



BLUEPRINT

FOR COOPERATION IN ENERGY ACCESS AND EFFICIENCY IN EAST AFRICA

**RECOMMENDATIONS FROM
THE INTERNATIONAL CONFERENCE
“FOSTERING COOPERATION IN ENERGY
EFFICIENCY AND ACCESSIBILITY IN EAST AFRICA”**



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Project	Enhancing Energy Accessibility & Efficiency through establishing sustainable STI Support National Networks with a regional dimension in East Africa
Acronym	ENRICH
Grant Number	FED/2013/330-235

Project	East African Higher Education Network on Sustainable and Energy Efficient Campus Development
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ABBREVIATIONS

ABER	The Burundian Agency for Rural Electrification	GEF	Global Environmental Finance
ACEESD	The Africa Centre for Excellence in Energy for Sustainable Development	GIS	Geographic Information System
ADB	The African Development Bank	GIZ	German International Cooperation
AFDB	African Development Bank Group	HEIs	Higher Education Institutions
ANEREE	The National Agency for Renewable Energy and Energy Efficiency	ICT	Information and communications technologies
BADEA	Arab Bank for Economic Development in Africa	IEA	International Energy Agency
BRN	The Big Results Now	IPP	Independent Power Producer
CIDPH	The Interministerial Committee for the Determination of Prices of Hydrocarbons	IRDI	Integrated Rural Development Initiatives
CNEE	National Water and Energy Commission	IRP	Integrated Resource Plan
CEBEA	Burundian Centre for Alternative Energies	JEEP	Joint Energy and Environment Projects
CEPGL	The Economic Community of the Low Countries Great Lakes	JICA	Japanese International Cooperation Agency
COSTECH	The Commission for Science and Technology	LCPDP	Least Cost Power Development Plan
CTB	Cooperative Technique Belgium	LPG	Liquefied petroleum gas
DIT	Dar es Salaam Institute of Technology	MEEATU	The Ministry of Water, Environment, Land Management and Urban Development
EAC	East African Community	MEM	The Ministry of Energy and Mines
EARP	The Electrification Access Rollout Programme	MEMD	Ministry of Energy and Mineral Development
EDPRS/EDPRS-I	The Economic Development and Poverty Reduction Strategy	MINAGRI	Ministry of Agriculture and Animal Resources
EDPRS-II /EDPRS 2	Medium Term Economic Development and Poverty Reduction Strategy for 2013-2018	MINECOFIN	Ministry of Finance and Economic Planning
EE	Energy Efficiency	MINICOM	Ministry of Trade and Industry
ENRICH	Enhancing Energy Accessibility & Efficiency through establishing sustainable STI Support National Networks with a regional dimension in East Africa	MININFRA	Ministry of Infrastructure
ERA	The Electricity Regulatory Authority	MINIRENA	Ministry of Natural Resources
ERC	The Energy Regulatory Commission	MoEST	Ministry of Education and Sports
ESSP	Energy Sector Strategic Plan	MoFPED	Ministry of Finance, Planning and Economic Development
EU	European Union	MoWT	Ministry of Works & Transport
EWSA	The Energy, Water and Sanitation Authority	MUK	Makerere University, Kampala
EWURA	Energy and Water Utilities Regulatory Authority	NABC	The Center of Excellence in Agricultural Biotechnology
		NBI	The Nile Basin Initiative
		NBS	National Bureau of Statistics
		NDPII	The Second National Development Plan
		NEMA	National Environment Management Authority
		NEMC	National Environment Management Council

NEP	National Energy Policy	UETCL	Uganda Electricity Transmission Company Ltd
NGO	Non-governmental organization	UKAID	UK Aid (Department for International Development)
NM-IST	The Nelson Mandela African Institute of Science and Technology	UN	United Nations
PEAP	The Ugandan Government's Poverty Eradication Action Plan	UNCST	Uganda National Council for Science and Technology
PPP	Public Private Partnership	UNDP	United Nations Development Programme
RE	The Renewable Energy	UNIDO	United Nations Industrial Development Organization
REA	Rural Energy Agency	UNU-IAS	United Nations University Institute for the Advance Study of Sustainability
REG	Rwanda Energy Group	UIRI	Uganda Industrial Research Institute
REGIDESO	The Control and Regulation Agency for the Water and Electricity	USAID	U.S. Agency for International Development
REMA	Rwanda Environment Management Authority	VETA	The The Vocational Educational and Training Authority
REP	Renewable Energy Policy	VPO	Environment - the Vice President's Office, the Environmental Division
RES	Rural Electrification Strategy	WEO	World Energy Outlook
RIDEM	Rural Initiative for Development and Environmental Management	WWF-UCO	World Wide Fund for Nature Uganda Country Office
RURA	Rwanda Utilities Regulatory Authority		
SEFA	The Sustainable Energy for All		
SEPP	The Petroleum Products Storage Company		
SINELAC	The Societe Internationale des Pays des Grand Lacs		
SREP	The Scaling Up Renewable Energy Program		
STEG	International Société Tunisienne de l'Electricité et du Gaz		
STI	Science, technology and innovation		
SUCCEED Network	East African Higher Education Network on Sustainable and Energy Efficient Campus Development		
TANESCO	Tanzania Electric Supply Company		
TPDC	Tanzania Petroleum Development Corporation		
UCSD	Uganda Coalition for Sustainable Development		
UEDCL	Uganda Electricity Distribution Company Ltd		
UEEF	Uganda Environmental Education Foundation		
UEGCL	Uganda Electricity Generation Company Ltd		

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FOREWORD

The 2012 conference of the United Nations Rio+20 outlined that energy was a key component in development, with access to modern energy contributing to poverty reduction, health improvement and provision of basic human needs. This makes it crucial for developing countries to have access to “reliable, affordable, economically viable and socially and environmentally acceptable energy”, and UN Secretary-General Ban Ki-moon declared Sustainable Energy for All to be a top priority given its key relationship to all aspects of sustainable development.

According to the 2015 World Energy Outlook, approximately 17% of the world's population – 1,2 billion people – lack access to electricity. In addition, 38% – 2,7 billion people – rely on the traditional use of solid biomass for cooking, putting their health at risk as a consequence. And although progress has been made in recent years (1,3 billion people without access to electricity in 2011), it will need to progress at a faster pace in order to reach the 2030 goal of universal energy access as established in the UN Sustainable Development goals. Additionally, improvements will need to be made in energy efficiency as it will play a critical role in limiting world energy demand growth to one-third by 2040.

Globally, the vast majority of the population lacking access to electricity are concentrated in Africa and developing Asia (95% in 2011), particularly in rural areas (84%) (WEO, 2011). To this is added the above-mentioned excessive dependence on biomass as the major source of energy for households.

East Africa is of particular concern, as energy deficit and energy poverty have become a major obstacle to growth and development in the region. In general East African countries underperform in energy access (around 27% average) compared with the

sub-Saharan average of 30,5% which can go up (UN Economic Commission for Africa, 2014).

One of the major energy issues is price volatility and energy security as East Africa suffers from high prices in the energy market and shrinking natural energy resources. The deficit in electricity supply and the lack of access to sustainable energy services hampers the satisfaction of basic human needs. The EU-EA Regional Strategy Paper revealed that 70% of the total inhabitants do not have access to sustainable energy sources. This leaves the region on a high dependence on fossil fuels, energy insecurity and high-carbon emission systems, which together with climate change provoke a very complex situation for the region. In sum, restricted access to energy resources is hampering the East African region from sustainable development.

Most recently, the EC Country Strategy Papers stated as common problems in these countries:

- Lack of regional and national policies on Energy Efficiency and Renewable Energy that match the decision maker's decisions with society's actual needs.
- Poor infrastructures to produce, store and distribute energy in a more sustainable way.
- Lack of professionals trained in Energy Efficiency and Renewable Energy.

Despite the energy emergency in the region, support from research institutes and academia is inadequate to address this situation. However, at the policy level, various countries have stressed the importance of energy access and quality research and innovations. Unfortunately, there is a mismatch between policies, political decisions and societal needs.

The present work is the main output of the International Conference "*Fostering Cooperation in Energy Efficiency and Accessibility in East Africa*", organised by the ENRICH and SUCCEED Network projects in Zanzibar, Tanzania on 13 and 14 March, 2017. The conference aimed to bring together stakeholders involved in the field of Energy from academia, researchers, project managers, NGOs, representatives of the industry and policy makers in order to encourage dialogue and strengthen cooperation links in the energy sector in East Africa. Furthermore, the Conference was meant to raise awareness of the real needs of Science, Technology and Innovation related to Energy Access and Efficiency, and foster discussions on how the Higher Education system can contribute to this.

ENRICH and SUCCEED Network are three-year capacity building projects co-financed by the European Commission in the framework of the cooperation programmes between the EU and the ACP group of states: Science & Technology II and Edulink II. Launched in October 2013, SUCCEED Network (contract number FED/2013/320-274) aimed to promote East African university campuses in Burundi, Kenya, Rwanda, Tanzania and Uganda as "living laboratories" for sustainability and energy efficiency, in particular by establishing a sustainable campus development platform to foster collaborative learning and action for energy access and efficiency, with the idea of contributing to solve the problems described above. Launched in February 2014, ENRICH (contract number FED/2013/330-235) aimed to promote quality science, technology and innovation (STI) support services in Kenya, Tanzania and Uganda, and strengthen co-operation links in the energy sector at national and regional level among academia, researchers, industries and policy makers.



Inauguration of the International Conference "*Fostering Cooperation in Energy Efficiency and Accessibility in East Africa*". (Photo credit C.Beans)

1

BACKGROUND ON ENERGY IN EAST AFRICA

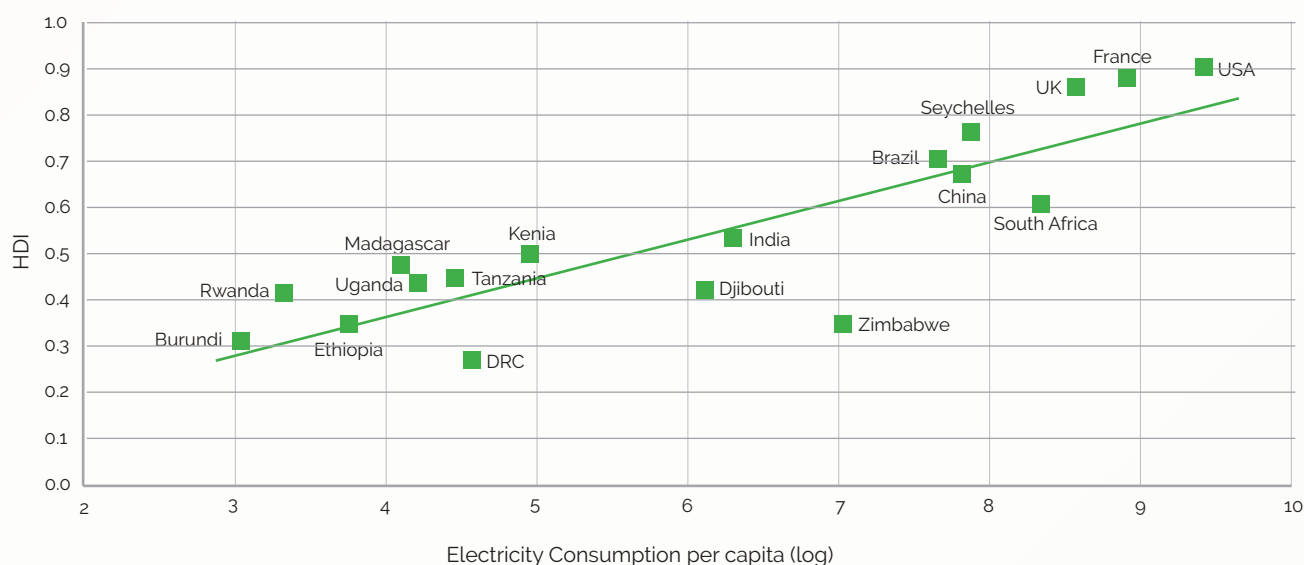
Energy is a crucial utility for societies and national development. Indeed, socio-economic development requires energy as one of its essential inputs as access to modern energy contributes to poverty reduction, health improvement and provision of basic human needs. Populations need energy for their daily activities, for quality public services (e.g. health, education, clean water) and for enhanced economic development. As the UN Economic Commission for Africa indicated in 2013 "the human capital development of countries, in health, education and other indicators is closely related to the level of energy consumption. Countries with lower levels of energy consumption show lower levels of human capital development." (Fig. 1)

Unfortunately a majority of societies in developing countries are marginalized in this very important utility. Globally, the vast majority of the population lacking access to electricity are concentrated in Africa and developing Asia (95% in 2011), particularly in rural areas (84%) (WEO, 2011). This is due to the many challenges that are faced by the energy sector and by societies wishing to have access to energy, resulting in price volatility and poor security in the energy sector. These challenges include:

- Limited development of vast clean energy resources in the region.
- Energy infrastructure inadequacy
- Limited investment in energy generation capacity for a prolonged period of time.
- Low income levels
- Nature of energy policy reform
- Market organisation

Figure 1

Energy consumption and human development index (HDI)
(UN Economic Commission for Africa, 2014)



In addition, the low capital and adaptive capacity makes developing economies (especially African countries) more vulnerable to extreme weather and climate change which will negatively impact their energy systems in the future. Finally, households in Africa are exposed to a series of health risks due to an excessive dependance on biomass as a major source of energy (Fig. 2). And with declining forest resources in many areas, fetching firewood or other biomass requires more time, time that could have been spent on more productive actions.

