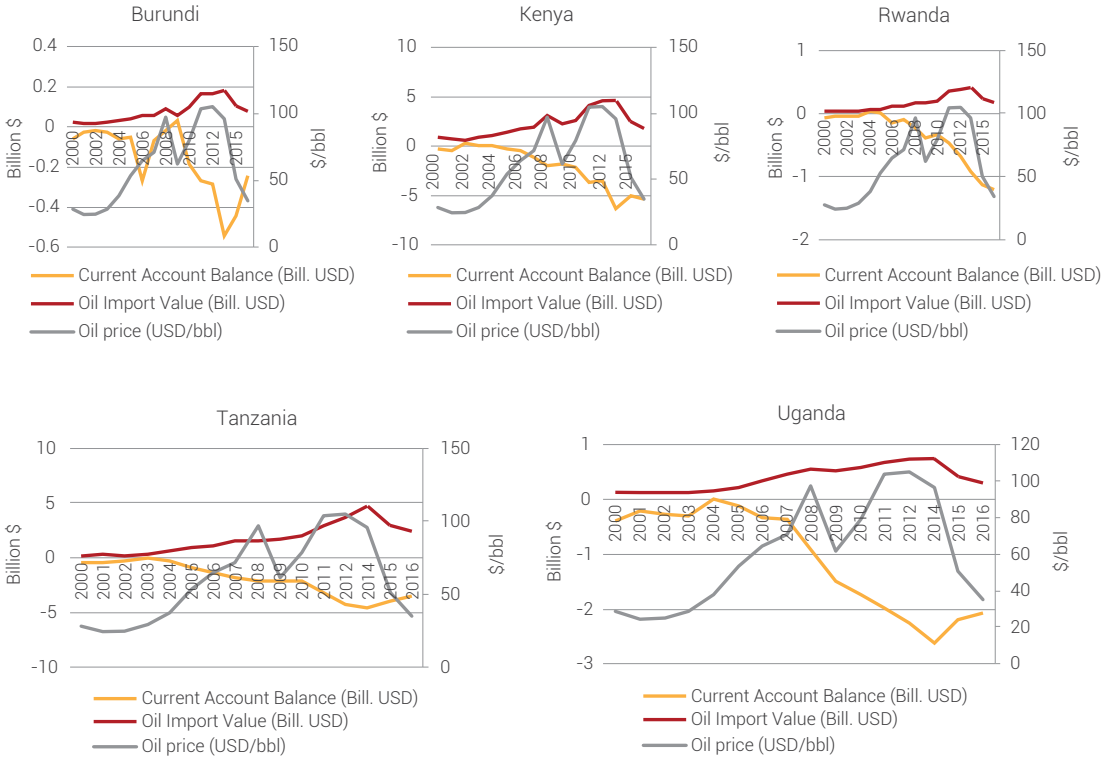
Experts in the EAC Partner States advise that unaddressed energy security challenges will lead to short to long-term impacts, including exposure to external shocks, inflationary pressures, rising cost of energy, unreliable and unaffordable supply (inducing some households to resort back to biomass energy for cooking), deforestation, and market distortions. The longer-term impacts involve the negative effects of all these phenomena on the rate of growth of GDP across the region.

Figure 18. Oil and gas energy challenges and impacts in the EAC

Source: Based on inputs from consultative meetings on energy security in Burundi, Kenya, Rwanda, Tanzania (Mainland, Zanzibar) and Uganda.

Data from the IMF's World Economic Outlook for 2012 and 2016 on oil import bills and balance of payments impact demonstrate that rising energy commodity prices, such as crude oil and natural gas, have a consistently negative balance of payment effect as more resources are required to import petroleum products on which the EAC region fully relies. The deterioration of the current account balance in all EAC Partner States from the post global recession period of 2009 through 2012 coincides with rising energy commodity prices and oil import cost. However, 2015-16 reversals in crude oil prices also see an improvement in the balance of payment position of EAC Partner States, largely due to the decline in oil import bill. The immediate impact of oil supply insecurity in the EAC and its negative economic impacts are apparent, establishing the premise that energy security and economic security are closely linked.

Figure 19. Oil and gas energy challenges and impacts in the EAC



Source: Based on data from the 2016 and 2012 World Economic Outlook, IMF. Data on oil import was not available after 2012. 2014-2016 oil import bill data calculated based on 2000-2012 average annual oil import growth applied to average annual crude oil prices as a conservative estimate.
Note: bbl = barrels

3.4. Tracking energy security in the oil and gas sub-sector: upstream and downstream factors

Energy security in the oil and gas sub-sector is driven by domestic demand and supply side, and external factors related to oil and gas availability and affordability.

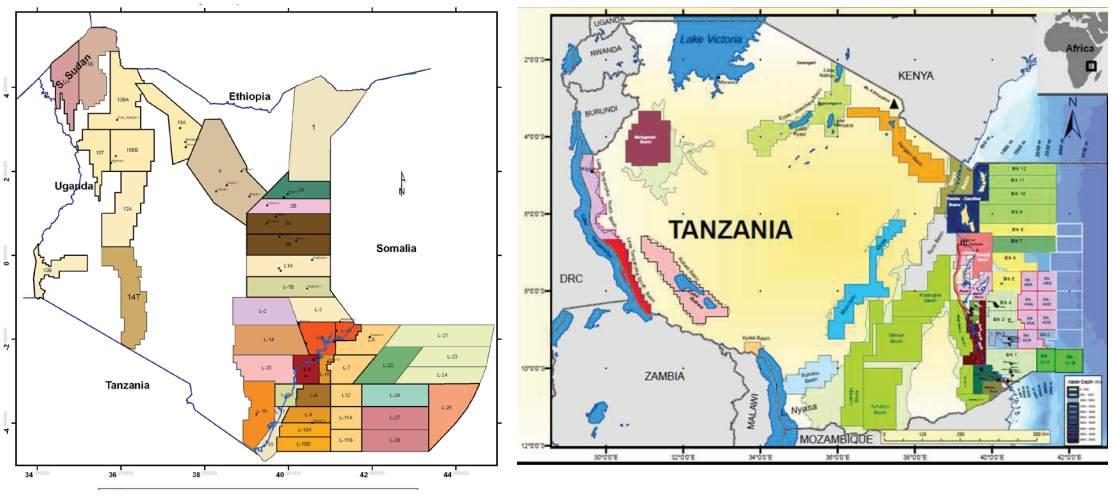
3.4.1. Supply-side factors

Supply-side energy security risks in the oil and gas sub-sector relate to factors that directly, or indirectly, affect the availability and flow of oil and gas supply to markets at any given time. These include the following.

Enhancing exploration, discovery, and development of oil and gas resources

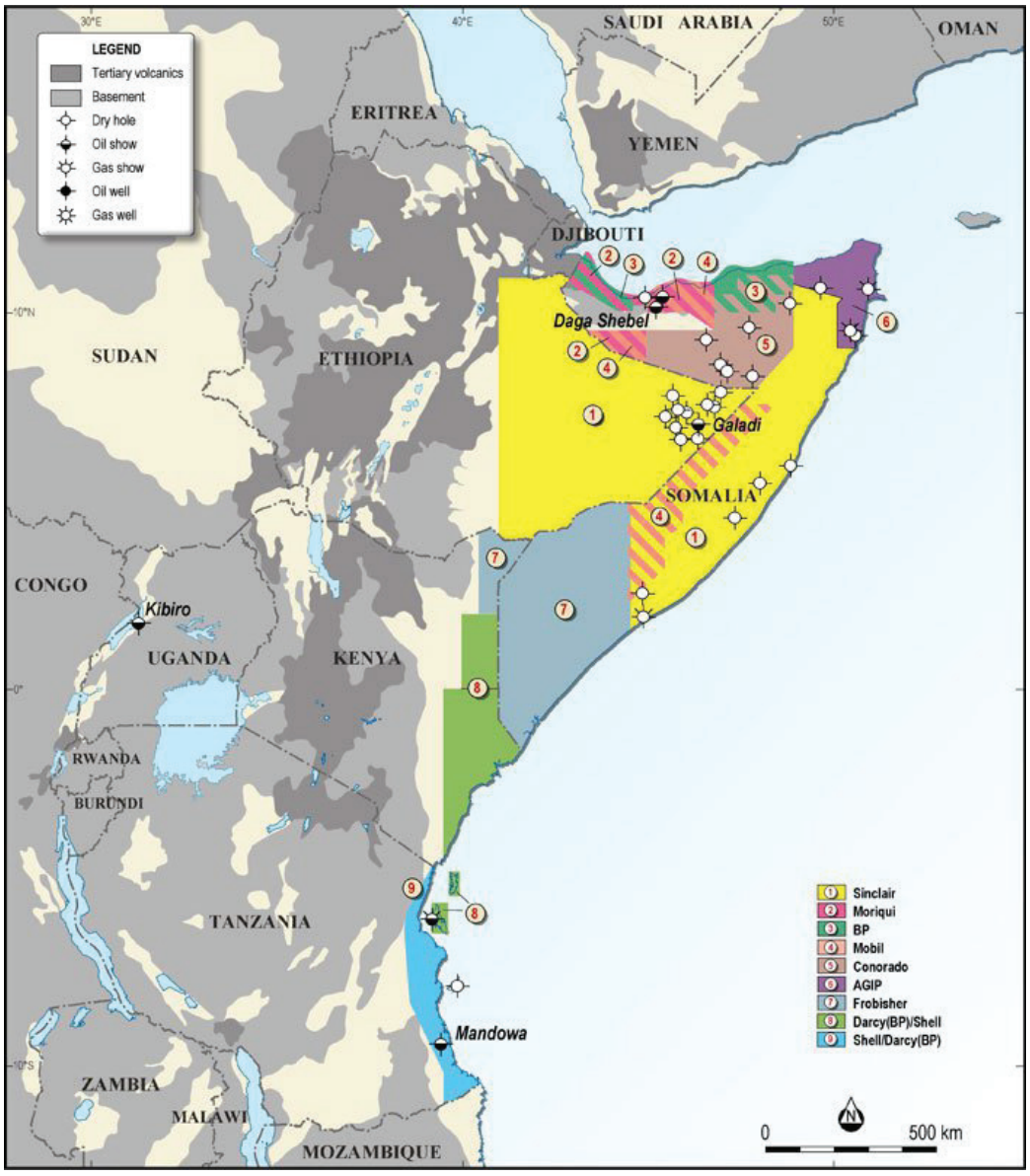
Accelerating the exploration of oil and gas resources in the EAC offers the opportunity to source production within the region. In Uganda, exploration, and development is taking place, with the potential to explore 80% unexplored area. Upstream petroleum exploration, identification and availing exploration blocks and facilitating, in the event of discovery, production license issuance and operation are key upstream activities to support long-term supply-side domestic production capacity enhancement. Similarly, in the event of oil and gas discoveries, prioritisation of the regional market through refinery development and gas supply integration will be crucial. The comparison of exploration activities from the 1950s to the present indicates increased exploration in the EAC, including in off-shore blocks of Kenya and Tanzania. Among key challenges for offshore exploration has been maritime security (particularly in the northern Indian Ocean), maritime boundary disputes and the sparse mapping of oil and gas resources on the ocean bed.

Figure 20. Offshore exploration blocks of Kenya and Tanzania

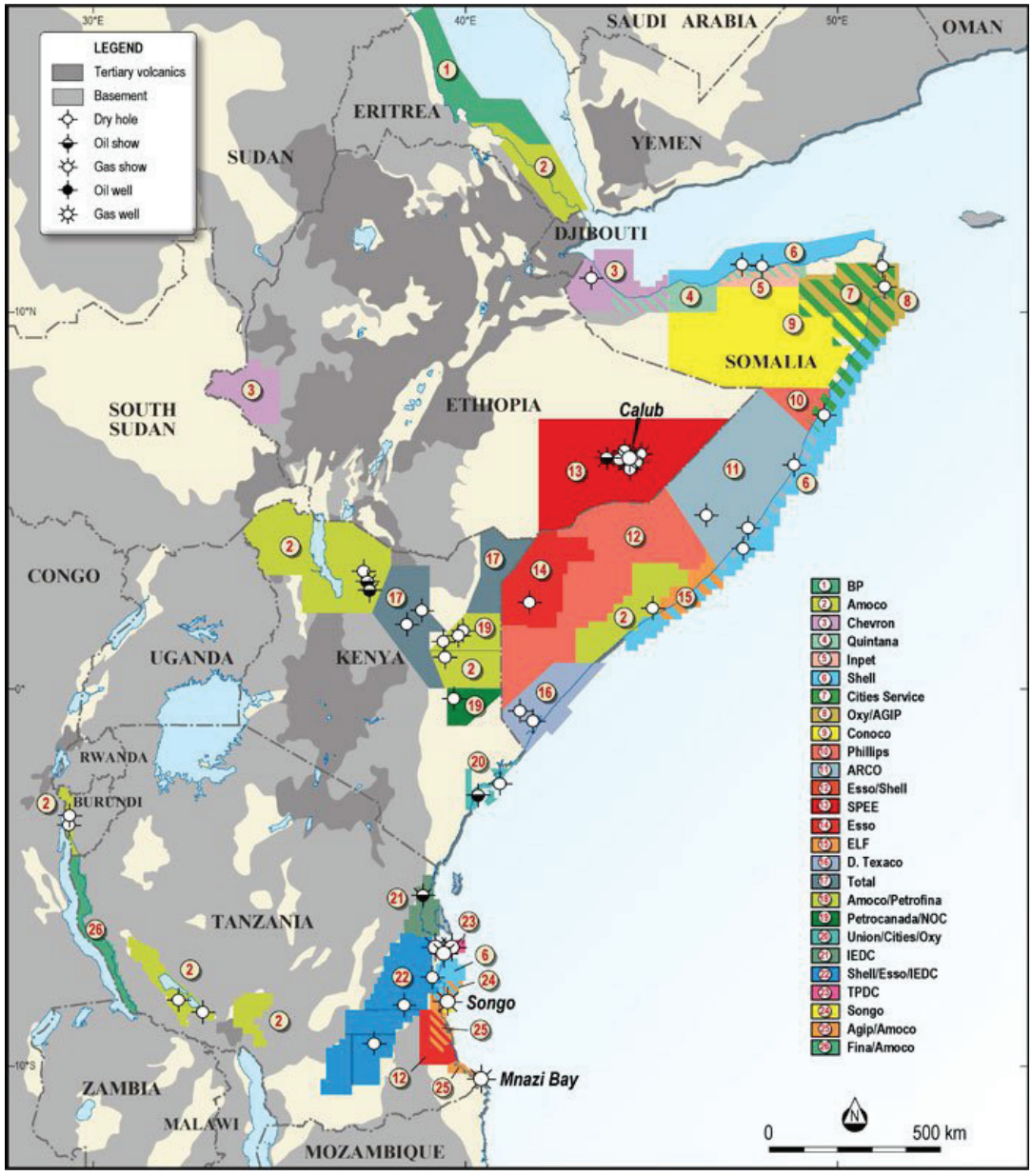


Sources: Exploration Block Map of Kenya (Government of Kenya) and Exploration Block Map of Tanzania (TPDC).

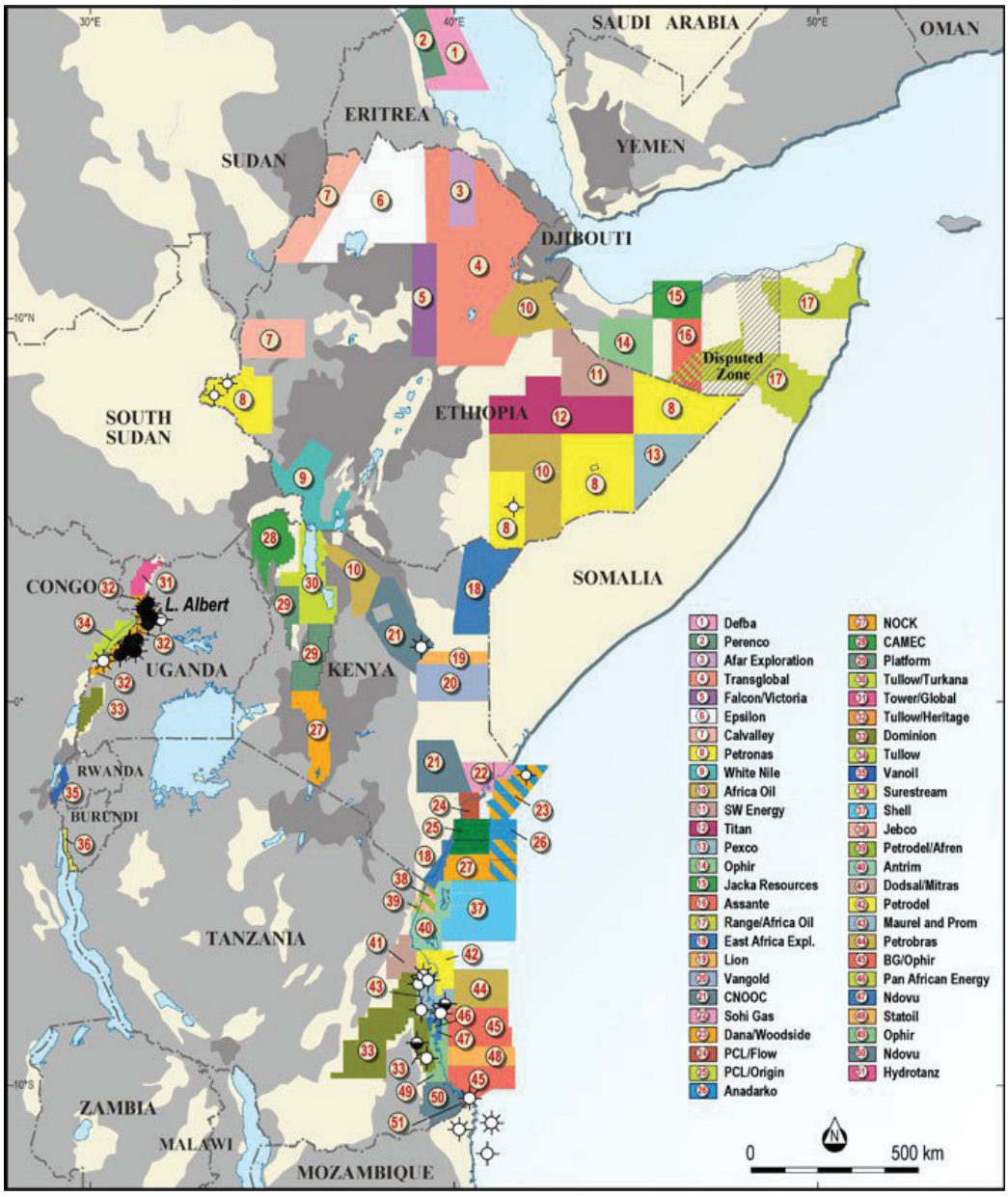
Figure 21. Oil and gas exploration pattern in Eastern Africa by decade – 1950, 1980, 2000 and 2010



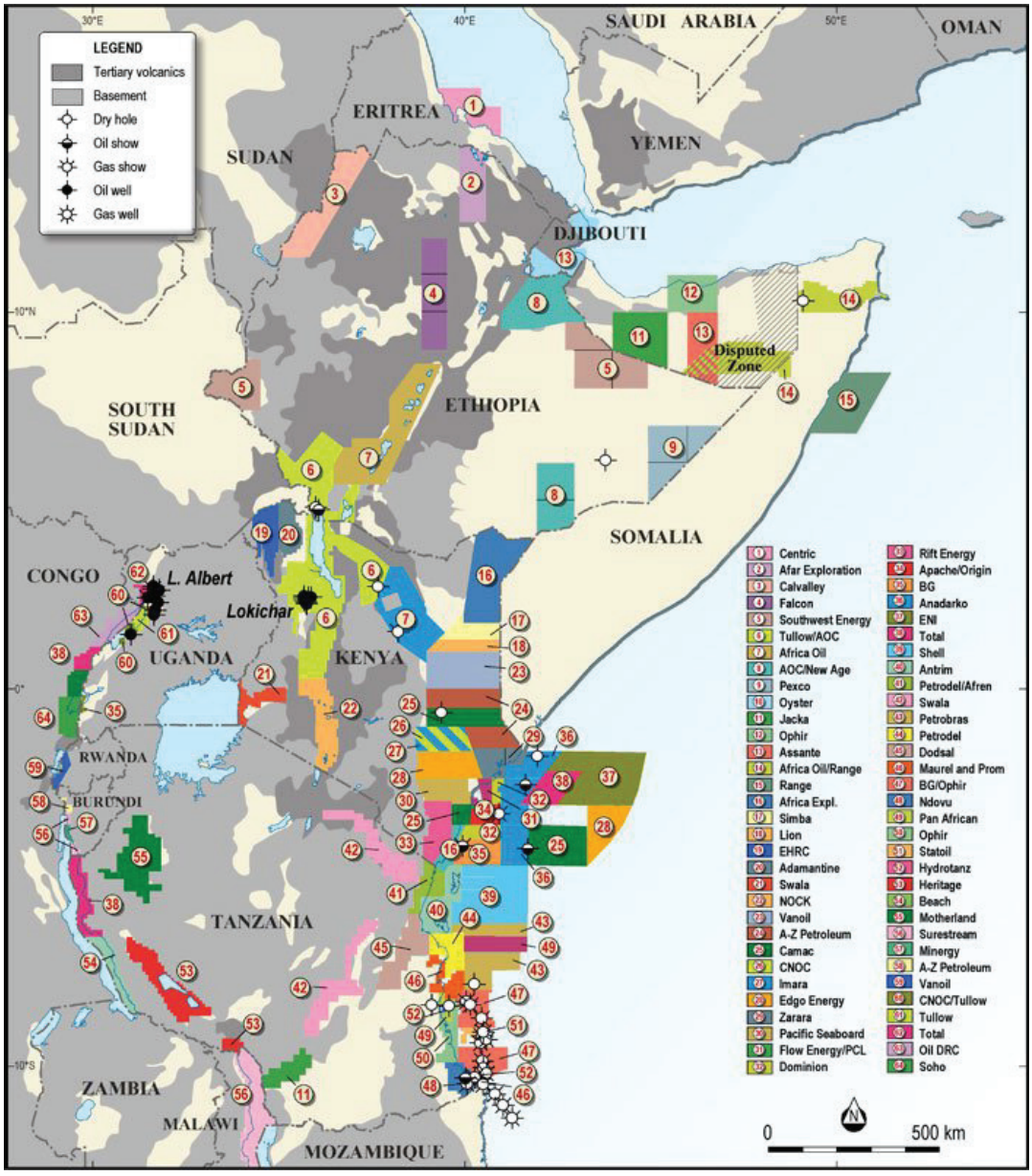
Source: Peter Purell, P&R Geological Consultants Pvt Ltd, 2014.



