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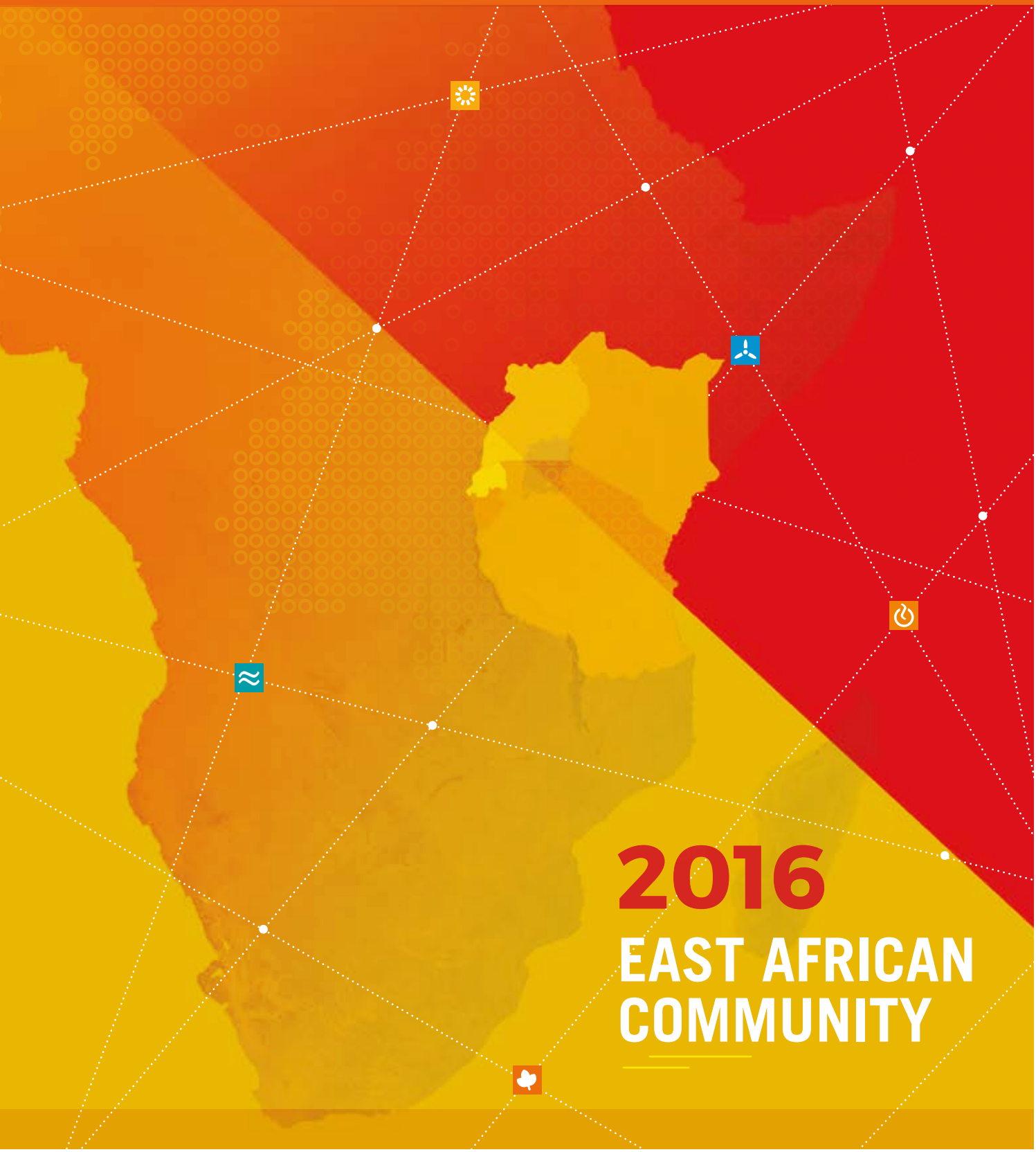
REN21 Renewable Energy Policy Network for the 21st Century

EAC RENEWABLE ENERGY AND ENERGY EFFICIENCY REGIONAL STATUS REPORT



2016 EAST AFRICAN COMMUNITY

PARTNER ORGANISATIONS

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors. REN21's goal is to facilitate knowledge exchange, policy development and joint actions towards a rapid global transition to renewable energy. REN21 brings together governments, non-governmental organisations, research and academic institutions, international organisations and industry to learn from one another and build on successes that advance renewable energy. To assist policy decision making, REN21 provides high-quality information, catalyses discussion and debate and supports the development of thematic networks.

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2016

EAST AFRICAN COMMUNITY

FOREWORD

Dear colleagues and partners,

We are excited to present the first edition of the *East African Community (EAC) Renewable Energy and Energy Efficiency Status Report*, which presents a comprehensive regional perspective on the current status of renewable energy and energy efficiency markets as well as industrial development trends in the region.

The East African Community faces significant energy challenges. The region needs, amongst other actions, to: increase access to modern energy services, especially in rural areas; ensure energy security; address the human health and environmental challenges associated with the current energy systems; and develop its electricity infrastructure, especially harnessing locally available renewable energy resources to meet rising demand for energy.

The region's high reliance on traditional biomass coupled with national electrification less than 25% and the rapid growth of motorised transport have important implications for regional energy planning and investment. Climate change impacts are already negatively affecting existing energy systems (particularly hydro power) and thereby the region's economy.

The EAC recognises that regional integration is central to rapid economic growth. Addressing the existing challenges of energy access for industrial development, and creating new opportunities for clean and efficient energy services are key actions that underpin this growth. This is captured in various regional policy documents, including the Regional Strategy on Scaling Up Access to Modern Energy Services, the Regional Power Masterplan, and the EAC 2050 Vision document.

Against this background EAC sectoral council on Energy and the council of Ministers directed the EAC Secretariat to establish the East African Centre for Renewable Energy and Energy Efficiency (EACREEE) , which was launched on 11 June 2016. EACREEE will contribute to the development of a regional renewable energy and energy efficiency market by addressing gaps related to policies and regulations, capacity building, technology co-operation and promoting partnerships and investments.

The *EAC Renewable Energy and Energy Efficiency Status Report* contributes to this process by providing a comprehensive overview of the status of renewable energy and energy efficiency markets, industry, policy and regulatory frameworks, and investment activities in the region. It draws on information from national and regional sources to present the most up-to-date data on renewable energy and energy efficiency. It contributes to understanding the region's emerging renewable energy industry, market development and is critical to realising the region's potential and scaling up investment opportunities.

We sincerely hope that the first edition of this report will provide a tool for decision makers and a solid basis for renewable energy and energy efficiency development in the EAC region. The report presents the region as one ripe for a dramatic increase in renewable energy and energy efficiency activities, which will in turn attract much-needed investment. Accordingly, EACREEE's activities to promote regional efforts in this regard will lead to increased energy access, improved energy security and reduction of the environmental externalities associated with existing energy systems. Collectively these elements form a favourable environment for inclusive and sustainable industrialisation to occur across the region and in turn help meet sustainable development objectives.

Looking ahead, EACREEE will ensure that this report is updated regularly, and work with all our partners, especially EAC partner states, which have been the source of data used in this report

Dr Pradeep Monga
Director and Special Representative of DG on Energy UNIDO

Over the past decade, the share of people who lack access to modern energy services has fallen by nearly 10 percentage points – down from almost 25% – even as the global population has expanded significantly. Renewables have played a role in this improvement. These advances, however, are not spread evenly geographically. Large areas of sub-Saharan Africa remain without access to modern energy services, and progress in expanding electricity access has lagged behind population growth. Despite vast grid extension in recent years, electrification rates in the East African Community (EAC) remain low, particularly in comparison with the rest of the continent.

Renewables are uniquely positioned to provide needed energy services in a sustainable manner – more rapidly and generally at lower cost than fossil fuels. The EAC has a vast potential of, among other renewable energy sources, hydropower, geothermal and solar photovoltaic (PV), which have been exploited only marginally so far.

A decade ago, markets for modern renewable energy technologies were concentrated mainly in Europe and the United States. In 2015, for the first time ever, investment in renewable energy power capacities and fuel in developing countries exceeded that in developed economies. Renewables deployment has reached a global spread. Renewable energy technologies are viewed not simply as tools for improving energy security but also as strategies for mitigating and adapting to climate change. They are recognised increasingly as investments that provide both direct and indirect economic advantages by reducing dependence on imported fuels, improving local air quality and safety, advancing energy access and security, propelling economic development and creating jobs.

Developments in 2015 continued to demonstrate the important role of renewable energy in the energy mix. In December 2015 renewable energy deployment received global attention at the COP21 climate conference in Paris. This event highlighted the importance of renewables and showed global commitment to their future deployment. Despite rising energy use, global carbon dioxide (CO_2) emissions associated with energy consumption have remained stable, illustrating a "decoupling" of economic growth and CO_2 emissions. This has been due primarily to the increased use of renewable energy sources along with energy efficiency measures. This decoupling also demonstrates that renewables can play a central role in meeting sub-Saharan Africa's energy needs in a sustainable way.

REN21 is committed to tracking the development of renewables worldwide. In addition to its annual flagship publication – the *Renewables Global Status Report* – REN21 works with regional partners to shed further light on renewables development in different world regions. The *EAC Renewable Energy and Energy Efficiency Status Report* complements earlier regional status reports on China, India, and the MENA, ECOWAS and SADC regions.

This report will help raise awareness about the extraordinary potential of the African continent to become a leader in renewable energy development and deployment. It also will be useful for the newly established EAC Centre for Renewable Energy and Energy Efficiency (EACREEE), serving as a baseline for renewable energy and energy efficiency in the region. We would like to thank UNIDO and all partners involved for the excellent collaboration throughout the production of this report. We hope that you find the information contained in the report informative.

Christine Lins
Executive Secretary
Renewable Energy Policy Network for the 21st Century (REN21)

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TABLE OF CONTENTS

TABLES, FIGURES AND SIDEBARS

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The East African Community (EAC) comprises the Republics of Burundi, Kenya and Rwanda, the United Republic of Tanzania and the Republic of Uganda. The Republic of South Sudan acceded to the EAC Treaty in April 2016 and will become a full member following the country's ratification of the treaty. Covering an area of 1.8 million square kilometres, the EAC region is home to 156.6 million people, or 16% of the overall population of sub-Saharan Africa. The majority of the EAC population is rural, with only 22% living in urban areas.

The EAC is the second largest single regional market in Africa and economically one of the fastest growing regions in sub-Saharan Africa. In 2014 EAC partner states witnessed a combined average growth in their gross domestic products (GDPs) of 6.2%, well above the sub-Saharan African average of 4.4%. Since the 2000s, GDP has increased almost five-fold in Kenya and Tanzania, 3.5 fold in Burundi and 4.5 fold each in Rwanda and Uganda. Agriculture is the single largest economic sector in the region, but in recent years EAC countries have begun diversifying into the service and industry sectors and, in the case of Burundi, the construction sector. Despite strong growth rates, overall levels of human development, as per the United Nations Development Programme's Human Development Index, remain relatively low in the EAC region.

ENERGY STATUS

Population growth and rapid urbanisation are magnifying the energy challenges of the EAC region. Increasing demands to electrify and to provide access to modern energy services are stretching the region's limited energy sources. The energy situation can be characterised by:

- A high reliance on solid biomass for cooking and heating,
- Low electrification rates,
- Policy makers' focus on the power sector to improve electrification rates and
- Increasing demand for transportation fuels.

Traditional solid fuels, such as wood and charcoal, form the backbone of the region's energy supply and are used for heating and cooking at both the household and institutional levels. Household cooking represents the largest share of final energy consumption: the share of the population using solid fuels for cooking is more than 95% in all EAC partner states except Kenya, where it is 84%.

Low electrification rates due to limited coverage of the power grid, coupled with low electricity consumption rates, have resulted in electricity currently contributing less than 10% to the region's energy balance. Progress in expanding electricity access has trailed population growth. In 2015 electricity access was less than 22% in the EAC region, well below the average electrification rate of 33.5% for sub-Saharan Africa as a whole.

The EAC region's electricity sector is based primarily on hydropower. In 2015 renewable electricity accounted for approximately 65% of the region's total installed grid-connected power generation capacity. The remaining 35% was from thermal-based generation. Although hydropower is the predominant energy source in the region, it is being affected adversely by rainfall caused by climate change as well as by the alteration of river flows due to deforested catchment areas. As low water levels reduce hydropower generation, diesel generation is playing an increasing role. Despite this, EAC partner states continue to develop new hydropower projects.