East Africa is of particular concern, as energy deficit and energy poverty have become a major obstacle to growth and development in the region. In general, as seen in Figure 3, East African countries underperform in energy access (around 27% average) even when compared with the sub-Saharan average of 30,5% (UN Economic Commission for Africa, 2014).

Figure 2

The health impact of traditional biomass use
(IEA estimates based on WHO data, UN Economic Commission for Africa, 2014)

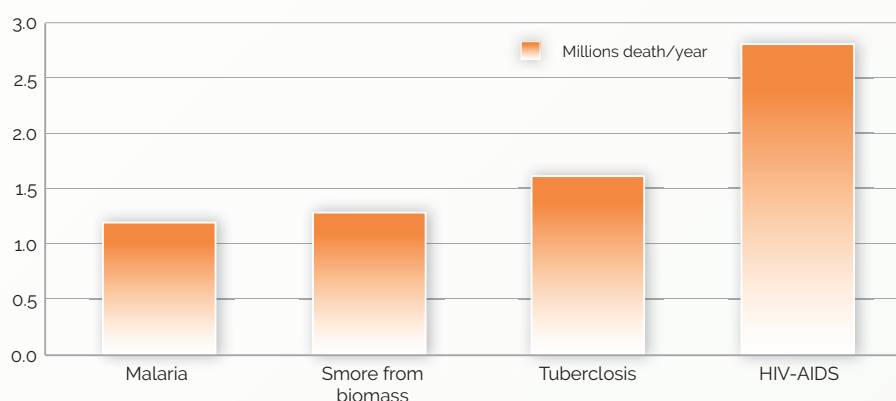
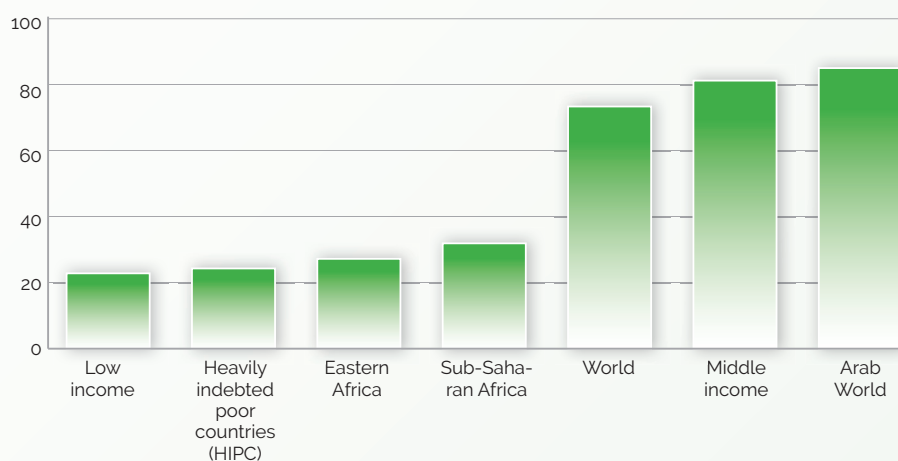


Figure 3

Comparison of electricity access in Eastern Africa with other regions
(Data from WEO 2010, UN Economic Commission for Africa, 2014)



In accordance with these issues, the Millennium Development Goals have established the relevance of addressing the challenges and prospects for energy service provision in the region:

- Providing energy access to all
- Ensuring supply security
- Mitigating gas emissions
- Policies limiting the use of fossil fuels

Furthermore, in 2011 UN Secretary General Ban Ki-Moon launched an ambitious global vision for energy access: the Sustainable Energy for All (SEFA) global agenda (Fig. 4), in the view that achieving its three objectives would lead to the realisation of many development goals.

Added to this is the priority of many governments to develop more and more renewable energy sources in order to sustainably transition to a fossil fuel free system. Indeed, the African Development Bank (ADB) considers green growth as the top priority of its development strategy (2013-2020), and wind and solar are the fastest growing renewable energy technologies in East Africa. In fact, although oil and natural gas play a role on domestic energy sources, the main sources of energy in East Africa are hydropower and geothermal, with solar increasing in popularity. The use of renewable energy sources could significantly impact:

- Reduction of energy poverty
- Stimulus of economic growth
- Ensure environmental sustainability

Figure 4

The SEFA agenda and development regions
(UN Economic Commission for Africa, 2014)

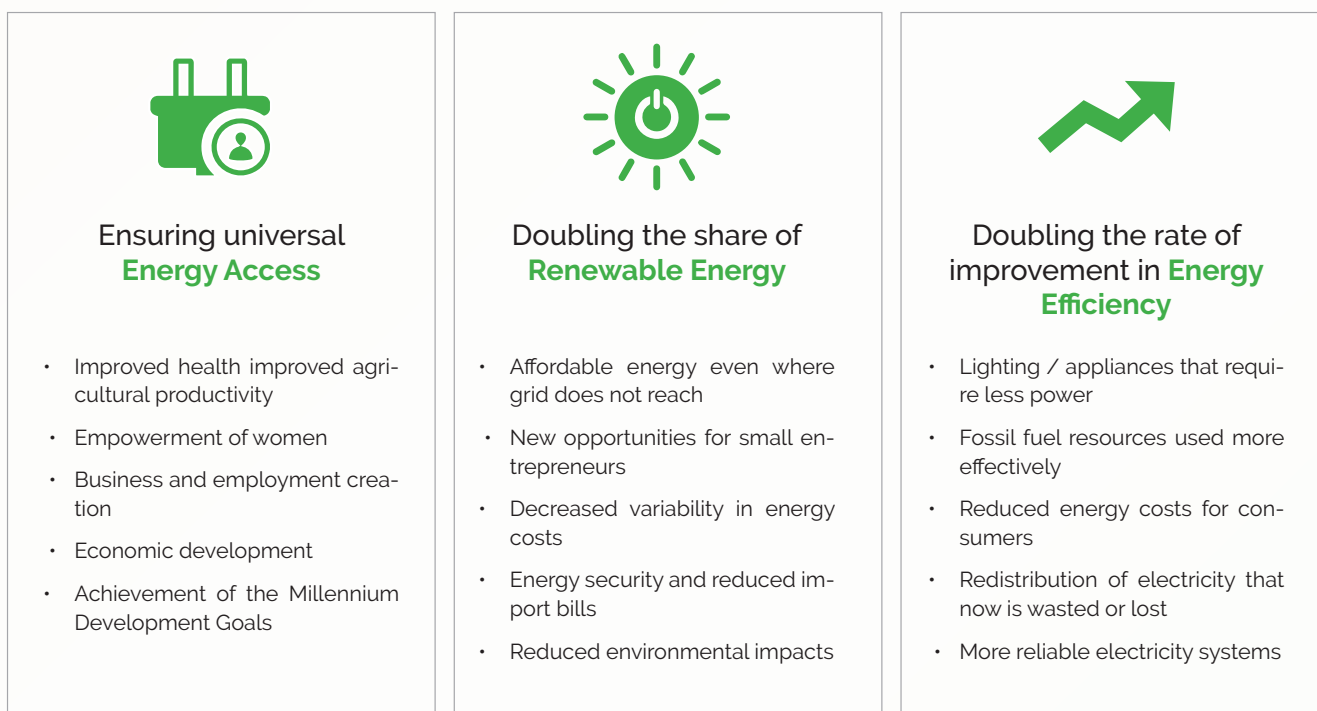


Table 1
Renewable Energy Potential across Africa. (ADB)

Region	Wind (TWh/yr)	Solar (TWh/yr)	Biomass (EJ/yr)	Geothermal (TWh/yr)	Hydro (TWh/yr)
East	2,000-3,000	30,000-20	20-74	1-16	578
Central	-	-	49-86	-	1,057
North	3,000-4,000	50,000-60,000	8-15	-	78
South	16	25,000-30,000	3-101	-	26
West	0-7	50,000	2-96	-	105

However, as Prof. Kimambo of the University of Dar es Salaam so aptly stated during his keynote speech in the International Conference "Fostering Cooperation in Energy Efficiency and Accessibility in East Africa", in East Africa most people aren't thinking too much about where their energy is coming from. They simply want reliable access to "modern energy", that is to say electricity, for their

businesses and for domestic use (like lighting and cooking), as this is something large parts of the population do not have so they depend on firewood, charcoal or kerosene. As a result biomass is the principal source of energy in East Africa. These sources each have their own advantages and challenges as presented in Table 2 below.

Table 2
Energy Sources, Advantages and Challenges in EAC Countries
(Kimambo, 2017)

Energy Source	Advantages	Challenges
Charcoal	<ul style="list-style-type: none"> Cheap and affordable when bought in bulk Easily accessible Easy to use Economical Convenient Lasts longer (when used with improved stoves) 	<ul style="list-style-type: none"> Illegal logging Unsustainable production practices Low use of energy-saving charcoal cooking stoves Lack of efficient distribution mechanism for improved cookstoves Lack of effective policies for sustainable charcoal production
Natural Gas / LPG	<ul style="list-style-type: none"> Quick and efficient Easy to use Clean Does not produce smoke Economical Mostly available Can be used for both lighting and cooking 	<ul style="list-style-type: none"> Sale of half-filled gas cylinders Lack of standardized gas cylinders effective distribution channels Liberalized petroleum sector Introduction of 6 kg and 3 kg gas cylinders mainly targeting the poor Introduction of weighing scales at refilling stations
Kerosene	<ul style="list-style-type: none"> Cheap and affordable when bought in bulk Easily available Convenient to use Low access to electricity High cost of electricity Has dual functions of both cooking and lighting Easy to use 	<ul style="list-style-type: none"> Shortages of kerosene supply are common Deregulation of the petroleum industry has seen small-scale kerosene pumping stations opened Delivering kerosene in a cheaper ways and safer way than kiosks.
Electricity	<ul style="list-style-type: none"> Cheap and affordable (once upfront costs are paid and if used only for lighting) Easy and convenient to use Has bright light Can be used both for lighting and cooking Quick and efficient Does not produce smoke 	<ul style="list-style-type: none"> Illegally tapping electricity from the supply lines exposing users to potential risks Inefficient use of electricity by not employing energy efficiency and saving measures Use of energy-saving devices at both household and SME levels, avoiding wastage of electricity and employing energy efficiency measures Introduction of communal electrification programme

Regarding electricity, according to the UN Economic Commission for Africa report (2014), the electrification rate in Eastern Africa is far below 60%, as is shown in Table 3.

Furthermore, according to Prof. Kimambo, energy access in East Africa Community countries varies greatly from country to country: Burundi 5%, Kenya 60%, Rwanda 16% (although they aim for 70% by 2018), Tanzania 46% and Uganda 27%. These numbers may not however be the best indicators, as among different actors there appears to be a lack of a clear definition on "energy access": In the homes? In the workplaces? Is it reliable access or interrupted? Electricity? It is clear that an important initial step would be for all the actors involved to

start by reaching a common definition for energy access.

Africa in its ensemble represents one of the fastest growing economies in the world, and East Africa represents the second-fastest growing region on the continent. With Africa's highly underdeveloped power sector and low electricity rates, as indicated above, there is clearly a huge potential (and necessity) for investment in many of these countries. All have the basic institutional infrastructure to improve energy in the region and have regulators in place, important as the supplies need to be managed. Some countries are currently developing tariffs for different energy sources, different applications.