Source: Peter Purell, P&R Geological Consultants Pvt Ltd, 2014.



Source: Peter Purell, P&R Geological Consultants Pvt Ltd, 2014.



Source: Peter Purell, P&R Geological Consultants Pvt Ltd, 2014.

Domestic production capacity risks (upstream)

The EAC region relies exclusively on imported petroleum products. However, Tanzania has domestic natural gas production capacity. Investment in gas wells has been identified as a challenge and may lead to volatility in gas output. Uganda also anticipates capturing collateral gas output from its crude oil production operation, estimated at 500 billion ft^3, with peak production of 4-5 years. The "no gas flaring" policy is expected to induce gas production. Risks to the sustained domestic production of gas, from investment to technical and operational challenges, will, therefore, shape the state of energy security.

Import dependence (downstream and upstream)

The degree of dependence on imported energy commodities indicates the level of risk exposure to price and supply shocks. In the EAC, there is a 100% reliance on imported petroleum products, with full exposure to external shocks. The closure of refining capacity in Kenya, and the time lag in making the Uganda refinery operational indicates that dependence on imported petroleum will continue to be a key source of energy insecurity for the region. For natural gas, the exception is Tanzania where domestic production capacity has mitigated reliance on imported gas. Mitigating the exclusive reliance on imported energy through the increased accessibility of regional oil and gas and alternative fuel resources will, therefore, constitute a key energy security measure.

The degree of dependence on imported energy commodities indicates the level of risk exposure to price and supply shocks. In the EAC, there is a 100% reliance on imported petroleum products, with full exposure to external shocks.

Table 4. Petroleum products import dependence

	Motor Gasoline	Aviation Gasoline	Kerosene Type Jet Fuel	Gas/Diesel
Kenya	100	100	100	100
Tanzania	100	-	100	100
Uganda	100	100	100	100
Rwanda	100	100	100	100
Burundi	100	-	-	100

Source: UNECA, 2015. Energy access and security in Eastern Africa: Status and Enhancement Pathways.

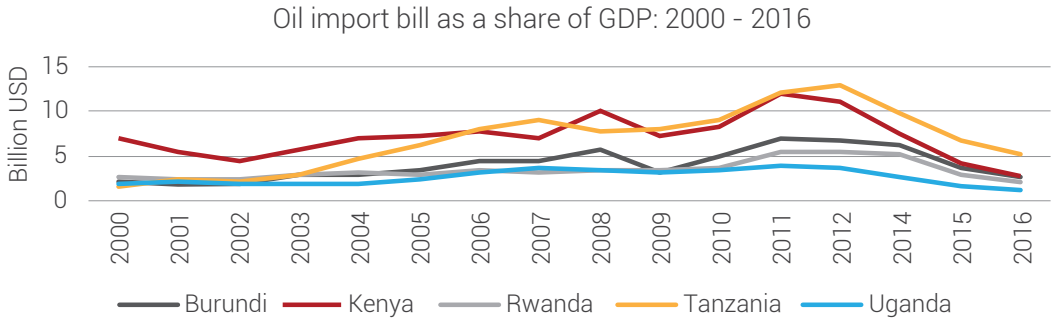
Economy oil vulnerability (upstream and downstream)

Energy insecurity has a direct impact on economic performance. Between 2011 and 2012, oil imports accounted for nearly 12% of GDP and 13% of GDP in Kenya and Tanzania, respectively, and 7% of GDP in Uganda, 5.5% in Rwanda and 3.4% in Burundi. A high share of GDP devoted to importing petroleum products, with little or no domestic production, indicates economic vulnerability to oil import shocks.

Oil Imports share of GDP in the EAC between the years 2011 and 2012

Kenya	12%
Tanzania	13%
Uganda	7%
Rwanda	5.5%
Burundi	3.4%

Figure 22. Oil import dependence and vulnerability of the EAC



Source: Based on data from the 2016 and 2012 World Economic Outlook, IMF. Data on oil import was not available after 2012. 2014-2016 oil import bill data calculated based on 2000-2012 average annual oil import growth applied to average annual crude oil prices as a conservative estimate.

Oil market volatility and political risks (downstream)

The volatility of market prices of crude oil accentuates these risks (Fig. 22). Between 2010 to 2015, market price volatility increased by 594%. Regarding its physical availability, rising political tensions in oil-exporting countries have raised the risk of disruption for countries with limited diversified oil supply.

Energy import and inland transportation corridor security (downstream)

The import of oil and gas to the EAC requires a secure maritime and inland transportation. Maritime transportation to the EAC has been impacted by piracy, thereby raising the cost of insurance. Between 2000 and 2005, the Indian Ocean experienced an increase in reported piracy incidents from 4.7% of the global total to 17.2%, escalating to 53.4% by 2009.[49] The One Earth Future Foundation estimates that by 2011, the economic cost of the Somali piracy security challenge was between $6.6 - $6.9 billion per year, due to increases in fuel costs (because of faster ship speeds to avoid pirates), military expenditures and higher insurance premium. Approximately 15% of pirated ships were oil tankers.[50]

Maritime transport security in the Indian Ocean has since improved substantially. However, the risk of recurrence remains. The inland transportation of oil and gas by road and pipeline, particularly to Uganda, Rwanda, and Burundi, poses further risks. The decision of Uganda to route the oil pipeline through Tanzania, based on security, tariff, implementation time and financing considerations, highlights the continued importance of transportation and pipeline corridors for energy security.

The capacity of ports to handle domestic and regional petroleum imports is also a challenge. At Dar-es-Salaam port, the storage capacity for oil imports is 851,154 m^3, while at Tanga, it is 34,100 m^3. Receiving facilities are also limited (Single Point, handling crude oil, Kurasini Oil, Jet 1, PMS, Jet A1 and IK and 2, LPG). At the port of Mombasa, there is a single jetty at Kipevu with a capacity of handling 85,000 metric tons, leading to queues of vessels, demurrage costs, and contributing to cost increases. The efficient facilitation of off-loading and expanded port and storage capacity will, therefore, improve the value chain.

49 ICC-International Maritime Bureau. Multiple years. Piracy and Armed Robbery Against Ships annual reports, 2003-2009.
50 One Earth Future Foundation. 2011. "The Economic Cost of Somali Piracy 2011."

Energy conversion technologies, efficiency/intensity in inelastic oil demand sectors (downstream)

Oil and gas resources, whether imported or domestically produced, go through a series of conversion technologies before being used for power generation, transport, industrial production, and so on. In each case, the efficiency and reliability with which oil and gas resources are utilised shape future oil and gas import demand. The inefficient conversion of oil and gas into electricity (if system losses are high), low mileage standards for vehicles, and inefficient industrial energy use all contribute to increased import requirements. In this context, policies to increase the resilience of the energy system – among other things, industrial energy audits, limits on the age of second-hand imported vehicles, system loss monitoring in the electricity system, all help to build more resilience. Figure 23 shows an example of the mapping of the energy inputs, conversion technologies, and outputs for Tanzania.

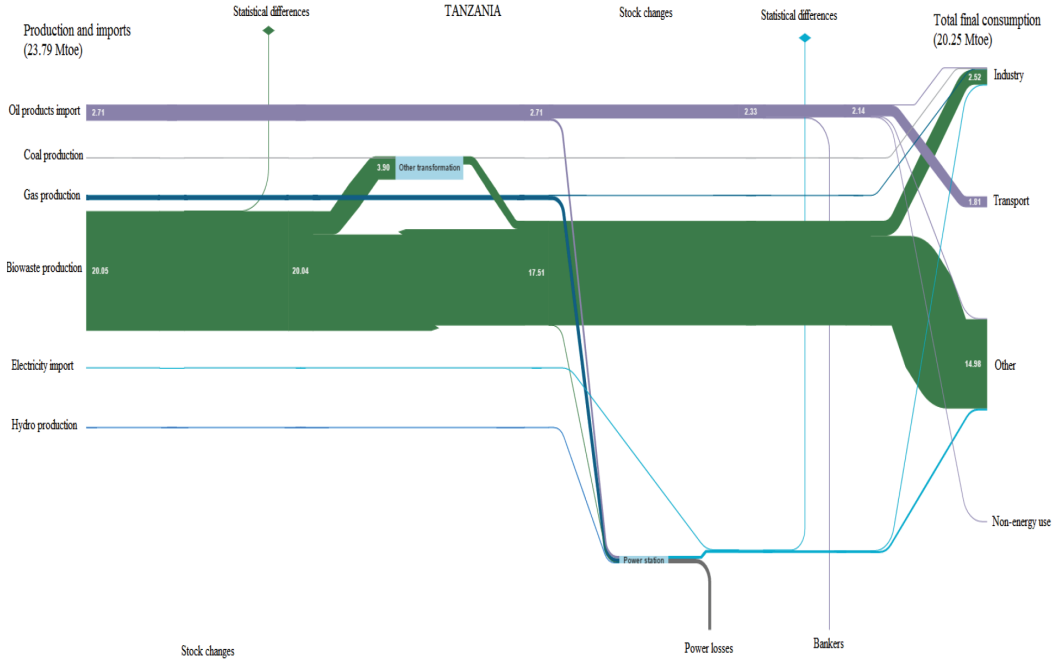
Another dimension to energy security is the study of elasticity of demand of particular sectors. The delivery of imports to oil and gas to sectors with a highly inelastic demand increases the risk of energy insecurity.

Oil refining and oil and gas distribution network capacity (downstream)

The EAC strategy for the development of a regional refinery stipulates that regional demand would require refining 290,000 barrels/day by 2015. With the refining capacity of the former Kenya Petroleum Refineries Ltd (KPRL) of 80,000, new refining capacity of 210,000 barrels/day would be needed to meet this target. But with the closure of the KPRL, and with increases in demand, by 2025 it is estimated that 400,000 barrels/day of refinery demand would be required for the region. The planned refining capacity for Uganda, at an initial rate of 30,000 barrels/day by 2019 may contribute in alleviating some of Uganda's domestic demand. However, the refinery capacity gap continues to be a major constraint within the EAC, making the implementation of an EAC regional strategy even more pressing. The regional distribution infrastructure, including pipelines, distribution centres, and related infrastructure, were identified by country experts as a constraint. In this regard, the proposed Eldoret-Kampala-Kigali-Bujumbura-Dar es Salaam linkages, when fully implemented, will offer a regional evacuation and distribution solution. Regarding the existing infrastructure, data from the Kenya Pipeline Company (KPC) indicates that disruptions in oil pipelines are mainly driven by a power failure, a lack of ullage, and emergency stoppage.[51]

51 In the Mombasa-Nairobi (Line 1), operational disruption is largely caused by lack of ullage (36%), power shortage (23%), emergency stoppage (11%) and equipment failure. In the Nairobi-Eldoret pipeline (Line 2), planned shutdown is the main reason (79%), but lack of ullage (12%) is also a factor. The Nairobi-Eldoret Parallel pipeline (Line 4) also has a high planned stoppage (44%), along with lack of ullage (13%), lack of product to evacuate (17%) and equipment failure and testing (16%).

Figure 23. Energy conversion technologies and efficiency system map of Tanzania



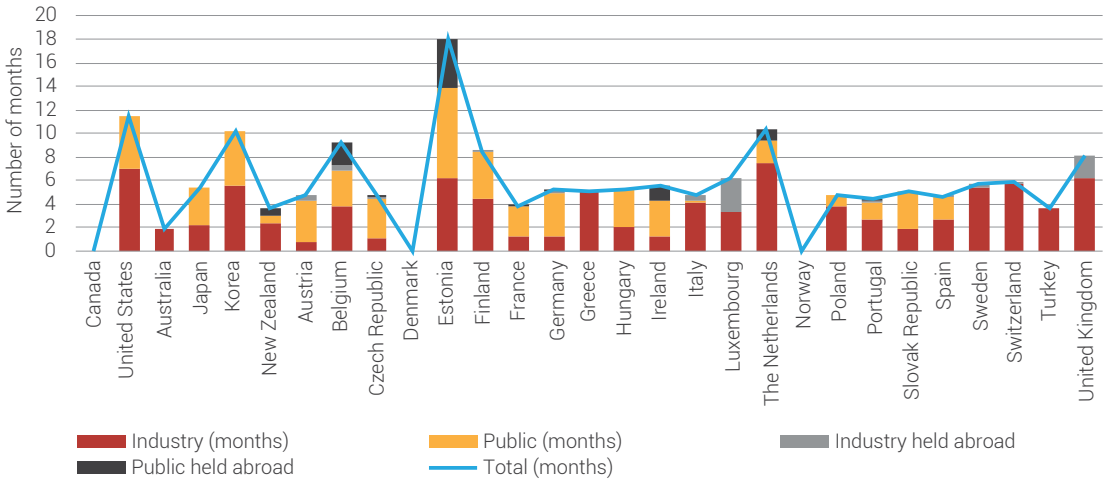
Source: IEA, 2013 data, available [Online] at http://www.iea.org/Sankey/#?c=United Republic of Tanzania&s=Balance.

Strategic Petroleum Reserves (SPR) (downstream)

The dependence on imported petroleum products is mitigated to some extent by strategic petroleum reserves in the EAC. The review of strategic petroleum reserves within the EAC indicates that no country in the region currently has a public strategic petroleum reserve system, but they do maintain operational stocks. Rwanda has put in place infrastructure to increase fuel stocking capacity for public and private sector use from 30 million to over 70 million litres. Tanzania maintains a two week supply storage requirement on distributors and maintains 851,154 m^3 of storage capacity at Dar-es-Salaam and 34,100 m^3 at Tanga. Zanzibar places a 30% stock reserve requirement. Storage facilities are operated in Uganda, Kenya, and Burundi as well.

The need for further strategic petroleum reserves has been identified by the Partner States. For example, the National Oil Corporation of Kenya (NOCK) is mandated by Legal Notice No. 43 of 2008, under the Energy Act of 2006, to maintain strategic reserves equivalent to 30 days of consumption, along with an additional 90 days procurement. As at February 2016, except the oil producing countries of Norway, Denmark, and Canada, all maintain at least three months strategic reserve. In one case (Estonia), the reserve exceeded 15 months. Industry reserves, public reserves, and industry and public storage abroad constitute the strategic reserves.

Figure 24. Strategic reserves of IEA member States, as of February 2016



Source: Based on data from IEA, adding to total reserves those held abroad by industry and the public. Available at www.iea.org/netimports

Development of domestic alternatives and promotion of fuel-switching, particularly in the transport sector, helps reduce the dependence on imported petroleum products.

Fuel switching capacity (downstream)

Development of domestic alternatives and promotion of fuel-switching, particularly in the transport sector, helps reduce the dependence on imported petroleum products. An experimental programme in Addis Ababa, Ethiopia required a 10% blending of ethanol, with plans to raise it to 20%. In line with this goal, new sugar factories are being set-up to increase the supply of ethanol, along with the establishment of a standardised fuel blending facility at Sululta. Ethanol production levels of 2.2 million tons are expected, along with setting aside some 2.5 million hectares of land for biofuels, for both the domestic and export markets.[52] The programme is claimed to have saved $20 million in fuel imports per year. Similar programmes of blending, and encouraging greater reliance on biofuels, will help mitigate the excessive reliance on imports. Fuel switching also requires end users to have sufficient flexibility to alternative energy fuels in times of shortages and disruptions. The African Union and the UN Economic Commission for Africa have developed an *Africa Bioenergy Policy Framework and Guidelines* to assist countries in developing their bioenergy potential, including biofuels.

3.4.2. Demand side factors

Demand-side restraints

Demand-side restraints can be implemented to economise on the available oil and gas resources. This implementation could be through information and awareness campaigns about energy saving practices to change public attitudes on energy saving, placing energy saving requirements such as restrictions on driving days, or the introduction of mandatory actions, such as limits on the age of imported cars. Such demand-side measures can lead to savings that will reduce the rate of growth of imports.

52 UNECA, Sub-regional Office for Eastern Africa. 2014. "Enhancing Energy Access and Security in Eastern Africa: Status and Enhancement Pathways."

Energy end-use efficiency (transportation, industry, and households)

Efficiency gains on the demand side also aim to save energy by encouraging the introduction of fuel-efficient transportation and the design of efficient urban transport systems. Industrial energy audits, and household energy efficiency measures - from energy efficient houses to efficient appliances – also have their role. Transport, utilities, and industrial sectors are leading consumers of oil and gas. They thus offer great opportunities for energy saving.

3.4.3. Oil and gas value chains organisation and energy security outcomes

The petroleum value chain, from import to end user, is a complex system. The first challenge within the EAC is regulation. Regulators have brought downstream petroleum under regulatory oversight: the Energy and Water Utilities Regulatory Authority (EWURA) in Tanzania, and the Zanzibar Utility Regulatory Authority (ZURA); the Rwanda Utilities Regulatory Authority (RURA); the Ministry of Energy and Mineral Development of Uganda and the Petroleum Authority of Uganda (PAU); and the Energy Regulatory Commission (ERC) in Kenya. Burundi is in the process of establishing the Agence Autonome de Régulation du Secteur de l'Eau et de l'Energie du Burundi (Autonomous Regulatory Agency of the Water and Energy Sector of Burundi). The mandate and authority to regulate the oil and gas sector in these institutions vary.

In the case of the adulteration of petroleum products, a challenge for the EAC is the power and enforcement capacity of regulators. National inspection systems often have limited capacity, and few mobile labs, to enforce fuel standards. Moreover, differences in fuel marking systems, such as those that exist between Kenya, Tanzania, and Uganda, further introduce a challenge to harmonising regulation and standards.

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The market organisation represents another challenge in the regional oil and gas value chain. The Kenya Open Tender System allows oil marketing companies (with at least five stations and a storage depot) to participate in an organised manner, with a guaranteed profit margin for operators to avoid price gauging (at 6-6.5KSh/litre). By a cost-of-business study, a price formula, applicable along the value chain, is determined and reviewed periodically. For regional importers, direct participation in the OTS system is a challenge and requires their participation through local operators. The system is credited with reducing hoarding and stabilising prices while increasing the chances of guaranteed import and supply.

Tanzania implements a comparable system under its Bulk Procurement System operationalised by the Petroleum Importation Coordinator (PIC). The role of PIC is to bring efficiency and economies of scale on oil import through coordination of import demand, using a bid award system that enables the importation of bulk petroleum products efficiently in fewer vessels. The Tanzania Petroleum Development Corporation (TPDC) has also initiated the establishment of a publicly owned oil marketing company – the Commercial Petroleum Company Limited (COPEC) - to serve as an oil marketing company and undertake the distribution of petroleum products. Regional importers can communicate the quantity of import through an agent. Operational delays in petroleum supply as planned is fined at $0.5/metric tonne/day to enable supply guarantee. The system is reported to have reduced demurrage cost, supply delays (to average 5-6 days) and increased efficiency through organising fuel import transportation in a coordinated manner. Profit in the value chain is also pre-determined as in the Kenya case, which is reviewed periodically based on prevailing global crude prices and other criteria in the price build-up. Key challenges in the system include private import vessel facilitation, a system of direct payment for imports and delays in payment and direct procurement participation for regional importers.

Uganda operates a market-based system where market forces determine profitability and demand and supply conditions. Similarly, while pump prices are regulated, Rwanda and Burundi do not have a national coordination system for bulk petroleum imports. Therefore, varying forms of value chain organisations in the EAC require harmonisation, particularly for regional petroleum importers through the OTS and the BPS systems and their participation. Another challenge in the value chain is the redirecting of transit fuels and dumping in local markets. While the export marker of fuel is a useful system, gaps in the monitoring and enforcement system leave such incidents at times unnoticed.

3.5. Oil and gas energy security: system risks and building resilience

The oil and gas energy security framework has eleven dimensions, with strong supply side indicators, one value chain indicator and one for demand side measures. The monitoring and management of these dimensions determine oil and gas energy security.

Figure 25. Oil and Gas Energy Security Framework

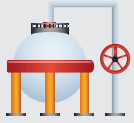
Risks and resilience factors in the oil and gas energy security framework

In the identified eleven dimensions of oil and gas energy security, the degree of impact depends on the intensity of risk factors, and the built-in resilience of Partner States in dealing with them. The risks across the different dimensions of the oil and gas energy security framework rely on conducting business as usual or taking minimal action with inconsequential system improvement. Awareness, measurement, and management of risks and building resilience in the oil and gas value chain help minimise the magnitude of the impact of the oil and gas security risks if and when they materialise.