Electricity demand is projected to grow by an estimated 5.3% annually to 2020, meaning that the region's power generation capacity will have to increase significantly. Projections indicate that capacity will have to grow by 37.7% in Uganda, 75.3% in Tanzania, 96.4% in Kenya and 115% in Rwanda.

The combination of population growth, urbanisation and rising economic prosperity in the region is leading to an increase both in the number of personal vehicles and in carbon emissions. EAC partner states are making investments in the petroleum sector to meet rising demand for petroleum products and to decrease dependence on fuel imports. As a result, there is limited impetus to develop renewables in the region's transport sector.

The EAC region faces energy challenges similar to those in other parts of sub-Saharan Africa, including issues of energy access and security as well as associated health and environmental concerns. An estimated 90% of public expenditure on energy infrastructure is invested in extension of the electricity grid. However, EAC governments struggle to manage the costs of grid maintenance and of developing new connections in peri-urban and rural areas. Challenging topography, poor road maintenance, low population density and the depletion of hydropower storage in the dry season all aggravate these challenges.

To address these concerns, EAC partner states are engaging in intra-regional development and operation of power generation.

Efforts are hampered, however, as countries prefer to focus on strengthening their national electricity infrastructure. Each EAC government has formulated energy access targets and policies, with Kenya leading the way with a target of achieving 100% energy access by 2030. Uganda aims for at least 98% energy access by 2020, and Rwanda has targeted 70% access by 2017. Burundi hopes to achieve 25% energy access by 2020.

Efforts also are being made to improve the long-term energy security of the region by promoting energy policies that encourage diversification of both energy type and supply sources. The EAC region aims to increase the use of renewable energy sources such as hydropower, geothermal, wind, solar and modern biomass to diversify the electricity mix and to buffer countries from fluctuating global petroleum prices.

The reliance on biomass in the EAC energy sector has a negative impact on both the environment and people's health. The unsustainable harvesting of woody biomass contributes to forest depletion and to the disruption of ecosystems and hydrological catchment areas. In 2012, indoor air pollution caused by the burning of biomass affected the health of an estimated 138 million people in the region, resulting in 60,000 premature deaths.

Funding for energy projects in the EAC region continues to be a significant challenge. Major barriers include uncertainties about political stability as well as the reluctance of major investors to commit to long-term financing before buyers are contracted. EAC partner states, however, are recognising the role of private funding and international donors in accelerating the uptake of renewable energy technologies.

The East Africa Community, headquartered in Arusha, Tanzania, is responsible for facilitating the broader EAC objectives of attracting investment, competitiveness and trade for the region. The EAC's energy mandate places emphasis on the power sector (including transmission and inter-connectivity); on new and renewable energy sources and energy conservation and efficiency; and on fossil fuels. Regional integration in the power sector, including through the development of a regional power pool, has been slow, however. The 2006 Regional Strategy on Scaling Up Access to Modern Energy Services aimed to improve access to modern cooking fuels and electricity and to provide energy access for school, hospitals and community centres. Because targets were not met by 2015, a new implementation plan is now in the pipeline.

The East African Power Pool, established in 2005, extends beyond the EAC countries and includes the Democratic Republic of the Congo, Egypt, Ethiopia and Sudan. Today it comprises 13 utilities and 7 national energy/electricity regulators from across East Africa. Its main objective is to promote the development of energy resources in the region and to facilitate access to electricity through regional power interconnections.

In 2015 the East African Centre for Renewable Energy and Energy Efficiency (EACREEE) was established to support the implementation and monitoring of regional strategies for renewable energy and energy efficiency, and to encourage the creation of a renewable energy market. It also has a mandate to minimise existing regional barriers in the energy sector by providing political support and creating a platform for knowledge exchange.

Despite the variety of regional initiatives, national institutional players (primarily ministries) continue to drive energy strategies and policies in the region. Alongside issues related to energy security, a leading concern of policy makers is improving energy access. In response to rising pressures to increase power production and improve distribution, several trends are discernible within the power sector:

- A shift away from government ownership and management of generation, transmission and distribution to diversified portfolios that include the private sector,
- An increase in the role of rural energy or electrification authorities to help reach unelectrified populations and
- An unbundling of key power institutions.

RENEWABLE ENERGY: MARKET AND INDUSTRY OVERVIEW

Biomass and hydropower both play a dominant role in the region's energy mix. From a renewable energy perspective, the challenge in the heating and cooking sector is to make the use of biomass more sustainable and develop a truly renewable energy source. In the power sector, renewables offer a prime opportunity to increase power generation capacity and to relieve pressure on hydrological resources.

Off-grid renewable energy represents a dynamic renewables market as well. However, the potential of renewables to meet energy needs across the power, heating and cooking, and transport sectors has not been harnessed to-date.

Solid biomass currently accounts for about 80% of final energy consumption in the region, ranging from 75% in Kenya to 95% in Burundi, and spans both the household and commercial/institutional levels. As in much of Africa, use of solid biomass in the EAC region is higher in rural areas, at 98.6%, than in urban settings (85.7%). Rural households use woody biomass, whereas most urban households use charcoal. In some urban settings, such as in Kenya, fuel stacking also is practiced. Biomass is used widely for industrial activities in the region.

As population levels rise, the region's biomass consumption is set to double every 20 to 25 years. A lack of regulation has hindered the ability of the private sector to enter the biomass market to increase efficiency in both fuel production and consumption, and to develop economically viable fuel alternatives. Policy makers also have focused on reducing overall demand for solid biomass and have not paid enough attention to fuel substitution.

Recently developed strategies in Rwanda, Tanzania and Uganda point to a change in how governments are managing the biomass sector. These strategies focus on the whole supply chain, including developing and strengthening the supply of

sustainable woody biomass; developing modern biomass fuels; improving the efficiency of biomass use; and strengthening institutional capacities. As woody biomass is the region's dominant energy source for heating and cooking, the main challenge is making the fuel source truly renewable. An additional challenge is ensuring co-ordination of relevant government agencies for both the demand and supply aspects, as well as achieving overall energy efficiency throughout the sector.

Biogas is present in East Africa, but its use is still low. By the end of 2015 more than 38,000 biogas digesters were in place compared to 18.5 million installations for Africa as a whole. Uptake has been slow due to a lack of technical awareness, high installation costs and access to required inputs such as piped water and prepared waste collection sites. There is signification potential to grow the domestic biogas industry as it provides clean, healthy cooking energy. Through the Africa Biogas Partnership Programme, projects have been implemented in Kenya, Tanzania, Uganda and, to a lesser extent, Rwanda.

Solar thermal heat has seen relative success in the region. The main solar thermal market is urban and peri-urban households, hotels and institutions, with some industrial sites using solar water heaters (SWH) to pre-heat water. Kenya is the current leader in the region, accounting for 80% of the market volume. Kenya's 2012 Solar Heating Regulation requires that all newly constructed buildings using more than 100 litres per day install SWHs. Retrofitting of pre-2012 buildings must be done by April 2017. In total the regulation aims to have 800,000 installations in place by 2020, covering 60% of hot water demand. Uganda and Rwanda have smaller but growing SWH markets. The Uganda government's programme offers a grant of up to 50% for SWH purchase and installation. Success has been lower in Rwanda due mainly to a lack of supply and incentives.

Use of **direct geothermal heat** is low in the region, with only Kenya currently exploiting its geothermal potential.

Renewable electricity accounted for 65% of the EAC region's total installed, grid-connected power generation capacity in 2015, as compared to 28.6% in the ECOWAS region and 23.5% in the SADC region. By the end of 2015, 3 gigawatts (GW) of the EAC's region's installed grid connected electricity came from renewables.

Hydropower led with 2,188 megawatts (MW), followed by geothermal (598 MW), biomass co-generation (110.5 MW), wind (25.5 MW) and solar (9.2 MW). At the national level Kenya is investing primarily in wind and geothermal power; Tanzania, Uganda and Burundi are focusing on hydropower; and Rwanda is developing hydropower and solar. Kenya has the highest installed renewable energy capacity (820 MW), followed by Uganda (693 MW), Tanzania (562 MW), Rwanda (78.8 MW) and Burundi (33.8 MW).

Currently the region is home to more than 60 small-scale hydropower plants (ranging from 250 kW to 10 MW in size), totalling 158 MW of installed capacity. The region's potential for small-scale hydropower is estimated at more than 4 GW. In Uganda and Tanzania private project developers, independent power producers and non-governmental organisations own the majority of the small-scale plants in operation. In contrast, in Burundi, Kenya and Rwanda plants are held by the national utilities. As countries establish power purchase agreements (PPAs) and feed-in tariffs (FITs), small-scale hydropower projects increasingly are being implemented with the involvement of the private sector. Capacity development and training continue to be bottlenecks in the process, however.

Despite its large potential in the region, **geothermal power** is not a priority of most EAC countries. To-date Kenya is the only partner state with installed capacity. The country's 607 MW of geothermal ranks it eighth in the world for geothermal operating capacity and, in 2015, accounted for 26% of Kenya's installed power generation capacity.

Although **bioenergy** is used primarily for cooking and heat generation, it also is used for power generation and for co-generation of heat and power in the industrial sector. Solid biomass, particularly sugarcane bagasse, is the main source of biomass power and generation. For example, the Moso Sugar Company in Burundi has an embedded biomass co-generation plant with an installed capacity of 4 MW. In Uganda the Kakira Sugar Works operates a biomass power plant with an installed capacity of 34 MW. Although EAC partner states recognise the potential for biomass electricity generation or co-generation, policy support is insufficient. Additional barriers such as low electricity prices and low FITs hinder larger-scale development.

Grid-connected wind power is not common in the EAC region despite good wind energy potential in some areas. Currently, Kenya is the only EAC country that has installed wind farms. A recent expansion by KenGen, the national operator, increased installed capacity from 5.1 MW to 25.5 MW, meeting part of the government's target to add 5 GW of energy by the end of 2016. Additional projects in the pipeline include the 310 MW Lake Turkana project and a 400 MW wind farm in Meru County. Tanzania has a 10 MW plant under construction which is expected to be connected to the national grid by 2017. Relatively low wind speeds in Burundi, Rwanda and Uganda mean that the sector is not developed in these countries.

Grid-connected solar power has experienced better success than wind. As of 2015, the EAC region had at least 9.15 MW of installed grid-connected solar photovoltaic (PV) capacity. Despite its small size, Rwanda has emerged as the regional forerunner, with 8.75 MW of installed capacity. Other countries lag due to high perceived capital costs and the prioritisation of larger-scale natural gas, hydropower and geothermal projects. Although a small market for urban rooftop solar PV systems exists in the EAC region, widespread use will occur only if net metering regulations come online or if more aggressive distribution generation and auction policies are implemented.

Distributed renewable energy (DRE) systems are rapidly becoming the preferred option for the millions of people in the EAC region that lack energy access. The region accounts for nearly half of all sales of pico solar systems in Africa, and Kenya and Tanzania are the continent's leading markets for solar lighting products. These two countries also are Africa's largest micro grid markets.

Among the DRE systems, **stand-alone solar PV systems** have had the greatest market success in the EAC region. Favourable government policies, innovative business models and a rapid decline in global prices for PV equipment all have contributed

to the region's spectacular market growth. From mid-2014 to mid-2016, Kenya, Tanzania, Rwanda and Uganda accounted for approximately half of reported sales of Lighting Global quality-verified pico solar products in sub-Saharan Africa.

The total capacity of off-grid solar PV products sold annually in the EAC region is estimated at between 25 MW and 40 MW. The cumulative total for the region, however, is likely to be closer to 76 MW. Because no official regional trade records or import statistics are kept, capacity estimates are based on publicly accessible data such as commercial activity and household censuses. As of June 2016, an estimated 50,000 off-grid systems had been installed in Tanzania and Rwanda, providing the equivalent of 5 MW of solar power to some 250,000 beneficiaries.