Table 3
Electrification Rate in Eastern Africa
(UN Economic Commission for Africa, 2014)

Countries	Electrification rate (%)	Countries	Electrification rate (%)
South Sudan	1	Burundi	2
DRC	11.1	Malawi	9
Uganda	12	Zambia	18.8
Tanzania	13.9	Zimbabwe	41.5
Kenya	16.1	Comoros	46
Madagascar	19	Djibouti	55
Ethiopia	22.5	Mauritius	99.4
Eritrea	32	Seychelles	99.8
Eastern Africa	27	Sub-Saharan Africa	30.5

Table 4

Energy Sources, Advantages and Challenges in EAC Countries
(Kimambo, 2017)

Type	Burundi	Kenya	Rwanda	Tanzania	Uganda
Energy Regulator	Burundian Regulator for Water and Electricity	Energy Regulatory Commission	Rwanda Utilities Regulation Authority	Energy and Water Utilities Regulatory Authority	Electricity Regulatory Authority
Power Utilities	Water & Electricity Utility for Production and Distribution	Kenya Electricity Generating Company; Kenya Electricity Transmission Company; Kenya Power & Lighting Company	Rwanda Energy Group; Energy Development Corporation Limited; Energy Utility Corporation Limited	Tanzania Electric Supply Company Limited	Uganda Electricity Generation Company; Uganda Transmission Electricity Company Limited
Rural Electrification Agency	Rural Electrification Agency of Burundi	Rural Electrification Authority	Rwanda Energy Group/Energy Utility Corporation Limited	Rural Energy Agency	Rural Electrification Agency
Ministry	Ministry of Energy and Mines	Ministry of Energy and Petroleum	Ministry of Infrastructure	Ministry of Energy and Minerals	Ministry of Energy and Mineral Development

Finally, efforts have been made, and are ongoing, to improve the situation in the region, but there are many areas where further engagement can be made, not only at the level of large investments, but also at the human and society level, with the intervention of Higher Education Institutions (HEIs). HEIs have well trained and respected human resources, they develop research, can collaborate

with industry to further technological innovation, provide policy or technical advice to local/regional/national governments. They can also contribute in raising public awareness and be important actors in regional or international collaborations.

2

CURRENT SITUATION IN EAST AFRICA

As stated previously, the situation can vary greatly from country to country among the East African Community. It is thus of interest to take a closer look at the different countries who presented reports on their current situation during the International Conference "Fostering Cooperation in Energy Efficiency and Accessibility in East Africa".

2.1 BURUNDI



Energy for Sustainable Development

Vision Burundi 2025, a planning instrument established by the UNDP and the Government of Burundi, outlines the path for the long-term development to guide the country's policies and strategies regarding sustainable development. Among the actions outlined, Vision Burundi 2025 gives priority to economic infrastructures that will help achieve the desired accelerated growth, in particular in transport, communication and energy.

Concerning the energy sector, among the Vision's principal objectives is to ensure that by 2025 both the rural and urban populations have access to reliable, clean sources of energy and at competitive prices, as well as to provide sufficient energy for industrial, artisanal and mining activities. Increased efforts will be made to build hydroelectric power stations (harnessed either directly by the State or by private companies) and invest in renewable

energies. Additionally, the "wood-energy" sector will be further developed while safeguarding the environment. The promotion of renewable energies will focus on solar energy, biogas, ethanol and wind power.

Policy Framework, Laws and Regulations

In Burundi the energy sector is largely under the responsibility of the government, with private participation and investments fostered by rules and regulations through a public tendering process. Law No. 1/014 of 1 August 2000 relates to the liberalization and regulation of the public services of water and electricity. According to the law, the energy sector remains a public service under the responsibility of the state, but it opens its doors to Burundian public and private investors, selected through invitation to tender with specific criteria.

Decree No. 100/320 dated 22 December 2011 established the Control and Regulation Agency for the Water and Electricity (REGIDESO) sectors in Burundi, with a mandate to ensure the development of an orderly and profitable water and electricity sector in Burundi. It controls, regulates and monitors activities related to water and electricity in order to ensure compliance with contract conditions for delegation as well as specifications and additional clauses on the part of operators. It also ensures the implementation, monitoring and application of tariffs in accordance with the pricing principles that have been established by regulation.

Decree No. 100/318 dated 22 December 2011 established the Burundian Agency for Rural Electrification (ABER), the objective of which is to develop and implement rural electrification projects and programmes, including small-scale hydropower,

solar and wind energy, as well as other forms of energy that can improve electricity access for the rural population.

Burundi has substantial potential for hydroelectric power and the government plans for expansion base mainly on hydropower. Thermal power production is considered a temporary measure to bridge the short term gap between supply and demand. The focus of the energy policy is on rehabilitation of existing (hydropower) plants and distribution grids as well as the development of new hydroelectric sites. Finally, a rural electrification program is planned mainly by grid extension and by providing information on alternative energy sources affordable for low-income households.

In the coming years, the Government of Burundi is planning to carry out the following actions in the energy sector (EnergyPedia, 2017):

1. Double the hydroelectric power stations of Nyemanga (2.8 MW) and Buhiga.
2. Execute feasibility and implementation studies for Kabu 16 (max. capacity: 20 MW), Kaganuzi (5 MW), Mpanda (10.4 MW), Mule 34 (16.5 MW). For the longer term feasibility and implementation studies for Makembwe (115 MW), Kabulantwe (67 MW) Rushihi (15 MW) and Ruzibazi (7 MW) are foreseen.
3. Construct regional power plants in cooperation with neighbouring countries: Ruzizi III (145 MW) and Rusumo Falls (61.5 MW).
4. Develop rural electrification by the construction of mini-hydros, solar and wind- power, the use of biogas and grid extension.
5. Renovate the existing hydroelectric power stations, as well as the electricity transmission and distribution networks.
6. Construct a Power generation plant of Kabu16, Kaganuzi, Mpanda and Mule 34.
7. Extend the urban and rural electric networks
8. Rehabilitate existing non functioning plants
9. Do an organizational audit and financial turnaround of the Electricity Utility (REGIDESO).
10. Develop a performance contract between the Government and REGIDESO.

Key stakeholders in the energy sector

Although multiple ministries and agencies have overlapping responsibilities for the energy sector, the main actor responsible for the development and implementation of energy policies, as well as sectoral planning and coordination, is the Ministry of Energy and Mines (MEM). Its Energy Directive is responsible for project planning, including the undertaking of hydroelectric development studies. The main mission of the MEM is to:

- Conceive and execute the National Policy for Energy, Geology and Mining.
- Promote research activities in Geology and the Mining sector.
- Participate in collaboration with the Ministry of Water, Environment, Land Management and Urban Development (MEEATU) to the elaboration of the National Water Policy and the necessary reforms for a proper management of the sanitization process.
- Develop an Energy Supply programme in order to ensure sustainable access to modern energy sources to the population.
- Promote renewable energies through appropriate research and dissemination actions.
- Participate in exchange and partnership programmes in the field of energy with regional and international institutions of which Burundi is a member.

- Ensure, in collaboration with the other services concerned, the planification, construction and management of the basic hydraulic, energetic and sanitizations infrastructures.
- Develop and ensure the monitoring of the Ministry's investment projects.

Burundi's state-owned public utility company REGIDESO (supervised by MEM), which until the energy market liberalisation of 2000 had a monopoly on energy production, is in charge of electricity and water distribution, as well as the commercialisation of these products in Bujumbura and 23 urban centres. It operates and controls all of Burundi's thermal power stations which have a combined installed capacity of 30.6 MW and a small amount of hydro capacity, in the form of small units in rural areas. Electricity is transmitted and distributed by REGIDESO, whilst the Societe Internationale des Pays des Grand Lacs (SINELAC), a jointly owned utility with Burundi, Rwanda and Congo, is responsible for the development of indigenous and joint power ventures generating and selling power to REGIDESO.

The Agency for Rural Electrification (ABER) is responsible for developing and implementing projects to improve rural electrification, including via solar, wind and small-scale hydropower.

In October 2016 the National Agency for Renewable Energy and Energy Efficiency (ANEREE) was launched by the Burundi Council of Ministers with the following missions:

- To control and support the Renewable Energy (RE) and Energy Efficiency (EE) markets.
- To establish a National Strategy for the promotion of Energy Efficiency.
- To support, evaluate and pilot national projects in the field of RE/EE.

- iv. Involve the private sector, NGOs and technical and financial partners in the field of RE/EE.
- v. Deliver commercial services and all other public service missions in the field of RE/EE.
- vi. Support research, innovation and training in the field of RE/EE.

Other stakeholders include:

- The Interministerial Committee for the Determination of Prices of Hydrocarbons (CIDPH).
- National Water and Energy Commission (CNEE)
- Burundian Centre for Alternative Energies (CEBEA)
- The Ministry in charge of Trade
- The Ministry in charge of Finances
- The Ministry in charge of the Water Environment
- The Ministry in charge of Scientific Research and Innovation .
- The Petroleum Products Storage Company (SEPP).
- Natural or legal persons to whom the public energy service is delegated .
- Local authorities
- Socioprofessional and corporate organizations
- Technical and financial partners (i.e. GIZ, World Bank, African Development Bank, Chinese Exim Bank, UNDP/GEF, EU...).

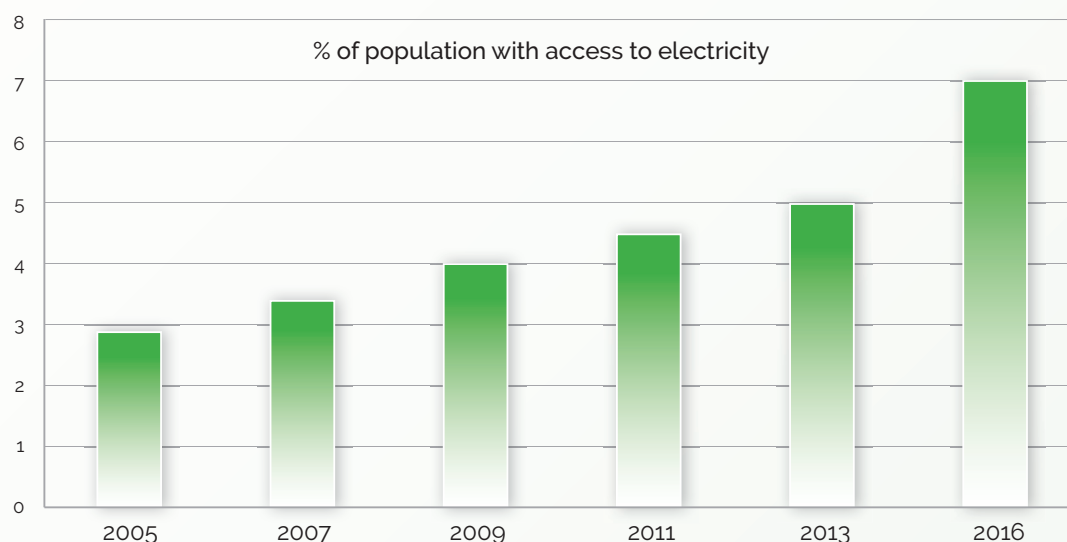
Current energy situation in Burundi

Although the country has seen some improvement in the past decade, with barely 2% electrification in rural areas, and 2,8% in urban areas, Burundi is among the least electrified countries in Eastern Africa, surpassing only South Sudan. Additionally, and despite rapid urban growth in the past decade, about 90% of the population lives in rural areas. Gitega and Bujumbura are the only two cities in Burundi that have a municipal electricity service. As a result, 93% of the population has little to no access to electricity (Energylopedia.info, 2017), and even the ones who do have access face power cuts on a daily basis during the dry season. Burundi's goal is to reach 25% electrification by 2025.

Indeed, electricity is the smallest source for primary energy consumption in Burundi, representing only 1,3%, followed closely by petroleum (2,5%). The main fuel source for primary energy consumption in the country remains biomass (>95%), as households are the main consumers of energy in the country (94% of consumption) and have most of their needs met by traditional biomass which is composed of approximately 70% fuel wood, 18% agricultural residues, 6% charcoal and 1% bagasse.

Figure 5

Electrification among population of Burundi
(adapted from Karangwa 2017 & www.energylopedia.info)



Education

Vision Burundi 2025 highlights Education as an area where significant investments and improvements are needed. Indeed, the Education system in Burundi is hampered at all levels (primary, secondary, higher) by an insufficiency of infrastructures, equipment and teaching staff. Indeed, the 50 year-old University of Burundi, which is still the most important higher education institution in the country, only has 10'000 students divided into 13 faculties and institutes. Although the labour market is currently quite restricted, as Burundi moves forward with Vision 2025 new jobs will be created in a number of sectors. In order to meet this new demand, an aggressive policy of training and education will be required in order to form a pool of skilled labour and high-level and competitive expertise.

Vision Burundi 2025 aims to equip Burundi with a competitive and diversified economy, which cannot be carried out without well-trained and qualified professionals. This will require a reform of the Burundian education system as the decline in the quality of results from the Burundian school system means that graduates are not competitive and cannot reach the external market. Scientific, technical and technological sectors will therefore be prioritized in order to promote research and creativity which are necessary in order to develop a competitive industry that can adapt to modern






technologies. This reform will be accompanied by a policy of vocational training and continuous skills improvement.