Table 5. Oil and gas energy security framework dimensions, indicators, measurement, risks and resilience factors

Security Factor	Indicators	Measurement	Risks	Resilience Building
Market volatility and political risks 	Oil price volatility in global markets	Quarterly variance of oil prices	▪ Lack of action on changing prices and full exposure. ▪ Concentration of oil import countries	▪ For bulk procurement, provide participation in oil market hedging ▪ Diversify oil import countries
	Diversity of oil import countries	Herfindahl diversity index		
Import dependence 	Domestic petroleum products consumption met by imports	% consumed met by imports	▪ Above 85% import share ▪ Total reliance on consumption on imports ▪ Exposure to external changes, such as prices	▪ Develop domestic bio-energy sources ▪ Diversify import sources ▪ Strengthen domestic strategic stocks build-up
	Domestic natural gas consumption met by imports	% consumed met by imports		
Maritime and inland transit security 	Maritime corridor security	Number of reported security incdents per year	▪ Lack of storage capacity expansion relative to growing demand ▪ Lack of investment in port capacity expansion ▪ Evacuation inefficiency for unplanned reasons ▪ Interplay between electricity supply insecurity and evacuation performance ▪ Lack of addressing reported transit security incidents	▪ Expand storage capacity dynamically based on anticipated regional demand ▪ Improve on port services efficiency ▪ Address electricity outages impact on petroleum evacuation ▪ Share transit corridor security information in the region, and build law enforcement capacity to ensure secure transit passage ▪ Strengthen regional review of transit security
	Port handling and facilitation efficiency	Average delay time at ports and average demurrage costs		
	Port storage facility and evacuation	% deficit in storage capacity relative to total demand; % per month optimal evacuation could not be met for non-planned reasons		
	Inland transport corridor security	Number of reported security incidents per year		

Security Factor	Indicators	Measurement	Risks	Resilience Building
Conversion technologies and efficiency 	Efficiency of power plants and distribution of produced energy	Power plants load factor, and transmission and distribution losses	▪ Lack of improvement plan on power plants and grid efficiency	▪ Implement performance improvement plans on power plants and grid infrastructure
	Efficiency standard on imported vehicles	Existence of standards on imported vehicles	▪ Lack of requirement on age or performance of imported vehicles	▪ If absent, institute sensible age limits on imported vehicles
	Industrial energy efficiency audit	Number of firms undergoing voluntary energy audits	▪ Limited participation of industry in energy audits ▪ Lack of awareness on savings from energy efficiency audits	▪ Initiate a national programme of voluntary industrial audits. Promote realised savings. ▪ Launch a national energy efficiency programme at large
Domestic production capacity 	Domestic production capacity of oil and gas	Barrels, ft^3	▪ Volatile domestic oil and gas production capacity ▪ Unreliable production levels for planned use	▪ Support investment in oil and gas fields for stable and planned outputs ▪ Mitigate and manage output destabilising factors
Refinery and distribution networks 	Refinery capacity	barrels/day	▪ Lack of progress on refinery construction and operation ▪ Instituting small-scale refining capacity ▪ Inability to access refined petroleum within the region	▪ Implement the EAC regional refinery development plan ▪ Invest in improving existing pipeline infrastructure, and implement extensions to Rwanda and Burundi ▪ Progress towards elimination of non-tariff barriers ▪ Link strategic petroleum reserves requirement of the region with regional refinery
	Operational effectiveness of pipelines and trucking of oil and gas	M^3/hr Delivery in days		

Security Factor	Indicators	Measurement	Risks	Resilience Building
Strategic petroleum reserves 	Public, industry and private strategic stock reserves	Barrels, m^3	▪ Lack of regulatory requirement to stock petroleum products ▪ Continued inadequate enforcement capacity on fuel stock monitoring ▪ Delays in instituting public strategic petroleum reserves	▪ Establish a national public strategic petroleum reserve system. ▪ Maintain at least three months of prior year's import quantity. ▪ Strength monitoring and enforcement of reserve requirements ▪ Review and update national policy to meet energy security requirements ▪ Mainstream the EAC petroleum supply emergency plan
Fuel switching capacity 	Fuel switching capacity of power plants	% of power plants operational in more than one fuel source	▪ Lack, or limited, fuel switching flexibility at power plants ▪ Lack of national biofuels development plan ▪ Limited awareness about the potential of biofuels and its trade-offs	▪ Conduct national review of power plants to identify potential fuel switching options ▪ Establish national biofuels development strategy ▪ Institute fuel mixing mandates at small scale and scale-up matching biofuels supply capacity ▪ Encourage commercial growing of energy crops for biofuels
	Fuel switching capacity in the transport sector	% of biofuels in total fuel supply		

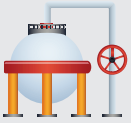
Security Factor	Indicators	Measurement	Risks	Resilience Building
Value chain organisation and regulation 	Regulatory enforcement capacity	Number of inspections/ month	▪ Lack, or poor, capacity development in inspection and enforcement ▪ Continued limited capacity at regulating transit product diversion and dumping ▪ Continued capacity gap in monitoring product quality, and limited inspection and enforcement measures	▪ Build inspection, monitoring, and enforcement capacity, including for transit fuel ▪ Review legal provisions for product adulteration penalty and update lax penalty structures ▪ Consider national coordination capacity for oil and gas importation
	Market organisation	Presence of oil and gas import coordination		
	Product diversion	Number of product diversion incidents/month		
	Product adulteration	Number of incidents/month		
Exploration and development of oil and gas 	Investor interest in exploration and/or development of oil and gas	Number of exploration blocks announced Number of investors participating in exploration of oil and gas Number of production licenses issued	▪ Lack of investor interest in upstream opportunities ▪ Country business environment for energy investors	▪ Review and announce exploration blocks ▪ End any moratorium on exploration ▪ Expedite the review process and issuance of well-informed licenses ▪ Strengthen contract negotiation institutional capacity ▪ Build human capital in key technical areas of upstream oil and gas

Security Factor	Indicators	Measurement	Risks	Resilience Building
Demand-side restraints 	Demand-side energy saving programmes by industry	Number of industry energy audits and energy efficiency measures undertaken Number of industry energy efficiency standards put in place	▪ No, or limited, measures being taken on industrial and household energy efficiency measures ▪ Limited awareness on the role of demand-side policies on energy security ▪ Limited policy attention for energy efficiency and demand restraint measures	▪ Raise awareness about the role of industrial and household energy efficiency on energy saving ▪ Strengthen capacity to undertake industrial energy efficiency audits ▪ Initiate a national programme on industrial and household energy efficiency ▪ Review demand retraining policies and raise awareness for their implementation during appropriate conditions (such as rationing)
	Demand-side energy saving programmes by households	Number of households implementing energy efficiency measures Number of household energy efficiency standards put in place		

3.6. Policy actions to enhance oil and gas supply security

Table 6. Policy Actions to enhance oil and gas supply security in Partner States of the EAC

Energy Security Factor	Key areas	Policy Actions
Market volatility and political risks 	Oil price volatility in global markets Diversity of oil import countries	▪ Work with OMCs towards a minimum oil and gas import diversification plan. In the case of Kenya and Tanzania, OTS and BPS systems may introduce phased-in requirement for import diversification by OMCs ▪ Through OTS and BPS systems, consider a regional bulk procurement that enables oil market hedging and mainstreaming hedging options
Import dependence 	Domestic petroleum and gas products consumption met by imports	▪ Develop and implement national biofuels strategy and action plan, with set target on displacing imported fuels ▪ Pursue import country diversification plan as advised above
Maritime and inland transit security 	Maritime and inland corridor security, port efficiency and capacity	▪ Strengthen existing regional cooperation on maritime safety and security ▪ Strengthen EAC regional transit security periodic review with the Northern and Southern Corridor institutions ▪ Pursue investment models to finance port storage, handling and evacuation capacity improvement and expansion based on regional demand
Conversion technologies and efficiency 	Efficiency of energy conversion technologies and systems	▪ Continued country actions and investment on performance improvement of power plants and grid infrastructure ▪ Review transport sector policy related to efficiency of imported cars and if absent consider import age limits ▪ Initiate national industrial and household energy efficiency strategy and targets, and implement strategy
Domestic production capacity 	Domestic production capacity of oil and gas	▪ Promote investment in stabilising oil and gas output and field performance, and build capacity to address output fluctuations
Strategic petroleum reserves 	Public, industry and private strategic stock reserves	▪ Establish a national public strategic petroleum reserve system, with capacity to hold at least three months of prior year's import quantity as reserve ▪ Review private stocking practices and enforce reserve requirements ▪ Review options for industrial stocking minimum requirements ▪ Mainstream the EAC petroleum supply emergency plan

Energy Security Factor	Key areas	Policy Actions
Refinery and distribution networks 	Refinery capacity, pipelines, and trucking of oil and gas	▪ Implement the EAC regional refinery development plan and fast-track ongoing EAC initiatives on pipeline infrastructure extensions to Rwanda and Burundi and road infrastructure development with the Corridor institutions ▪ Strengthen regional trade facilities to mitigate non-tariff barriers on fuel tracking, and coordinate and expedite emergency fuel transits ▪ Link strategic petroleum reserves requirements of the region with regional refinery infrastructure
Fuel switching capacity 	Fuel switching capacity of power plants and the transport sector	▪ Develop and implement national biofuels strategy and action plan ▪ Institute fuel mixing mandates at small scale and scale-up mandate matching national biofuels realisable supply capacity ▪ Undertake a national review of power plants to identify potential for fuel switching options in times of emergency
Value chain organisation and regulation 	Regulatory enforcement and value chain organisation	▪ Institute fuel mixing mandates at small scale and scale-up mandate matching national biofuels realisable supply capacity ▪ Undertake review of legal provisions for product adulteration and other violations and update any lax penalty structures ▪ Consider enabling direct participation of OMCs from Burundi, Rwanda, and Uganda in the OTS and BPS systems ▪ Institute fuel mixing mandates at small scale and scale-up mandate matching national biofuels realisable supply capacity
Exploration and development of oil and gas 	Investor interest in exploration and/or development of oil and gas	▪ Fast-track announcement of remaining exploration blocks and expedite the review and issuance of well-informed exploration/production licenses ▪ Strengthen human capital in key technical areas of upstream oil and gas, including contract negotiation for institutional capacity ▪ Advocate and plan for a regional market in oil and gas resources discovery and development strategies to strengthen collective energy security
Demand-side restraints 	Demand-side energy saving programmes by industry	▪ Initiate a national programme on industrial and household energy efficiency ▪ Conduct national review of demand retraining policies for oil and gas and raise awareness about their implementation during appropriate, or emergency, conditions (such as rationing and quotas, conditional restrictions, and so on.)

4 ENERGY SECURITY IN THE ELECTRICITY SUB-SECTOR

4. ENERGY SECURITY IN THE ELECTRICITY SUB-SECTOR

Electricity availability, affordability, and capacity have become relevant considerations for, and enablers of, achieving economic development and transformation aspirations of countries. With the increased importance placed on the energy sector, particularly the electricity sub-sector, some objectives have become priorities. These include improving industrial energy supply, expanding electricity access to the population, increasing per capita electricity consumption, enabling commercial and productive uses of energy to support social goals, and enhancing the overall sustainability and security of the electricity system.

Following member countries' 2011 Ministerial meeting call for improved electricity security, the IEA put forward an Electricity Security Action Plan (ESAP) to advise on energy security management, in the context of decarbonisation of the sector. The IEA identifies the security of electricity supply as comprising system security, power adequacy, and fuel security.[53] The management of fuel sources, system management, and power adequacy planning, are key pillars of electricity supply security within the IEA framework.

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In the context of the European Union (EU), the Union of the Electricity Industry (EURELECTRIC) notes that with growing dependency on electricity, the continuity of supply has become vital due to the damage "even short interruptions" can cause to an economy. It views the security of electricity supply time-bound – the short-term electricity supply security encompasses the operational reliability of the system, and its long-term dimension encompasses the "simultaneous" adequacy of fuel sources, generation, network systems and energy markets.[54] Consequently, electricity systems that optimise short-term operational performance and manage risks from the fuel source to markets effectively are more resilient and have better security of supply.

Following a similar time-wise approach, the UK Parliamentary Office of Science and Technology identifies the key dimensions of energy security over time. It indicates "very short-term" risks as emanating from the quality of electricity supply (nature of interruptions, outages, others) and the short-term challenges of matching supply and demand over the day (including peak demand management). The medium-term refers to maintaining sufficient generation and network capacity up to 2 years ahead (thereby sustaining the system capacity margin). The long-term risks relate to investment planning more than 2 years ahead (forward looking system investment), and the "very long-term" risks related to demand and technology shifts 10 or more years ahead (anticipatory system management).[55]

However, beyond the security of supply, affordability is also a key economic consideration. High-cost energy is regarded in some economic sectors as unviable. As such the security of electricity supply is articulated as the ability to ensure continual adequate, affordable and quality electricity supply, through the effective management of risks in the entire electricity system, including markets. In other words, supply security is the stability and reliability of the electricity system in a manner that delivers adequate, quality and affordable power supply to end-users.

53 International Energy Agency. 2013. "Secure and Efficient Electricity Supply During the Transition to Low Carbon Power Systems."

54 Union of the Electricity Industry (EURELECTRIC) (EU). November 2004. "Security of Electricity Supply."

55 Ibid.

Electricity demand and supply conditions in the EAC

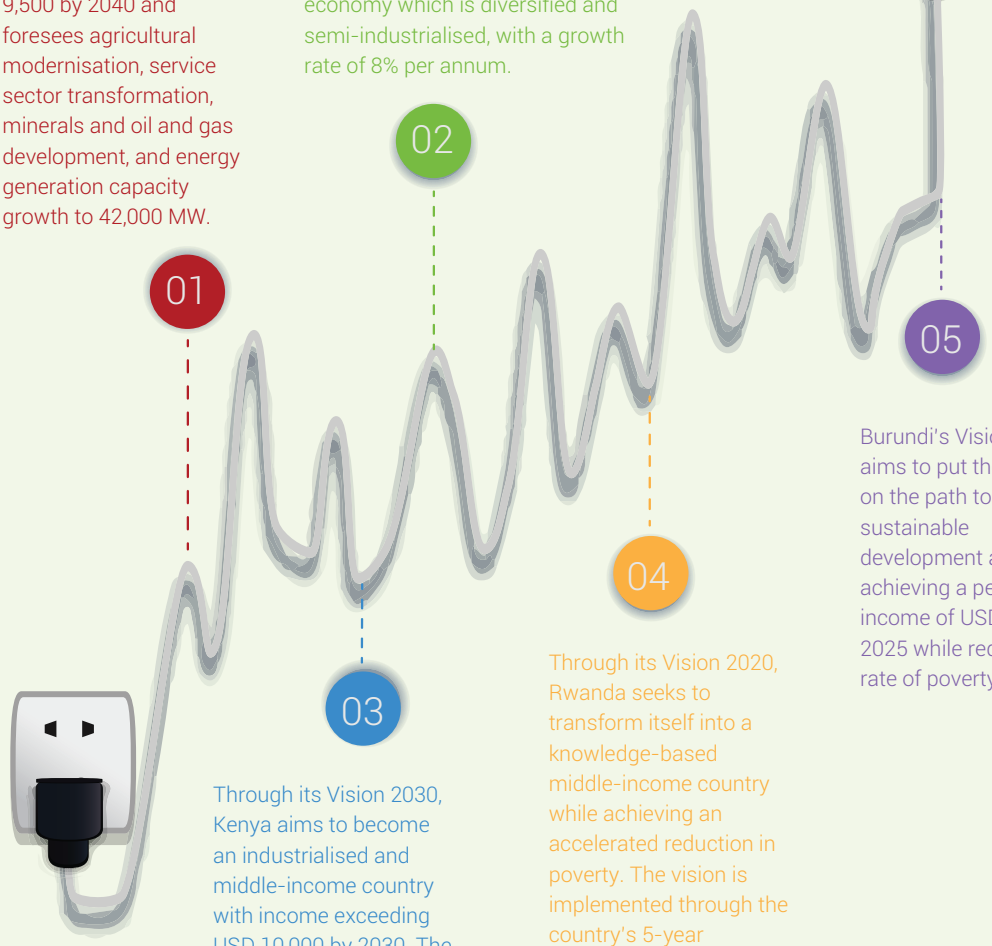
The EAC Partner States have set themselves ambitious economic development and transformation objectives.

Uganda's Vision 2040 seeks to increase per capita income to USD 9,500 by 2040 and foresees agricultural modernisation, service sector transformation, minerals and oil and gas development, and energy generation capacity growth to 42,000 MW.

01

Through its Vision 2025, the United Republic of Tanzania aims to build a strong and competitive economy which is diversified and semi-industrialised, with a growth rate of 8% per annum.

02



03

Through its Vision 2030, Kenya aims to become an industrialised and middle-income country with income exceeding USD 10,000 by 2030. The vision is anchored in the growth drivers of tourism, agriculture, trade, manufacturing, business process outsourcing and financial services.

04

Through its Vision 2020, Rwanda seeks to transform itself into a knowledge-based middle-income country while achieving an accelerated reduction in poverty. The vision is implemented through the country's 5-year development plans.

05

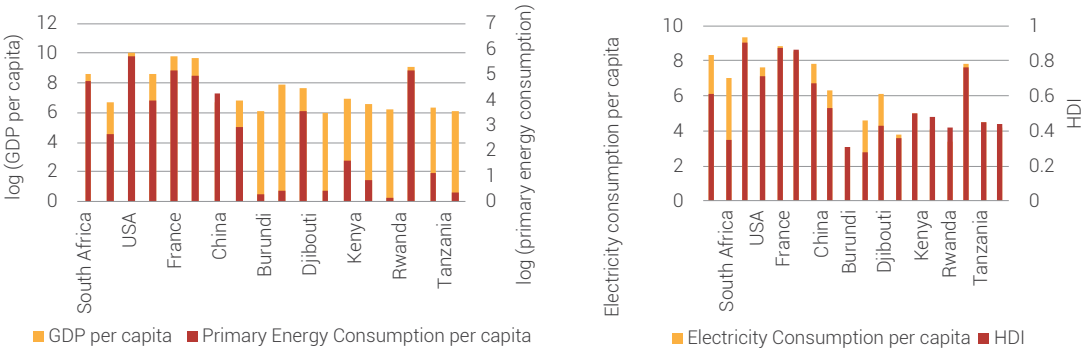
Burundi's Vision 2025 aims to put the country on the path to sustainable development and achieving a per capita income of USD 725 by 2025 while reducing the rate of poverty by half.

The achievement of these EAC Partner States' economic visions, particularly those related to industrialisation and economic transformation, require the rapid expansion of the electricity supply capacity, affordably and reliably.

4.1. Global, continental and regional electricity sub-sector agendas

Energy and socioeconomic development are closely linked, whereby energy access supports economic activities[56] and collectively affects the growth of GDP.[57] Based on analysis of countries at different levels of economic development, there is a positive relationship between per capita income levels and per capita energy consumption, and that the degree of human development is associated with levels of electricity consumption per person.

Figure 26. Development and energy consumption



By these observations, the UN Rio+20 Conference noted that since 1992 the lack of sufficient progress in sustainable development had been affected by energy crises at the global scale, particularly in developing countries. Therefore, challenges related to developing sustainable energy need to be addressed.[58] Similarly, the World Summit on Sustainable Development in 2002 adviced, through the Johannesburg Plan of Implementation, the importance of expanding energy access to economic and social development. The New Partnership for Africa's Development (NEPAD) put forth a continental vision for access to reliable and affordable energy supply for 35% of the continental population by 2015, and availability of energy to support 6% economic growth per year.

The operationalisation of Regional Power Pools in Africa gave the energy agenda further continental momentum and aimed to implement a broader agenda. Similarly, the Regional Economic Communities (RECs) of Africa pursued various energy sector development initiatives. These include Economic Community of West African Countries (ECOWAS) Regional Energy Strategy, the Central African Economic and Monetary Community (CEMAC) Energy Action Plan, the East African Community's (EAC) various energy sector regional initiatives, including the East Africa Power Master Plan and the Regional Strategy on Scaling Up Access to Modern Energy Services, and Southern Africa Development Community (SADC) Energy Activity Plan.[59]

These multiple efforts to provide a broader vision and direction to the development of the electricity sector are consolidated globally through the UN Sustainable Energy for All (SE4ALL) initiative. The

56 Allerdice, A. and J.H. Rogers. 2000. "Renewable Energy for Microenterprise." National Renewable Energy Laboratory, USA.
57 Nondo, et al. 2010. "Energy Consumption and Economic Growth: Evidence from COMESA Countries." Southwestern Economic Review 39(1): 107-120.
58 UNECA, Sub-Regional Office for Eastern Africa. 2014. "Energy Access and Security in Eastern Africa: Status and Enhancement Pathways."
59 UNECA, Sub-Regional Office for Eastern Africa. 2014. "Energy Access and Security in Eastern Africa: Status and Enhancement Pathways."

initiative aims to achieve universal access to modern energy by the year 2030, doubling the share of renewable energy in the global energy mix, and doubling energy efficiency. These initiatives helped bring more policy attention to electricity sub-sector development. Supplemented by country-level initiatives; the sub-sector is now entering into a period of transition and transformation. However, managing the security of electricity supply during this transformation is crucial.

4.2. Electricity demand and supply conditions in the EAC

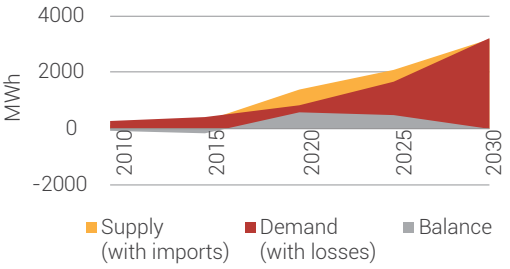
The EAC Partner States have set themselves ambitious economic development and transformation objectives. Uganda's Vision 2040 seeks to increase per capita income to USD 9,500 by 2040 and foresees agricultural modernisation, service sector transformation, minerals and oil and gas development, and energy generation capacity growth to 42,000 MW. Through its Vision 2030, Kenya aims to become an industrialised and middle-income country with income exceeding USD 10,000 by 2030. The vision is anchored in the growth drivers of tourism, agriculture, trade, manufacturing, business process outsourcing and financial services. Through its Vision 2025, the United Republic of Tanzania aims to build a strong and competitive economy which is diversified and semi-industrialised, with a growth rate of 8% per annum. Similarly, the Zanzibar Vision 2020 seeks the eradication of poverty, a diversified and semi-industrial economy, high level of employment in modern sectors, with their contribution to GDP reaching 60%, and per capita income rising from USD 200 to middle-income levels. Through its Vision 2020, Rwanda seeks to transform itself into a knowledge-based middle-income country while achieving an accelerated reduction in poverty. The vision is implemented through the country's 5-year development plans. Burundi's Vision 2025 aims to put the country on the path to sustainable development and achieving a per capita income of USD 725 by 2025 while reducing the rate of poverty by half. The achievement of these EAC Partner States' economic visions, particularly those related to industrialisation and economic transformation, all require the rapid expansion of the electricity supply capacity, affordably and reliably.