"Green mini-grids" use renewable energy to power off-grid communities. Current estimates suggest that as much as 25% of the un-electrified off-grid population in the EAC region could be powered through mini-grids. At the end of 2014, Kenya had an estimated 19.2 MW of installed mini-grid capacity; more than 18 MW of this was thermal capacity and 5% was from renewables (0.55 MW of wind and 0.5 MW of solar PV). In Rwanda mini-grids are being used to reach the country's target of 22% rural electrification by 2018. Hydro-powered mini- and micro-grids currently provide 4.5 MW of off-grid capacity, and Rwanda has plans for an additional 18 MW of small-scale and mini-hydro projects by 2025. In Tanzania the Rural Energy Agency is planning 90 off-grid projects, many of which involve mini-grids. Uganda will use mini-grids to electrify the island communities of Lake Victoria, complementing a variety of mini-grids projects already in place. Despite the clear opportunities that mini-grids can bring to remote and off-grid communities, the needed regulatory environment and business models are not yet in place in the EAC partner states.

Off-grid stand-alone wind power has not experienced the same success as off-grid solar PV due to technology and higher costs. Only a small number of suppliers and installers operate in the region. To-date only a few hundred systems have been installed, primarily in Kenya and Tanzania.

Renewables play only a marginal role in the transport sector of the EAC region, despite rising fuel demand. Regulatory uncertainty, a lack of assured feedstock and multiple-end markets for ethanol contribute to the limited success of renewables in transport region-wide. Electric vehicles, likewise, have seen very little market development across the EAC region.

RENEWABLE ENERGY POLICY LANDSCAPE

To capitalise on the region's renewable energy potential, the EAC partner states have developed specific renewable energy policies and instruments. Kenya, Rwanda, Tanzania and Uganda each have introduced FIT policies, and Kenya and Tanzania have adopted innovative zero-VAT and tariff policies on solar products. The main focus of these policy frameworks to-date has been the power sector, with less attention being paid to the heating, cooking and transport sectors.

Although renewable energy targets have been set, there is a lack of clarity on how those targets are to be implemented, highlighting partner states' ambition rather than achievable goals. Kenya's 2013 plan of having 5,000 MW of renewable power capacity by 2016 has been hampered by financial constraints, inadequate infrastructure and a lack of public buy-in. To-date, only 586 MW of renewables has been added to the country's grid. Under its 2015 Energy Sector Strategic Plan 2013–2018, Rwanda set a target of adding 450 MW of power capacity by 2018, of which 200 MW was to be met with renewables. By end-2015 only 156 MW of installed capacity had been reached. Tanzania's 2014 Electricity Supply Industry Reform Strategy and Roadmap envisages adding 200 MW of wind, 100 MW of solar and 200 MW of geothermal by 2025. Uganda is making good progress in meeting its target of increasing the share of renewables in total energy consumption to 61% by 2017; by end-2014 the share of renewables was 25%, up from 4% in 2007.

Feed-in tariffs have played a key role in pushing renewable energy development across four of the partner states. Kenya pioneered FIT development in the region in 2008 by setting a pre-determined fixed tariff over a 20-year period for wind, small-scale hydropower and biomass. Over the years the FIT has been reviewed, and additional renewables have been added to the scheme. As of 2015 more than 1.2 GW of wind, 272 MW of geothermal, 221 MW of solar and 28 MW of hydropower were operational or in the pipeline in Kenya. In Uganda, the Renewable Energy Feed-in Tariff met with little success; however, the establishment of the GET FiT programme in 2013 has helped to greatly improve the financial stability of renewable energy projects in the country and has successfully attracted private investment to the region. Currently some 17 renewable energy projects totalling 157 MW are in the pipeline in Uganda. Rwanda introduced a FIT policy in 2012, and Tanzania introduced a FIT system in 2008, together with a technology-neutral Standard PPA for projects below 10 MW. An estimated 15 projects are operational and another 60 or so are in the pipeline, for a total installed capacity of some 50 MW.

Renewable energy auctions are gaining prominence in the EAC region. In Rwanda the country's landmark 8.5 MW solar PV project was commissioned following a competitive tending process for 18.5 MW of solar. Uganda has awarded contracts to two private companies for the installation of 20 MW of solar PV systems. Although other fiscal incentives, such as duty and VAT exemptions are in place, the lack of clarity from governments has sent mixed signals to private investors and has contributed to market uncertainty.

Policy support for the region's heating and cooking and transport sectors has been weaker than for the power sector. The few policies that have been implemented, however, have had good results. Kenya's Energy (Solar Water Heating) Regulation spurred demand for SWHs in homes, hotels, hospitals and learning institutions. As of 2015, an estimated 140,000 SWHs were in use in Kenya, and demand is project to reach 800,000 by 2020. Rwanda's SolaRwanda programme had installed 12,000 SWHs by the end of 2015, and there are plans to make SWH mandatory for all hotels and major residences. Biogas digesters are gaining prominence primarily in Kenya, Rwanda and Tanzania. Kenya is looking into

adopting a Biogas Regulation that would streamline the installation and maintenance of biogas plants. In the transport sector only Kenya, Uganda and Tanzania have developed acts or guidelines for ethanol blending and for the use of biofuels in general. Progress on implementation has been slow, however.

ENERGY EFFICIENCY IN THE REGION

With economic growth in the EAC region, the lack of energy resources is becoming a major obstacle. Implementing energy efficiency measures can allow the delivery of more service for the same energy input. Energy efficiency also can reduce the need to install new peak capacity and can support the development of renewable energy in the region.

EAC partner states have started to adopt energy efficiency measures in the power, heating and cooking sectors; however, the level of energy efficiency varies widely. Burundi has the highest energy intensity at 13 megajoules (MJ) per USD of GDP, while Rwanda has the lowest at 5.6 MJ/USD. Energy intensity across the region, with the exception of Rwanda, is higher than both the world average of 5.8 MJ/USD and that of sub-Saharan Africa (8.2 MJ/USD). Within the power sector countries are focusing on increasing the energy efficiency of power transmission and distribution systems. Network losses in the region currently average 22%. Additional losses include technical losses as well as commercial losses, through power theft and billing anomalies.

Energy-efficient lighting programmes that aim to replace incandescent light bulbs with compact fluorescent lamps (CFLs) have had significant success in the region. Uganda distributed 800,000 CFLs free-of-charge between 2008 and 2010, yielding USD 100 million in savings. In Rwanda the replacement of 800,000 incandescent bulbs with CFLs resulted in annual power savings of 64 gigawatt-hours and in a reduction in power demand of 30 MW. Energy efficiency efforts also are being carried out in industry. Tanzania has a National Energy Audit Programme, and Kenya's 2012 Energy Management Regulation requires that large-scale energy consumers carry out energy audits every three years. Uganda has a similar programme in place.

Since the 1980s the five EAC governments also have been promoting the use of improved, more-efficient cook stoves. Between 2012 and 2014 an estimated 5.3 million clean cook stoves were distributed in the region. In addition, Kenya, Rwanda and Uganda have initiatives to improve the efficiency of charcoal production. Despite these efforts there continues to be a need to implement further energy efficiency measures in all of the EAC partner states through an integrated and holistic programme across all sectors.

INVESTMENT FLOWS

Renewable energy investment in developing countries surpassed that in industrialised countries for the first time in 2015. Africa attracted USD 12.5 billion in renewable energy investment, up from USD 8 billion in 2014. Despite these encouraging trends, the EAC region still faces significant private investment challenges: in 2015, it accounted for only some 4% of renewable energy investments in Africa.

Investment in renewables in the region traditionally has been in hydropower and geothermal projects. From 2010 to 2015 Kenya achieved a national record of USD 3.3 billion in renewable energy investments. Uganda surpassed the USD 100 million mark in 2015, totalling USD 134 million in renewables, and Burundi set a national record of USD 274 million in 2014. Investments in both countries were in hydropower and solar PV installations.

Kenya continues to be the clear leader in geothermal investments, although Tanzania has plans to secure some USD 563 million in funding for the development of a 100 MW geothermal project. In 2015 Uganda received a USD 50 million grant from the Climate Investment Funds to conduct a wind assessment project and to support the construction of two 10 MW pilot wind projects. Rwanda was the first EAC partner state to attract significant investment for its on-grid solar PV sector, securing USD 23.7 million in 2014 for the commissioning of an 8.5 MW solar farm. Burundi, in an effort to reduce its dependence on hydropower, is planning to invest USD 20 million in the construction of a 7.5 MW solar farm.

Investment in off-grid renewables, particularly solar PV, is rising. In 2015, global investment in off-grid solar reached a record USD 276 million, of which roughly half was raised by companies expanding their activities in the EAC region. In parallel, the "pay as you go" company M-KOPA secured USD 31.5 million in 2015, up from USD 20 million in 2014. Other off-grid companies in the region also have also amassed substantial investment for their activities.

The mini/micro-grid sector also is attracting significant investment. For example, Powerhive and Enel Green Power plan to invest USD 12 million in the construction of 100 solar-powered micro grids throughout rural Kenya in the coming years.

The commercialisation of clean cook stoves has attracted considerable investment in recent years. Kenya-based BURN Manufacturing secured USD 4 million in 2013 to establish its first cook stove manufacturing facility and obtained additional funding of USD 800,000 to expand its activities in Kenya and Tanzania.

The World Bank, the French Development Agency (AFD) and the Japanese International Cooperation Agency traditionally have been the main development partners financing renewable energy projects in the EAC region. Currently they represent 60% of the total international financing aid for the development of renewables projects and related infrastructure in the region. Other development finance institutions have begun to play major roles as well. Bilateral commitments for climate-related official development assistance totalled USD 898 million in 2014, with 41% (approximately USD 368 million) targeting climate change mitigation activities.

01

REGIONAL OVERVIEW

01 REGIONAL OVERVIEW

The East African Community (EAC) is a regional intergovernmental organisation of five partner states: the Republic of Burundi, Republic of Kenya and the Republic of Rwanda; the United Republic of Tanzania; and the Republic of Uganda.[1] (The Republic of South Sudan acceded to the EAC Treaty in April 2016 and will become a full member after ratification of the treaty; see sidebar 1.[2]) The region has a total land surface area of 1.8 million square kilometres (km^2), with Tanzania accounting for slightly over half (51.7%) of this area. Kenya and Uganda cover 32.1% and 13.3% of the region, respectively, and Burundi and Rwanda each account for about 1.5% (see figure 1).[3]

In 2014, the EAC region was home to approximately 156.6 million people, or about 16% of the overall population of sub-Saharan Africa (see figure 2).[4] Tanzania had the largest population, with about 51.8 million people, and Burundi had the smallest, with about 10.8 million people.[5]

In recent decades, the region has experienced high population growth, with the highest rate occurring in Burundi (3.3% in 2014) and the lowest in Rwanda (2.4%) (see figure 3).[6] The region's population is growing at a rate of 3% overall and is set to double by 2040, increasing pressure on already limited energy resources.[7] This growth is significantly higher than the 1.9% growth rate in the Southern African Development Community (SADC) region and is marginally higher than the 2.5% growth rate in the Economic Community of West African States (ECOWAS) region.[8]

As the overall population has grown, population density in the EAC region has increased to 84.7 persons per km^2 in 2014, compared to 30 persons per km^2 in the SADC region and 88.5 persons per km^2 in the ECOWAS region that same year.[9] Due to their smaller size, Rwanda and Burundi have the highest population densities in the EAC, at 460 persons per km^2 and 421 persons per km^2, respectively.[10]

Only 22% of the EAC population currently lives in urban areas, but, as in other parts of the African continent, urbanisation is accelerating.[11] In Rwanda, the urban share of the population nearly doubled from 15% in 2000 to 28% in 2014.[12] Urban populations in the EAC are increasing by 5% annually.[13] By 2030, between 30% and 50% of the region's population is expected to live in urban areas, leading to a doubling in the population size of the region's cities within the next 15 to 17 years.[14]

Regional population growth rates and rapid urbanisation magnify the region's energy challenges, increasing the pressure to electrify and to provide access to other modern energy services, and straining the region's limited energy sources. For example, consumption of traditional biomass is expected to double over the next 20 to 25 years.