According to the World Bank 2014 report "Republic of Burundi Skills Development for Growth", as Burundi's Energy Global Value Chain is upgraded, job profiles required to do the work will change (Fig. 6), with some new jobs emerging, and others requiring improvements and/or increased supply. These include:

- Geographic Information System (GIS) Analysts
- Electrical Engineers
- Electrical Technicians
- Electricians
- Solar panel installers and maintainers
- Micro-hydro installers
- Dispatchers (for electricity distribution)
- IT Operator (for electricity distribution)
- Project Managers
- Entrepreneurs

Figure 6

Job profiles, skills level and training providers for Electricity
sector upgrading in Burundi (World Bank, 2014)

ELECTRICITY SECTOR				
				
No Formal Education No Schooling or Incomplete Primary	Literacy and Numeracy Basic Education	Technical Education Certification Secondary Level	Technical Education/Undergraduate Tertiary	University Degree or Higher Tertiary
Training Providers				
Utility	CEMs, Utility	CFPs, CEMS, Utility	l'Université du Burundi, l'Ecole National Supérieur, l'Institute National de Santé Public, Utility	International Universities, l'Université du Burundi, l'Ecole National Supérieur, l'Institute National de Santé Public
Plant operator		GIS Analysts	Microhydro plant Entrepreneurs	Regulatory Analyst
Manual Laborer		Solar Entrepreneurs	Project Manager	Procurement Manager
Meter Reader		Solar Panel Assembler	Electrical Inspector	Management/Planning
Customer Service Representative		Solar PV Installer & Maintenance	Plant engineer	Management/Planning
Note Green Existing job profiles that will grow Orange New job profiles that come about due to upgrading Black Jobs that will continue but will not expand		Technician/ Line Operator	Electrical Engineer	Senior Manager
		Distribution Technician	Transmission Engineer	
		Power dispatcher	Asset Manager	
		Electrician	Financial Manager	
		Generation technician	Middle Management	
		Electrician		
		Microhydro installers & maintenance		
		Electrician		
		Systems Operator		
		Electrical Engineer		

As the upgrading progresses, more complex higher level skills will be required, varying dependent on the technology that is adopted. Additionally, financial and project management skills will be increasingly important as the system expands, as will specific skills for regulatory policy and its operation.

The Higher Education sector in Burundi must therefore play a key role in providing opportunities

for Burundi's youth to gain the necessary skills and degrees in these areas. An improved flow of students to the labour market with these skills is clearly required. Furthermore, HEIs should seek to support and cooperate with the National Institute for Renewable Energy that MEM and the Ministry of Education are planning to create in order to train qualified personnel to support the new National Agency for Renewable Energy and Energy Efficiency (ANEREE).

2.2 KENYA



Energy and STI as Kenyan National Priorities

The economic, social and political pillars of Kenya Vision 2030 are anchored on macroeconomic stability, continuity in governance reforms, enhanced equity and wealth creation opportunities for the poor. Energy and Science, Technology and Innovation (STI) are two of the infrastructural enablers of the three "pillars" of Kenya Vision 2030:

- Energy - A vibrant power sector that meets electricity required to drive flagship Programmes.
- STI - Harnessing STI for sustainable development and global competitiveness.

Kenya Vision 2030 and the Second Medium Plan 2013–2017 identify energy as one of the infrastructure enablers for Kenya's transformation into "a newly-industrialising, middle-income country providing a high quality of life to all its citizens in a clean and secure environment". Access to competitively-priced, reliable, quality, safe and sustainable energy is essential to achieve the Vision.

Kenya is expected increase the commercial sector use of energy on the road to 2030. In addition, the government has continued to finance the extension of the electricity supply in rural areas as part of the basic infrastructure to stimulate economic growth and employment creation, as shown in the following Flagship Projects:

- Increasing Electricity Availability through Power Generation.
- Drilling and Steam Field Development of Wells
- Development of Multi-Purpose Dams by Regional Development Authorities.
- Increasing Electricity Access
- Construction of Pipeline and Storage Facilities
- Development of New and Renewable Sources of Energy.

Policy Framework, Laws and Regulations

The energy and petroleum sector is guided by Sessional Paper No. 4 of 2004 and several pieces of legislation, the principal ones being:

- The Energy Act No. 12, (2006) sought to amend and consolidate the law relating to energy, provide for the establishment, powers and functions of the Energy Regulatory Commission, the Energy Tribunal and the Rural Electrification Authority.
- The Geothermal Resources Act No. 12, (1982), to control the exploitation and use of geothermal resources and vests the resources in the Government.
- The Petroleum (Exploration and Production) Act, Chapter 308 of the Laws of Kenya was enacted to regulate the negotiation and conclusion by the Government of petroleum agreements relating to the exploration, development, production and transportation of petroleum.
- The Petroleum Development Fund Act (1991) for the establishment of a Petroleum Development Fund and the imposition of a Petroleum Development Levy.

Key stakeholders in the energy sector

In terms of the institutional framework, there are different stakeholders in the energy sector, among which, the Ministry of Energy and Petroleum, responsible for the Energy Policy and Development; Kenya Power Limited and Kenya Transmission Company Limited, responsible for distribution of grid connectivity; Ministry of Energy and Petroleum and Rural Electrification Authority, responsible for Rural Electrification and Ministry of Education, Science, Technology and Universities, responsible for Training and Research.

Furthermore, the National Commission for Science Technology Innovation (formed in 2013 by the Science, Technology and Innovation Act), whose role is to advise the Government, have developed the 2011-2031 Least Cost Power Development Plan (LCPDP) which lays out the best way to develop affordable energy. According to Dr Otwoma, Chief Science Secretary of the National Commission for Science Technology and Innovation, economical factors must be considered carefully in order to align business, government and lower cost generation facilities. In addition Dr. Otwoma mentioned the need for marketers to buy electricity at off-peak times.

Another key stakeholder is the Energy Regulatory Commission (ERC), a single sector regulatory agency responsible for the economic and technical regulation of electric power, renewable energy and downstream petroleum sub-sectors, whose tasks include setting and reviewing tariffs, issuing licences and permits, enforcement of compliances, resolution of complaints and disputes and approval of power purchase and network service contracts as well as providing indicative national energy planning.

Current energy situation in Kenya

The energy sector in Kenya is largely dominated by petroleum and electricity, with wood fuel providing the basic energy needs of the rural communities, urban poor and the informal sector. An analysis of the national energy sector shows heavy dependency on wood fuel and other biomass that account for 68% of the total energy consumption (petroleum 22%, electricity 9%, others account for 1%). Electricity access in Kenya is low despite the government's ambitious target to increase electricity connectivity from the current 15% to at least 65% by the year 2022.

As of the end of March 2015, Kenya has an installed generation capacity of 2,295 MW or 0.049 kW per capita, being the current electricity demand approximately 3,400 MW. The main sources of energy in Kenya are hydro, fossil fuel (thermal) and geothermal. Generation energy mix comprises:

- 52.1% from Hydro
- 32.5% from Fossil Fuels
- 13.2% from Geothermal
- 1.8% from Biogas
- 0.4% from Wind

Although hydropower accounts for a large proportion of energy production in Kenya, its unreliability has pushed the government to favour wind, thermal and geothermal generation in its current plans for the energy sector. By 2031, geothermal energy is intended to be the main contributor to the grid, followed by nuclear.

The LCPDP 2011-2031 has set an ambitious target to raise installed electricity capacity to 22.7 GW by 2033. It is estimated that 2011 peak load will grow 13 times by the year 2031. Forecasted peak demand for 2031 is 15,026 MW (Fig. 7). The government of Kenya in its LCPDP for period 2011-2031 identified

that geothermal is the least-cost choice technology to meet Kenya's growing energy demand. The cumulative geothermal capacity target is 5.5 GW for the planning period, which is equivalent to 26% of the system peak demand by 2031. Wind and hydro power plants will provide 9% and 5% of total capacity respectively by 2031.

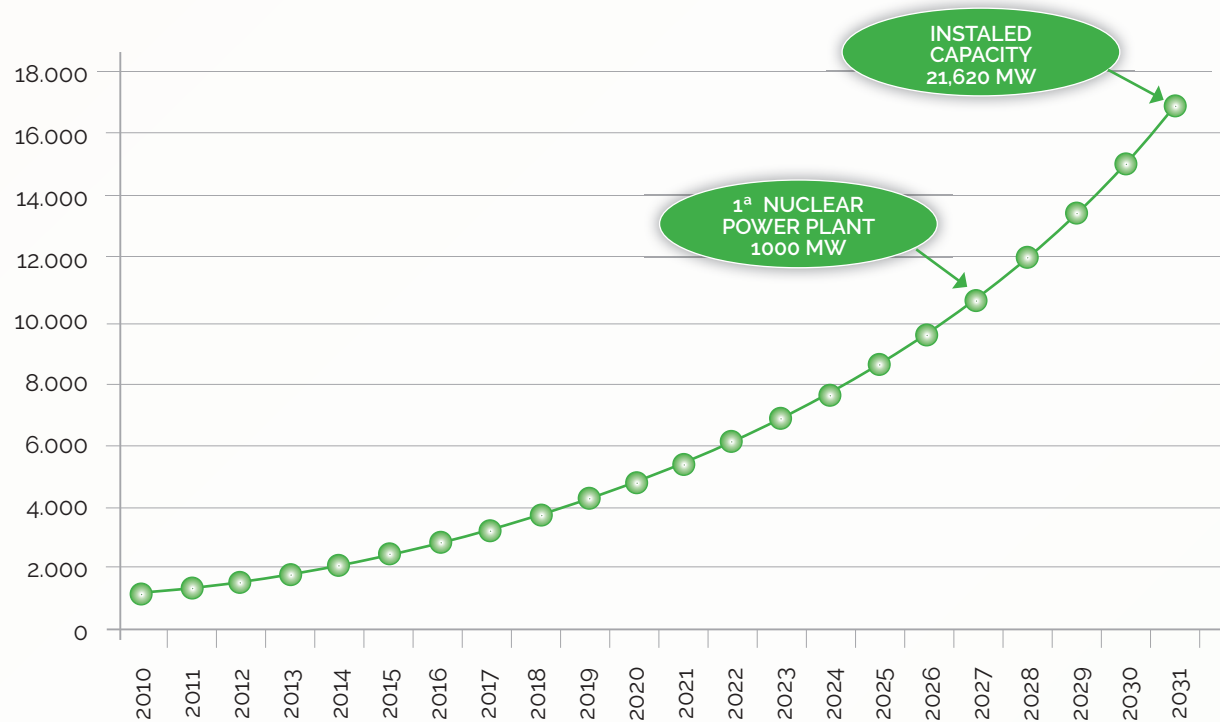
At the moment connectivity to the national electric grid in Kenya stands at 45%, but accessibility is only at 25%. These numbers are a result of the challenges present in Kenya, which include:

- Lack of performance of requisite tests of installations.
- Use of substandard materials and poor workmanship.

- Difficulty in distinguishing genuine materials from counterfeits.
- Non-compliance with safety standards
- Ignorance of relevant standards, statutes and regulations.
- High system power losses (>20%)
- High number of HV/MV/LV breakdowns
- Stagnant load growth

The Kenyan government's objective is to have 70% of connectivity by 2017 and universal access by 2020.

Figure 7
Job profiles, skills level and training providers for Electricity sector upgrading in Burundi (World Bank, 2014)



Role of the Higher Education System and the private sector

According to Dr. Margaret Gichuhi of Institute of Energy and Environmental Technology, Jomo Kenyatta University of Agriculture and Technology, there is a disconnect between HEIs and societal needs. HEI graduates do not have sufficient practical training, when they enter the labour market they are "mini-Academics" who only consider the theoretical framework as the final solution instead of looking closely at the problem at hand in order to find a better solution. HEIs should ensure Energy education is multi-disciplinary and not limited to scientists and engineers (provided to all degree students among the "general knowledge" courses). Also, more cooperation and networking is needed between HEIs and the private sector to provide meaningful internships for students and graduates so they can have "hands-on" experience and be

better adapted to the workplace. At the moment the private sector does not facilitate this because they do not understand how it could be of any use for them.

There is currently little interaction between the higher education system, the private sector and the government. Although there is a vision on the importance of having a fluid relationship between those actors, there is almost no implementation at this time.

Energy supply in Kenya, particularly electricity, has been falling below current demand and the growing demand requires corresponding capital outlay for investment in incremental generation capacity. It is envisaged that the private sector on its own or through Public Private Partnership (PPP) will play a key role in Kenya to provide the required capital.

2.3 RWANDA



Energy in Rwanda's VISION 2020

Although there was no specific Energy Policy nor strategy for the Energy Sector approved by the Rwandan government before 2009, the Government of National Unity under President Paul Kagame drafted and presented a document to a large cross-section of Rwandan society, by whom it was amended and validated. This resulted in VISION 2020, in which a long-term development path for Rwanda is outlined and ambitious development goals to transform Rwanda into a middle-income country by the year 2020 are formulated.