Demand and supply capacity conditions indicate that the near-term energy prospects vary in the Partner States. If planned energy sector projects are implemented through 2030 in Burundi, the energy deficit is expected to narrow, and transition to some supply capacity margin. With the implementation of planned energy projects, including the 5,000+ MW generation expansion initiative, Kenya is expected to acquire surplus capacity over the 2018-2020 period. With the implementation of generation expansion, Rwanda could acquire significantly better supply. However, in the current period, the country's margin is too narrow. Uganda is expected to have a similar experience to Kenya, where a power surplus is anticipated by 2030. Tanzania's power supply margin, relative to demand, is expected to hold in the 2016-18 period. However, the margin is expected to narrow in the 2018-2020 period.

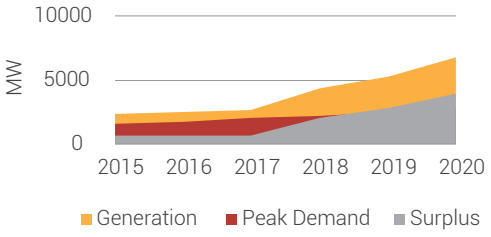
Demand and supply capacity conditions indicate that the near-term energy prospects vary in the Partner States. If planned energy sector projects are implemented through 2030 in Burundi, the energy deficit is expected to narrow, and transition to some supply capacity margin.

Figure 27. Electricity demand and supply conditions in the EAC

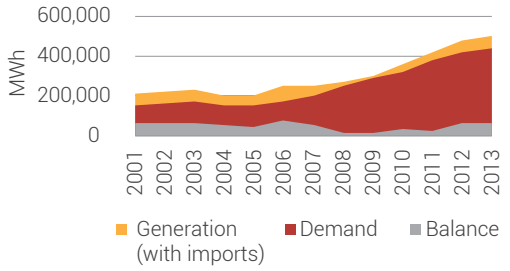
Burundi electricity demand and supply conditions: 2010 - 2030



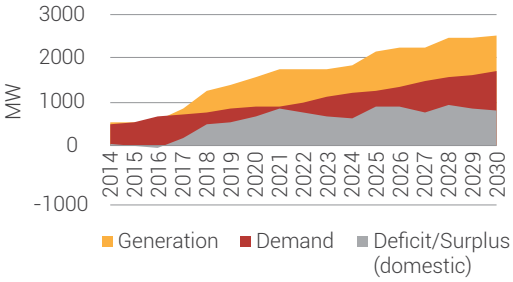
Kenya electricity demand and supply conditions: 2015 - 2020



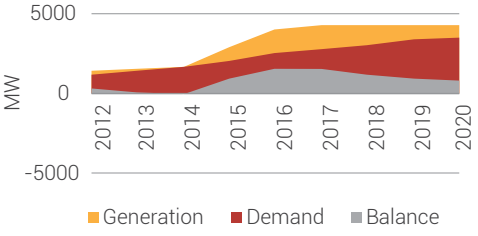
Rwanda demand and supply conditions: 2001 - 2013



Uganda electricity demand and supply conditions: 2014 - 2030



United Republic of Tanzania demand and supply conditions: 2012 -2020



With the implementation of generation expansion, Rwanda could acquire significantly better supply. However, in the current period, the country's margin is too narrow. Uganda is expected to have a similar experience to Kenya, where a power surplus is anticipated by 2030. Tanzania's power supply margin, relative to demand, is expected to hold in the 2016-18 period. However, the margin is expected to narrow in the 2018-2020 period.

4.3. Electricity supply security challenges in the EAC and their impacts

The impact of electricity supply insecurity is often immediate, and when in the form of outages, end users notice the lack of supply quickly and leave little time to address the cause. In the absence of an effective electricity supply risk management, and built-in capacity and resilience, the effects of supply insecurity reach from micro to macro levels of the economy in the short-run and can affect development opportunities in the long-term. Based on the input of country-experts during the various energy security consultative workshops in the Partner States, a summary of the key electricity supply security challenges and the impacts from insecurity is shown in figure 28. At the country level, Burundi faces numerous electricity supply security challenges, caused by: network inefficiency; heavy reliance on hydro-based generation (nearly constituting all of the national supply); tariff administration and revenue collection challenges; contract enforcement and the overall low purchasing power. Kenya faces a different set of sector challenges, including: limited current generation diversification; lack of requirement on reserve margins; stability of the electricity system; network capacity and planned redundancy and policy gaps in select areas. In Rwanda, the challenges in the sub-sector include: managing fast growing demand; long distribution networks and performance; system stability and limited electricity access. Tanzania's current challenges in the sub-sector encompass non-cost reflective tariff structure, infrastructure capacity, under-investment and limited integration of non-hydro renewable energy sources. Furthermore, Zanzibar faces regulatory capacity challenges, along with high cost of self-generation and high losses in the distribution network. Sector experts in Uganda articulate that while low electricity access is a challenge, limited investment, intermittency at generation stage, the unreliability of distribution networks and transportation challenges for electricity equipment import are identified among the current constraints.

Partner States also share common challenges in the sector in their effort to shore-up electricity supply security. The high cost of energy, excessive reliance on hydro generation, high power losses over the transmission and distribution networks, aging and under-developed electricity infrastructure, lengthy delays in materialising investments and poor regional interconnection are shared challenges. Moreover, some Partner States also identify land acquisition for energy projects, vandalism of assets, current energy supply deficiency and the overall risk of climate change as shared challenges. The lack of electricity supply security framework and management strategy and practice will, therefore, lead to limited ability to mitigate the effects of the country-specific or shared challenges, resulting in undesirable impacts.

Country energy experts have identified a series of impacts from electricity supply insecurity. Electricity supply insecurity hinders economic development, limits industrial production, constraints small businesses, affects the operation of health centres and the overall affordability of energy. In Kenya, energy sector experts outline that energy insecurity will further result in higher electricity costs, and may increase system interruptions and blackouts inducing more reliance on generators, and ultimately affects the productivity of end-users. Rwanda stakeholders similarly view the nature of electricity insecurity impact compromising industrial development, project-level negative impacts, and hindrance to the overall economy. Experts and stakeholders in Tanzania caution that electricity supply insecurity is already discouraging investment, reducing productivity and constraining the national economy, and can lead to rising electricity costs. Moreover, Zanzibar experts share the concern about disruption of public services, but further caution the negative impact of energy insecurity to the tourism sector, and overall economic growth. Experts and stakeholders in Uganda

similarly indicate that energy insecurity is affecting businesses, operational quality of public service centres and the overall business climate perception. Similarly, the necessity of investing in increasing power and system capacity due to lost energy is outlined as another effect of electricity supply insecurity on long-term investment in the sub-sector. Therefore, the overall effect of electricity supply insecurity is far reaching, affecting both the energy sector and the economy at large, as well as constraining the economic development and transformation aspirations of EAC Partner States. Strengthening existing electricity supply enhancing measures taken by the Partner States and expanding the scope of action through electricity supply security framework, strategy and action can shift the long-term energy security condition in the EAC.

Figure 28. Electricity sub-sector challenges and impacts in the EAC

4.4. Tracking energy security in electricity sub-sector: key factors

4.4.1. Fuel sources and energy resources input supply risks

Fuel input shapes energy security in the electricity sub-sector from input market organisation factors to external risks with effect on electricity availability and affordability over time.

Fuel/energy resources input stability

Electricity is generated based on various fuel sources and energy resources as inputs. The availability and affordability of these inputs are part of the overall generation security. The fuels sources in the EAC are:

- **Hydro -** the continual water flow at the acceptable level of water capacity is a recurrent challenge. Water volume available to hydro plants varies based on seasons, drought conditions, land use patterns, competing use for water and the effects of climate change. Drastic changes to water input supply to reservoirs and plants is a major risk to hydro-dependent systems. Partner States have experienced drastic power output cuts due to drought conditions in recent years. Tanzania in 2014/15 faced drastic power output cuts due to drought. Historically, drought conditions in 1998-2000 have led to a 25% decline in hydro generation.[60] Through its effect on temperature and evaporation and temporal hydrological variations due to floods and particularly droughts, climate change poses a significant risk to input stability of hydropower systems.

- **Geothermal -** geothermal resources risk persists throughout operation of the field(s) and at all stages of development. In the greater Olkaria geothermal field of Kenya, for instance, sections of the geothermal field demonstrated different features, and at times wells within the same section also feature different characteristics in terms of temperature, pressure, and drilling.[61] Monitoring and investing in wells output stability and allowances for output decline are crucial.

- **Heavy fuels/liquids -** thermal generation from heavy fuels relies on the security of supply of fuels to plants. Fuel input stocks at the plant site and guaranteeing uninterrupted supply determines reliable generation from thermal sources.

- **Natural gas -** thermal generation plants based on natural gas rely on a stable and reliable supply of natural gas input. Tanzania relies on expanded use of natural gas for generation, delivering gas through a 225 km pipeline delivering processed gas from Songo Songo gas field. Based on plant capacity, 55-70 million standard cubic feet of gas per day (MMsfd), the gas input is delivered. However, increases in power demand had induced the gas processing plant to increase production to 90 MMsfd by 2009 to ease power generation challenges. One risk feature is field gas production limits have been reached. As stated by Songas company "Songas facilities are now at their physical limits and cannot increase throughput any further without significant investment."[62] Supply interruptions at production well sites planned interruptions and lack of gas storage facility highlight the risks to gas input to thermal generating units, and therefore electricity supply security.

60 Karekezi, et al. 2009. "Climate Change and Energy Security in East Africa." A policy paper.
61 Geothermal Development Company Limited, Republic of Kenya. Undated. "Risks and Risk Mitigation in Geothermal Development."
62 Available [Online] at www.songas.com.

- **Coal and peat -** currently utilised at a limited scale, with plans to expand coal-fired generation in Kenya and Tanzania and peat-based generation in Burundi and Rwanda. Stable coal and peat supplies from mines operation and storage capacity will be crucial. Interruptions in coal mining, due to operational or labour reasons, with limited storage conditions, can affect power output.
- **Wind and solar -** the intermittency of the wind and solar inputs affect stable generation. Wind and solar technologies are improving with high-efficiency resource capture and conversion to energy. However, the intermittency of the resource input requires risk management measures, such as site selection, technology identification, and other mitigation measures.
- **Bio-energy -** either in terms of fuels or direct agro-waste input for thermal generation, the constant supply of bio-energy inputs is relevant. Current co-generation related to sugar cane processing, or pineapple, coffee, flower or other related agricultural wastes indicate the risks associated with consistent input supply.
- **Ocean energy -** wave, tidal, salinity gradient and other forms of ocean energy are promising new energy resources well suited for consideration in Kenya and Tanzania. However, the resource characteristics and stable energy supply potential from these resources are currently unknown in the EAC. The generation technology for ocean energy, while has matured for off-shore wind and tidal energy, is largely not competitive today for other sources.
- **Nuclear energy -** nuclear power is identified as an option in meeting the generation needs of Kenya and Uganda. In Kenya, through the Kenya Nuclear Electricity Board, a plan of generating 1,000 MW by 2022 is underway.[63] Through the planned 20 years system expansion (2011-2031), Kenya seeks to achieve 19% of energy generation from nuclear energy, the preparatory work for which is being undertaken by the Nuclear Energy Programme Implementation Office (NEPIO).[64] Uganda similarly aims to generate 1,000 MW of nuclear energy between 2026 and 2034 as outlined in the 2015-2040 energy plan, following the 2008 Atomic Energy Act and establishment of Nuclear Energy Unit (NEU) and the Atomic Energy Council (AEC). Key areas of preparation for implementation of the plan are identified, including human resources, site selection, physical infrastructure, and financing.[65] Securing the enriched uranium fuel source will, therefore, be a crucial consideration in nuclear energy security of supply.

Stability and reliability of supply of energy fuels and resource inputs to generating plants will continue to affect the security of electricity supply.

To date, the generation technology for electricity in the EAC is barely diversified, with predominant reliance on few fuel sources and technologies. For the security of electricity supply, the planned transition of generation technology diversity is a relevant consideration.

Generation technology and entity diversity

To date, the generation technology for electricity in the EAC is barely diversified, with predominant reliance on few fuel sources and technologies. For the security of electricity supply, the planned transition to diversify generation technologies is a relevant consideration (see Fig. 29). The generation technology for Burundi and Uganda will continue to rely on hydropower heavily. Tanzania is planning to evolve into moderate diversification, with coal, natural gas, and hydropower playing a dominant role by 2025. Rwanda plans to feature a diversified energy portfolio, with planned development of peat, methane gas, solar, limited geothermal and integration to the regional grid, from the current hydro and thermal reliance. Kenya plans a highly diverse generation portfolio,

63 Ministry of Energy and Petroleum, Republic of Kenya. 2013. "Strategic Plan 2013-2017."

64 Ministry of Energy, Republic of Kenya. March 2011. "Updated Least Cost Power Development Plan: 2011-2031."

65 James Baanabe Isingoma, Ministry of Energy and Mineral Development, the Republic of Uganda. 2015. "Uganda Nuclear Power Development Approach."

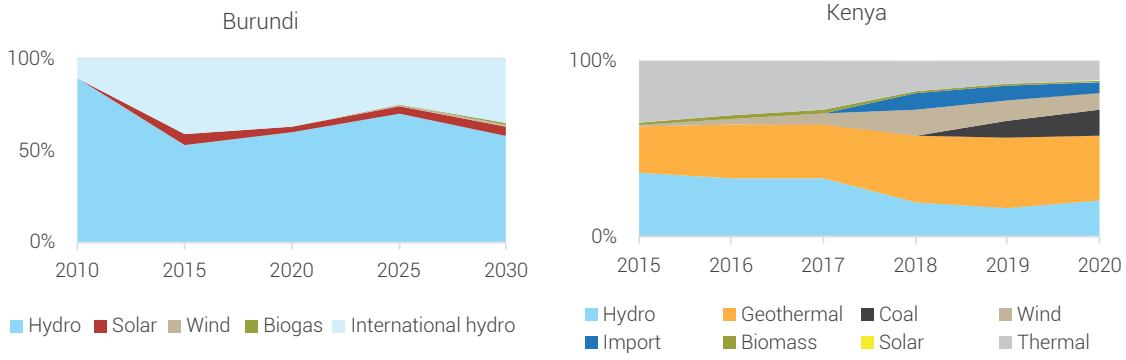
expanding on geothermal, and bringing in coal, wind and interconnecting with the regional grid for potential import/export. These plans indicate that non-hydro renewable energy will still play a limited role, except wind in Kenya and solar in Burundi and Rwanda. Diversification of generating entities also shapes the resilience of the system. Major power sector reform in Uganda, and reforms in Kenya and Rwanda on allowing IPPs participation in generation, and planned implementation of major power sector reform in phases in Tanzania are expected to increase diversified suppliers and therefore better resilience of the system. Generation diversification in the case of Zanzibar is constrained by the cost of energy, where cheaper supplies from the Tanzania Electric Supply Company Ltd (TANESCO) limited options from self-generation. A 2015 report indicates that the cost of generation of TANESCO at $0.12/kWh is more favorable than self-generation options from diesel ($0.30/kWh), large solar ($0.20-0.30/kWh) and large wind systems ($0.16-0.21/kWh).[66] However, the reliance of Unguja and Pemba on electricity generation from mainland raises concern about the security of electricity supply and lack of diversification. The 25 MW diesel generation capacity in Unguja partly compensates for the risk. However, assessment of generation diversification options, including from energy resources from Mainland, in the medium to long-term seems relevant.

Lack of implementation of generation diversification will raise risks to the security of electricity supply.

Generation system adequacy

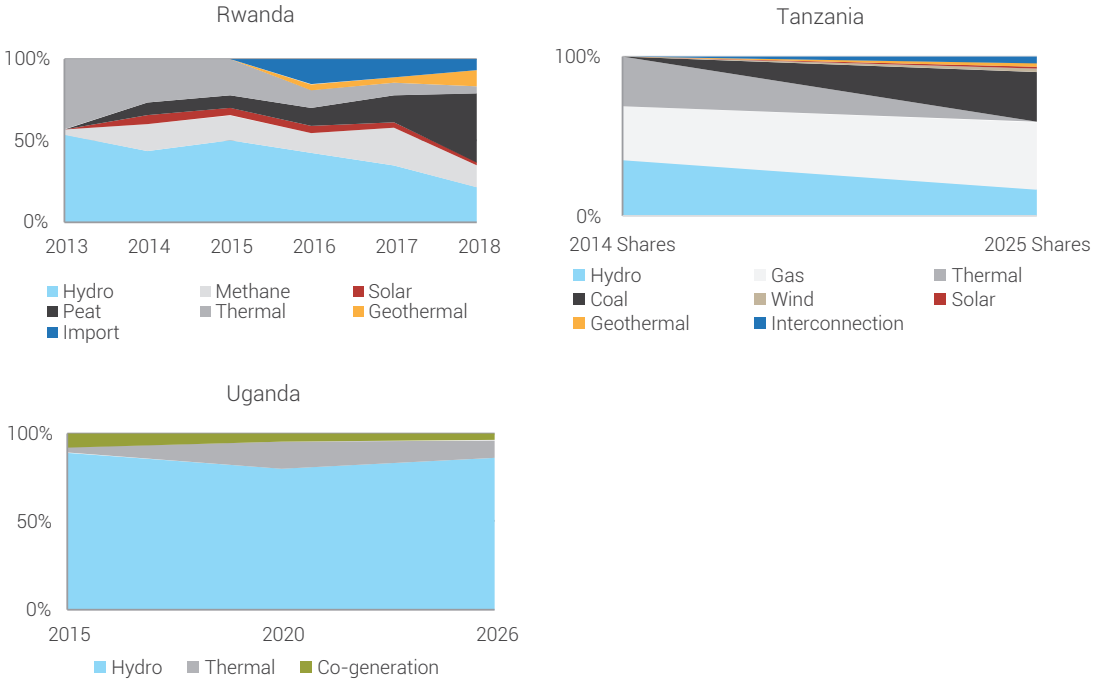
Based on generation capacity, reliably available capacity will consider margin against peak, outages, non-usable capacity and other required system reserves. Reliable available energy, with generation spinning reserve, relative to peak demand over time is a relevant consideration for the security of electricity supply. In Uganda, for example, a reserve margin of 10% is planned, but under contingency conditions, equipment load of up to 120% is expected.[67] Experts in Rwanda, on the other hand, caution that the generation spinning margin is limited due to demand and supply conditions, which are expected to be eased with the implementation of generation projects in the pipeline. Generation system adequacy shapes security of electricity supply, and planning and retaining such capacity will strengthen system performance.

Figure 29. Planned generation diversification in the EAC



66 The Revolutionary Government of Zanzibar. March 2015. "Zanzibar Energy Sector Review, Final Report."

67 Uganda Electricity Transmission Company Limited (UETCL). 2015. "Grid Development Plan 2015-2030."



4.4.2. Transmission and distribution system adequacy and risks

Transmission system effectiveness and adequacy

The operational efficiency and adequacy of the transmission system have a major role in electricity supply security. In this regard, three aspects of the transmission system are relevant: power evacuation capacity, system performance, and regional interconnection capacity to diversify and reduce risks.

Evacuation capacity

A transmission capacity enabling effective evacuation of power, including from new generation sites, helps expand reliably available energy capacity for end users. Experts in Uganda view that in the past load shedding was largely due to generation shortfall, but today power evacuation capacity has become a constraining factor whereby there is stranded energy capacity. Considering that Power Purchase Agreements (PPAs) may include provisions for "deemed energy," the cost of the generated energy is incurred, but the supply is not delivered, therefore affecting both costs of energy and its availability, affecting the security of electricity supply. In some cases, generated power is directly fed into the distribution network due to system constraints. Experts in Kenya similarly highlight system constraints on evacuating power to Nairobi. In Tanzania, the Kirwa power project aims to generate over 300 MW. However, the infrastructure to evacuate this power is not in place. Tanzania requires that plants within 10 km of grid infrastructure can expect off-takers to build the necessary infrastructure, but developers are expected to consider infrastructure cost for locations more than 10 km from the grid. Addressing effective generation-transmission linkages and ensuring enhanced power evacuation capacity will strengthen supply security of electricity. Partner States are already investing in new transmission lines, including cross-border interconnections, and improving existing networks. In the case of Zanzibar, underwater cables have the capacity of evacuating up to 100 MW of electricity for Unguja and 25 MW for Pemba, with 45 MW second line to Unguja with enough transmission capacity margin through 2020 for Unguja and beyond for Pemba. Security of the transmission network is critical due to full reliance on the infrastructure for the security of electricity supply.

System performance

The performance of the transmission system can be observed based on interruptions, power losses, power quality and other metrics. For the security of electricity supply, high performing networks are necessary.

Interruptions

The frequency and duration of interruptions in delivering power to distribution networks and end users imposes costs. Data from Uganda, for example, indicates that power not supplied increased sharply from 2009 to 2011 (by 102% between 2009 and 2010, and 1,209% between 2010 and 2011) to have subsequently also sharply declined (by 51%, 97% and 44% between 2012 to 2014, respectively). System constraints and load shedding, however, continues to be system challenges in the EAC. Recent improvements in Uganda are also related to the expansion of hydro generation capacity that reduced load shedding. Interruptions are perennial problems in the EAC in general.