The EAC is the second largest single regional market in Africa and economically is one of the fastest growing regions in sub-Saharan Africa. In 2014, EAC partner states witnessed a 6.2% increase in overall gross domestic product (GDP), well above the sub-Saharan African average of 4.4%.[15] Since the 2000s, GDP has increased almost five-fold in Kenya and Tanzania, 3.5 fold in Burundi and 4.5 fold each in Rwanda and Uganda.[16]

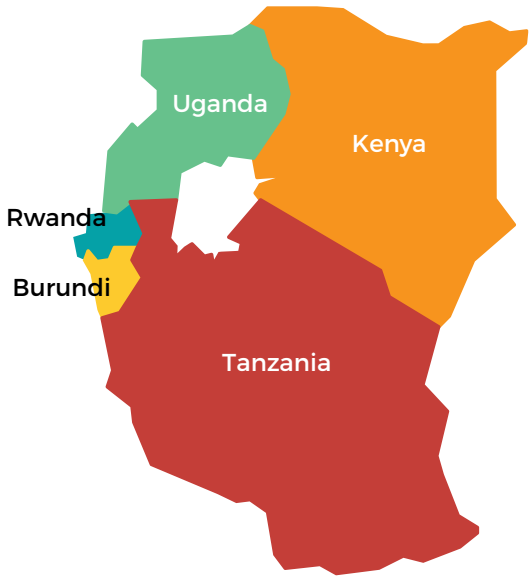
In parallel with rising GDP, per capita GDP also has increased across all EAC partner states.[17] In 2014, the average per capita GDP in the region was USD 1,014, compared to the sub-Saharan African average of USD 1,775.[18] However, the regional average masks wide differences among countries: for example, Kenya's per capita GDP in 2014, at USD 1,358, was more than quadruple that of Burundi (USD 286).[19] Despite strong economic growth, per capita GDP remains relatively low in all EAC partner states, especially by global standards[i].

National economies vary widely in size and complexity across the EAC region. While the service sector as a whole contributes roughly 50% of the region's GDP, agriculture remains the single most

i For 2014, the World Bank classified national economies according to four levels of gross national income (GNI): 1) low-income (GNI per capita of USD 1,045 or less), 2) lower-middle income (GNI per capita of between USD 1,045 and USD 4,135), 3) upper-middle income (GNI per capita of between USD 4,135 and USD 12,736) and 4) high-income (GNI per capita of USD 12,736 or more). Except for Kenya, which moved to the lower-middle income status, all EAC partner states fall into the low income category.

EAST AFRICAN COMMUNITY OVERVIEW

FIGURE 1. Key statistics of EAC partner states, 2014

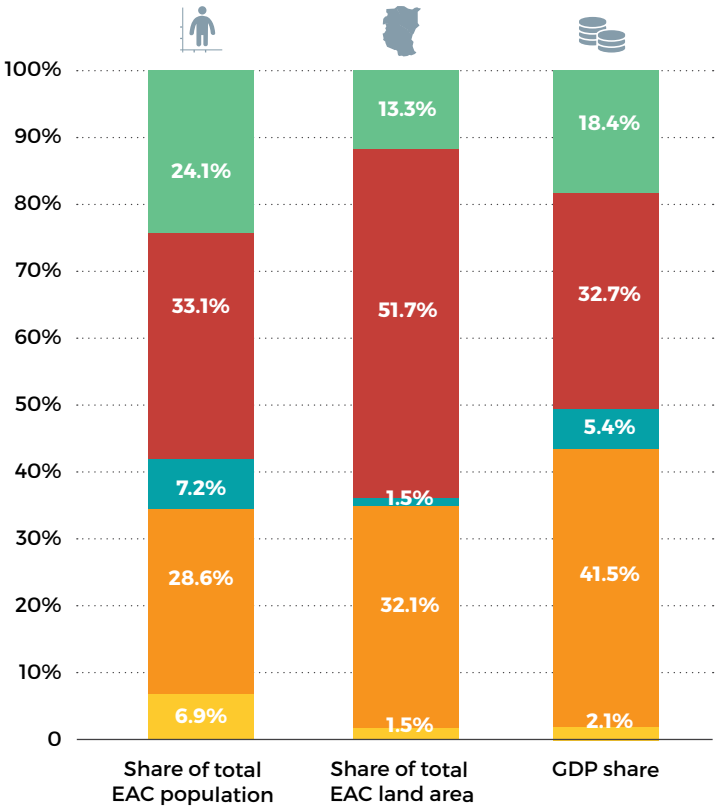


EAC Total

Total population	156.6 million
Land area	1.71 million km²
Population density	84.7 people / km²
Population growth	3%
Share of population living in urban areas (2014)	22.4%
Urbanisation rate (2014)	5.4%
GDP (2014)	146.9 billion USD
GDP per capita (2014)	1,014 USD

Source: see endnote 3 for this chapter

FIGURE 2. Relative shares of population, land area and GDP of EAC partner states (in %), 2014

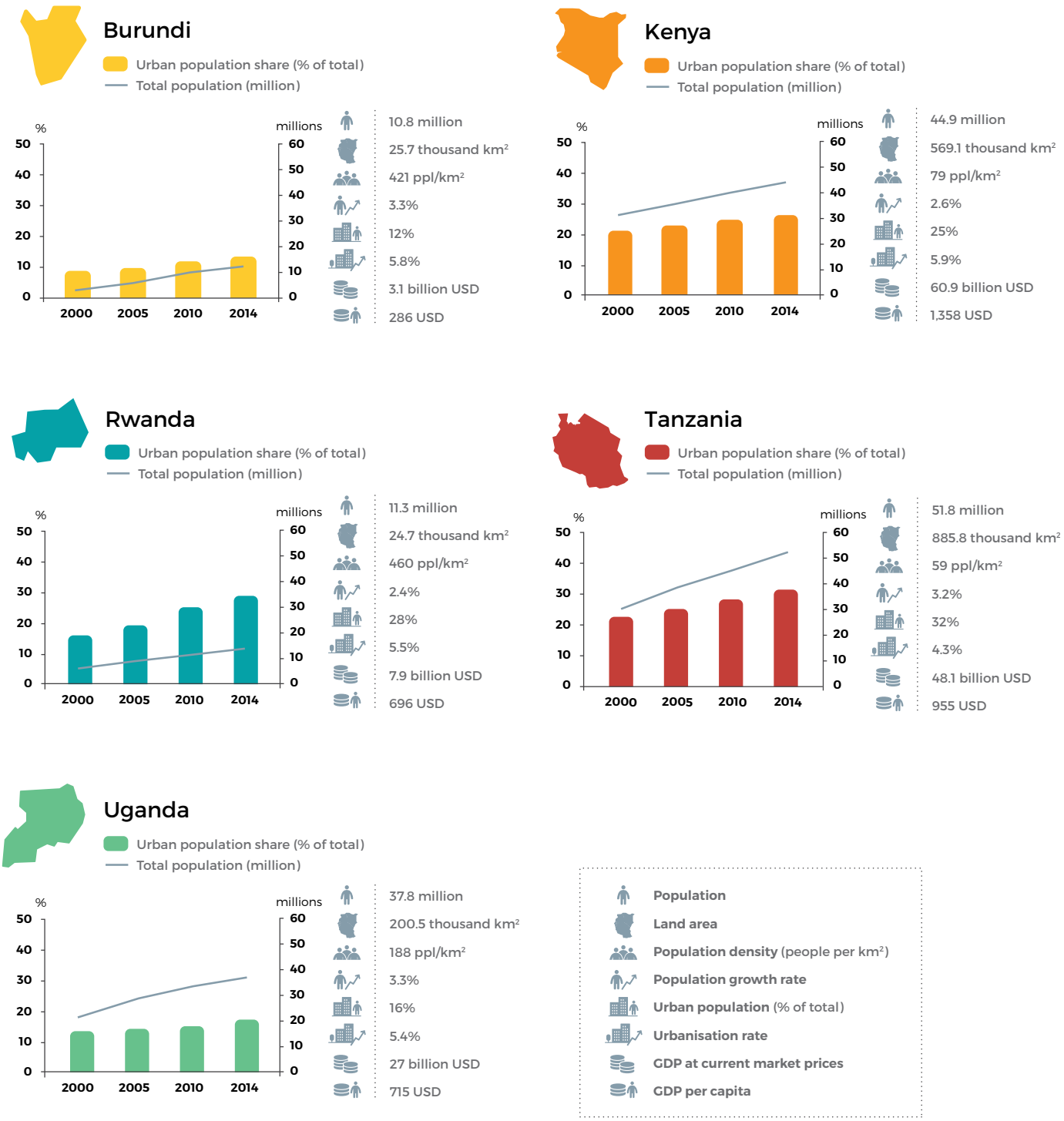


In 2014, EAC partner states witnessed a 6.2% increase in overall GDP, well above the sub-Saharan African average of 4.4%.

Source: see endnote 4 for this chapter

Note: Data on population density, population growth rate, urban population and urbanisation rate for the EAC and sub-Saharan Africa reflect averages for these regions.

FIGURE 3. Key statistics and population development of EAC partner states, 2014



Source: see endnote 6 for this chapter.

important contributor.[20] About 80% of the EAC population lives in rural areas and depends on agriculture as the main source of livelihood, mostly in the form of smallholder farms.[21] Agriculture's share of GDP ranges from 39.3% in Burundi to 27.2% in Uganda.[22] Other important sectors include construction, tourism, wholesale and retail, finance and manufacturing. Due to rapid urbanisation and economic diversification, the importance of agriculture in national balance sheets is declining, albeit slowly.[23]

The region's GDP growth is driven by diverse factors. All EAC countries are transitioning from subsistence-based agriculture to more-diverse economies; in recent years, the service and industry sectors have been leading drivers of growth. The exception is Burundi, where growth remains primarily in agriculture and construction.

Since its independence in 1963, Kenya has had the region's largest economy. The country's economic leadership has been underpinned by investment in cash crops and service sectors (e.g., banking, tourism, etc.) and by a relatively educated population. Thanks to strong growth in both total GDP and per capita GDP, Kenya not only has leapt to be the ninth biggest economy in Africa, but also has moved to the status of "lower-middle income", as defined by the World Bank.[24]

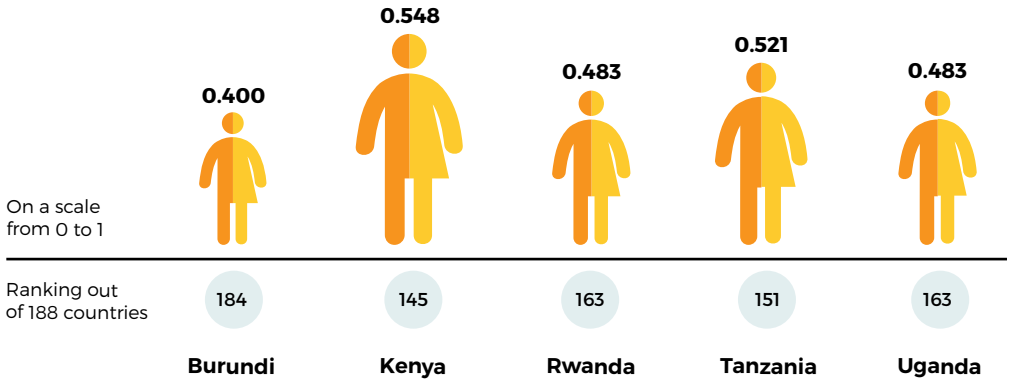
Tanzania's economy has enjoyed steady growth since 2000, due in large part to good governance, liberalisation of the economy, a growing tourism sector and exploitation of mineral and natural gas resources. Further growth in the service sector has been fuelled by the construction, information and communication sectors.[25]

Thanks to strong growth in both total GDP and per capita GDP, **Kenya not only has leapt to be the ninth biggest economy in Africa**, but also has moved to the status of lower-middle income.

After periods of political turmoil, both Uganda and Rwanda are experiencing periods of growth fuelled by the production of cash crops. Rwanda's service sector has expanded as a result of increased activity in trade, transport, information and communication.[26] In Uganda, the service sector has seen significant expansion in the trade, telecommunication, health and business sectors.[27]

Despite strong growth rates, overall levels of development remain low in the EAC region, particularly relative to global standards. This is mirrored in the region's rankings in the United Nations Development Programme's (UNDP) Human Development index (HDI) (see figure 4).[28] All EAC partner states are classified in the "low human development" category.Burundi has one of the lowest HDI rankings in the world, ranking 184th out of 188 countries, while Kenya, the most developed country in the region, has a ranking of 145.[29]

FIGURE 4. Human Development Index rankings in EAC partner states, 2015



Source: See endnote 28 for this chapter.

SIDEBAR 1. South Sudan - a new EAC partner state

South Sudan gained its independence from Sudan on 9 July 2011 and applied for EAC membership shortly thereafter. South Sudan acceded to the EAC Treaty in April 2016 and will become a full member of the EAC after ratification of the treaty.