VISION 2020 is a framework for Rwanda's development, presenting the key priorities and providing Rwandans with a guiding tool for the future. It supports a clear Rwandan identity, whilst showing ambition and imagination in overcoming poverty and division.

Among the Key Indicators in VISION 2020, three relate specifically to energy (Table 5), showing

clear intentions to increase annual electricity consumption (from 30 Kwh/inhabitant in 2000 to 100 Kwh/inhabitant in 2020), access to electric energy (from 2% to 35% of the population) and a decrease by half of the proportion of wood energy in the national energy consumption.

Energy is indeed a key element of the fourth of VISION 2020's six pillars: Infrastructure Development. The rehabilitation and development of infrastructure is considered to be a crucial aspect in lowering the costs of doing business in Rwanda, which will attract domestic and foreign investment.

From VISION 2020:

"Inadequate and expensive electricity supply constitutes a limiting factor to development. Wood is the source of energy for 99 % of the population, which leads to massive deforestation and soil destruction. Imported petroleum products consume more than 40% of foreign exchange. Rwanda will therefore increase energy production and diversify into alternative energy sources. To achieve this, Rwanda has considerable hydroelectric potential, in addition to large deposits of renewable methane gas in Lake Kivu, estimated at 60 billion cubic metres. In rural areas direct solar energy or photovoltaic energy can be used, whilst up to 1/3 of 155 million tons of peat deposit is currently exploitable. Rwanda projects that by 2020, at least 35 % of the population will be connected to electricity (up from the current 6%) and the consumption of wood will decrease from the current 94% to 50% of national energy consumption."

Table 5
Renewable Energy Potential across Africa. (ADB)

Indicators	Situation in 2000	Target in 2010	Target in 2020
Annual electricity consumption (Kwh/inhabitant)	30	60	20-74
Access to electric energy (% of population)	2	-	49-86
Wood energy in the national energy consumption (%)	94	50,000-60,000	8-15

Rwanda will therefore increase energy production and diversify into alternative energy sources.

To achieve the energy sector's goals and objectives as laid out in VISION 2020 will require Rwanda to prioritize the following policy imperatives (ADFB, 2013):

- i. development of domestic energy sources;
- ii. efficient use of energy;
- iii. rationalizing energy pricing and subsidies;
- iv. institutional development of the sector; and
- v. capacity building

Policy Framework, Laws and Regulations

In order to achieve its long-term development goals, the Rwandan government has formulated a medium-term strategy to set the country's development objectives: the "Economic Development and Poverty Reduction Strategy" (EDPRS), which is fully supported by country level stakeholders, including development partners.

In 2013, the Rwandan government published its second **Medium Term Economic Development and Poverty Reduction Strategy for 2013-2018 (EDPRS-II)**. Among its thematic area priorities, two address energy directly: Economic Transformation (targets accelerated economic growth and restructuring of the economy towards increased services and industry) and Rural Development (focused on ensuring poverty is reduced from 44,9% to below 30%).

For Economic Transformation, energy and private sector development emerge as the leading sectors, accounting for more than half the total cost. Indeed, the first priority intervention is to increase the domestic interconnectivity of the Rwandan economy through investments in hard and soft infrastructure. To meet future demand and accelerate economic

transformation, Rwanda needs to:

- (i) meet the energy demand of the private sector;
- (ii) increase access to public goods and resources in priority sectors of the economy; and
- (iii) deepen the integration of key value chains.

To achieve these three objectives, EDPRS 2 proposes interventions that will:

- a) Increase Rwanda's electricity generation capacity to 563 MW, leveraging large-scale private sector investment;
- b) Give preferential access to electricity, water, roads, and land to priority sectors of the economy and/or large investors;
- c) Increase inter-linkages between large firms and suppliers in priority sectors, leading to increased investments by large firms in upstream activities

To increase energy generation to meet projected future demand and better develop Rwanda's indigenous sources of energy, EDPRS2 proposes two measures:

- (i) the development of a clear roadmap for investment in electricity generation; and
- (ii) a new approach to leveraging private sector investment in the sector.

Investments and planning in the electricity sector under EDPRS 2 will be based on a clear roadmap for investment aimed at delivering increased access to electricity and sufficient generation to meet all of Rwanda's energy demand. This roadmap will take a long-term view as investments that are made now will impact on tariffs for many years to come. It will also prioritise incremental improvements in energy generation rather than one big project that might materialise in 5-7 years, thereby bringing forward the increase in generation capacity.

The objectives of this roadmap are to:

- (i) meet demand for electricity using a balanced mix of energy sources;
- (ii) gradually eliminate subsidies to the electricity tariff, freeing up public funds for other investments; and
- (iii) prioritise public investments with a clear view on when and how funds are invested to ensure value for money.
- (iv) reduce the cost of energy to facilitate business.

Public finance will also be used to de-risk electricity generation projects for the private sector and thereby attract a wider range of investors on better terms. There are three parts to this:

- (i) proving the technical and economic feasibility of resources in geothermal, hydro, peat and methane (expected to cost over \$100m in public investment), financed by an energy development fund with donor support;
- (ii) putting in place systems to effectively project demand for electricity; and
- (iii) restructuring the procurement process following the guidelines of the Energy Policy (2012), shifting towards a more competitive and transparent procurement strategy, minimising unsolicited proposals, and encouraging local private sector involvement.

For Rural Development, the fourth priority intervention is to connect rural communities to economic opportunity through improved infrastructure. Interventions will include a feeder roads programme and information and communications technologies (ICT) expansion for rural areas with the aim of linking communities to markets, the electrification programme, modern biomass and other cooking methods, and full coverage of quality water and sanitation.

Despite being one of the most densely populated countries in Sub-Saharan Africa, only 4% of rural households use electricity as the main source of lighting and connected rural households consume below 30kWh/year/capita, well below urban consumption and ten times less than the Sub-Saharan African average at 478 kWh/year/capita. In the future, productivity increases through the use of small-scale technology at household enterprises or SMEs will depend on the provision of energy. The typical rural household requires energy for a cell phone, radio and lights. These types of consumption may be suited to solar and microgrid which are much more economical than on-grid solutions. Additionally, the energy used for cooking is currently dominated by biomass in the form of wood fuel used by over 90% of rural households. Biomass is an important source of rural employment, and low-cost energy for households and small industries and it reduces large-scale importation of alternative sources of energy.

The electrification programme for EDPRS2 promotes twin strategies facilitating 100% of the population to be connected through on-grid and off-grid solutions:

- The Electrification Access Rollout Programme (EARP) will ensure on-grid networks connect the bulk of the population in settlements and urban centres. It will target around 45% of households with direct connections by 2017.
- For the remaining households (> 1,2 million), off-grid solutions are an attractive cost-effective solution. For this rapid growth in private sector solar products will be encouraged, and off-grid micro-hydro generation will be expanded to communities located in isolated areas away from the grid.

In addition, energy education will be provided for the population – the rural population will be sensitized on the relative costs and benefits of alternati-

ve technologies to induce households to make informed decisions – and efficient cooking methods will be promoted for rural households:

- Biomass is the most economic option for rural households but should be used in a sustainable, safe and efficient manner.
- Sourcing of wood for fuel will be improved.
- Biogas and alternative sustainable biomass sources will be promoted.
- Use of improved energy efficient cooking stoves will be promoted.

To support the EDPRS-II, the Government of Rwanda has undertaken partnership with the private sector for the socio-economic transformation in easing doing business and reducing barriers to private investment in renewable energy such solar systems and mini-grids, in promoting competition which will help drive down costs and improve customer choice.

With regards to energy specifically, the strategic framework for Rwanda's energy sector is established in:

- **Energy Sector Strategic Plan (ESSP) 2013–17**, an implementation plan to achieve national targets as reflected in EDPRS-II (i.e. increasing power generation capacity to 563MW by 2018 and boost electricity access to 70% of population with 48% on grid and 22% off-grid. 100% access to electricity is targeted by 2020).
- **Rural Electrification Strategy (2016)**
- **National Energy Policy (NEP)** of 2015, which set targets up to 2017/18.
- **Rwanda Electricity Access Roll out Program (EARP)** (2009), the flagship program to realise the primary targets of EDPRS-I (2009–2013) and EDPRS-II (2013–2017) for electricity access.

These documents recognize the essential role of electricity access in accelerating economic deve-

lopment, as well as improving health outcomes and standards of living for people in Rwanda.

Key stakeholders in the energy sector

Key stakeholders in the Rwandan energy sector include:

- Ministry of Infrastructure (MININFRA) – responsible for the overall coordination of activities in the energy sector and for the strategies, planning and monitoring of the implementation of the different programmes. MININFRA is the lead ministry responsible for development of renewable energy and also plays an important role in attracting private sector investment and coordinating support of development partners and developed the Rural Electrification Strategy.
- Ministry of Natural Resources (MINIRENA) and Ministry of Agriculture and Animal Resources (MINAGRI) support MININFRA in providing policy control for the biomass sector.
- Ministry of Local Government (MINALOC) and local government structures are involved in renewable energy development and biomass.
- Ministry of Trade and Industry (MINICOM) is responsible for setting the prices of petroleum products, together with the Ministry of Finance and Economic Planning (MINECOFIN) to set fuel taxation and industry margins.
- The Energy, Water and Sanitation Authority (EWSA), responsible for the implementation of MININFRA energy programmes and for generation, bulk transmission and distribution and retailing of energy, was reformed and transformed in October 2013 into two public companies that should operate as commercial companies:
 - The Power and Energy Holding Company

- The Water and Sanitation Company
- Rwanda Utilities Regulatory Authority (RURA), is in charge of electricity regulations and is responsible for ensuring that electricity tariffs reflect recurrent costs as well as for the approval and registration of all energy activities.
- Rwanda Environment Management Authority (REMA), under the guidance of MINIRENA, supervises the environmental aspects of the energy sector and is responsible for coordination and implementation of legislation and policies relating to environmental impacts of energy production and consumption.
- Ministry of Education, Science, Technology and Scientific Research (MINEDUC) is in charge of implementing the National Policy on Science Technology and Innovation.
- The Private Sector has had a limited role in the past – other than as a significant energy user – but the Government is encouraging electricity production through PPPs at a large scale (for example Lake Kivu methane projects) as well as in the hydro power sector to support management and construction.
- International donor organisations support the implementation of the government energy strategy through technical and financial resources. These include World Bank, AfDB, Arab Bank for Economic Development in Africa (BADEA), EU, UNIDO, Cooperative Technique Belgium (CTB), Netherlands, France, Japanese International Cooperation Agency (JICA) and Société Tunisienne de l'Electricité et du Gaz (STEG International).

Current energy situation in Rwanda

The Government of Rwanda has launched ambitious reforms to meet the objectives set out in its

comprehensive economic development agenda (EDPRS-I and EDPRS-II), particularly in the energy sector and the power sub-sector, to the point that the country's national electricity company is viewed as a model utility in East Africa (AfDB, 2013). As a result of the country's success in rapidly increasing the population's access to energy, the initial target of 35% laid out in VISION2020 in 2000 has been increased to 50% in 2010, and then to 70% in 2012, with the current objective laid out in EDPRS-II (2013) to have 100% of the population connected through on-grid and off-grid solutions.

Rwanda's energy balance indicates that about 85% of its overall primary energy consumption is based on biomass (cooking), 11% from petroleum products (transport, electricity generation and industrial use) and 4% from hydro sources for electricity.

In April 2011 about 14% of the total population had access to electricity from the grid and the government started a roll-out programme to rapidly increase this to 16% (350 000 connections) by 2012 and 57% by 2016, with targets of 70% by 2018 and 100% by 2020. As of 2016, 19.8% of the population had access to electricity, while current data from the Rwanda Energy Group indicates that Rwanda's national electrification rate as reached 31% (3% off-grid, 28% on-grid). Over seven million people still lack access to electricity. (National Round Table Reports, 2017; Energypedia.info).

Installed generating capacity in Rwanda has increased steadily from 45 MW available in 2008, to 97 MW in 2013 (57 MW hydro and 40 MW diesel), and it reached a peak of 208MW in January 2017 – an increase of 360% since 2008 (National Round Table Reports, 2017; Energypedia.info; Wikipedia.com). Sources include hydropower plants, thermal/diesel power plants, thermal/methane gas power plants, solar power plants and imported power (Table 6).