Transmission losses

Transmission network power losses in the EAC are generally within range. Kenya had a 3.55% loss rate in 2010, coming to 3.5% through 2015 by taking such measures as loss minimisation, economic merit order of generation loading, improvement in reactive compensation in the distribution network, installation of equipment to compensate for reactive power and improvements in the optimal dispatch of power plants.[68] Similarly, Uganda saw transmission losses reduction from 3.8% in 2009 to 3.27% by 2014.[69] Estimates for Tanzania show a transmission loss of 5.3%, with the expectation of decline over time at 0.2% per year for planned years.[70]

Power quality

Experts at the EAC country consultative workshops identified power quality as a challenge. Kenya, for example, seeks through the national system stability improvement strategy to include maintaining system frequency deviations at 1.54 hrs/day, voltage deviations at 0.01 hrs/day and improving system monitoring capabilities.[71] Power quality in the context of power trade will further be a challenge, requiring harmonisation of standards. System frequency management is undertaken, in Uganda, by the Uganda Electricity Transmission Company Ltd (UETCL) and, in Kenya, by Kenya Power and Lighting Company (KPLC) – currently named Kenya Power -which then coordinate joint system frequency control. However, keeping the same accuracy frequency measurement is identified as a challenge to comply with the grid code.[72] UETCL – KPLC Joint System Operation procedures that are in place are being followed to ensure the best frequency management.

Other factors - polls, vandalism, and security

Transmission infrastructure relies on polls, which in some cases, such as Uganda, are predominantly wood polls. State companies previously produced transmission polls, with a system of poll quality monitoring. The wood polls market now sees private sector operators and importers. During country consultations, it was observed that new poll supplies are largely sub-standard, outside the oversight

68 Ministry of Energy and Petroleum, Republic of Kenya. June 2015. "Power Sector Medium Term Plan 2015-2020."

69 Uganda Electricity Transmission Company Ltd (UETCL). May 2015. "UETCL Annual Power System Report for 2014."

70 Ministry of Energy and Minerals, United Republic of Tanzania. May 2013. "The Executive Summary of Power Master Plan 2012 Update."

71 Ministry of Energy, Republic of Kenya. March 2011. "Updated Least Cost Power Development Plan, Study period: 2011-2031."

72 Uganda Electricity Transmission Company Limited. May 30 2015. "UETCL Annual Power System Report for 2014."

of the national bureau of standards, are often low in price and competing with state wood polls in bids, and are in need of replacement in shorter years than anticipated. There is limited capacity to regulate the quality and standard of wood polls. At estimated rate of USD 50/poll for treated and USD 40/poll untreated, poor quality polls with short service life may affect infrastructure cost and system-wide cost of energy. In one case, it is reported that new transmission infrastructure was available at 10% of capacity due to poll quality shortfalls. Furthermore, in cases of fire, wood polls are also vulnerable infrastructure.

Vandalism of infrastructure is another major challenge, reported in Kenya, Uganda, and Tanzania, in some cases characterised as "rampant." It is affecting cost in replacement of lost assets and asset protection measures. In the case of UETCL, compared with 4th quarter 2006, the share of security expenditure on total operation and maintenance cost had increased by 286% by the 4th quarter of 2010. This share further increased by 228% in the second quarter of 2015. Vandalism and asset protection measures, therefore, will introduce system-wide costs, raising long-term energy unit costs.

Regional trade capacity

Despite current constraints in regional interconnection capacity, Partner States are undertaking investments in regional interconnections, and long-term plans anticipate a well-integrated regional network. Through the Eastern electricity highway, with a length of 612 km, Kenya anticipates linking with Ethiopia over 500 kV bipolar line with a capacity to evacuate 2,000 MW. The Tanzania-Kenya interconnection over 400 kV double circuit line is planned to evacuate up to 1,400 MW and is expected to facilitate Southern African Power Pool (SAPP) and Eastern Africa Power Pool (EAPP) interconnection. The Lessos-Tororo interconnection has evacuation capacity of 300 MW. The Kigali-Kampala-Lessos interconnection is facilitated through the Nile Equatorial Lakes Subsidiary Action Plan (NELSAP), with the goal of also linking Burundi and D.R. Congo. These regional initiatives, when finalised, are expected to bridge the infrastructure capacity to evacuate power, and improve on availability and affordability of energy. Currently, the role of regional power trade in the security of electricity supply is minimal.

Through the Eastern electricity highway, with a length of 612 km, Kenya anticipates linking with Ethiopia over 500 kV bipolar line with a capacity to evacuate 2,000 MW. The Tanzania-Kenya interconnection over 400 kV double circuit line is planned to evacuate up to 1,400 MW and is expected to facilitate Southern African Power Pool (SAPP) and Eastern Africa Power Pool (EAPP) interconnection.

Distribution system effectiveness and adequacy

Distribution capacity

The capacity and development of the distribution network is a requirement considered for the national energy access plans in the EAC. Through the Last Mile Connectivity project, Kenya sought to increase electricity access from 25% to 75-80% by 2017. Tanzania seeks to increase electricity connectivity to 50% and electricity access to 75% by 2025. By 2017, Rwanda sought to expand electricity access to 70% of the population. Through the Sustainable Energy for All country action plan, Uganda seeks universal electricity access by 2030. The Sustainable Energy for All action agenda for Burundi also requires an ambitious access target. These objectives will require investment in grid infrastructure expansion. The current distribution capacity is limited, concentrated largely in urban areas. Aging and inefficient distribution networks are often identified in country consultative meetings as a constraint in the security of electricity supply.

System performance

Transmission related challenges, such as power quality and cascading interruptions, vandalism and infrastructure security,[73] the quality of polls and others are also ongoing concerns in distribution networks. The performance of distribution networks in the EAC at large is a major risk to the security of electricity supply. Burundi experiences a combined transmission-distribution network loss of 24.4%, of which 15% is commercial.[74] Kenya's distribution line losses have come down from 12.9% in 2008 to 11% by 2014, with 2.5% non-technical losses.[75] Distribution network technical losses of 8.1% by 2012 is reported in Tanzania, with 11.6% additional commercial losses.[76] The losses for Zanzibar are similarly high but declining, from 32% in 2012 to 17% in 2014.[77] Rwanda has a 23% combined transmission and distribution loss.[78] Therefore, EAC-wide, the performance, and adequacy of the distribution network to guarantee the security of electricity supply remain to be a challenge.

4.4.3. Electricity market organisation and risks

Market organisation and security of supply

The energy market in the EAC has overall moved in the direction of reform. There are different market structures today shaping the nature and outcome of electricity markets. The long-term energy supply capacity improvement and accessibility of affordable electricity are partly dependent on the market organisation. One aspect is an investment in generation and distribution systems, which in integrated monopolies with socially-set tariffs were inadequate. Monopoly over power generation and lack of access to grid infrastructure to the private sector were also barriers to energy supply and system performance improvements. The electricity market in Burundi is largely an integrated monopoly, where generation, transmission, and distribution are undertaken by the State utility Régie de Production et Distribution d'Eau et d'Electricité (REGIDESO). Burundi share of hydro power through La Société Internationale d'Electricité des pays des Grands Lacs (SINELAC) is also delivered to REGIDESO. For rural households, the Direction Général de L'Hydraulique et de l'Electrification Rurales (DHGER) distributes power to rural households by purchasing it from REGIDESO. Currently, there is no independent regulator in Burundi, and coordination and some regulatory functions are undertaken by the Ministry of Energy and Mines.

73 KPLC reports that high rate of transformer vandalism is having adverse system performance effects, with average monthly number of transformers vandalism in June 2014 reaching 45, necessitating anti-vandalism measures such as installation of transformers in areas regarded as secure and fixing transformers high, above the voltage conductors (Republic of Kenya, Ministry of Energy and Petroleum. June 2015. Power Sector Medium Term Plan 2015-2020).

74 Ministère de L'Energy et des Mines, Direction Gènèral de L'Energie et de L'Eau, Rèpublique du Burundi. Janvier 2011. "Elaboration de la Stratègie sectorielle pour le secteur de l'energie au Burundi."

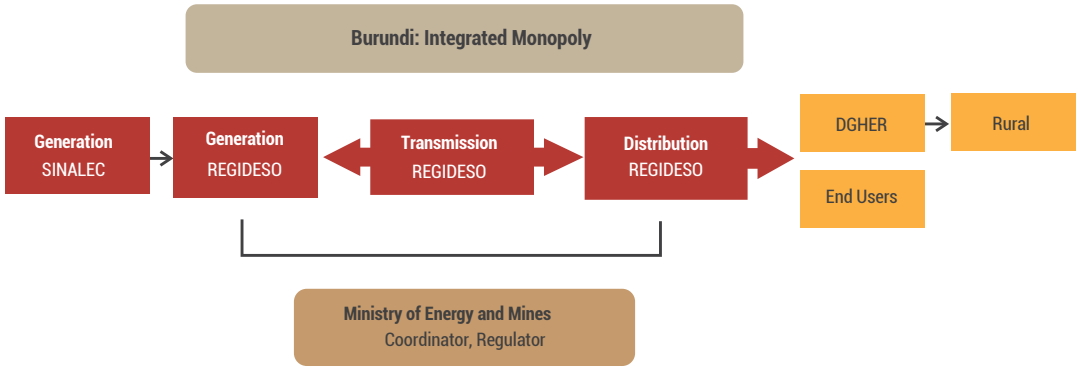
75 Ministry of Energy and Petroleum, Republic of Kenya. June 2015. "Power Sector Medium Term Plan 2015-2020."

76 Ministry of Energy and Minerals, United Republic of Tanzania. May 2013. "The Executive Summary of Power Master Plan 2012 Update."

77 The Revolutionary Government of Zanzibar. March 2015. "Zanzibar Energy Sector Review, Final Report."

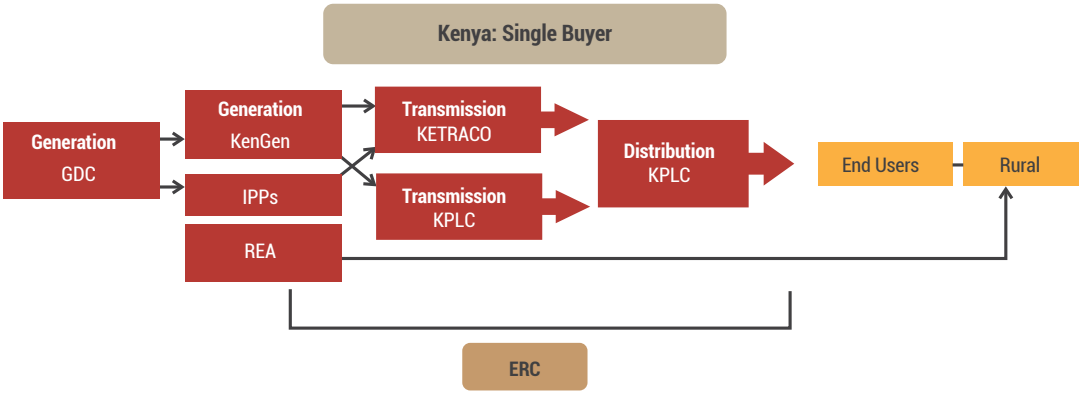
78 Ministry of Infrastructure, Republic of Rwanda. November 2014. "Sustainable Energy for All, Rapid Assessment Gap Analysis."

Figure 30. Electricity market organisation of Burundi



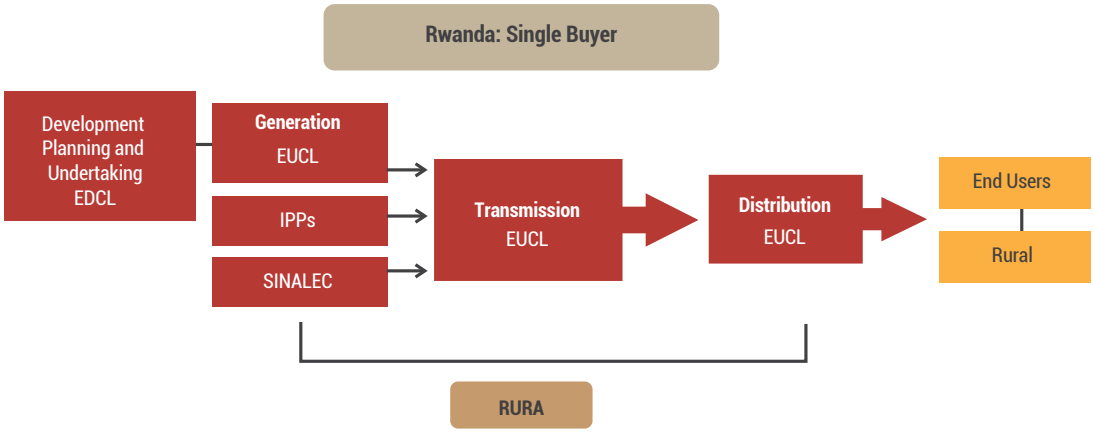
Following the 1997 market reform, Kenya has unbundled the vertically integrated monopoly of the Kenya Power and Lighting Company into new State generation company (Kenya Electricity Generating Company Limited, or KenGen), the Geothermal Development Company (GDC), and the Kenya Electricity Transmission Company (KETRACO), regulated by the Energy Regulatory Commission (ERC). Rural electrification efforts are led by the Rural Electrification Agency (REA). This reform enabled greater participation and investment in generation, and new investment in transmission infrastructure through KETRACO. Generation is open to independent power producers (IPPs). However, it is a single buyer market structure where KPLC and KETRACO evacuate all generation, and KPLC solely distributing electricity, thus constituting a different form of vertical integration.

Figure 31. Electricity market organisation of Kenya



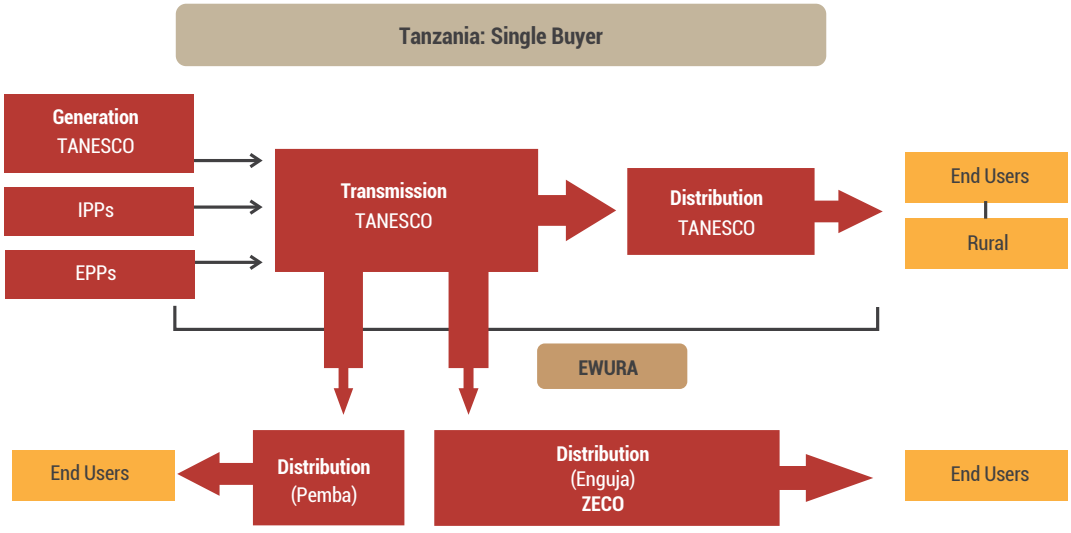
Rwanda had a vertically integrated monopoly market structure, but recent reform has introduced limited market structure change. Generation, transmission, and distribution are undertaken by the Energy Utility Corporation Limited (EUCL), in an integrated fashion. However, independent power producers (IPPs) are allowed to generate electricity. Energy Development Corporation Limited (EDCL) undertakes the plans and construction of energy infrastructure and hands over to EUCL for operation. The Rwanda Utilities Regulatory Authority (RURA) regulates the sector. The reform has separated energy from other responsibilities of the utility, such as sanitation and water services, however much of the value chain remains vertically integrated.

Figure 32. Electricity market organisation of Rwanda



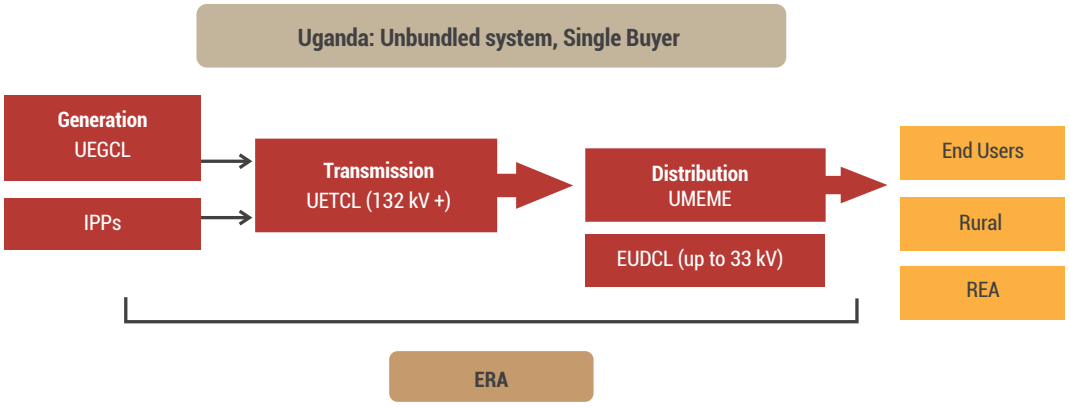
Tanzania is in the midst of a major, but gradual, market reform. Currently, generation, transmission, and distribution are vertically integrated and operated by the Tanzania Electric Supply Company Limited (TANESCO), with measures that opened generation to IPPs and emergency power producers (EPPs). TANESCO also supplies power to Zanzibar through the utility - Zanzibar Electricity Corporation (ZECO). Further reform over time is expected to lead to transmission and distribution unbundling.

Figure 33. Electricity market organisation of Tanzania



Following the unbundling of the Uganda Electricity Board (UEB) in 2001, the Uganda Electricity Generation Company Ltd (UEGCL) has taken over much of the generation infrastructure, while the Uganda Electricity Transmission Company Ltd (UETCL) has taken management of transmission lines 132 kV beyond. The Uganda Electricity Distribution Company Ltd (UEDCL) has oversight over distribution assets, which is managed through concession by the distribution company, UMEME. The Rural Energy Agency facilitates rural electrification. The market is regulated by the Electricity Regulatory Authority (ERA). Despite private concession of the distribution network and participation of IPPs in a generation, the market is largely a single buyer system. The market structure and integration determines patterns of investment, cost and generation capacity in the electricity sub-sector, with long-term effects on availability and affordability of electricity.

Figure 34. Electricity market organisation of Uganda



Regulations and regulatory capacity

Regulatory capacity and enforcement are identified by EAC experts as a complex undertaking. Setting codes and standards for ensuring power supply and quality is often a challenge, and in the incident of system failures, the role of the regulator in some cases, such as Tanzania, is advisory and consultative to mitigate disruptions. Regulatory capacity is similarly a challenge in Burundi where such independent institution is being considered, and in Kenya where vertical integration meant challenges in one government agency regulating another, and enforcing it. In these cases, regulators are playing mitigating and advisory roles, pursuing system improvement, however with limited capacity to enforcing the codes. In the case of Uganda, the regulator sets performance criteria in the system and evaluates results, and aims to mitigate performance challenges including through the application of penalties for lack of up-to-standard performance. A market structure that enables independent and capacitated regulatory functions, including system performance, improves the security of electricity supply.

4.5. Demand side management and risks

Demand side management measures aim to curb the speed of energy demand growth, institute greater efficiency of energy use to conserve scare power supply and mitigate the demand-supply imbalance. These are undertaken through a series of measures. These include: industrial electricity use audits and improvement measures; promotion, standardisation, and adoption of energy efficient appliances; instituting energy saving bulbs for household, commercial and public uses; establishment of national standards for renewable energy systems such as solar panels; utilisation of supply rationing under constrained supply conditions (including rotational supply) and monitoring the overall electricity (or energy) intensity of the economy.

The EAC Partner States are already undertaking numerous energy efficiency measures which require scaling-up for large impact. These include Kenya's conduct of over 40 energy efficiency commercial, institutional and industrial audits, and 20 general energy conservation and efficiency audits across the country.[79] Rwanda's experience shows dissemination and adoption of compact fluorescent lights (CFL) targeting households with distribution of 400,000 CFLs sold to 95,000 customers, and additional 400,000 CFLs given to 80,000 new customers with estimated saving

79 Ministry of Energy and Petroleum, Republic of Kenya. 2013. "Strategic Plan 2013-2017."

per year of 54 GWh, and street lighting programme replacing high pressure sodium (HPS) lamps with light emitting diodes (LEDs) with estimated 60% power savings.[80] Uganda's efforts extend to power loss reduction and efficiency improvement in the grid, where investment requirement on grid operators and regulatory performance standards and deviation penalty are bringing efficiency gains. Tanzania's *Luku,* a prepaid electricity credit system introduced in the late 1990s shaped energy consumption by availing relevant information on consumption and cost to consumers. Furthermore, for large clients (tariff 2 and 3 categories), *Luku* is utilised with the Automated Metre Reader (AMR) system which improved user access to consumption and cost information, shaping consumption patterns and energy conservation.[81] Through national initiatives, Burundi was pursuing energy savings through transmission loss reduction efforts, distribution of efficiency bulbs, an energy audit of the utility itself and national guidelines on the application of energy efficient (EE) appliances.

Under severe supply-demand imbalance conditions, rationing energy is implemented in the EAC. In July 2011, drought in the region had brought hydro power output down, leading Kenya to ration electricity evenings from 6:40 pm to 9:30 pm, particularly in industrial places. Repair work on the natural gas turbine in Tanzania in May 2016 has caused shortfall and rationing of up to 10 hours a day for nearly a week. In 2013, Zanzibar had rationed power due to power cable faults, reducing electricity supply to key sectors such as tourism, in an emergency condition that took weeks. To avert an energy crisis, Rwanda in 2012 also opted for electricity rationing and introduced "time of use" tariffs where by industrial electricity use between 5 pm and 11 pm faced a 33% hike in rates. Low rainfall in 2011 also compelled Burundi to ration electricity for 4 hours a day. Power supply crisis in 2011 in Uganda led to riots due to outages, and protest from some thermal generators for lack of timely payment. These measures hit the industry, particularly coffee processing. Demand side management measures such as energy efficiency improvement and its scaling, and demand side use management, including rationing, offer operational scope to improve the overall security of supply of electricity.