With a size of 644,329 km^2, South Sudan will be the second largest country in the EAC region after Tanzania (see figure 2). South Sudan's population of 11.3 million is comparable to that of Rwanda; however, with a growth rate of 3.9%, South Sudan's population is expanding much more rapidly than the EAC average (3%). As in many of the EAC partner states, the urban share of South Sudan's population is relatively small (19%), although the urban population is growing at 5% annually (as in the rest of the African continent) and the country will see a rise in urban settlements.

Economically, South Sudan depends heavily on oil exports. In 2014, oil exports accounted for approximately 50% of the country's GDP of USD 13.3 billion and for more than 95% of government revenue. Thanks primarily to oil revenues, South Sudan has a per capita GDP of USD 1,115, well above the EAC average of USD 1,014. However, in the face of ongoing low oil prices, reduced oil production and political instability, the country's GDP was expected to contract by 7.5% in 2015. With 95% of the population still earning a livelihood through small-scale activities such as agriculture, long-term developments for the country remain unclear.

As in other EAC partner states, access to grid-connected electricity is low in South Sudan. With only 1% of the population connected, South Sudan has one of the lowest electrification rates on the African continent. Per capita electricity consumption is only 1–3 kilowatt-hours (kWh), compared to 80 kWh on average in sub-Saharan Africa. More than 96% of the population of South Sudan relies on solid biofuels for household heating and cooking purposes.

Due to its rich oil reserves, exploitation of renewable energy sources has not been prioritised in South Sudan. Even so, several hydropower projects are in the pipeline, driven by the need to strengthen the capacity of the distribution network and to improve energy access rates. In 2013, in co-operation with the African Development Bank (AfDB) and the Norwegian investment fund Norfund, South Sudan planned the construction of the 42 megawatt (MW) Fula Rapids hydropower plant. Although the plant was scheduled to go online in October 2016, this has been delayed due to the ongoing civil unrest in the country.

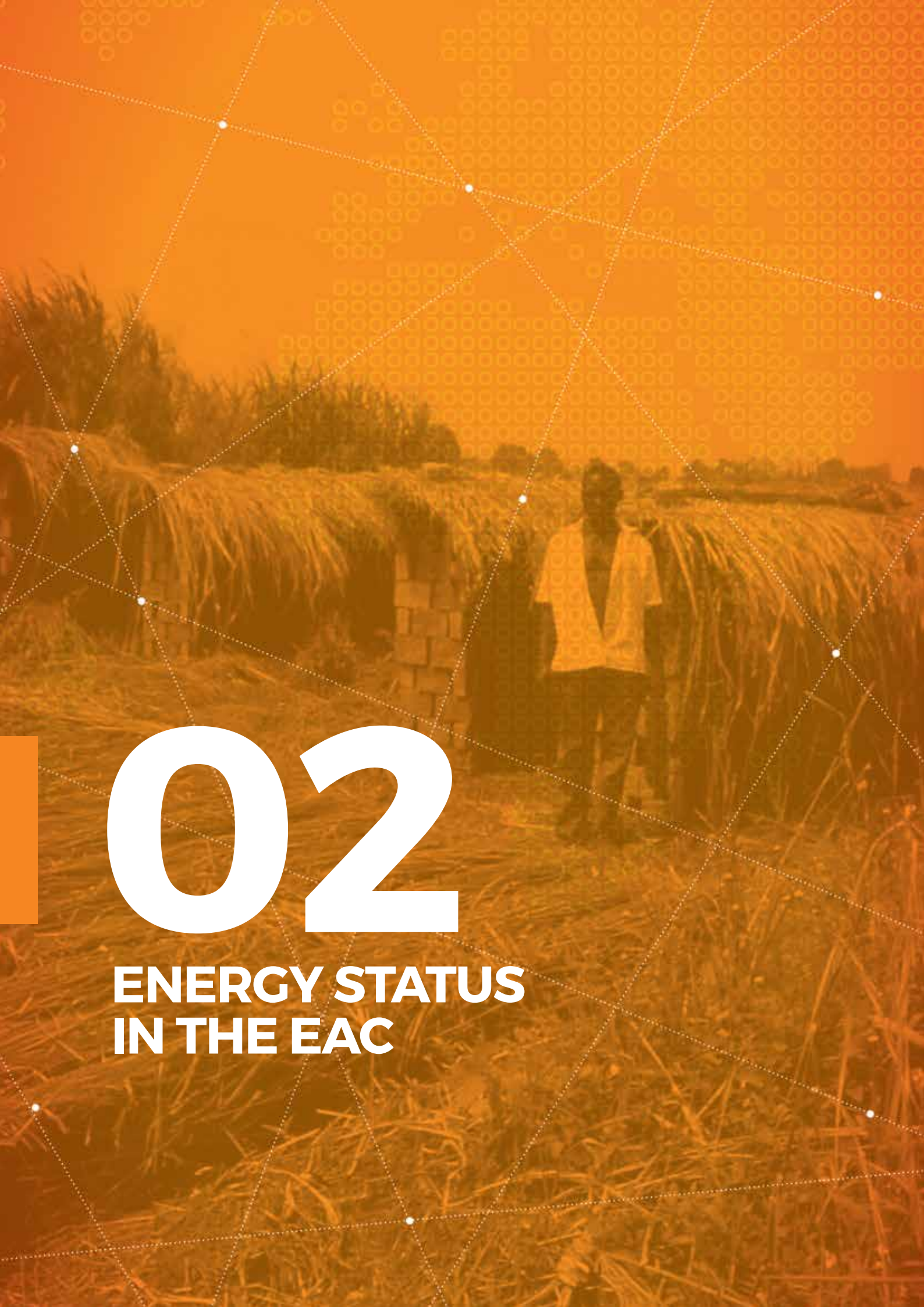
FIGURE 5. Key statistics for South Sudan, 2014/15

Total population	11.3 million
Land area	644.3 km^2
Population growth	3.9%
Share of population living in urban areas (2014)	19%
Urbanisation rate (2014)	5%
GDP (2014)	13.3 billion USD
GDP per capita (2014)	1,115 USD

0.467
Human Development Index (2015)

(ranked 169 out of 188 countries)

Source: see endnote 2 for this chapter



02

ENERGY STATUS IN THE EAC

02 ENERGY STATUS IN THE EAC

Developments in renewable energy and energy efficiency are shaped by the status of the energy sector – by energy supply and demand, relevant policies and the institutional landscape – as well as by existing energy challenges. This chapter provides an overview of the energy situation in the EAC region, which is characterised by:

- The predominant role of solid biomass for cooking and heating, which is not expected to change in the near future,
- Low electrification rates in all EAC partner states,
- Policy makers' focus on the power sector to advance electrification and
- Increasing demand for transport fuels.

ENERGY SUPPLY AND DEMAND

Figure 6 provides a breakdown of final energy consumption by fuel source in the EAC partner states.[1] All of the countries remain heavily dependent on traditional solid fuels such as wood and charcoal, especially for household-level cooking and heating. The share of biomass in primary energy consumption is lowest in Kenya, at 68%, and highest in Burundi, at more than 95%. On average, traditional biomass accounts for approximately 80% of final energy consumption in EAC partner states; if modern biomass is included, this share rises to 86.5% (see chapter 3).[2] The EAC regional average for solid biomass in the energy mix is somewhat comparable to that of the ECOWAS region (85.7%) and is substantially higher than that of the SADC region (61.2%).[3]

In the primary energy balance of EAC partner states, the share of petroleum products is relatively small compared to the use of traditional biomass, but it is still significant.[1] This share is smallest in Burundi, at 2.5% and highest in Kenya, at 22%.[4] Petroleum products are used primarily in the transport sector but also play a role in the industry sector — specifically for the tea, flower/horticulture, coffee and agro-industries — where they are used to power in back-up diesel generators.

Electricity contributes only a small share to the region's primary energy balance, ranging from 9% in Kenya to 1.3% in Burundi.[5] The EAC partner states struggle with providing stable and reliable electricity supply, as the power grid is considered to be among the worst in Africa.[6] This reflects the reality of low electrification rates as well as low average electricity consumption in the region.

Cooking and heating sector

The major demand for heat in the EAC region is for cooking at the household and institutional levels (e.g., in schools and clinics). This is followed by demand for process heat in the industrial sector and for commercial uses, particularly for the manufacture of clay products, brick burning, brewing, steam production and tea processing. For example, in Tanzania, almost 90% of heat demand comes from the household sector, with the remainder coming from household enterprises (cottage industries) as well as from commercial, institutional and some industrial demand.[7]

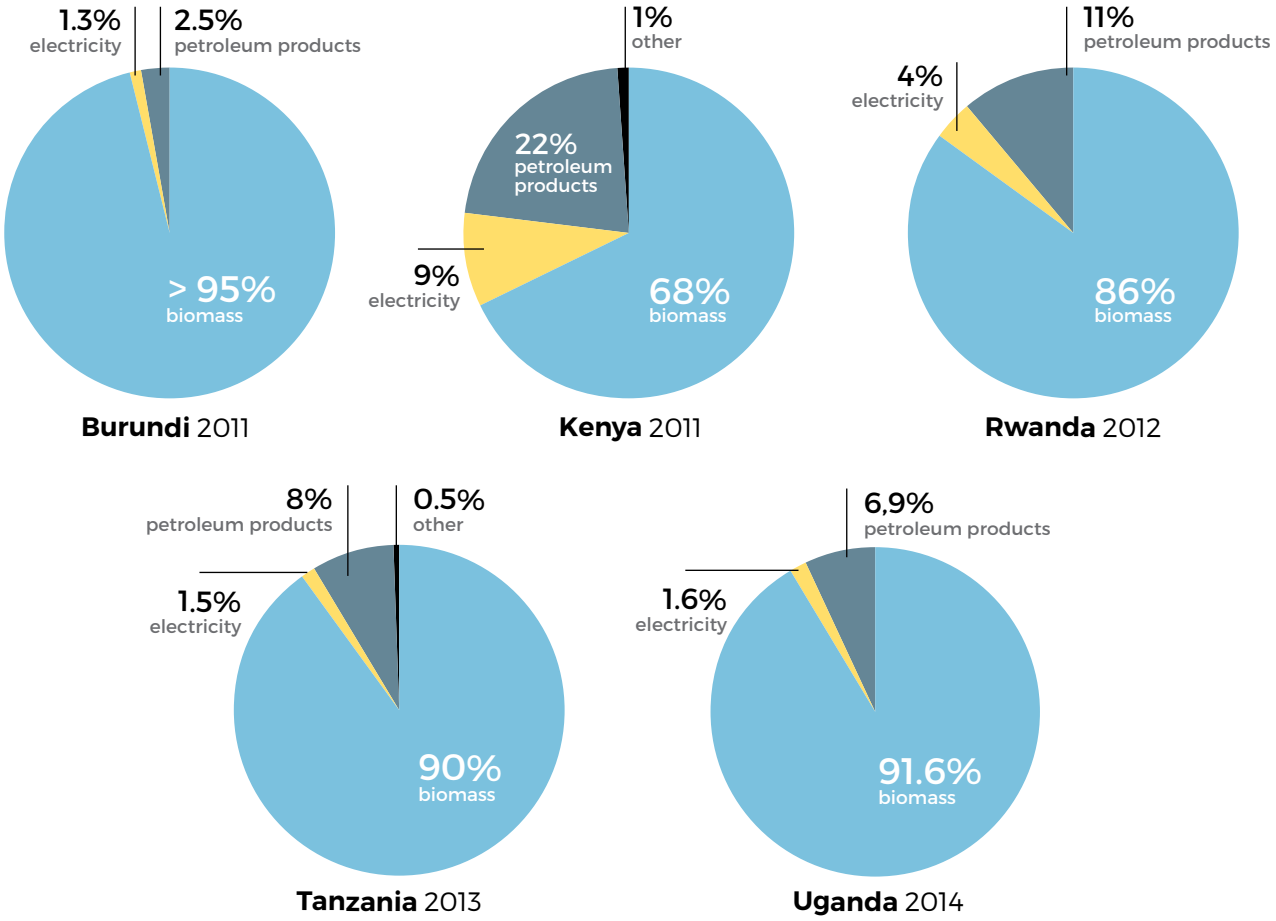
The main energy sources used for cooking and heating in the region are biomass and agricultural wastes. In rural areas, households, commercial uses and institutions use woody biomass as their primary energy source, whereas in urban areas the population relies more widely on charcoal.