Table 6

Contribution of power plants in the networks

(from <http://reg.rw/index.php/our-business/generation/465-current-electricity-generation-Status>)

Power Plants	Installed Capacity (MW)	Contribution to total (%)
On-grid hydropower plants	78,73	42,31%
On-grid thermal/diesel power plants	37,8	20,31%
On-grid thermal/methane gas power plants	28,6	15,37%
On-grid solar power plants	8,75	4,70%
Offgrid hydropower plants	1,7	0,91%
Offgrid thermal powerplants	14	7,52%
Important power	18	8,87%
TOTAL	188,03	100%

The economic sectors with the highest potential for growth (agricultural processing, mining, tourism, IT) depend heavily on energy supply. The costs of electricity are very high and require government subsidies. At the same time, the lack of electricity in rural areas reduces the efficiency of the social services (health, education and administration), requiring additional support from the government to increase their access.

Education and Science, Technology & Innovation (STI)

Education is a key component of Rwanda's VISION2020 (Pillar 2, Human resource development), both in terms of increasing education access and quality of the national population, and specifically to reach its energy objectives. Currently there aren't enough skills to meet specific needs of the energy sector and specialised training is mostly done abroad. The Government and stakeholders need to engage in a systematic capacity building process to create a critical mass of technicians at all levels and all District and Sector levels who are capable of installing, operating, maintaining and repairing re-

newable energy technologies in the country. HEIs and Vocational Schools would be key in providing much of this training, and improved cooperation with industry would allow for better internships for both undergraduate and master's students.

The Africa Centre for Excellence in Energy for Sustainable Development (ACEESD) of the University of Rwanda College of Science and Technology, created with support of the World Bank Group, is envisioned to address key economic challenges resulting from low rural energy access, poor adoption of energy technologies in rural areas, and poor inter-state energy trading in the East Africa region. It will also develop strategies and regional policies aimed at strengthening and promoting harmonization of the energy trade. It offers multidisciplinary science and engineering courses at Master's and PhD levels in Renewable Energy, Power systems and Energy Economics.

Rwanda's Ministry of Education, Science, Technology and Scientific Research is in charge of implementing the country's National Policy on Science, Technology and Innovation, approved by the Rwandan Cabinet in 2005. This policy aims to in-

tegrate Science, Technology, Scientific Research and Innovation in the context of the issues facing Rwanda, and provides strategies to strengthen science and technology across all sectors of the economy, including energy.

The National Policy goal is to meet the Energy challenges and needs of the Rwandan population for economic and social development in an environmentally sound and sustainable manner. The Science and Technology Policy in Energy aims to promote scientific and technological activities that will increase access to electricity and provide good quality, cost-effective service, including the development of capacity in all areas of energy research, development and implementation, with particular regard to renewable energy and the protection of the environment. Science and Technology Strategies in Energy state:

- Research and development shall be carried out in renewable and Energy alternatives: solar, wind, geothermal, including equipment and best practise applications;
- Research and development shall be carried out in Energy use & conservation practices;
- Research & Analysis of waste and recycling options and system of management shall developed;

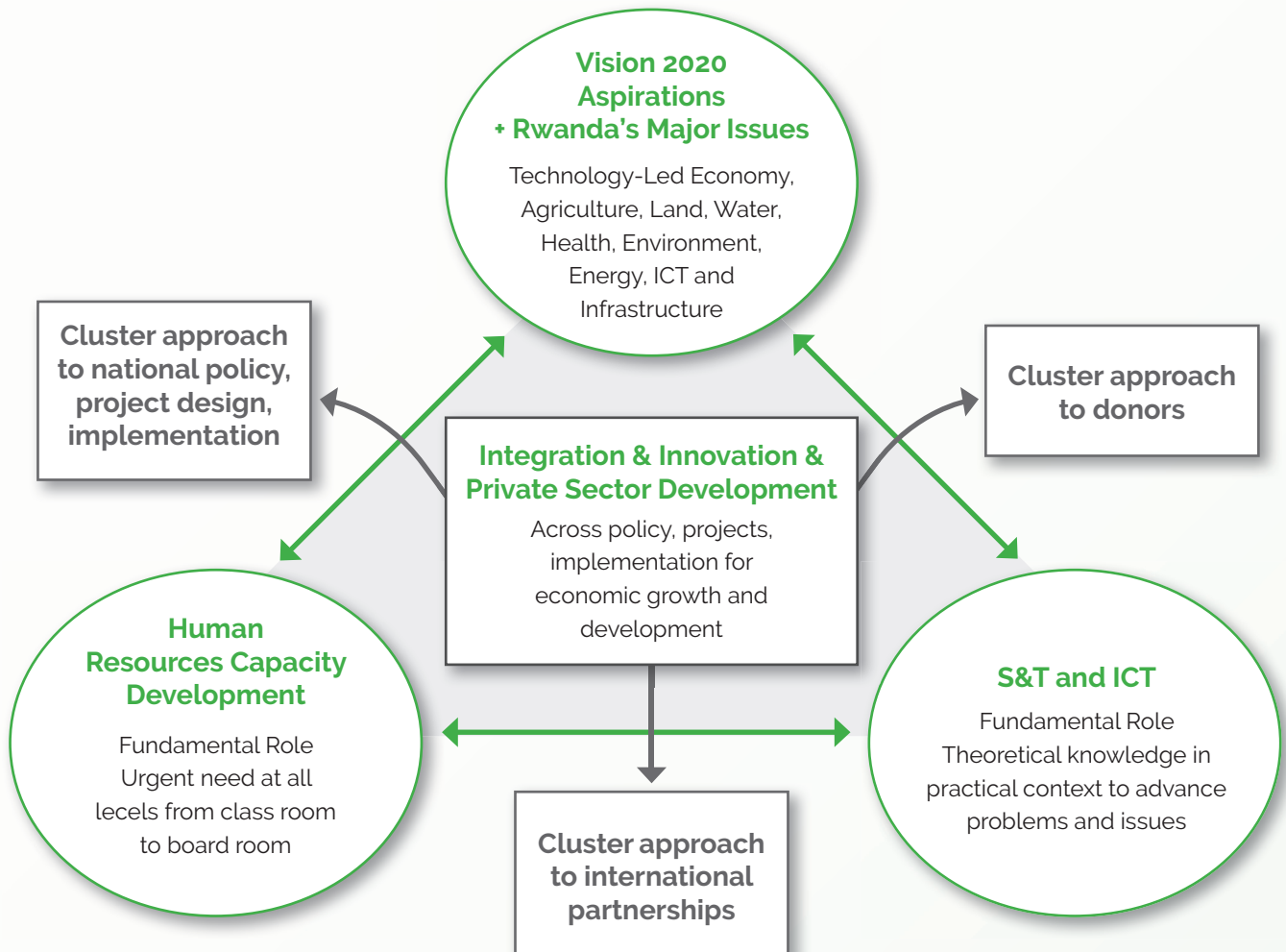
- Exploration shall be conducted in the extraction of methane gas from lake Kivu including and best practise technologies;
- Capacity Building and human resource development shall be carried out to develop local Rwandan capacity in all areas of engineering and technical fields, including expertise in the field of renewable energy technologies, etc.

Finally, the National Integrated Innovation Framework for Rwanda (Fig. 8) creates linkages between policy, capacity, and major country issues, and emphasises a cluster approach, not only to national policy and projects, but also to external relationships with donor community and the international community.

Rwandan Higher Education Institutions are actively involved in preparing the country's future engineers, technicians, and researchers in Energy. Indeed many research opportunities exist in the energy field, including regarding renewable energy sources in the country (solar, peat, methane, geothermal); Hydro resources in light of Climate Change; future energy mixes, etc.

Figure 8

Overview of Integrated Innovation Framework Linkages
(UNU-IAS Report, 2006)



2.4 TANZANIA



Energy as a priority sector

The Tanzania Development Vision 2025 outlines a roadmap to a middle income country. Within Vision 2025, the Big Results Now (BRN) initiative aims to speed up project completion in six priority sectors. As a priority sector, Energy BRN proposes several steps to increase natural gas generation, improve electricity access, strengthen the financial capacity of the public utility, Tanzania Electric Supply Company (TANESCO), and develop mini- and off-grid renewable opportunities.

Policy Framework, Laws and Regulations

In Tanzania, the legal framework for energy resource management and development is governed by the National Energy Policy and various Acts of the Parliament.

The National Energy Policy document was launched in April, 1992. From that time the policy has undergone a review process which was prompted by social and economic changes taking place in all sectors of the economy. The revised Energy Policy was launched in February 2003 and focuses on market mechanisms as a means to reach its objectives and achieve an efficient energy sector. The objectives of the National Energy Policy are to ensure availability of reliable and affordable energy supplies and their use in a rational and sustainable

manner in order to support national development goals.

The Acts of the Parliament include:

- The Electricity Act of 2008 whose main task is the privatisation of the electricity market and an improved framework for market introduction of renewable energy technologies in particular in rural areas.
- The Rural Energy Act of 2005 which established the Rural Energy Agency and Fund (REA/F) whose main task is to promote access to modern energy services and to provide performance based subsidies for rural energy including renewable energy systems.
- The Energy and Water Utility Regulatory Authority Act established in 2001 which provides the regulator with the responsibility of tariff setting effecting also the independent renewable energy power producers.
- The Petroleum (Exploration and Production) Act.
- The Environmental Management Act.
- The Atomic Energy Act.
- The Water Resources Management Act.
- The Land Act.
- The Natural Gas Policy (URT, 2015)

Key stakeholders in the energy sector

Key stakeholders in the Tanzanian energy sector are:

- The Ministry of Energy and Minerals, Water and Natural Resources.
- Government Institutions - NEMC, COSTECH, TANESCO, REA, TPDC, NBS, EWURA, VPO-Environment, Universities and Training Colleges e.g., VETA, DIT etc.

- Development partners - UNIDO, UNDP, USAID etc
- Other organizations – NGOs, Sector Associations and Commercial companies.
- End-user (Consumers) – households, farmers, business organizations e.g., manufacturing/service firms.

Current energy situation in Tanzania

Tanzania has abundant and diverse indigenous energy resources which are yet to be fully exploited. The sources include wood fuel and other biomass fuels, hydropower, natural gas, coal, uranium, wind, geothermal and solar.

Tanzania's energy supply depends mainly on biomass. Since 85-90% of the population are not connected to the electricity grid, the overwhelming majority of households use wood and charcoal for cooking. In total, biomass makes up close to 90% of the total primary energy consumption in Tanzania. Unfortunately, this leads to the deforestation of 100,000 ha per year, of which only about a quarter is reforested. Other energy sources are petroleum, which makes up 7.8% of total primary energy consumption, natural gas (2.4%), hydropower (1.2%) and coal/peat (0.3%). About 6.6 percent of primary energy needs to be imported, primarily from Uganda and Zambia.

Electricity makes up only 0.6% of total energy consumption. Out of Tanzania's 41.5 million inhabitants, so far only 12 percent of urban and 2 percent of rural areas are electrified, which means that less than 10% have access to grid-based electricity or other forms of commercial electricity. The national electricity connectivity is about 14% and it is expected that electricity demand will triple by 2020.

Science, Technology and Innovation support services on energy access

Energy access and efficiency is a current issue of global concern. Energy shortage and poverty have become a major factor hindering the economic growth and development in Africa. Energy policy emphasizes Science, Technology and Innovation (STI) support on energy access. Despite its role, the extent to which STI supports energy access and efficiency in Tanzania is yet to be established.

Significant efforts have been made by the Government of Tanzania to create awareness on the real needs and opportunities of STI in the society such as the adoption of the National Science and Technology policy. The government initiatives include:

- The establishment of Commission of Science and Technology (COSTECH).
- Establishment of the Ministry of Science, Technology and Higher Education.
- A review of national Science and Technology Policy.
- Establishment of the Nelson Mandela African Institute of Science and Technology (NM-IST).
- Establishment of the Life Sciences Governance Center.
- The Center of Excellence in Agricultural Biotechnology (NABC).