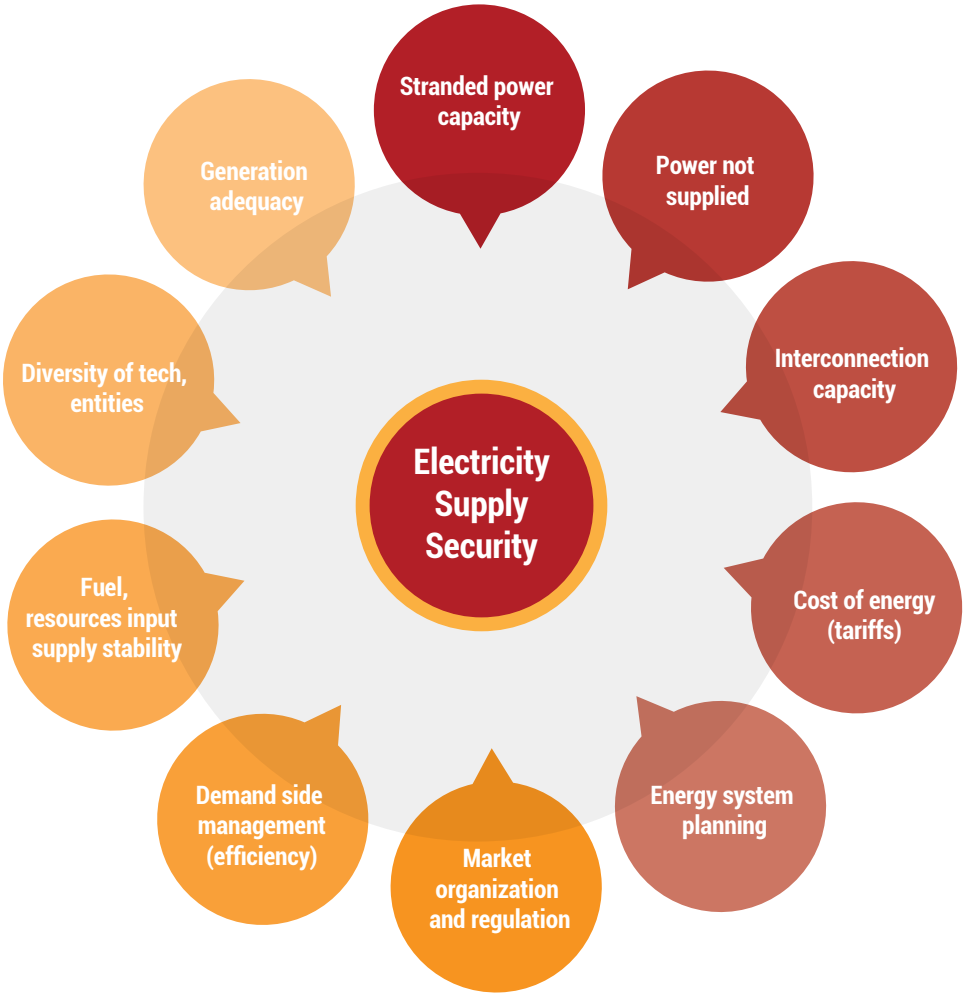
4.6. Electricity supply security: system risks and building resilience

The supply security of electricity has ten dimensions, with eight supply side indicators, one value chain, and one demand side indicators. Monitoring and management of these dimensions determine the supply security of electricity, with short, medium and long-term outcomes observable on continual availability and affordability of electricity. For the ten dimensions of supply security of electricity, monitoring indicators, their measurement, evaluation approach and the risks and resilience factors for each factor are outlined. Beyond identification of the indicators and their monitoring and evaluation, risks and resilience factors are incorporated.

The supply security of electricity has ten dimensions, with eight supply side indicators, one value chain, and one demand side indicators For the ten dimensions of supply security of electricity, monitoring indicators, their measurement, evaluation approach and the risks and resilience factors for each factor are outlined.

80 Ministry of Infrastructure, Republic of Rwanda. 17 March 2015. "Energy Sector Strategic Plan: 2013/14-2017/18."
81 Kaijage, K. 2015. "Achieving Sustainable Energy Consumption in Tanzania."Available [Online] at https://sustainabledevelopment.un.org/content/documents/634985-Kaijage-Achieving%20Sustainable%20Energy%20Consumption%20in%20Tanzania.pdf.

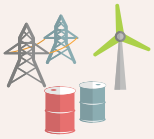
Figure 35. Electricity Supply Security Framework



Risks and Resilience Factors in Security of Electricity Supply

In the identified dimensions of supply security of electricity, the degree of impact from risks in the identified dimensions depends on the intensity and built-in resilience of the electricity system in the Partner States. Similar to oil and gas and biomass supply security, the risks across the different dimensions of electricity supply security stem from conducting business as usual, or taking minimal energy security enhancing measures. Awareness, measurement, and management of risks in the electricity sub-sector and building resilience throughout the system help minimise the magnitude of impacts from experienced risks. Indicators and their monitoring and evaluation enable assessing the state of electricity supply security; and with resilience building, system security is enhanced in the Partner States.

Table 7. Electricity supply security framework dimensions, indicators, measurement, risks and resilience factors

Security Factor	Indicators	Measurement	Monitoring and Evaluation	Risks	Resilience Building
Fuel, resources input supply stability 	Non-renewable fuel input (diesel, coal, gas, etc.) supply stability	Number of hours/ year generation was reduced from average, or stopped, due to fuel input shortage	Assess the effect of input fuels on generation and compile periodic report	▪ Limited/no national strategic reserve for fuels ▪ Limited/no power plant-level fuel stocking ▪ Increased intermittency in renewable resources inputs ▪ Variance in hydro availability ▪ Climate change effects	▪ Institute national strategic reserve for fuels ▪ Establish plant level fuel stocking ▪ Strengthen hydro forecast and generation planning ▪ Manage intermittency through reliable base load
	Renewable energy resource inputs (water, wind, etc.) supply stability	Number of hours/ year generation was reduced from average, or stopped, due to fuel input shortage	Assess the effect of energy resource inputs on generation and compile report		
Diversity of tech and entities 	Diversity of generation technologies	Herfindahl diversity index of generation sources - measured as sum of generation share of each technology squared	Trace periodic changes in generation diversification	▪ Continued reliance on hydro generation ▪ Limited generation technology diversification ▪ Small scale development of renewable energy resources ▪ Participation of few players in generation	▪ Prioritise generation diversification in planning ▪ Develop national atlas of energy resources and their power output potential ▪ Enable participation of the private sector in generation ▪ Establish grid accessibility through FiT and, where appropriate, net metering
	Diversity of generation players	Herfindahl diversity index of generation players - measured as sum of generation share of each generation company squared	Update national database on the number of players		

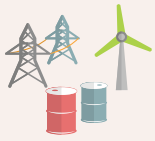
Security Factor	Indicators	Measurement	Monitoring and Evaluation	Risks	Resilience Building
Generation adequacy 	Generation spinning reserve	Percent reserved reliably available spinning generation capacity by generation source	Compile data on reserve capacity and prepare report	▪ Insufficient spinning reserve ▪ Demand growth faster than supply ▪ Limited capacity expansion to meet unserved demand ▪ Longer lead time to develop generation capacity	▪ Plan long-term expansion of power capacity and enable safe capacity margin ▪ Incrementally prepare peak load forecast for 2 years ahead ▪ Evaluate and consider suppressed demand in planning ▪ Review project delay sources and pursue required reforms
	Capacity to meet peak demand	Loss of load expectation (LOLE) - measured as number of hours/year available generation capacity will not meet peak load demand	Review energy demand and supply conditions and evaluate trends		
	Unserved energy need (cost of unserved energy need)	Expected unserved energy (EUE) - measured as MWh/year that will not be supplied due to generation capacity limits	Estimate and share the cost of unserved energy		
Stranded power capacity 	Locked-in generation capacity not evacuated	MW/year of available energy not evacuated due to transmission and distribution network availability and capacity	Conduct periodic review of stranded power capacity and share analysis	▪ Insufficient grid investment to match planned generation capacity expansion ▪ Grid condition discouraging investment in generation ▪ Increase in true cost of energy due to deemed power	▪ Clarify responsibilities of developer and off-taker on grid investment for plants ▪ Coordinate generation and grid development planning ▪ Prioritise system upgrade in hot spot areas
Energy not supplied 	Integrated system power loss	Integrated loss factor (one minus the ratio of electricity sales to electricity supplied to the grid)	Compile data and analyse trends in integrated system power loss	▪ Insufficient action to reduce system losses ▪ Limited investment capacity to upgrade infrastructure ▪ Monitoring and enforcement capacity on commercial losses	▪ Establish mandate for max allowable integrated system loss ▪ Scale-up prepaid electricity credit system ▪ Scale-up Automated Metre Reader for bulk consumers ▪ Strengthen monitoring and enforcement capacity for commercial loss mitigation

Security Factor	Indicators	Measurement	Monitoring and Evaluation	Risks	Resilience Building
Interconnection capacity 	Availability of cross-border(s) interconnection	Number of cross-border interconnections	Update information base on cross-border interconnection	▪ Delays in interconnection projects ▪ Limited/no integrated cross-border energy planning ▪ Lack of regulatory framework for regional energy trade ▪ Financial mobilisation	▪ Maximise viable regional interconnections ▪ Expand power import/export capacity ▪ Facilitate long-term establishment of a regional regulator ▪ Leverage regional markets to finance investment in generation
	Power import/ export capacity of interconnection	MW of import/ export capacity on each interconnection infrastructure	Review infrastructure capacity expansion in interconnections		
Cost of energy 	Cost of energy for end users	US$ cents/kWh by type of user	Review regulator decision on tariffs by end user	▪ Urgency and bringing-in expensive technology ▪ Sustained system inefficiency ▪ Contract negotiation gaps ▪ Continued supply deficiency ▪ Lag in needed investment ▪ Implementation delays	▪ Develop and implement least cost generation ▪ Minimise emergency planning, strengthen long-term planning ▪ Reform energy project implementation chock points ▪ Strengthen contract negotiation capacity ▪ Enable private sector investment and finance
	True cost of energy	Cost of generating, evacuating and distributing energy (including losses) (US$ cents/kWh)	Generate information on the true cost of energy		
Energy system planning capacity 	Duration of energy system planning	Number of months between assessment date and the last energy system national plan (or its revision) date	Review energy system planning cycles and delays	▪ Lack of institutionalised periodic planning ▪ Gaps in planning capacity ▪ Lack of training and human capacity development ▪ Limited, or no, use of standard planning tools ▪ Urgency, emergency, and short-term planning	▪ Institute periodic system planning, and review ▪ Invest in energy planning training and education ▪ Adopt energy planning tools through partnership with institutions, such as the International Atomic Energy Agency (IAEA)
	Institutional capacity - human capital	Number of professionals with training or expertise in energy system planning	Review human capital with planning skills		
	Institutional capacity - planning tools and utilisation	Institutionalisation of planning tools and their utilisation (demand and supply management, generation planning, transmission planning, system performance management, etc.)	Compile information on the planning methods used and the tools employed		

Security Factor	Indicators	Measurement	Monitoring and Evaluation	Risks	Resilience Building
Market organisation and regulation 	Degree of electricity market openness	Number of operating generation, transmission and distribution companies	Review progress on number of operators in the electricity market	▪ Functional vertical integration of power sector ▪ Insufficient regulatory capacity and enforcement ▪ Regulator as advisor, than enforcer ▪ One government agency regulating another	▪ Enable continued electricity market reform in the EAC ▪ Continued implementation of EAC regional electricity master plan ▪ Strengthen the independence and enforcement capacity of regulators ▪ Transform regulators, where appropriate, from largely advisory to enforcing entities
	Enforce-ment capacity in regula-tory functions	Number of enforcement measures taken/year Number of system performance standard enforcement measures taken/year	Review enforcement capacity of the regulator through its decisions		
Demand side management 	Energy efficiency	Total energy saved per year from industrial, household, institutional and public service energy efficiency measures	Estimate the total energy saved per year from implemented energy efficiency programmes	▪ Small scale improvement in industrial, institutional and household energy efficiency ▪ Lack of efficiency standards ▪ Continued high system loss	▪ Launch a national programme on industrial, institutional and household energy efficiency ▪ Request national bureau of standards to establish efficiency standards in high impact areas ▪ Consider allowable maximum integrated system power distribution loss mandate
	Power rationing	Number of times per year electricity rationing is implemented Average duration (Number of hours) of electricity supply during power rationing	Estimate and assess electricity rationing frequencies and duration	▪ Unplanned demand rationing ▪ Inadequate advance communication on rationing	▪ Review power rationing measures; where required improve such administration ▪ Strengthen communication for demand side measures

4.7. Policy actions to enhance oil and gas supply security

Table 8. Policy Actions to enhance electricity supply security in Partner States of the EAC

Energy Security Factor	Key areas	Policy actions
Fuel, resources input supply stability 	Non-renewable fuel input (diesel, coal, gas, etc.) supply stability	▪ Work with thermal generation plants to establish operational fuel stocks to minimise fuel input-induced electricity supply security challenges ▪ With the Ministry and Agencies overseeing water resources, strengthen hydro systems modelling and forecast to support generation planning ▪ Plan for high intermittency energy resource inputs through reliable base load ▪ Anticipate and integrate into generation planning climate change effects
	Renewable energy resource inputs (water, wind, etc.) supply stability	
Diversity of tech and entities 	Diversity of generation technologies	▪ Prioritise, in generation planning and implementation, diversification. Consider establishing non-traditional generation sources share through such instruments as Renewables Portfolio Standards (RPS) policy beyond hydro ▪ Undertake national assessments of power output potential from energy resources and integrate into long-term generation development planning ▪ Expand grid accessibility to investors through FiT, PPA and potentially net metering provisions
	Diversity of generation players	
Generation adequacy 	Generation spinning reserve	▪ Plan generation capacity long-term expansion with at least 10% built-in spinning reserve margin ▪ Gradually institute dynamic generation expansion plan to meet at least 2 years ahead peak load forecast ▪ Pursue cross-sectoral reforms in key areas of lengthy delay for energy projects implementation (such as land use)
	Capacity to meet peak demand	
	Unserved energy need (cost of unserved energy need)	

Energy Security Factor	Key areas	Policy actions
Stranded power capacity 	Locked-in generation capacity not evacuated	▪ Prioritise the expansion and upgrade of grid infrastructure in stranded power hot spot areas ▪ Clarify the responsibility of, and expectations on, investors in power evacuation ▪ Coordinate generation and grid development planning to minimise power evacuation constraints
Energy not supplied 	Integrated system power loss	▪ Establish mandate for max allowable integrated system loss ▪ Scale-up prepaid electricity credit system ▪ Scale-up automated metre reader for bulk consumers ▪ Strengthen monitoring and enforcement capacity for commercial loss mitigation
Interconnection capacity 	Availability of cross-border(s) interconnection Power import/ export capacity of interconnection	▪ Fast-track regional interconnection projects ▪ Expand power import/export capacity ▪ Promote long-term establishment of a regional regulator
Cost of energy 	Cost of energy for end users True cost of energy	▪ Develop and implement least cost generation plans ▪ Strengthen contract negotiation capacity in energy institutions ▪ Enable investment of the private sector in the energy sector
Energy system planning capacity 	Duration of energy system planning Institutional capacity - human capital Institutional capacity - planning tools and utilisation	▪ Institute the conduct of periodic energy system planning, and review implementation ▪ Invest in institutional energy planning capacity and bridge global partnerships to adopt planning instruments and tools

Energy Security Factor	Key areas	Policy actions
Market organisation and regulation 	Degree of electricity market openness	▪ Pursue continued electricity market reform in the EAC ▪ Implementation of the EAC regional electricity master plan ▪ Strengthen the independence and enforcement capacity of regulators
	Enforcement capacity in regulatory functions	
Demand side management 	Energy efficiency	▪ Launch and strengthen a national industrial, institutional and household energy efficiency improvement initiative ▪ Request national bureau of standards to establish energy efficiency standards for appliances and renewable energy technologies ▪ Consider establishing allowable maximum integrated system power distribution loss mandate
	Power rationing	

5 ENERGY SECURITY MONITORING AND EVALUATION

5. ENERGY SECURITY MONITORING AND EVALUATION

5.1. Monitoring and evaluation of security of supply of biomass

Assessment of energy security in the biomass sub-sector is based on tracking, measuring and evaluating eleven dimensions that shape short, medium and long-term biomass energy security, in terms of wood and charcoal supply capacity and costs. The monitoring mechanism of the components of the eleven dimensions of biomass energy security is summarised in Table 9. The reporting period on energy security dimensions of biomass depends on the nature of available data on biomass, however reporting on each dimension at least annually is advised to trace progress towards achieving improved energy security in the sub-sector.

Monitoring the state of biomass energy security in the Partner States, based on the developed framework, will require maintaining and updating data. These include on forest fire incidents and forest crimes (including illegal harvest), efficient technology adoption (classified by efficiency tier) based on information from national programmes or assessments, monitoring progress on energy tree plantations and receiving and compiling data on national forest stocking efforts by all players and analyses of the trends. The monitoring and evaluation need to also look closely at changes in forest productivity by type of forestland, even though such data may not be available annually. Forest productivity assessments could be far and in between, but interim assessments from forest sector experts can fill the gap for in-between years.

Forest health data could similarly be challenging, but national forest health incidents database may be developed and utilised for this purpose. Alternative biomass development data can be obtained from businesses operating in biomass energy technology distribution. Land use change data can be reviewed and compared with international data to trace the impact of land use change on forests. The impact of climate change on forest resources, including forest productivity, is not naturally collected. However, until national climate change assessment reports become available, scientific studies in the Partner States, or in the EAC, are useful references.

The biomass value chain is currently largely informal, but this will need to be progressively replaced with better data, information, and statistics to trace the evolution of the wood and charcoal national value chain.

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Table 9. Monitoring and evaluation framework for biomass energy security

Forest fire and crime		Number of forest fire incidents	• Review fire incident data and report number of incidents	**Efficient conversion technologies**	Tier 1: > 50% efficient carbonisation adoption • Compile national database of carbonisation operators and review Tier 1 adoption rate
		Intensity of forest fire (loss)	• Review forest fire intensity (damage) and report forest damage assessment		Tier 2: 26-50% efficient carbonisation adoption • Compile national database of carbonisation operators and review Tier 2 adoption rate
		Quantity of wood illegally harvested	• Assess illegal forest harvest and report estimates		Tier 3: 1-25% efficient carbonisation adoption • Compile national database of carbonisation operators and review Tier 3 adoption rate
Energy plantation		Energy plantation	• Review and report size of forest plantation established in a year for energy purpose	**Resource stocking**	Afforestation • Review and report annual afforestation
Forest productivity	• Update and report plantation forest productivity assessment	Plantation forest productivity		Community forest productivity	• Update and report community forest productivity assessment
				Natural forest productivity	• Update and report natural forest productivity assessment
	• Update and report agroforestry productivity assessment	Agro- forestry productivity		Other lands productivity	• Update and report other lands forest productivity
Forest health		Percentage of forest land afflicted by disease	• Update data and report on forest health	**Alternative biomass**	Share of alternative biomass in cooking • Update data and report on share of alternative biomass in cooking energy use
		Percentage of major fuel wood forest afflicted by disease species	• Update data and report on forest healthy by relevant species for fuel wood		
Land use change		Forestland converted to other uses	• Review and report forestland conversion to other uses	**Value chain organisation**	Assessed total wood and charcoal production by licensed operators • Maintain database of licensed wood and charcoal operators and provide assessment of total supply from licensees
		Assessed impact of climate change on forest	• Report any known impact of climate change on forests, and annualise for continuing effects		Assessed total wood and charcoal distribution by registered operators • Maintain database of licensed wood and charcoal distributors and provide assessment of total distribution
Efficient cooking technology		Tier 1: > 50% efficient cookstove adoption	• Compile national database of improved cookstove distributors and assess Tier 1 adoption rate	**Population and economic growth**	Population growth • Review national population growth numbers and report implied increases to wood and charcoal demand
		Tier 2: 26-50% efficient cookstove adoption	• Compile national database of improved cookstove distributors and assess Tier 2 adoption rate		Economic growth • Review national Economic growth numbers and report implied increases to wood and charcoal demand
		Tier 3: 1-25% efficient cookstove adoption	• Compile national database of improved cookstove distributors and assess Tier 3 adoption rate		

5.2. Monitoring and evaluation of security of supply of oil and gas

Monitoring and evaluation framework for oil and gas is summarised in Table 10. This sub-sector requires tracing and analysing international, regional and national data. Market volatility and political risks can be viewed from a global perspective and traced through their effect on oil and gas markets. Import dependence is a relatively easy data to acquire and analyse, as is domestic oil and gas production capacity, refinery outputs and distribution capacity. Maritime and inland transit security can rely on existing maritime crime reporting global databases, mainly for piracy, international maritime insurance data and reported security incidents for inland transit products, including oil and gas.

Similarly, based on data from port authorities in Kenya and Tanzania, efficiency, capacity and delay times for transit and local delivery of oil and gas and trends over time can be assessed and reported to decision makers. Information on the efficiency of conversion technologies is crucial to build and maintain. While the efficiency of thermal plants data and national policy on the efficiency of imported vehicles can be tracked and compiled periodically, industrial efficiency data can be challenging. With the relevant ministries and institutions, voluntary reporting systems for industrial energy efficiency could be instituted. Alternatively, industrial and household efficiency improvement interventions can be utilised as initial data to monitor efficiency and power saving annual gains. The dimensions of fuel switching capacity and national strategic petroleum reserves and stocking per year are available datasets.

Oil and gas sub-sector market organisation and regulation data may be available but requires coordination with various agencies and the sector regulator. Enforcement actions of the regulator, known cases of product diversion, port condition data and product adulteration data based on samples of national inspection can be compiled to provide a picture and important trend data. Progress on exploration and development of oil and gas is accessible.