Household cooking represents by far the largest share of final energy consumption in the region. Solid fuels – wood and charcoal in particular – remain the central energy source for household cooking. The share of the population using solid fuels for cooking is greater than 95% in all EAC partner states except Kenya, where it is 84%.[8] Many households in the region practice "fuel stacking", which involves combining solid fuels with charcoal, kerosene or liquefied petroleum gas (LPG).[9] This practice is common in more than half of Kenya's households, for example.[10]

In general, policy makers have not placed priority on reducing dependence on biomass in the heating and cooking sector. As a result, woody biomass will remain the central energy source in the sector for the foreseeable future, as the transition to other fuels will take decades to materialise.

i In some EAC partner states, it is not further specified what kind of petroleum products are used. In Uganda, the 7.7% compromises: gasoline (3.2%), diesel (3%), aviation fuel (0.9%), kerosene/paraffin (0.3%) and fuel oil (0.3%).

FIGURE 6. Share of primary energy consumption in EAC partner states, by fuel source, 2011-2014



Source: see endnote 1 for this chapter.

Electricity sector

The electricity sector in the EAC region is characterised mainly by low electrification rates and low average electricity consumption, a consequence of the limited coverage of the power grid.

Historically, the region's electricity sector has relied extensively on renewable energy, primarily hydropower. In 2015, renewable electricity accounted for about 65% of the region's total installed grid-connected power generation capacity.[13] The remaining 35% was from thermal generation sources, mainly diesel and gas.[14]

Since 2000, the EAC region has experienced steady growth in electricity capacity, including from renewables. Kenya has added significant geothermal capacity to its electricity mix, Tanzania has added natural gas-fired capacity, and Uganda and Rwanda both have added hydropower. In all EAC partner states, diesel generation has become more important in providing power, mostly to compensate for reduced hydropower generation resulting from low water levels, but also to serve as back-up power and to bridge power shortages in key industries (such as agribusiness, tourism and mining).

Although grid extension is advancing in the EAC region (see table 1), full market penetration is decades away.[15] As of 2015, the share of the regional population with access to electricity was under 22%, compared to an average electrification rate of 33.5% (2012) for sub-Saharan Africa as a whole.[16] Electrification in 2013 was lowest in Burundi, at 5%, and highest in Tanzania, at 24% (see table 1).[17] In general, rural areas, and rural electrification rates are significantly lower than urban ones (see figure 7).

Burundi has the region's lowest per capita electricity consumption, at 23 kWh per year, and Kenya has the highest, at 168 kWh per year

(see reference table R2).[18] Although not strictly comparable, these levels remain well below the African per capita average of 592 kWh per year and are significantly lower than South Africa's per capita consumption of 4,300 kWh in 2013.[19] Across sub-Saharan Africa, progress in expanding access to electricity and non-solid fuels has lagged behind population growth, thereby hampering the power supply situation.[20]

The sectoral demand for grid-connected electricity varies by country. In Burundi and Rwanda, households account for the largest share of national electricity consumption, at 50%, whereas in Tanzania, residential consumers account for only 5% of consumption.[21] In Kenya and Uganda, the commercial and industrial sectors account for over 70% of the electricity consumed.[22]

Electricity demand in Kenya, Rwanda, Tanzania and Uganda is expected to grow by approximately 5.3% per year to 2020.[23] To meet this demand power generation capacity will have to increase by an estimated 37.7% in Uganda, 96.4% in Kenya, 75.3% in Tanzania and 115% in Rwanda.[24]

To foster electricity access, policy makers in the region are prioritising grid-connected electrification over off-grid strategies. Off-grid electrification is often seen as a second-class solution because it is perceived as providing only a limited amount of electricity and as being less suitable for larger appliances and productive uses. As a consequence, the majority of financial resources have been directed to grid-based strategies. Given the low levels of electricity access, as well as slow advancements in grid extension, a dynamic off-grid market driven by private businesses is evolving in many EAC member states, particularly in Kenya (see chapter 3).

Transport sector

Economic growth and rising prosperity have contributed to growing numbers of personal cars, motorcycles, pick-up trucks and other vehicles in the EAC region. This has increased the demand for fossil fuels, contributed to rising regional carbon emissions, and led to growing traffic congestion, as entire cities "seize up" during rush hours. In big cities such as Nairobi and Dar es Salaam, motorisation is a key source of urban air pollution, leading to heightened levels of PM10 and PM2.5.[25]

To serve this increasing demand for transport fuel and to decrease dependence on fuel imports, EAC partner states are making major investments in the petroleum sector. The region's only refinery was closed in 2013, leaving the region with no pipelines, delivery infrastructure or refining capacity. The discovery of major oil reserves in 2012 and 2014 has accelerated infrastructure development plans, including investment in an oil pipeline linking Uganda to the Kenyan coastal town of Lamu.[26] Uganda also is aiming to start oil extraction by 2017.[27]

As a result of these developments, there is very little impetus to transition to renewables in the region's transport sector. Although there is no policy drive within EAC partner states to support biofuels, some biofuel-related activity has occurred in the form of pilot studies and research (see chapter 3).

ENERGY CHALLENGES AND TRENDS

Considering the region's overall energy status, including EAC partner states face similar challenges to other parts of sub-Saharan Africa – particularly related to energy access, energy security, and health and the environment. These have far-reaching socio-economic implications for the EAC region.

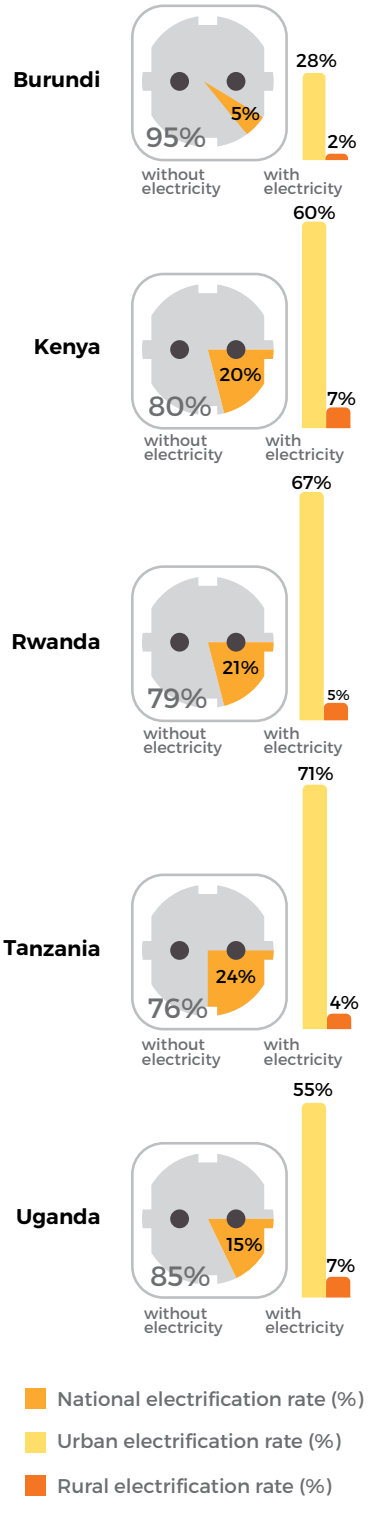
Electricity access

Electricity access is at the core of the energy sector in EAC partner states. As a consequence, electrification strategies are a main driver for energy policy and in particular for renewable energy development.

Although grid extension has advanced during the last decade, electrification rates in the EAC region remain among the lowest in sub-Saharan Africa, hindering economic development. This is why "active" energy policy in the EAC partner states focuses mainly on increasing power generation capacities and extending the grid, with the objective of improving grid-connected electricity access.

ELECTRICITY STATUS IN THE EAC

FIGURE 7. Electrification status in EAC partner states, 2013



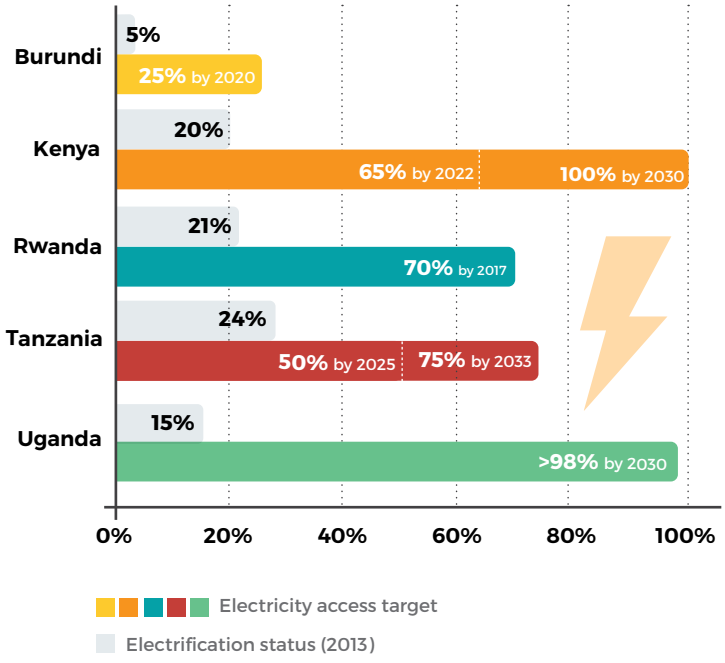
Source: see endnote 17 for this chapter

TABLE 1. Electrification rates in EAC partner states (%), 1990-2013

	1990	2000	2010	2013
Burundi	0%	4%	5%	5%
Kenya	11%	15%	18%	20%
Rwanda	2%	6%	11%	21%
Tanzania	5%	9%	15%	24%
Uganda	7%	9%	9%	15%

Note: For 2010 and 2013, data for Kenya, Tanzania and Uganda are from the WEO Electricity Access database.
Source: See endnote 15 for this chapter.

FIGURE 8. Electrification rate (2013) and electricity access targets in EAC partner states



Source: See endnote 33 for this chapter.

Grid expansion efforts across the region have led to gradually increasing electrification rates, particularly in urban and peri-urban areas. Currently, about 90% of the public money spent on energy infrastructure is invested in the extension of grid-based electricity.[28] However, EAC governments struggle to manage the costs of grid maintenance, extension and new connections outside of urban centres. All five EAC partner states are investing in "last kilometre" access programmes as well as transmission and distribution networks to bring electricity to new areas, but grid extension typically occurs in the more prosperous urban areas first.[29]

The development of electricity infrastructure is hindered by topography, poor road networks and low population density, making local and international transmission very expensive.[30] Existing infrastructure is characterised by poor transmission and distribution systems, outages during peak demand periods and depletion of hydropower storage during the dry season.[31]

To address these challenges, efforts are under way to facilitate intra-regional development and operation of power generation (see section *Regional Integration*). Yet progress on regional grid interconnection has been relatively slow, in part because none of the EAC partner states produces excess electricity for export, and they prioritise strengthening their national electricity infrastructure. Inadequate access to finance – and the inability to jointly fund projects – have hindered improved electricity transmission projects in the region.[32]

The EAC governments all have acknowledged the critical role that electricity access plays in national development and have prepared vision documents and plans to greatly expand access. To support the achievement of the United Nations Millennium Development Goals, in 2006 the EAC adapted the *Regional Strategy on Scaling Up Access to Modern Energy Services*, with a target of providing at least half of the population with access to modern energy services by 2015. Although no partner states were able to meet these ambitious targets, there is strong commitment at both the partner state and EAC levels to achieve them.

Energy access targets and energy policies are formulated at the partner state level. At the regional level, however, the EAC supports the partner states with harmonisation, best practices, and platforms for collaboration and co-operation. A strategy paper on EAC activities is currently in the pipeline.

Each EAC partner state has defined specific electricity access targets (see figure 8).[33] Kenya has by far the most ambitious target, aiming to achieve 100% electrification by 2030.[34]

Governments also are co-operating with various financial bodies and development partners to achieve additional energy access targets, including providing access to modern cooking energy for 50% of traditional biomass users, providing reliable energy services for 100% of urban and peri-urban residents, and delivering modern energy services to all schools, clinics, hospitals and community centres.[35] Additionally, EAC partner states are implementing actions to contribute to the Sustainable Energy for All (SEforALL) initiative (see sidebar 4 on page 30).[36]

Energy security

The EAC power sector is adversely affected by poor transmission and distribution systems, outages during periods of peak demand and the depletion of hydropower storage during the dry season.[37] Energy availability is further restricted by continued reliance on traditional biomass and on imported petroleum with fluctuating prices.[38]

Improving the region's energy security is of primary importance for the EAC partner states. Efforts are being made to improve long-term energy security by promoting energy policies that encourage diversification of both energy types and supply sources, and that facilitate better-functioning and better-integrated energy markets.[39] Together with the United Nations Economic Commission for Africa (UNECA).