2.5 UGANDA



Energy at the National Development Plan

Energy is an integral part of the Ugandan Government's Poverty Eradication Action Plan (PEAP) which includes frequent references to the link between energy and poverty alleviation. In June 2015 the Government of Uganda launched the Second National Development Plan (NDPII) 2015/16 – 2019/20, which covers a number of energy issues:

- As regards to energy infrastructure, investment will be focused on exploitation of the abundant renewable energy sources including hydro-power and geothermal, so as to increase power generation capacity from 825MW in 2012 to 2,500MW by 2020;
- Expansion of the national electricity power grid network;
- Develop the oil and gas sector;
- Promote energy efficiency and use of alternative sources of energy;
- Formulate energy related Policy and other regulatory frameworks;
- Promote capacity building in the energy sector

Policy Framework, Laws and Regulations

The Government of Uganda has over the past years embarked on a Power sub-Sector Reform Programme, which has resulted in the implementation of significant structural changes within the sector. The Reform Programme was aimed at providing adequate, reliable and least-cost power supply to meet the country's demand, promoting the efficient operation of the power sector and scaling up rural and peri-urban access to maximize the impact on poverty reduction. Despite the implementation of these reforms, the country continues to experience significant power supply shortages, low rates of access to electricity and high levels of power losses, all negatively impacting the country's economic growth. The low level of access to modern forms of energy, particularly electricity, has continued to be one of the major infrastructure bottlenecks to socio-economic growth in Uganda. The following laws have been passed in order to reform the energy sector:

- Electricity Act, 1999: this act sets the legal basis for the industry's restructuring, including the establishment of the Electricity Regulatory Authority (ERA).
- Energy Policy for Uganda, 2002: the main policy goal is "to meet the energy needs of the Ugandan population for social and economic development, in an environmentally sustainable manner".
- Renewable Energy Policy for Uganda (REP), 2007: the overall goal of REP is to increase the use of modern renewable energy.
- The Atomic Energy Act, 2008

Key stakeholders in the energy sector

There are a number of ministries, government agencies, local authorities, regulatory authorities, Higher Education Institutions and private companies relevant in the energy sector in Uganda, each with their own roles (Table 7):

Public authorities

- Ministries: Ministry of Energy and Mineral Development (MEMD), Ministry of Finance, Planning and Economic Development (MoFPED), Ministry of Works & Transport (MoWT), Ministry of Education and Sports (MoEST).
- Agencies: Electricity Regulatory Authority (ERA), Rural Electrification Agency (REA), National Environment Management Authority (NEMA).
- National Crop Resources Research Institute
- Uganda Industrial Research Institute (UIRI)
- Uganda National Council for Science and Technology (UNCST).

NGOs/CBOs/Development Partners

- Integrated Rural Development Initiatives (IRDI)
- Joint Energy and Environment Projects (JEEP)
- Rural Initiative for Development and Environmental Management (RIDEM).
- Uganda Coalition for Sustainable Development (UCSD).
- Uganda Environmental Education Foundation (UEEF).
- World Bank, GIZ, UKAID, USAID, EU, UNDP, WWF-UCO.

Parastatal corporations & Private sector

- Uganda Electricity Generation Company Ltd (UEGCL).
- Uganda Electricity Transmission Company Ltd (UETCL).

- Uganda Electricity Distribution Company Ltd (UEDCL).
- Private Power Generators (Kakira SWL, Kinyara SWL).
- Private Power Distributors (UMEME, Ferdsult, Global Networks, NEK).
- Construction Companies
- Charcoal dealers
- Briquette manufacturers

Higher Education Institutions & Other

- Makerere University, Kampala (MUK), has introduced a number of training courses focusing on the petroleum industry.
- Other Degree Awarding Institutions & Technical Colleges.

Table 7
Role of Ugandan stakeholders
(Eilu, 2017)

Actor	Role
Government	Policy formulation Monitoring & Enforcement Financing research and Innovation Buyer and Seller of Energy Regulation and Standards Decision Making on national priorities
Industry	Investment in energy Construction Consultancy Services (Supervision, Feasibility and ESIA) Training (internships/attachments) Uptake and adoption of innovations (e.g. YAKA, Renewable Energy)
Tertiary Institutions and Science and Tech Councils	Research Innovation e.g. -KIRA EV Dissemination/promoting networking Training and refresher courses
Civil Society and Development Partners	Financing, Implementation and Policy guidelines
Communities	Information source, Labour Uptake of Innovations Consumer loyalty-pay bills Anti-vandalism

Current energy situation in Uganda

About 90% of the total primary energy consumption is generated through biomass, which can be separated in firewood (84%) and charcoal (6%). Electricity only contributes 4% to the national energy balance while oil products, which are mainly used for vehicles and thermal power plants, contribute 5%. Most of the biomass energy is from wood, which is consumed in the form of charcoal and firewood (Fig. 9). There is a high dependency on firewood as a cooking energy source among households in Uganda (Fig. 10).

Concerning electricity generation, Uganda has an installed capacity of 822 MW, mostly consisting of hydropower (692 MW; 84%). At only 15% at a national level, access to electricity in 2013 was very low, and fell to just 7% in rural areas. Uganda currently has one of the lowest per capita electricity consumptions in the world, with 215 kWh per capita per year.

There are cross-cutting issues affecting the energy sector and barriers to Renewable Energy development in Uganda including the following:

- Inadequate standards and limited testing facilities for a number of technologies.
- Inefficient legal frameworks to encourage and promote the use of Renewable Energy.
- Insufficient technical data and awareness on investment options in renewable and biomass energy technologies.
- High upfront investment costs for renewable energy technologies.
- Limited technical and institutional capacity to roll out the technologies.
- Irrational utilization of biomass resources among others.
- Low generation of HEP, limited distribution, and low level of coverage.
- Absence of district electricity branches and limited awareness.
- Resistance from people towards new technologies.

- High inefficiencies in biomass utilization as a threat to the environment.
- Inadequate funding for Research and Development geared to local manufacturing.
- Inadequate legal and institutional framework to support investment in efficient improved biomass technologies.
- Need to balance food security and fuel production - i.e. need to reduce competition between food and alternative fuel production.

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Figure 9
Overview of the energy situation in Uganda
Source: MEMD Energy Balance Report (Eilu, 2017)

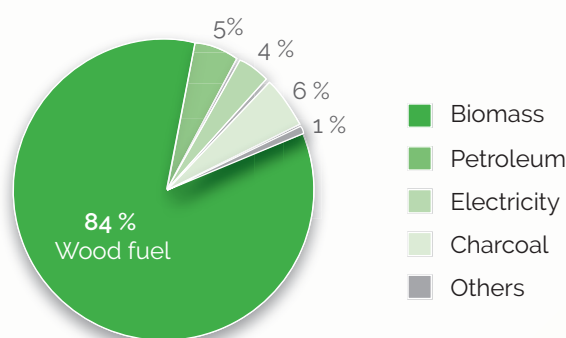
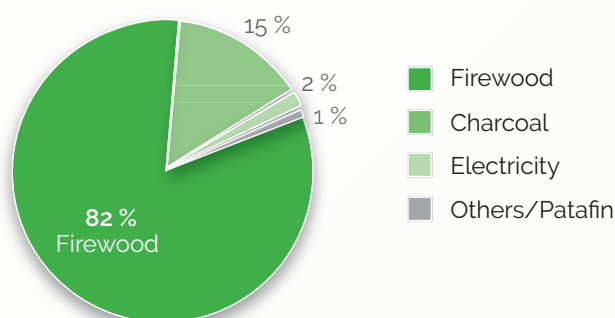


Figure 10
Relative use of energy sources for cooking in Uganda
(Eilu, 2017)



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Role of Higher Education Institutions

The Uganda Vision 2040 identifies human capital development as one of the key fundamentals that need to be strengthened in order to accelerate the country's transformation and harnessing of its demographic dividend. The availability of appropriate and adequate human capital facilitates increases in production, productivity and technological growth,

making it one of the key endogenous drivers of economic growth.

Despite the increased enrolment in university education, student enrolment in science and technology programs at both private and public universities is still low (about 37%) which is below UNESCO's minimum requirement of 40% of students registering in Science and Technology.

The Uganda National Council of Science and Technology has supported various universities and research institutions to train scientists and engineers, develop research capacities and undertake cutting edge research.

Within the Second National Development Plan (NDPII) 2015/16 – 2019/20, one of the key focus areas of the energy sector is to build capacity in the sector via two interventions: strengthening the institutional and human capacity and training staff in specialized fields like nuclear science, geophysics, geology, hydropower and geothermal technology.

According to Dr. Gerald Eilu of Makerere University, Higher Education Institutions in Uganda should:

- Develop curriculum and programmes on relevant STI topics such as Intellectual Property and Technology Transfer related to the energy sector;
- Establish clear strategies for engaging private sector to support Research, Innovation and Knowledge Exchange;
- Strengthen training programmes in oil and gas, thermal energy, hydroelectricity and other innovative energy sources;
- Strengthen networks for researchers and other actors in the energy sector at national regional & international level;
- Conduct cutting edge research to guide policy.

3 CHALLENGES

According to Prof. Kimambo of the University of Dar es Salaam, the main challenges on energy access in East African countries vary considerably. Kenya has the highest access rate to electricity at 60% followed by Tanzania at over 46%, with Uganda at 27% and Rwanda at 19.8%. Burundi is at the bottom of the list with access rates of 5%. The low access rate to electricity in these countries is due to the low levels of power generation and the insufficient transmission and distribution networks. There are inadequate regional interconnections and weak strategies on electricity access and energy policies. Slow performance to sustain and increase extraction of modern energy sources such as renewable energy, oil and gas remains a major challenge. Serious efforts have been made by some of the EA countries to address these challenges and significant achievements have been recorded. The existing challenges can be turned into opportunities, thus improving energy access in EA countries.

The main challenges on energy access in Burundi, Kenya, Rwanda, Tanzania and Uganda are the following:

3.1 BURUNDI

- Weak regulatory environment
- Weak institutions at both policy and operational levels.
- Lack of entrepreneurial capacity in the country which hampers small commercial electricity projects.
- Poverty.
- Weak plans in the energy sector due to country's political instability.
- Lack of access of inputs and finance for installation of connections.
- Lack of accurate data on energy supply and demand.

- Lack of maintenance on the transmission and distribution lines.
- Generation facilities need upgrading
- Overdependence on hydropower, leaving the country vulnerable to rainfall variations.
- Foreign exchange shortages for fuel importation.
- Lack of foreign investors due to political instability.

3.2 KENYA

- Massive deficit in fuelwood supply leading to high rates of deforestation, resulting in adverse environmental effects such as desertification, land degradation, droughts and famine.
- Lack of access to comprehensive, accurate and reliable information on the renewable energy regulatory landscape which has been a significant barrier to private sector participation on energy coverage.
- Types and number of licenses/clearances, application procedures, associated costs, contacts of related government agencies, expected turn-around time and the sequence of application process remains unclear to many local and international investors interested in the renewable energy subsector.

3.3 RWANDA

- Supply shortfalls and high supply costs: due to insufficient generation capacity, the use of rental thermal generation has led to high electricity costs. Rwanda has the highest generation tariff in the East African Community (EAC) of about \$0.21/kWh.
- Low Access to electricity particularly in the rural areas: despite impressive gains, access rates remain low at about 25% nationwide from which

24% on grid and 1% off-grid. Significant investment is required in transmission and distribution in order to maintain the high connection rates.

- High costs of new electricity connections which are beyond the reach of most households in Rwanda.
- Lack of entrepreneurial capacity in the country, which hampers small commercial electricity projects.
- Insufficient capacity of Private Sector Investments: private sector investments remain low in energy sector due to limited financial capability and return on investment which is not immediate.
- The increasing population and rising incomes per capita resulting in a higher demand for cooking energy.
- Few and more expensive alternatives such as electricity, LPG and kerosene.
- Need to reduce the consumption of biomass (firewood/ charcoal). Dependence on biomass fuels such as charcoal in urban areas and firewood in rural areas resulting in many problems such as deforestation, land degradation, increased greenhouse gas emissions as well as various health and social problems.

3.4 TANZANIA

- Increased demand for electricity supply and distribution.
- Slow performance to sustain and increase oil and gas exploration.
- Poor regional interconnection.
- High electricity connection and tariff costs compared to the incomes of the expected users.
- Poor infrastructures which lead to failure in reaching rural households.
- Little awareness by households about cost-benefits of using non-renewable energy source

- Energy investments do not involve local citizens at earliest stages (not participatory).
- Lack of policy that guides energy investments - so far there is no policy that guides new investments in the energy sectors so that local opinions could be integrated in the energy investments.
- Lack of a nexus between government policies and local developments priorities.
- Very low role of high learning education (Universities) in STI support on energy access and efficiency.

3.5 UGANDA

- Poverty
- Weak energy policies
- Weak strategies on electrification coverage
- Overlaps, duplication of roles and limited networking/partnerships characterize the energy sector in Uganda.
- Lack of coordination, limited interaction between the higher education system, the private sector and the government is still limited.
- Insufficient information sharing
- Lack of competences
- Structural issues and inadequate infrastructure
- Bureaucracies
- Inadequate information
- Little appreciation for local actors who try to promote best practices
- Proliferation of counterfeit products on the market.
- Alternative energy options for Uganda are generally more expensive than biomass energy, making it difficult for communities to embrace them.