Finally, demand side measures, such as industrial and household energy efficiency measures will need to be gathered, compiled and analysed to monitor progress and depth of such programmes and achieved estimated energy savings per year.

Oil and gas sub-sector market organisation and regulation data may be available but requires coordination with various agencies and the sector regulator. Enforcement actions of the regulator, known cases of product diversion, port condition data and product adulteration data based on samples of national inspection can be compiled to provide a picture and important trend data. Progress on exploration and development of oil and gas is accessible.

Table 10. Monitoring and evaluation framework for oil and gas energy security

Market volatility and political risks

- Oil price volatility in global markets
  - Review and report oil price volatility
- Diversity of oil import countries
  - Review trends in diversity of oil import countries

Import dependence

- Petroleum consumption met by imports
  - Review petroleum consumption and import shares
- Natural gas consumption met by imports
  - Review natural gas consumption and import shares

Domestic production capacity

- Domestic production capacity of oil and gas
  - Volatility of domestic oil and gas production capacity
  - Unreliable production levels for planned use

Refinery and distribution networks

- Refinery capacity
  - Review bbl / day refining capacity
- Pipelines and trucking of oil and gas
  - Review the operational effectiveness of pipeline and trucking for oil and gas

Maritime and inland transit security

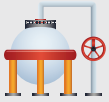
- Compile and review annual maritime corridor security data
- Maritime corridor security
- Compile and review data on port congestion and costs
- Port handling and facilitation efficiency

- Monitor and review reported incidents of road transit security for all transit goods
- Inland transport corridor security
- Port storage facility and evacuation
- Compile and review data on storage capacity gaps over time and evacuation performance

Conversion technologies and efficiency

- Efficiency of thermal power plants distribution of produced energy
  - Report on thermal power plants operational efficiency and transmission and distribution network losses
- Efficiency standard on imported vehicles
  - Trace policy on imported vehicles and limits
- Industrial energy efficiency audit
  - Follow with relevant industrial groups and Ministry to monitor progress on industrial energy efficiency audit

Fuel switching capacity



- Fuel switching capacity of power plants
  - Review changes to existing and new power plants related to ability to switch to alternative fuel sources
- Fuel switching capacity in transport sector
  - Review progress towards domestic biofuels production and use

Strategic petroleum reserves

- Public, industry and private strategic stock reserves
  - Monitor data on public, industry and private stocking of petroleum products

Value chain organisation and regulation

- Review the number of inspections per month
- Regulatory enforcement capacity

- Market organisation
  - Review the presence of oil and gas import coordination
- Review the number of product diversion incidents
- Product diversion
- Product adulteration
  - Review the number of incidents per month

Demand-side restraints

- Demand-side energy saving programs by industry
  - Compilation and review of industry energy efficiency measures and standards

Exploration and development of oil and gas

- Investor interest in exploration and/or development of oil and gas
  - Review of exploration and development progress in the upstream of oil and gas

5.3. Monitoring and evaluation of security of supply of electricity

Monitoring and evaluation in the electricity sub-sector are largely possible due to the availability of better data in the sub-sector. Generation shortfalls due to energy fuel and renewable energy inputs and diversity of both employed energy generation and participating private and public plants are traceable periodically. Generation performance data will inform generation adequacy-related assessments. Stranded power capacity is largely known, particularly by transmission and distribution companies, and regulators. Based on system performance data, energy not supplied can be regularly computed and reviewed to inform on energy security trends in the sub-sector. Interconnection data is widely available, as well as the frequency of energy sector planning and updating. However, institutional planning capacity requires an in-depth or cursory assessment to inform on progress.

Even though the cost of energy through tariffs is available for review over time, the true cost of energy requires assessment. The true cost of energy is the best economic value had electricity been available, which in the case of Kenya, for example, is USD 0.84/kWh. Alternative measurements can be utilised to reflect on trends in the true cost of electricity beyond tariffs. Trends in market reform, change in the number of players, the enforcement capacity of regulators, the organisation of the energy market, and regulatory capacity changes can help map assess electricity supply security. Finally, demand side management data is relatively accessible for measures such as frequency and duration of rationing of power. Energy efficiency data would require to be gathered nationally based on energy efficiency programmes for industry, households, and institutions. Alternative data could be industries that undertook energy audits, the number of energy efficient bulbs distributed to households per year, energy losses averted in grid infrastructure due to efficiency gains, or other indicators.

Even though the cost of energy through tariffs is available for review over time, the true cost of energy requires assessment. The true cost of energy is the best economic value had electricity been available, which in the case of Kenya, for example, is USD 0.84/kWh.

It is important to recognise that energy security in the three sub-sectors can be largely traced based on available databases, but a comprehensive, integrated and updated database maintenance, inter-institutional collaboration, and information sharing and engagement of dedicated monitoring and evaluation experts will be crucial steps. Generation of the periodic state of energy security reports at the national level will also be a formal mechanism to encourage institutionalising reporting, monitoring and evaluation processes to best inform policy and decision-makers in the sector on improving the state of national energy security.

Table 11. Monitoring and evaluation framework for oil and gas energy security

Fuel, resources input, supply stability		Non-renewable fuel input (diesel, coal, gas, etc) supply stability Renewable energy resource inputs (water, wind, etc) supply stability	• Review the number of hours per year generation was reduced due to fuel inputs shortage • Review the number of hours per year generation was reduced due to fuel inputs shortage	**Diversity of tech and entities**		Diversity of generation technologies Diversity of generation players	• Trace periodic changes in generation diversification • Update national database on the number of players
Generation adequacy		Generation spinning reserve Capacity to meet peak demand Unserved energy need (cost of unserved energy need)	• Compile data on reserve capacity and prepare report • Review energy demand and supply conditions and evaluate trends • Estimate and share the cost of unserved energy	**Stranded power capacity**		Locked-in generation capacity not evacuated	• Conduct periodic review of stranded power capacity and share analysis
Energy not supplied		Integrated system power loss	• Compile data and analyse trends in integrated system power loss	**Interconn-ection capacity**		Availability of cross-border(s) interconnection Power import/export capacity of interconnection	• Review the number and capacity of interconnections • Review the import / export capacity of interconnections
Cost of energy		Cost of energy for end users True cost of energy	• Review regulator decision on tariffs by end user • Generate information on the true cost of energy	**Energy system planning capacity**		Duration of energy system planning Institutional capacity - human capital Institutional capacity - planning tools and utilization	• Review energy system planning cycles and delays • Review human capital with planning skills • Compile information on the planning methods used and the tools employed
Market organisation and regulation		Degree of electricity market openness Enforcement capacity in regulatory functions	• Review progress on number of operators in the electricity market • Review enforcement capacity of the regulator through its decisions	**Demand side management**		Energy efficiency Power rationing	• Estimate the total energy saved per year from implemented energy efficiency programs • Estimate and assess electricity rationing frequency and duration

6 INSTITUTIONAL FRAMEWORK FOR ENERGY SECURITY POLICY AND MANAGEMENT

6. INSTITUTIONAL FRAMEWORK FOR ENERGY SECURITY POLICY AND MANAGEMENT

6.1. Institutional framework for biomass energy security monitoring and evaluation

Institutional framework

The regulation, structure, and management of biomass resources are similar in the EAC. The Forests Act (2005) of Kenya delineates types of forests and institutes the Kenya Forest Service (KFS) to oversee the management and harvest of forest products. The KFS oversees Forest Management Plan, protects forests and formulates policy and guidelines for forest management and utilisation of all types of forests. KFS also enforces and regulates logging, charcoal making and other benefit extraction from forests, as well as collects revenue and monitors forestry land uses. The KFS is governed by a Board represented from various sectors. There appears to be no representation on the Board from the Ministry of Energy, therefore limiting upstream engagement of the Ministry relevant for biomass energy security. The Minister of the Ministry of Forestry and Wildlife, as per the Forests Act, also has the mandate to set rules to control harvest, manage Forest Management Agreements and establish new forests.

Similarly, Tanzania's Forest Act (2002) authorises the Minister of the Ministry of Natural Resources and Tourism to formulate policies and implementation of the Act. The Act introduces permit issuance for fell or extracts timber for domestic uses and export, and gathering and transport of forest produce. The Ministry of Natural Resources (MINIRENA) in Rwanda ensures the protection and rational use of natural resources, and the Minister develops policies and strategies, and sector regulation through the Rwanda Natural Resources Authority (RNRA) which coordinates forest resources management.

Uganda's National Forestry and Tree Planting Act (2003) similarly establishes the National Forest Authority, declared forest reserves for protection and production and the roles of central and local government are clarified. Forest management sits in different agencies, including the National Forest Authority, Uganda Wildlife Authority, the National Environmental Management Authority and local government. The National Forestry Policy of Burundi (2012) promotes rational management and development of forest resources.

The institutional framework for forest resources management and harvest in the EAC is, therefore, under the relevant forestry ministry, managed by an agency, forest service or forest authority. The upstream forest resource management follows this framework. However, downstream post-harvest use of wood and charcoal is currently not regulated, and not within the regulatory purview of forest authorities. For energy security management of biomass, where management of the whole value chain is crucial, this leaves value chain organisation, formalisation and regulation challenges. The representation of energy sector institutions in upstream forestry management and decision making is also not visible and seems to be insignificant. Forest resources management, under the forest services and authorities, are managed to protect resources and allow rational use, as stated in the Acts and Policies of Partner States. Forest management in the context of demand and supply conditions in the biomass market is another consideration. Therefore, there is institutional fragmentation across the supply chain, and lack of downstream regulatory oversight.

Therefore, to ensure value chain-centred biomass energy security enhancement:

- Increase representation of the ministries of energy and related energy sector institutions in upstream forest sector decisions;
- Collaborate with forest sector institutions towards sustainable forest resources use, including to improve biomass energy security;
- Increase the role of the ministries of energy, and energy sector institutions in developing policies and strategies to organise downstream biomass energy markets and value chains; and
- Given the degree of importance of biomass energy to the population, and the current unsustainable practices leading the sub-sector to rapid decent to energy insecurity, the mandate of energy sector regulators should be expanding to include regulation of downstream biomass energy.

The monitoring and evaluation responsibility for biomass energy security should be within the ministries of energy as part of the sector policy and strategy formulation responsibilities, as well as sector reporting functions. More specifically:

- ***Forest fire and crime:*** is under the purview of national forest authorities and services, as outlined by the Forest Acts. However, the Ministries of energy may receive and maintain database on forest fires to assess impacts on biomass resource base, and forecasted wood and charcoal supply capacity;
- ***A national database of carbonisations using efficiency technology:*** the forest service through permitting of forest harvest may follow-up on the efficiency of carbonisation technologies used. Energy institutions, national bureaus of standards and forest sector institutions need to coordinate their activities to encourage high uptake of high-efficiency carbonisation methods, and establishing minimum required conversion efficiency standard. Data on the adoption rate of efficient technologies can be utilised to assess the contribution to energy security.
- ***Energy plantations:*** forest stocking and plantations is within the purview of forest sector institutions. However, for long-term biomass energy security, energy institutions need to partner with the forest sector and participate in decisions to provide support to national energy plantations and stock size increases. Data from forest services and authorities should be compiled under the Ministries of energy to trace progress over time.
- ***Forest productivity:*** the responsibility lies with the forest service and forest authorities. However, due to the importance of forest productivity to wood and charcoal supply, energy sector institutions need to partner with forest sector institutions in promoting and supporting forest productivity growth measures. The Ministries of energy need to compile available and updated national data on forest productivity for analysis of biomass energy security trends.
- ***Forest health:*** under the responsibility of forest services and authorities, data sharing with the ministries of energy should be pursued to trace the impact of forest health on biomass supply.
- ***Land use change:*** forest, land use, and energy institutions need to collaborate to evaluate long-term biomass supply effects of ongoing land use changes. Annual estimates assist measuring the impact of forestland use change on wood and charcoal supply.

The monitoring and evaluation responsibility for biomass energy security should be within the ministries of energy as part of the sector policy and strategy formulation responsibilities, as well as sector reporting functions.

- ***Value chain organisation:*** operation of downstream wood and charcoal is largely informal, where data is nearly non-existent, and therefore monitoring and evaluation is more difficult. Forest authorities, through their licensing functions, provide a degree of regulatory oversight on upstream wood supply. The ministries of energy and energy sector institutions need to induce energy regulators to take a greater role in formalising and regulating wood and charcoal markets. To conduct biomass energy security assessments, the ministries of energy need to initiate a national database of wood and charcoal licensed operators and undertake periodic national surveys in wood and charcoal value chains to assess demand, supply and price trends.
- ***Efficient cooking technologies:*** on the demand side, efficient cooking technologies can make a difference in mitigating demand for wood and charcoal. The ministries of energy need to develop a national database of penetration of improved cookstoves by the level of efficiency and estimate wood and charcoal annual savings.
- ***Population and economic growth:*** similar to electricity and oil and gas sub-sectors, the ministries of energy need to compile an assessment of the impacts of economic and demographic growth on wood and charcoal demand and offer annual estimates, and assess the impact on biomass energy security.

For the ministries of energy to conduct the above energy security-related monitoring, evaluation and reporting functions, it is necessary to expand institutional capacity in this area and create a new desk dealing with energy security. Existing functions within the ministries of energy related to biomass will need a review with a goal of performing energy security monitoring, evaluation, and reporting functions and integrate energy security as part of the annual institutional reporting for policy-makers and leaders. Such reports should lead to the identification of action plans to mitigate energy insecurity in priority areas outlined in the monitoring and evaluation framework, under the biomass energy security section.

The recommended institutional framework relates to the monitoring, evaluation and reporting function on the security of biomass supply and decision and directive issuance for energy security management and emergency responses. The ministry in charge of energy is advised to create a desk for the monitoring, evaluation, and reporting on biomass energy security based on the dimensions relevant for the security of biomass supply. To coordinate decisions and issuance of directives related to biomass energy security and supply emergencies, establishing an Inter-Ministerial Committee for Biomass Energy Security, with ministers, agency head, and authority executive level representation is advised. The Committee should constitute the ministry mandated with upstream forest resource management, forest service (where available), specialised agencies/authority on forest/natural resources, the ministry in charge of energy, and the energy sector regulator with an expanded mandate over downstream biomass energy supply regulation. The committee would receive periodic energy security reports from the ministry in charge of energy for guidance and emergency management decisions. Therefore, while the ministry in charge of energy is envisaged to conduct the monitoring, evaluation and reporting functions through a new desk, the Inter-Ministerial Committee for Biomass Energy Security performs the decision-making relevant for short, medium and long-term biomass system energy security and to address biomass supply emergencies.

6.2. Institutional framework for oil and gas supply security monitoring and evaluation, and emergency response mechanism

Institutional Framework

Oil and gas upstream and downstream operations are undertaken within existing institutional and operational frameworks, but regulatory frameworks are yet to be fully developed in some areas, including downstream petroleum products regulation and upstream operations. Regulatory oversight over upstream oil and gas activities requires further development, as articulated for example in the Kenya National Energy and Petroleum Policy. The ministries of energy largely undertake the institutional framework for management of oil and gas, the ministries of trade oversees petroleum trade, and national petroleum and pipeline management institutions oversee operations. In the case of Kenya, the Ministry of Energy, the National Oil Corporation (NOCK), the Kenya Pipeline Company (KPC) and the Energy Regulatory Commission provide an institutional framework for the management of oil and gas in Kenya.

Rwanda's Ministry of Trade and Industry, the Ministry of Infrastructure, Ministry of Natural Resources (MINIRENA, upstream regulation) and RURA (downstream regulation) constitute the institutional framework for managing oil and gas. Uganda's institutional framework stems from the National Oil and Gas Policy of 2008, developed by the Ministry of Energy and Minerals, and has established the Petroleum Authority of Uganda (PAU) for upstream regulation and the National Oil Company (NOC) for operation. These new institutions fill the prevailing gap in upstream and downstream oversight and operational management.

Tanzania's Ministry of Energy and Minerals provides sector oversight, including formulating strategies and laws, and the institutional framework includes the functions of the Tanzania Petroleum Development Corporation (TPDC) and EWURA (downstream regulation). The 2015 Tanzania Petroleum Act offers upstream regulation through the Petroleum Upstream Regulatory Authority (PURA). Burundi's Ministry of Energy and Mines plays a greater role in setting sector strategy and regulatory oversight and plays much of the sector role for oversight and operation.

Within the above institutional settings in the EAC, the reporting of oil and gas supply security and management of security risks are foreseen to take place through existing roles of the Ministry in charge of energy, the Ministry in charge of trade, oil and gas procurement/marketing institutions (where available), petroleum specialised agencies (where available), the Ministry in charge of upstream oil and gas development, and the energy sector regulator. As part of the reporting function for supply security of oil and gas, the Ministry in charge of energy is advised to institutionalise tracking. The tracking will include oil and gas market volatility, trends in import dependence, changes in domestic production capacity of oil and gas, progress on refinery and distribution networks, and security of maritime and inland transportation along with port operational performance review. It also includes recorded improvements in energy efficiency in the energy system, progress towards fuel switching including biofuels, progress towards instituting and operating strategic petroleum products reserves, the oil and gas value chain organisation and progress in regulatory capacity, review of demand side measures and update on exploration and potential development of oil and gas.

Related to decision making and issuance of directives for action on supply security of oil and gas, including emergencies, the recommendation is to adopt the EAC Petroleum Supply Emergency Plan (2008). The framework advises the establishment of the Management of Energy Emergency Teams (MEET), or to be named Inter-Ministerial Committee for Oil and Gas Supply Security. The

Oil and gas upstream and downstream operations are undertaken within existing institutional and operational frameworks, but regulatory frameworks are yet to be fully developed in some areas, including downstream petroleum products regulation and upstream operations.

Inter-Ministerial Committee, or MEET, is to be constituted by ministries responsible for energy, finance, trade, immigration, infrastructure, internal security, revenue authorities and EAC. MEET is the decision-making and emergency response institutional mechanism overseen by the ministry in charge of petroleum supply. MEET, or the Inter-Ministerial Committee, would receive periodic energy security reports from the ministry in charge of energy to base oil and gas supply security enhancing decisions and to address emergencies. Therefore, the Ministry in charge of energy is advised to conduct monitoring, evaluation and reporting on supply security of oil and gas through a new desk. The Inter-Ministerial Committee, or MEET, is expected to undertake decision-making and issue directives towards the management of short to long-term oil and gas supply security and response to emergencies.

Emergency response mechanism

The importance of resilience building in country energy systems to avert energy insecurity is highlighted in this policy framework. Resilience building measures in the biomass, oil and gas and electricity sub-sectors are identified. However, despite such measures, in the event of an energy security emergency, it is crucial to have an emergency response procedural plan. Emergency response is relatively well developed in the area of electricity supply interruptions, and unavailable in the case of biomass due to alternative fuels and lack of organisation of the value chain. In the case of petroleum products supply where alternative fuels are not available, and interruptions will have a direct effect, emergency response plans are regarded critical. There are different international models for response mechanisms in petroleum supply emergencies.

The China Framework

China has set-up a State Council, including the Premier, the Vice-Premiers, Ministers and State councilors as a decision-making body with authority to instruct releases of petroleum from strategic reserves of China. Implementation of the decision is facilitated through the National Development and Reform Commission, the Ministry of Finance and the National Energy Administration. The National Oil Reserve Centre implements the decisions.[82]

The Portugal Framework

Portugal requires oil market companies to maintain mandatory reserves, including gas to enable 15 days of power plant operations and 20 days of supply to household and other consumers. These required reserves are regarded as the base energy security safeguard to provide enough time for emergency responses.[83]

The India Framework

India has an Inter-Ministerial committee, including Secretaries of the Ministry of Finance, Planning Commission, Defence, National Security Council and Ministry of Shopping, chaired by the Secretary of the Ministry of Petroleum and Natural Gas. Based on the Petroleum and Natural Gas Regulatory Board Act 2006, the government can take over the downstream sector in an emergency (IEA).[84]

82 For additional information see: http://www.iea.org/publications/freepublications/publication/China_2012.pdf
83 For additional information see http://www.iea.org/publications/freepublications/publication/portugal_2011.pdf
84 For more information, see http://www.iea.org/publications/freepublications/publication/OSSIndia.pdf

The Turkey Framework

To address petroleum supply emergencies, Turkey has set-up the National Oil Stock Commission which is chaired by the Undersecretary of the Ministry of Energy and Natural Resources and composed of the Ministry of Finance, Interior Affairs, Defence, the Energy Market Regulatory Authority and the General Directorate of Petroleum Affairs (IEA). The Commission decides on oil stock releases from required industrial reserves. The decision is implemented by the General Directorate of Petroleum Affairs, which works closely with industry to effect the response.[85]

The UK Framework

The UK Department of Energy and Climate Change is the main institution to coordinate energy emergency response, extending beyond oil to electricity, nuclear power and gas supplies. Within the Ministry, the Energy Resilience Team coordinates the activities and works with companies to enforce guidelines. The response team from Government is joined by industry, through the UK Petroleum Industry Association (IEA). Implementation of the emergency response is based on an instruction to industry to draw down reserve stock, and through restraint measures to reduce demand.[86]

The USA Framework

In the US framework, in the event of oil supply security challenges, the President of the USA decides on strategic reserve draw down, an authority given by the US Energy Policy and Conservation Act. The decision of the President is implemented through the competitive sale of oil from strategic petroleum reserves, which stands above 715 million barrels. The US energy security system largely relies on maintenance of a large public strategic petroleum reserve system.

The EAC Recommended Framework

In the event of an oil supply emergency, which should also be extended to gas supplies, the EAC has put forth a response mechanism and procedure for the Partner States, communicated through the Petroleum Supply Emergency Plan (2008) summarised in the figure below. The Plan defines an emergency as "conditions, incidents or events that disrupt supplies or have adverse wide-spread effects on the ability to distribute petroleum products and/or damage facilities and infrastructure thereby affecting petroleum distribution." Implementation of the EAC petroleum supply emergency response procedure is advised in this policy framework.