Together with EAC partner states are developing a comprehensive energy security policy with a view towards enabling affordable and reliable supplies of electricity and petroleum products.[40] The initiative seeks to respond to the need for greater energy security as well as better monitoring and management of energy security in the EAC region, in order to mitigate the unplanned effects of energy sector disruptions on national economies.[41]

In parallel, the EAC partner states aim to increase the use of renewable energy sources such as hydropower, geothermal, wind, solar and modern biomass to diversify the electricity mix and make it more stable and resilient to fluctuations in international petroleum prices.[42] This is coupled with plans to improve regional interconnection to make better use of projected capacity. These plans are incorporated in the Regional Master Plan (see *Regional Integration*).[43]

> **Electricity access is at the core of the energy sector in EAC partner states. As a consequence, electrification strategies are a main driver for energy policy and in particular for renewable energy development.**

Source: See endnote 33 for this section

Health and the environment

The dominant use of traditional biomass in the cooking and heating sector contributes to social and environmental challenges in the EAC region. The harvesting and use of woody biomass is unsustainable in many areas and contributes to forest depletion and pollution-related health concerns. Rising populations and urbanisation are increasing the demand for cooking energy, particularly for charcoal, intensifying these pressures.[44]

The household cooking sector is key to the development of a sustainable heating sector. However, addressing institutional cooking and process heat is important as well, as these sectors consume a large share of the traded biomass fuel, contributing to the widespread deforestation.

The heavy reliance of EAC populations on solid fuels for cooking (see chapter 3) has negative impacts on public health – the equivalent of smoking two packs of cigarettes per day – particularly for women and children, who tend to spend more time near open fires and kerosene lanterns.[45] In 2012, an estimated 138 million people in the region were affected by household air pollution (HAP) from indoor smoke, small particle pollution, carbon monoxide and nitrogen oxides as a result of cooking with solid fuels, causing more than 60,000 premature deaths, about half of them are children (see figure 9).[46]

Cleaner and more efficient use of biomass cooking fuels is an essential component of regional efforts to reduce negative health impacts. More indirectly, the lack of sufficient electrical power in both rural and urban health clinics has adverse health impacts. Providing reliable access to electricity therefore is a priority of the EAC partner states.[47]

EAC governments also are aware of the significant challenges resulting from unsustainable use of biomass resources. Air pollution and forest depletion have impacts on water catchments, erosion, and efforts to mitigate climate change, all of which affect the viability of the EAC region and have direct, negative implications for key economic sectors such as tourism and agriculture.

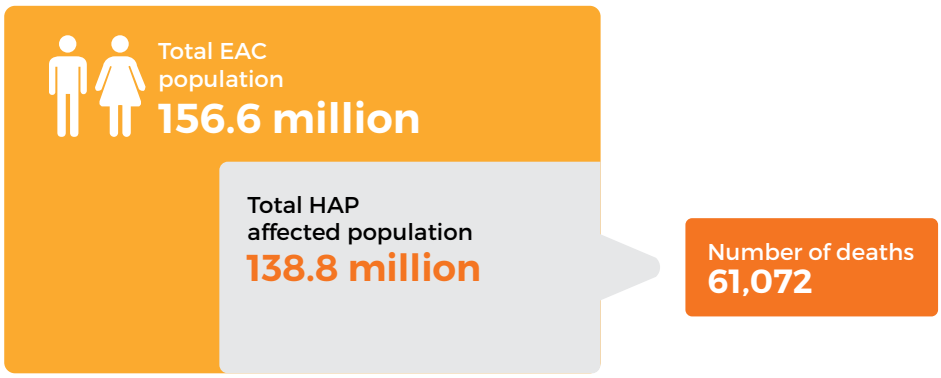
Efforts are under way to mitigate the loss of forest cover, improve biomass energy efficiency throughout the value chain, increase sustainably grown biomass supply, and provide alternative solutions for cooking and heating to reduce reliance on biomass. Alternatives include electric or solar stoves, and kerosene or LPG alternatives. So far, however, the electricity access situation requires considerably more political will and budgetary support than exists currently.

Financing

Obtaining timely and effective financing for energy projects in the EAC region is a significant challenge. This is due in part to the reluctance of major investors such as the World Bank, the African Development Bank (AfDB) and others to commit to long-term financing until agreement is reached among potential buyers of the generated power. This is coupled with uncertainties about political stability in the region as well as a lack of institutional trust. For example, in 2014, in response to allegations that officials in the energy sector were siphoning public funds, 12 international donors withheld USD 490 million in general budgetay support to Tanzania.[48] Although many grid-connected renewable energy projects have been under development in the country, not a single grid-connected Power Purchase Agreement (PPA) has materialised because investors have lacked trust in the solvency of the national electricity company, TANESCO.

EAC partner states increasingly recognise the role of private funding and international donors in accelerating the introduction of renewable energy technologies. As a result, all EAC partner states are driving the deployment of grid-connected renewables via public-private partnerships in co-operation with project developers, equity investors and international donors. The degree

FIGURE 9. Impact of cooking with solid fuels on household air (HAP) pollution in EAC partner states, 2012



Source: See endnote 46 for this chapter.

of co-operation differs among the partner states: in Kenya, for example, the national power company KenGen owns 70% of power generation.[49]

Despite these efforts, deals for grid-connected projects face difficulties being finalised, mainly because of the challenging investment environment. Although supporting policies exist, implementation is uneven (see chapter 3).

REGIONAL INTEGRATION

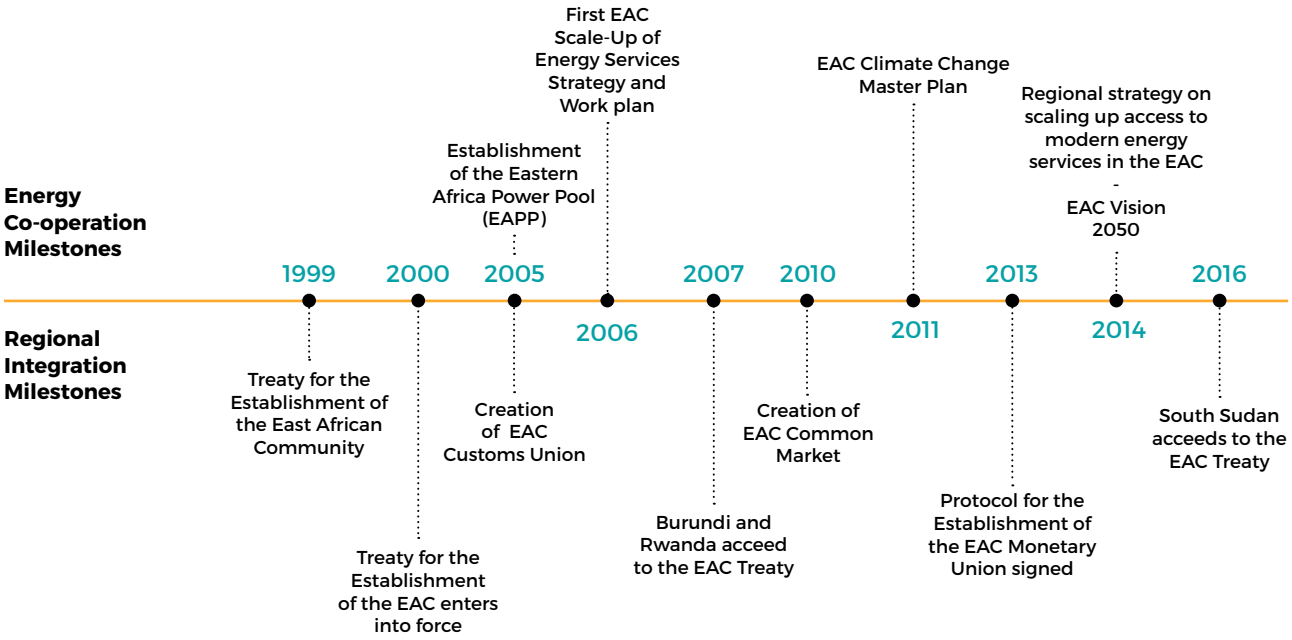
The East African Community, headquartered in Arusha, Tanzania, has developed over the years into an organisation with several subsidiary bodies. The following sections provide a brief overview of the historic development of the EAC itself and other key regional energy projects.

East African Community

Adopted in 1999[i], the EAC Treaty is the binding framework to foster co-operation in economic, social and political affairs among EAC partner states. The treaty envisages regional integration to progress from a customs union, to a common market, to a monetary union and eventually to a political federation.

From the beginning, economic integration has been the driver of regional co-operation. The customs union, created in 2005, strengthened the integration process through liberalisation and promotion of intra-regional trade. Later, this was complemented by the common market, which enabled the free movement of persons, capital, labour, goods and services. In 2013, a protocol was signed that foresees the establishment of a monetary union (see figure 10).[50]

FIGURE 10. Milestones for regional integration and energy co-operation in the EAC



i The EAC originally was founded in 1967 but collapsed 10 years later and did not succeed due to structural and political problems. In the early 1990s, the spirit of integration was revived, leading to the EAC Treaty in 1999.

Regional integration in the power sector and the development of a regional power pool has been slow.[51] Although progress is being made towards a regional energy sector master plan, there have been difficulties in agreeing on a single roadmap for the region.[52] This is due mainly to a focus on national strategies to improve energy access goals.[53] However, this is slowly changing: although earlier EAC Development Strategies touched only marginally on the energy issue, the 4th Development Strategy (2011) shows a growing recognition of the paramount need to supply sufficient, reliable, cost-effective and environmentally friendly energy.[54]

The 2006 *Regional Strategy on Scaling Up Access to Modern Energy Services* was introduced as a tool to achieve the MDGs and support poverty reduction efforts.[55] It aimed to improve access to modern cooking fuels and electricity for all urban and peri-urban poor and to provide energy access for schools, hospitals and community centres. To achieve this, the strategy built upon co-operation between EAC national governments and the EAC Secretariat. Because these targets were not met by 2015, a succeeding five-year implementation plan is being developed.[56]

Several EAC-sanctioned platforms have been created to promote renewable energy and energy efficiency in the region. These include the Regional Power Master Plan, and the EAC Climate Change Master Plan, which highlights the importance of renewables for climate change mitigation strategies.[57] All EAC partner states also have submitted Intended Nationally Determined Contributions (INDCs) to contribute to climate change mitigation, as agreed upon during the COP21 talks in Paris in 2015 (see sidebar 3).[58]

Regional collaboration on power sector projects

To satisfy national energy demand, EAC partner states generally have developed their power system infrastructure in an isolated manner. However, regional energy co-operation is taking place via joint ownership of hydropower projects. In 2012, the governments of Burundi, Rwanda and Tanzania established the jointly owned Rusumo Power Company to oversee the Rusumo Falls hydropower project.[59] Burundi, Rwanda and the Democratic Republic of the Congo (DRC) also are interconnected via the 45 MW Ruzizi II hydropower plant, operated by the joint utility Société Internationale pour l'Électricité des Grands Lacs (SINELAC).[60]

To improve interconnection, EAC partner states are collaborating on power sector projects to complete transmission lines for regional grid interconnection.[61] The cornerstone of this is the Regional Power Master Plan, which identifies generation and transmission projects for providing least-cost power to the region for a period of 25 years, from 2013 to 2038.[62]

Interregional power trade is driven mainly by the Nile Equatorial Lakes Subsidiary Action Program (NELSAP)[i], which has in the pipeline several interconnection projects between EAC partner states and non-EAC states (see reference table R3).[63] These power trade and development projects have attracted more than USD 360 million so far. The construction and upgrading of 769 kilometres of 110 kilovolt (kV) and 220 kV lines, coupled with transmission lines connected to the Rusumo plant, aim to create a more solid and reliable power supply in the region.