4 OPPORTUNITIES

According to the publication *Energy Access and Security in Eastern Africa: Status and Enhancement Pathways* by the United Nations Economic Commission for Africa (2014), although there are many challenges in the energy sector of Eastern Africa, opportunities are also plentiful. East African countries have with significant clean energy resources and development potentials in transboundary hydropower systems. Additionally, possibilities exist for private sector participation and capital infusion, and institutional and policy reforms can address the pent-up demand for rapid energy development. Given that energy access and security are indispensable to economic transformation, the UN Economic Commission for Africa advises the countries to:

- a) make a strong commitment to energy sector development consistent with their socioeconomic development aspirations.
- b) increase private sector participation, and private-public partnerships to enhance investment resources in the energy sector;
- c) pursue regional opportunities to engage in energy trade and benefit from lower energy costs and economies of scale.
- d) undertake renewable energy initiatives
- e) commit to the attainment of subregional and country targets set for energy access and striving to achieve the Sustainable Energy for All objectives by 2030.
- f) strengthen energy planning while synergizing with economic planning.
- g) institute and stock strategic reserves of petroleum to lower the economic costs of energy disruptions and developing partnerships for a regional procurement framework.
- h) strengthen regional cooperation on the develop-

ment of strategic energy resources such as oil and gas.

- i) engage in exchange of information and experiences to enhance energy access and security.
- j) address the issue of energy constraint which impedes economic transformation, through workable strategies implemented in the Eastern Africa subregion and beyond.

The main opportunities by country according to the national country reports, presented during the International Conference "Fostering Cooperation in Energy Efficiency and Accessibility in East Africa" are the following:

4.1 BURUNDI

- An important hydroelectric potential not yet exploited.
- Support by multilateral and bilateral funding partners: the World Bank, the African Development Bank, the European Investment Bank, Japanese, Chinese, German, etc.
- A very active sub-regional energy cooperation: several energy projects are being developed under the Nile Basin Initiative (NBI), the East African Community (EAC) or the Economic Community of the Low Countries Great Lakes (CEPGL).
- An improved legal framework for private investment.
- A law on the liberalization of public electricity services is already in place.
- Civil society involvement in sustainable development: environmental impact assessments of energy projects now take into account the opinions of the various components of civil society.

4.2 KENYA

- Increasing interaction between Learning and Research Institutions, private sector and the government (The Triple Helix).
- Higher Learning and Research institutions to engage the private sector in advanced energy solutions on a national scale.
- Public-Private Partnership Act 2013
- Enhance Technology Transfer Offices in HEIs;
- R&D Funding- Provide stable, sufficient funding for Research, Development, Demonstration and Deployment of a wide range of emerging clean energy technologies.

4.3 RWANDA

- A Least Cost Power Development Plan (LCPDP) and an Integrated Resource Plan (IRP) are being developed to ensure the sustainable development of the electricity sector.
- The implementation of Rural Electrification Strategy (RES) recently approved in June 2016 supplement the Rwanda Electricity Access Roll out Program (EARP) mainly in remote areas while EARP focuses on productive users.
- The Scaling Up Renewable Energy Program (SREP) approved in November 2015 will support sustainable financial long term market for private sector with USD 50 million in off-grid electricity services.
- Off-grid options, such as solar and biogas, are the most economical and sustainable options for poor households. Supporting biomass and other modern cooking sources will also support rural households.
- The General Manager of Symbion Power Lake Kivu Ltd has that the technology used in producing power from extraction of methane gas

of Lake Kivu as an opportunity for Rwanda to increase its capacity of production of electricity.

4.4 TANZANIA

- Increasing of revenue collection in relation to energy project investments.
- Investment opportunities in exploration, production, transportation of energy.
- Improving social services and economic activities in Tanzania.
- Adoption of the National Science and Technology policy and review.
- Establishment of Commission of Science and Technology (COSTECH).

4.5 UGANDA

- The immense energy demand
- Huge potential for renewable energy development.
- Good will of development partners
- Relatively favourable institutional, regulatory and policy frameworks.
- Policies within universities to encourage Knowledge Transfer, innovation & spin-off creation.
- Rapidly expanding private sector involvement
- Opportunity for capacity building – existence of numerous tertiary institutions.

5

RECOMMENDATIONS FOR COOPERATION IN EAST AFRICA

According to the United Nations Economic Commission for Africa 2014 report *Energy Access and Security in Eastern Africa: Status and Enhancement Pathways*, the Eastern Africa subregion requires a revolution in energy technology innovation and adoption to meet the profound economic, environmental and social challenge energy poses in the 21st century. The G8 Summit in Heiligendamm Declaration (2007) stated the aim of promoting major emerging and developing economic participation in international technology partnerships in the energy sector and to scaleup national, regional and international research and innovation activities. Without an energy policy based on technology-supported sustainability, Africa and other developing countries may not achieve strong sustainable development outcomes. As a result, the following recommendations were put forth for policymakers, decision makers and stakeholders to consider:

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

- Encouraging private sector participation in spreading technology.
- Better linkages between research and enterprise in specific sectors of energy.

In order to meet these recommendations, East African countries will have to continue developing their Higher Education Institutions in order to meet the needed skills and capacities, by increasing the educational offer in energy-related subjects and degrees, making sure to include multi-disciplinary aspects and have courses offered to a cross-section of the student body (not just the engineers and physics majors).

The main recommendations according to the national country reports, presented during the International Conference "Fostering Cooperation in Energy Efficiency and Accessibility in East Africa" are as follows:

5.1 BURUNDI

- Promote renewable energies (RE) (solar, ethanol and wind) and continue the construction of hydroelectric power stations and investments in renewable energy.
- Encourage and innovate in the search for RE solutions well adapted to the energy needs of populations.
- Sensitization of the population to the use of RE technology, and facilitate access to these technologies.
- Encourage the private sector to invest in REs through incentive mechanisms and facilities.
- Facilitate access to funding for the RE project promoters.
- Improve the wood-energy sector while safeguarding the environment.

5.2 KENYA

- Development of a database of Energy Experts categorised by areas of expertise.
- Develop and maintain a network of experts
- Respond to joint calls for research
- Develop more applied research
- More cooperation between HEIs and government and private sectors to grant researchers better access to data and promote public private partnerships.
- Obtain funding to further develop energy projects and networks by looking for opportunities presented by philanthropic bodies, development banks and regional programmes.
- Increase infrastructures and facilitates research
- Multisectorial collaboration and interdisciplinary research should be foreseen, with the support of government and the proper policy instruments (a triple helix approach), as the science of today could be the technology of tomorrow.
- Involve stakeholder industry players when developing university curriculum.

5.3 RWANDA

- Science and Technology has a key role to play in the realization of the vision of the country. Targets should focus on strengthening and integrating Science Technology and Innovation into the country's strategies and policies in order to achieve national socio-economic development.
- Higher Learning Institutions should strengthen their relations with Public Institutions, Private Institutions and Industries (PPP) through research, consultancy, internships, seminars and lectures.
- For a sustainable plan of any economic transformation, interaction between the Higher Education System, the Public Sector, Development Partners and the Private Sector and consulta-

tion with the Community a necessity.

- Regional and International Cooperation on STI is important for interaction, integration sharing of experience and development of cross-border projects.
- Further discussions needed on how to go forward including engagement with Rwanda Energy Group (REG), Rwanda Energy Private Developers and donors on the way of collaborating in promoting research and innovation and finding solutions on challenging problems related to sustainability.

5.4 TANZANIA

- Support Government efforts on implementation of strategies to support research, innovation and knowledge exchange.
- Conduct research on energy access and efficiency, and inform the society through different forums.
- Enhance the use of renewable energy in areas which are not connected to the national grid of electricity.
- Promote the use of energy saving (i.e., cooking, heating & lighting) in order to preserve the environment.
- Promote research projects on energy technologies (develop and commercialize energy sources).
- Promote research collaborations within and abroad as a means to share experience and transfer of technologies to the local context.
- Political-institutional support should be encouraged to speed up the rate of STI support on energy access and efficiency.
- Train qualified staff for STI support initiatives as part of capacity building at Institutional level.
- Promote and strengthen development of local

people in energy field example to develop local expertise i.e., formal and informal groups.

- HEIs should conduct training in:
 - Role of collaboration in energy sectors
 - Environmental conservations
 - Roles of Sustainable STI in enhancing energy access and efficiency.
 - Importance of energy policies and programs in supporting energy production and use in energy sectors.
 - How energy access can be sustained in disadvantaged areas.
 - Roles of Sustainable STI in enhancing energy access and efficiency.
 - General training on energy to all education levels to develop energy efficiency spirit in the entire community.

5.5 UGANDA

- Strengthen Co-ordination/ collaboration between stakeholders (Table 6): define clear roles, expectations and guidelines, ensure realisation of planned outputs, promote partnerships and reduce duplication and enhance coordination between Universities and Partners.
- Higher Education Institutions should play a key role in:
 - developing Curriculum/training materials/ programmes on pertinent STI issues – IPP, TT, KMT, relating to the energy sector .
 - establishing clear strategy for engaging private sector to support Research, Innovation and Knowledge Exchange.
 - strengthening networks for researchers and other actors in the energy sector at national regional & international level
 - conducting cutting edge research to guide policy.

- embracing renewable energy and promoting best practices in energy efficiency and access.
- ascertaining energy demands of Uganda and strategies made to meet them.
- encouraging multidisciplinary research
- ensure that research and innovations supply solutions to the energy needs of: Quality and durability, Reliable access, Affordability, Compatibility and Environment sustainability.
- Promote and strengthen networking between stakeholders in the energy sector and create a framework through UNCST for interaction of stakeholders at national level and University, for research and dissemination.
- Community engagement and national awareness: sensitize communities through various means to yield positive results.
- Disseminate renewable energy research information: target stakeholders in public and private sectors to promote uptake of new technologies.
- Policy Review: Reduce red tape policies and practices to encourage investors.
- Institutional framework: Promote collaboration in the energy sector (production, generation, distribution, marketing, consumers and researchers.
- Strengthen Science Technology and innovation: capacity building and involvement of local artisans.
- Increase research in Renewable Energies.

6

CONCLUSIONS

The International Conference "Fostering Cooperation in Energy Efficiency and Accessibility in East Africa" brought together close to 60 people from 12 countries, all involved in the field of Energy from academia, researchers, project managers, NGOs, representatives of the industry and policy makers, in order to encourage dialogue and strengthen cooperation links in the energy sector in East Africa.

The Conference addressed different aspects as follows: (1) the challenges for energy in East Africa, (2) the National Energy Reports from Burundi, Kenya, Rwanda, Tanzania and Uganda, (3) the issue of Renewable Energy in East Africa from the EU perspective, (4) results and experiences from the Edulink and ACP S&T projects SUCCEED Network, ENRICH, Re.edu, L3EAP, ANEER, SASEI and NEED. Discussions were held on the main challenges in the field of energy in East Africa and the role of HEIs in addressing these challenges.

The main challenges for energy in East Africa identified during the conference are summed up in the following table.

The discussion around these challenges led to the identification of opportunities for recommended future initiatives:

- ▶ **Networking**
- ▶ Consultancy for **policy** reforms
- ▶ **R&D** projects
- ▶ **Capacity building** at the 3 levels (individual, institutional, systemic) for all actors with an interdisciplinary approach.
- ▶ Keep searching for **new opportunities** for cooperation and funding.
- ▶ Projects should demonstrate **impact** and look for multiplier effects.

Following the discussions, the Conference participants agreed to start working on joint strategies to tackle these challenges, taking advantage of the know how and opportunities detected during the life time of the ACP S&T and Edulink projects.

Table 8
Main Challenges for Energy in East Africa
(Escarre, 2017)

NATIONAL/INTERNATIONAL LEVEL	SECTORAL LEVEL
<ul style="list-style-type: none"> • A disconnect between the different stakeholders (universities, industry, government). • Socio-cultural issues / use of energy technology • Lack of funding • Lack of appropriate policies/reforms • Limited regional cooperation 	<ul style="list-style-type: none"> • A debate on (renewable) energy sources • A lack of a clear definition on energy access • Limited sti activities in the energy field • Energy efficiency challenges in developing countries = urban vs. rural areas.



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Challenges on Energy Access in East Africa. Prof. Kimambo, University of Dar es Salaam.

Renewable Energy in East Africa and the EU Perspective. Dr. Oana Driha, University of Alicante.

National Energy Report – Burundi. Prof. Pierre Célestin Karangwa, Université du Burundi.

National Energy Report – Kenya. Tom O. Ojwang, African Virtual University.

National Energy Report – Rwanda. Prof. Bonfils Safari, University of Rwanda.

National Energy Report – Tanzania. Mr. Simeo Kisanjara, Mzumbe University.

National Energy Report – Uganda. Prof. Gerald Eilu, Makerere University.

Summary and Closure of the International Conference. Dr. Roberto Escarré, University of Alicante.



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RECOMMENDATIONS FROM THE INTERNATIONAL CONFERENCE

"FOSTERING COOPERATION IN ENERGY EFFICIENCY AND ACCESSIBILITY IN EAST AFRICA"



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