85 For additional information visit http://www.iea.org/publications/freepublications/publication/2013_Turkey_Country_Chapterfinal_with_last_page.pdf

86 For additional information visit http://www.iea.org/publications/freepublications/publication/uk_2010.pdf

Figure 36. Petroleum Emergency Supply Plan of EAC

6.3. Institutional framework for electricity supply security monitoring and evaluation, and emergency response

The electricity sub-sector is relatively the most organised compared with oil and gas and biomass. The roles and functions of institutions are also relatively better delineated. The Ministries of energy, under their function of policy and strategy guidance in the sector, along with an independent regulator and operators from generation to distribution provide the overall institutional framework for the sub-sector. The electricity sub-sector has better data and organisation. The regulators, in their capacity, already gather system performance data on generation, transmission, and distribution, which can be supplemented by additional information, assessment and data to support the annual state of energy security assessment in the electricity sub-sector. Monitoring is expected in the stability of fuel inputs into power plants, diversity of generation technology and entities over time, generation adequacy, state of stranded power capacity, trends in energy not supplied and interconnection capacity. Similarly, monitoring should extend to cost of energy, energy planning capacity, nature of market organisation and regulation and demand side management capacity. Data gathering in these areas for monitoring and evaluation towards assessment of the overall direction of energy security and identification of critical areas of intervention to improve the state of energy security will be crucial. The institutional framework to mainstream these roles and responsibilities depend on the existing institutional setting in the Partner States and simplicity to enable early stage adoption of energy security monitoring, reporting, and action guidance.

In the case of Burundi, the Ministry of Energy and Mines sets the policy direction of the sector and also plays a regulatory role. The Régie de Production et Distribution d'Eau et d'Electricité is the State utility operating the electricity system from generation to distribution, along with the Direction Général de L'Hydraulique et de l'Electrification Rurales for distribution to rural households. This institutional framework constitutes the scope within which supply security of electricity monitoring and evaluation roles and responsibilities can be institutionalised. In the case of Burundi, monitoring and evaluation of energy security will ideally be located within the Ministry of Energy and Mines, by instituting a new desk responsible for energy security monitoring, evaluation and intervention. The Ministry can also serve as an emergency response institution guiding emergency management interventions.

Kenya's institutional framework for the energy sector encompasses overall policy and strategy guidance from the Ministry of Energy, with specific functions of energy policy development, energy sources development, energy security and conservation, and others. At the operational level are the post-reform generation institutions of KenGen and Geothermal Development Company, along with infrastructure portfolios with the Kenya Electric Transmission Company and Kenya Power and Lighting Company (or Kenya Power). Rural electrification is managed through the Rural Electrification Agency. The Kenya Nuclear Electricity Board oversee plans for future development of nuclear energy. IPPs and EPPs are also part of the energy system. The system is regulated by the Energy Regulatory Commission, established following the 2006 Energy Act, with a mandate to regulate the sector, ensure fair competition, compile electricity data and provide to the minister, prepare indicative energy plans, determine tariffs and enforce regulations. Based on existing institutional framework, monitoring and evaluation of security of supply of electricity is best placed by instituting a new desk within the Ministry of Energy, with active and functional participation of the Energy Regulatory Commission (joint task force under the Ministry), particularly to implement regulatory action to enhance security of supply of electricity. The joint task force institutionalisation will also serve to be the decision advisory task force towards coordinating the response to electricity supply emergencies, issuing directives to plants and infrastructure operators.

The electricity sub-sector is relatively the most organised compared with oil and gas and biomass. The roles and functions of institutions are also relatively better delineated.

The institutional framework for the electricity sub-sector in Rwanda is constituted by the Ministry of Infrastructure (MININFRA) with a mandate of initiating and maintaining power generation to supply cost-effective and uninterrupted energy, increase access to affordable energy, develop policies and strategies for national infrastructure, and to supervise other energy sector institutions. Following the reform through EWSA Law of 97/2013, the Rwanda Energy Group is instituted along with subsidiary institutions of the Energy Utility Corporation Limited for increased efficiency in the operation of the utility and the Energy Development Corporation for timely and cost-effective implementation of energy development projects. The sector is regulated by the Rwanda Utility Regulatory Authority with a mandate to enforce compliance with regulations and laws governing the sector, ensuring continuity of service of providers, to promote the availability, accessibility and affordability of regulated services, issues licenses and pursues fair competition. It is, therefore, apparent that in the case of Rwanda the monitoring and evaluation of the security of supply of electricity is best addressed through a new desk under MININFRA within its mandate of affordable and uninterrupted energy supply maintenance, in close and functional collaboration with RURA (joint task force) under its mandate of ensuring continuity of available and affordable energy. Reporting functions of MININFRA can be utilised to integrate security of supply of electricity reporting to decision makers and leaders. The joint task force institutionalisation will also serve in coordinating responses to electricity supply emergencies, offering institutional clarity about issuance of directives and implementation by relevant institutions of the emergency directives.

Tanzania's institutional framework constitute the Ministry of Energy and Minerals with a mandate of setting policies, strategies and laws for sustainable energy, and to create conditions for reliable, efficient and affordable energy. The Tanzania Electric Supply Company operates generation, transmission, and distribution, with generation participation of IPPs and EPPs. TANESCO also supplies electricity to Zanzibar through Zanzibar Electricity Corporation, which transmits and distributes electricity in Zanzibar. The sector is regulated by the Electricity and Water Utilities Regulatory Authority established by EWURA Act Cap 414 with a mandate to issue licenses, establish and enforce quality standards, determine tariff levels, ensures the security of electricity supply and promote competition. The monitoring and evaluation of the security of supply of electricity can, therefore, be placed under a new desk in the Ministry with the robust participation of EWURA (through joint task force) to enable energy security enhancing enforcements by the prevailing mandate of EWURA on energy security. The task force can similarly serve as the decision coordination body to provide guidance on emergency management.

The electricity sub-sector institutional framework of Uganda is based on the policy and strategy guidance of the Ministry of Energy and Mineral Development, including in areas of sustainable and affordable energy. Post unbundling of the sub-sector in Uganda, the Uganda Electricity Generation Company operates the generation system, along with IPPs. The Atomic Energy Council provides guidance on potential future integration of nuclear energy into the generation mix. The grid infrastructure is managed by the Uganda Electricity Transmission Company, the distribution company UMEME and the Rural Energy Agency for rural energy access expansion. The sub-sector is regulated by the Electricity Regulatory Authority, under Section 10 of the Electricity Act of 1999, with mandates to issue licenses, enforcement of directions, approve tariff levels, review organisation of the sub-sector, to develop and enforce performance standards, advise the Minister on needed projects, and others.

From the review of the institutional setting for the electricity sub-sector in the EAC, it appears that the sub-sector is more homogeneous than biomass or oil and gas where multiple Ministries, agencies, and authorities are participating in sub-sector management.

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From the review of the institutional setting for the electricity sub-sector in the EAC, it appears that the sub-sector is more homogeneous than biomass or oil and gas where multiple Ministries, agencies, and authorities are participating in sub-sector management. The electricity sub-sector, therefore, offers relative institutional framework streamlining opportunity. The recommended institutional framework relates to the monitoring, evaluation and reporting functions related

to supply security of electricity and decision-making function to guide energy security actions and emergency responses. Related to the monitoring, evaluation, and reporting, the Ministry in charge of energy, as part of its mandate, is advised to institutionalise these functions through the establishment of a new desk, in tandem with similar functions for biomass and oil and gas supplies security, guided by the identified electricity supply security dimensions. The desk enables generating regular analyses and reports informing on the state of electricity supply security. To coordinate decisions and issue directives related to electricity supply security management and addressing supply emergencies, the establishment of Committee for Electricity Supply Security is advised, constituted by the Ministry in charge of energy, the sector regulator, and state generation, transmission and distribution entities, constituted by a Minister and executives of the relevant institutions. The Committee would receive periodic electricity supply security reports from the Ministry in charge of energy to facilitate its functions. Therefore, while the Ministry in charge of energy is advised to undertake monitoring, evaluation, and reporting on electricity supply security through a new desk, in tandem with biomass and oil and gas supply security, the Committee for Electricity Supply Security conducts decision-making relevant for short, medium and long-term supply security and emergency management.

7 CONCLUSION, RECOMMENDATIONS AND WAY FORWARD FOR THE EAC PARTNER STATES

7. CONCLUSION, RECOMMENDATIONS AND WAY FORWARD FOR THE EAC PARTNER STATES

7.1. Conclusion

The EAC energy security policy framework has put forth a model for conceptualising, measuring, monitoring and managing energy security in the biomass, electricity and oil and gas sub-sectors. Recognising that biomass energy constitutes a dominant primary energy source in the EAC, and the prevailing demand-supply deficiency in all Partner States and the experience of numerous impacts from this energy insecurity, a framework for biomass energy security is developed. The framework has eleven dimensions for monitoring, evaluating and strengthening the security of biomass energy supply. The dimensions are: forest fires and crime management; increasing the share of efficient conversion technologies; boosting forest productivity; resource stocking; expanding energy plantations; forest health protection; alternative biomass access; managing land use and climate change; value chain organisation and regulation; improving the efficiency of cooking technology and accounting for population and economic growth.

In the oil and gas sub-sector, recent discoveries of oil and gas in the region, the fast pace of economic growth and transformation, and the importance of supporting it with secure oil and gas supplies are noteworthy. Furthermore, the negative impacts of oil and gas insecurity stemming from the challenges of dependence on imported fuel, oil market volatility, energy import and corridor security, energy use efficiency, pipeline and refining capacity, and strategic petroleum reserve capacity are relevant energy security concerns. A framework for oil and gas energy security is, therefore, developed to address these and other challenges. Actions are recommended in eleven dimensions of the framework for oil and gas supply security. These are: exploration and development of oil and gas; market volatility and political risks management; reducing import dependence; ensuring maritime and inland transit security; conversion technologies and efficiency; domestic production capacity; refinery and distribution networks; strategic petroleum reserves; fuel switching capacity; value chain organisation and regulation and implementation capacity for demand restraint measures.

In the electricity sub-sector, the growing importance of access to electricity to enable social and economic activities is recognised. Demand and supply conditions for electricity in the EAC indicate that the near-term energy prospects vary in the Partner States. If planned energy sector projects are implemented, the energy crisis of the recent past is expected to subside, replaced by concerns of electricity supply security emanating from system efficiency, adequacy, cost, and reliability. The challenges of generation energy fuels and resources input stability, energy source diversification, generation and transmission system adequacy, system performance, energy losses, regional trade, electricity market organisation and regulation and demand side management are recognised as having a bearing on electricity supply security. Through action in ten dimensions of the supply security of electricity, the opportunity to restore the system to enhanced energy security is highlighted. Actions are required in fuel and resources input supply stability; diversity of generation technology; generation adequacy; reduction in stranded power capacity; reduction in power not supplied; improvement in interconnection capacity; reduction in overall cost of energy; capacity for energy system planning; market organisation and regulation and demand side management, encompassing energy efficiency.

To implement measures recommended in the various dimensions of the framework for energy security policy for the EAC, institutionalising the monitoring, evaluation, reporting, advising and

management functions is required. Furthermore, while advocating the importance of building energy system resilience to avert energy insecurity, in the event of energy security emergency, emergency response institutional coordination and decision directive mechanisms to implementing entities are also required. As a result, institutional frameworks for these functions towards ensuring energy security in the biomass, electricity and oil and gas sub-sectors are proposed in the context of existing institutional configuration for the energy sector in the Partner States. The institutional framework encompasses two functions: the monitoring, evaluation and reporting role; and decision-making on short, medium and long-term energy security management and emergency response.

In the case of biomass energy, the Ministry in charge of energy is advised to create a desk to institutionalise the monitoring, evaluation and reporting functions based on the identified dimensions relevant for supply security of biomass. To coordinate decisions and issue directives related to biomass energy security and supply emergencies, establishing an Inter-Ministerial Committee for Biomass Energy Security, with Ministerial, agency head and authority executive level representation, is advised. The Committee should constitute the Ministry mandated with upstream forest resource management, forest service (where available), specialised agencies/authority on forest/natural resources, the Ministry in charge of energy, and the energy sector regulator with an expanded mandate over downstream biomass energy supply regulation. The Committee would receive periodic energy security reports from the Ministry in charge of energy to guide security enhancing actions and address emergencies.

In the case of oil and gas, as part of the reporting function for supply security of oil and gas, the Ministry in charge of energy is advised to institutionalise tracking and reporting on oil and gas supply security based on the monitoring and evaluation dimensions identified. Related to decision-making and issuance of directives for action on supply security of oil and gas, including emergencies, the adoption of the EAC Petroleum Supply Emergency Plan (2008) is recommended. The Plan advises the establishment of the Management of Energy Emergency Teams (MEET), or to be named Inter-Ministerial Committee for Oil and Gas Supply Security. The Inter-Ministerial Committee is to be constituted by Ministries responsible for energy, finance trade, immigration, infrastructure, internal security, revenue authorities and EAC. MEET, or the Inter-Ministerial Committee would receive periodic energy security reports from the Ministry in charge of energy to facilitate overall guidance and emergency decision-making.

In the case of electricity supply security, monitoring, evaluation and reporting functions are advised to be undertaken by the Ministry in charge of energy, as part of its mandate, by institutionalising these functions through the establishment of a new desk, in tandem with similar functions for biomass and oil and gas supplies security. The function is recommended to be guided by the identified electricity supply security monitoring and evaluation dimensions. The desk enables generating regular analyses and reports on the state of electricity supply security. To coordinate decisions and directives related to electricity supply security and supply emergencies management, the establishment of Committee for Electricity Supply Security is advised, to be constituted by the Ministry in charge of energy, the sector regulator, and state generation, transmission and distribution entities, constituted by a Minister and executives of the relevant institutions. The Committee would receive periodic electricity supply security reports from the Ministry in charge of energy to facilitate its functions.

The comprehensive energy security policy framework, therefore, provides a system to organise action, monitor coherently and assess the overall state of energy security effectively, and guide on courses of action to pursue security of biomass, electricity and oil and gas supply and address energy security emergencies through a recommended institutional framework.

Adoption, mainstreaming and institutionalisation of the energy security policy framework, and active implementation of the recommended actions in biomass, oil and gas and electricity supply security dimensions, are expected to lead to better preparedness and effectiveness in managing energy security in the Partner States; improved capacity to restore resilience in the energy sector; and improved institutional and operational coherence necessary in minimising and containing the consequences of energy insecurity in the economy of Partner States.

7.2. Recommendations to the Partner States

Based on the developed regional energy security policy framework, Partner States are urged to take the following actions to strengthen energy security in the biomass, electricity and oil and gas sub-sectors:

Biomass energy security

- Strengthen the mandate of the forest service to monitor and manage forest fires.
- Establish annual restocking guidelines to match, over time, the afforestation rate to that of harvest rate beyond sustainable yield.
- Review the mandate of forest services on forest health management, and increase capacity for early detection and control of plant diseases.
- Initiate a national programme to promote the adoption and large-scale use of alternative biomass energy sources for cooking to a set national target.
- Improve the land use planning and change management capacity, and regulate and enforce the law on illegal land uses in forest lands.
- Expand the mandate of energy sector regulator to include mandate over biomass energy production and trade, with proposed regulatory mandate over most of the 11 dimensions of biomass energy security.
- Establish, or strengthen, a national programme to fast-track adoption of prioritised high-efficiency cookstoves with targets.
- Fast-track electricity access to displace reliance on biomass energy.

Oil and gas energy security

- Work with OMCs towards a minimum oil and gas import diversification plan.
- Develop and implement national biofuels strategy and action plan, with set target on displacing imported fuels.
- Strengthen EAC regional transit security periodic review with the Northern and Southern Corridor institutions.
- Initiate national industrial and household energy efficiency strategy and targets, and implement strategy.
- Promote investment in stabilising oil and gas output and field performance, and build capacity to address output fluctuations.
- Establish a national public strategic petroleum reserve system, with capacity to hold at least three months of prior year's import quantity as reserve.
- Implement the EAC regional refinery development plan and fast-track ongoing EAC initiatives on pipeline infrastructure extensions to Rwanda and Burundi and road infrastructure development with the corridor institutions.

- Institute fuel mixing mandates at small scale and scale-up mandate matching national biofuels realisable supply capacity.

Electricity energy security

- Work with thermal generation plants to establish operational fuel stocks to minimise fuel input-induced electricity supply security challenges.
- With the Ministry and Agencies overseeing water resources, strengthen hydro systems modelling and forecast to support generation planning.
- Expand power import/export capacity.
- Prioritise, in generation planning and implementation, diversification.
- Expand grid accessibility to investors through FiT, PPA and potentially net metering provisions.
- Plan generation capacity long-term expansion with at least 10% built-in spinning reserve margin.
- Gradually institute dynamic generation expansion plan to meet at least two years ahead peak load forecast.
- Prioritise the expansion and upgrade of grid infrastructure in stranded power hot spot areas.
- Establish mandate for maximum allowable integrated system loss.
- Strengthen monitoring and enforcement capacity for commercial loss mitigation.
- Promote long-term establishment of a regional regulator.
- Develop and implement least cost generation plans.
- Institute the conduct of periodic energy system planning, and review and implementation.
- Launch and strengthen a national industrial, institutional and household energy efficiency improvement initiative.

7.3. Way forward for the Partner States

The development of the regional energy security policy framework is motivated by the lack of comprehensive energy security policies and strategies in the Partner States, as a consequence exposing them to the effects of biomass, electricity and oil and gas energy insecurity. The regional policy framework provides a broader policy scope within which the Partner States may pursue national energy security policy and strategy development and implementation. In this regard, the following way forward for the EAC Partner States are recommended.

Develop national energy security policy and laws based on consideration of the regional policy framework

1. The EAC Partner States are advised, based on the regional energy security policy framework, to develop national energy security policies, strategies, and laws in their pursuit of a resilient energy system that ensures biomass, electricity and oil and gas supplies security. Such efforts will help address the current policy and strategy gap in the management of energy security.

Pursue regional cooperation for energy security management

2. The policy framework identifies common challenges faced by Partner States in biomass, electricity and oil and gas supply security, and shared policy opportunities to address them. These efforts should serve as bases for pursuing regional cooperation for the management of energy security. Partner States are already undertaking regional cooperation in the energy sector through joint planning and implementation of regional electricity and oil and gas infrastructure projects which could serve as building blocks.

Establish institutional framework for energy security monitoring and evaluation, and emergency response

3. Establishment of monitoring, evaluation and reporting functions within ministries of energy, and decision-making system through Inter-Ministerial Committee on energy security (or recommended institutional arrangement) is advised to strengthen national energy security management capacity, increase preparedness and enhance emergency response readiness.

Expand the mandate of energy sector regulator to encompass downstream biomass energy

4. Biomass energy constitutes an unregulated downstream, with deteriorating energy security condition in the Partner States. Alongside with review and implementation of recommendations to strengthen supply security of biomass, expanding the mandate of the energy sector regulator to encompass downstream biomass supply is advised.

Develop and strengthen national capacity in energy sector and energy security monitoring statistics

5. Energy statistical capacity is crucial for monitoring and evaluating energy security. Partner States are urged to prioritise the development of capacity for energy statistics in general, and statistics relevant to the identified monitoring and evaluation indicators of energy security in particular.

Engage partners in supporting policy, strategy and institutional and human capacity development and implementation of measures relevant for improving energy security

6. Engage the private sector development partners, donors, civil society organisations, regional and international partners, foundations and other partners to supplement national efforts in supporting skill and knowledge transfer, technology transfer, institutional and human capacity development in energy security, support for policy and strategy development, and investment partnership in energy security enhancing measures.

7.4. Way Forward for the EAC

Development of this energy security policy framework is in accordance with the stated commitment of the Partner States expressed through the Treaty for the Establishment of the EAC. Based on this commitment, the East African Legislative Assembly passed a resolution on integrated policy on energy security by urging the Partner States to develop policy and laws on energy security.

This policy framework, therefore, provides a regional guidance to the Partner States in their development of national energy security policies and laws. The framework outlines pillar areas of energy security in the biomass, electricity and oil and gas sub-sectors, along with monitoring and measurement frameworks and institutional arrangements. Mainstreaming the policy framework at the national level and establishing an institutional arrangement for energy security monitoring, evaluation and action will constitute major areas of action for the Partner States. In this regard, the ECA should be a catalyst in the following areas.

Support mainstreaming the Energy Security Policy Framework into country policies and laws

1. As part of its mandate under the Treaty to pursue regional harmonisation of policies in the energy sector, the EAC should avail technical support to the Partner States in mainstreaming the regional energy security policy framework into existing country policies and laws, including through partnerships.

Mobilise resources for development of energy security policies and action plans in the Partner States

2. Taking reference to the regional policy framework, Partner States are called upon to develop energy security policies and laws. The EAC should engage development partners and relevant regional and international organisations in mobilising resources to complement the effort of Partner States in the development of country energy security policies, strategies, and laws.

Technical support to strengthen energy security monitoring and evaluation capacity

3. The EAC should pursue a partnership with regional and international organisations to avail technical support to the Partner States towards strengthening the institutional capacity to undertake monitoring and evaluation of the state of energy security on a periodic basis. The support should include human, institutional and statistical capacity development supplementing Partner States' efforts.

Develop regional energy security monitoring and reporting capacity at EAC

4. The EAC publishes economic and social statistics of the region on an annual basis. The statistical and reporting capacity of EAC need to be strengthened to include regional energy security monitoring and reporting. This will depend on building such capacity at Partner States level to feed data and information into the regional database. EAC institutional capacity related to monitoring and reporting on energy security will need to be strengthened in tandem with capacity development efforts in the Partner States.

Regional harmonisation of common standards in relevant energy security pillar areas

5. In the biomass, electricity and oil and gas sub-sector pillar areas of energy security policy, numerous areas offer an opportunity for regional harmonisation of standards. The EAC should review the pillar areas to map and prioritise harmonisation opportunities on various standards in the biomass, electricity and oil and gas sub-sectors. One example of this effort is regional guidance on energy efficiency standards.

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