EAC partner states also have prepared standard contracts to allow cross-border electrification. This will enable communities located near national borders to access the grid from another EAC partner state if this is closer than the national grid.[64]

Eastern Africa Power Pool (EAPP)

Esatern Africa Power Pool (EAPP) was established in 2005 by seven East African countries – Burundi, the DRC, Egypt, Ethiopia, Kenya, Rwanda and Sudan – as the specialised electric power institution for the Common Market of Eastern and Southern Africa (COMESA).[65] Following the joining of Tanzania, Libya, and Uganda in 2010–12, the EAPP has grown to 10 member countries. Comprising 13 utilities and 7 national energy/electricity regulators from across the region, the EAPP's main objective is to promote the development of energy resources in the region and to facilitate access to electricity for all people in Eastern Africa through regional power interconnections.[66]

In 2011, the EAPP conducted a study, resulting in the EAPP Master Plan 2011 and Grid Code, which assessed short-to-long-term regional power generation and interconnection projects within EAPP and EAC member countries.[67] (See sidebar 2 on current efforts in Ethiopia.) In addition, the study sought to facilitate greater integration of development and operation efforts among EAPP member countries by establishing a common Grid Code, while also strengthening institutional capacity building.[68] In 2014, the Master Plan was updated to include the expanded East African electricity transmission system.[69]

Alongside the EAPP's Road Map, spanning 2010 to 2025, a market platform has been developed to facilitate hourly bidding for demand and generation, computing prices based on available transmission capacity.[70]

SIDEBAR 2.
Electricity imports from Ethiopia

Ethiopia is the second largest electricity producer in Africa and the only country in Eastern Africa that produces excess electricity which it can export to other countries. As a consequence, Ethiopia is the driving force of the EAPP. Electricity supply from Ethiopia is of growing importance for EAC partner states. Ethiopia currently is exporting electricity to Kenya and, in 2015, it signed deals to also provide electricity to Tanzania and Rwanda.

The Ethiopian power sector is growing very rapidly, as the country is endowed with an abundance of renewable energy resources. This includes an estimated 45 GW of additional hydropower potential, 10 GW from geothermal resources, and significant solar and wind generation potential. Ethiopia has set a target for total installed generation capacity of 37 GW by 2037.

Source: See endnote 67 for this chapter.

SIDEBAR 3. COP21 and the Intended Nationally Determined Contributions (INDCs) of EAC partner states

National commitments to renewable energy deployment received global attention throughout 2015 as the international community worked to reach a global climate change agreement. In December 2015, 195 countries adopted the first-ever universal, legally binding global climate change deal. In a shift from past processes, the Paris Agreement drew heavily on a bottom-up approach in which nations outlined their concrete post-2020 commitments under Intended Nationally Determined Contributions (INDCs) submitted throughout the year.

Although the INDC commitments relate to all sectors of the global economy, countries around the world identified the deployment of renewables as an effective mechanism for achieving emission reduction goals. The goals expressed in the INDCs draw on well-established renewable energy policies and targets that countries have enacted for decades. Although non-binding in nature, these activities outlined through the INDC process served as the basis for the Paris Agreement.

Per capita CO_2 emissions in the EAC partner states are among the lowest worldwide, but extreme weather events adversely affect the countries. Therefore, all partner states have submitted INDCs that comprise measures not only for climate change adaptation, but also for mitigation. These INDCs build upon already existing national strategies, development plans and vision documents.

Table 3 provides an overview of CO_2 emission targets for 2030 compared to a business-as-usual (BAU) scenario. Kenya and Uganda have submitted specific targets for reducing emissions by 30% and 22%, respectively, against BAU by 2030. Tanzania has set a reduction range of 10–22%. Burundi has submitted an unconditional reduction target of 3% and is willing to increase this to 20% if financial support from the international community is provided. Rwanda has yet to submit a reduction target before the end of 2017.

To achieve these emission reduction targets, all countries have highlighted strategies in specific sectors of their economy – including emission reduction in agriculture, livestock, water and infrastructure. Combatting deforestation is an important pillar of the commitment of most partner states. Due to the high reliance on solid biofuels in the EAC region, partner states have committed to promoting clean cooking solutions coupled with reforestation measures to increase forest cover. For example, Rwanda aims to achieve universal access to improved cook stoves by 2030.

In their INDCs, all EAC partner states also highlight the importance of renewable energy technologies to achieve sustainable development and green growth. Advancing renewable energy projects is considered to be crucial not only to improve energy access but also to ensure low-emission provision of energy. For example, in its INDC Burundi refers to being in the process of building three hydroelectric power plants, and Uganda mentions a goal of having at least 3.2 GW of renewable energy generation by 2030.

If fully implemented, the INDC renewable energy goals are expected to boost technological innovation and renewable energy deployment, particularly in the power sector. Further scaling up of the commitments made in INDCs will be necessary to keep the increase in global average temperatures below 2 degrees Celsius. Starting in 2018, national commitments will be revisited every five years, with countries assessing progress and encouraged to submitted progressively more ambitious goals.

TABLE 2. Overview of INDC activities in EAC partner states

	Emission reduction target (against BAU scenario)	BAU emissions (million tons of CO_2-equivalent/ year)	Selected national policy documents
Burundi	3% / 20%	Not available	• Burundi Vision 2025 • Growth and Poverty Reduction Strategic Framework 2012–2015 • Sectoral Strategy for the Energy Sector in Burundi (2011)
Kenya	30%	143	• National Climate Change Response Strategy (2010) • National Climate Change Action Plan (2013) • National Adaptation Plan
Rwanda	None submitted	Not available	• Rwanda's Green Growth and Climate Resilient Strategy (2011) • Vision 2020 • Economic Development and Poverty Reduction Strategy 2 (2013–2018) • Sustainable Energy for All (2015–2030)
Tanzania	10–22%	138–153	• Tanzania Development Vision (2025) • Zanzibar Vision (2020) • Tanzania Five Year Development Plan (2011/12–2015/16) • National Climate Change Strategy (2012) • Zanzibar Climate Change Strategy (2014)
Uganda	22%	77.3	• National Climate Change Policy (NCCP) (2015) reflects Uganda Vision 2040 (2012) • Priorities in the National Climate Change Policy have been integrated in the Second National Development Plan (NDP II) 2015/16–2019/2020 (2015)

Source: See endnote 58 for this chapter.

East African Centre for Renewable Energy and Energy Efficiency (EACREEE)

Approved by the EAC energy ministers in 2013 and supported by the United Nations Industrial Development Organization (UNIDO) and the Austrian Development Agency (ADA), the East African Centre for Renewable Energy and Energy Efficiency was inaugurated in June 2016. The centre's objective is to support the implementation and monitoring of regional strategies for renewable energy and energy efficiency and to encourage the creation of a renewable energy market to spur development. By creating an enabling environment for renewable energy and energy efficiency, it aims not only to improve energy access and energy security but also to ensure regional cohesiveness among partner states. EACREEE will mitigate existing regional barriers in the energy sector by providing policy support and creating a platform for knowledge exchange.[71]

ENERGY POLICY LANDSCAPE

Although a variety of regional energy plans exist, energy strategies and policies in the EAC countries are driven primarily at the national level.[72] Alongside issues related to energy security, improving energy access is at the core of the energy sector in the region and is the main concern of policy makers.

As noted earlier, all EAC partner states have adopted electricity access targets, the most ambitious being Kenya's goal to achieve 100% access to grid-connected power by 2030. These targets are very ambitious, raising questions about whether achieving them is both realistic and possible. Considering the crucial role of electricity for economic development and industrialisation, policy makers have focused their attention mainly on the power sector, particularly on increasing power production and improving distribution.

Policy makers in the region have tended to address energy efficiency within the overall renewable energy framework, with specific responsibilities given to the regulator and to power utilities for efficiency-related requirements and cost-saving measures. To date, energy efficiency as an energy "resource" has not received the same attention as renewable energy, with the exception of biomass efficiency concerns driven by growing awareness of resource depletion and indoor air pollution (see chapter 5).

A number of critical "political" changes have affected the region's power sector in recent years (see also chapter 4). Key trends include:

SIDEBAR 4. Status of SEforALL country action in EAC partner states

In 2011 the Sustainable Energy for All (SEforALL) initiative was started by United Nations Secretary-General Ban Ki-moon to ensure universal energy access to modern energy services, double the share of renewables in global energy mix and double the rate of improvement of energy efficiency. Building on this initiative, in September 2015, the UN General Assembly adopted Sustainable Development Goal #7 on ensuring access to sustainable energy for all. Implementation of this universal goal and of the SEforALL Initiative is taking place at the country level.

All of the EAC partner states have made progress in implementing the SEforALL initiative and its three main objectives. In December 2015, Kenya hosted the first SEforALL East Africa Forum, which underlined the progress made by the region and the importance of regional collaboration on SEforALL. Table 2 provides an overview of the status of SEforALL country action in the EAC partner states:

TABLE 3. Status of SEforAll country action in the EAC partner states

Country	Status
Burundi	Developing an energy master plan including a renewable energy master plan under the SEforALL umbrella with support from the AfDB, EU and World Bank. The World Bank also is supporting development of the SEforALL Investment Prospectus.
Kenya	Finalised the SEforALL Action Agenda and Investment Prospectus at the end of 2015 with support from the SEforALL Africa Hub. Working on the institutionalisation of the SEforALL process and implementation of the Agenda Action and Investment Prospectus.
Rwanda	Presented the Action Agenda to the Economic Cluster cabinet meeting at the end of 2015; it currently is undergoing a final revision.
Tanzania	Finalised the Action Agenda and Investment Prospectus at the end of 2015 with support from the SEforALL Africa Hub; now preparing follow-up actions.
Uganda	One of the first countries in Africa to finalise and adopt the Action Agenda in 2015 with support from the European Commission. Currently finalising the Investment Prospectus.

Note: South Sudan is not included here.
Source: See endnote 36 for this chapter.

i NELSAP member states are Burundi, the DRC, Egypt, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda.

- A **shift away from government** ownership and management of generation, transmission and distribution to diversified portfolios that recognise the major role that the private sector can play in the sector. A number of independent power producers (IPPs), emergency power producers (EPPs) and small power producers (SPPs) operate in the region and produce electricity from a variety of sources.

- The increasing **role of Rural Energy or Electrification Agencies (REAs)**, for reaching remote un-electrified populations through grid extension, "last kilometre" connections or off-grid power solutions.

- **Unbundling of key power institutions** as part of a multi-decade liberalisation trend that has been deemed successful in improving national electricity costs and grid maintenance and expansion.

Energy institutions in the EAC region

The following provides an overview of the most important institutional players involved in renewable energy policy making and procurement in the EAC partner states.[73]

Burundi

- The energy sector is largely under the responsibility of the government, but private participation and investment have been fostered by rules and regulations and by the establishment of public tendering processes.

- The **Ministry of Energy and Mines (MEM)** is in charge of developing and implementing energy policies as well as sectoral planning and co-ordination. The Ministry's energy directive is responsible for project planning by conducting hydroelectric development studies.

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

- Before market liberalisation of the energy sector in 2000, Burundi's state-owned public utility company, **REGIDESO**, had a monopoly on electricity production. It continues to be in charge of electricity distribution.

Kenya

- The **Ministry of Energy and Petroleum (MEP)** is responsible for energy policy formulation, for overseeing national energy planning and for mobilising financial resources for investments in the energy sector. It also is in charge of creating an environment which allows for private participation in the energy market.

- The **Rural Electrification Authority (REA)**, established in 2007, executes the government's Rural Electrification Programme. This includes mobilising the resources to promote renewable energy sources in order to expand the electricity supply to rural communities.

- **Kenya Power and Lighting Company (KPLC)** is the only off-taker of electricity in the market. KPLC purchases electricity from KenGen and other IPPs and owns and operates the majority of transmission and distribution systems. The Kenyan government holds 50.1% of KPLC's shares.

- **Kenya Electricity Generating Company (KenGen)** is the main electricity generation company in Kenya and produces approximately 80% of national electricity consumption. As of 2015, KenGen had an installed capacity of 1,580 MW, deriving from thermal, geothermal, hydro and wind energy sources.

Rwanda

- In contrast to other EAC partner states, Rwanda does not have a specific electricity regulator or rural electrification agency. These roles are played by departments within the **Ministry of Infrastructure (MINIINFRA)**.

- **MINIINFRA** is responsible mainly for guiding energy policies and strategies and for advancing the electricity sector. This includes efforts to achieve a higher share of renewables in the energy mix and to improve energy access rates.

- The **Rwanda Utilities Regulatory Authority (RURA)** has the mandate to regulate certain public utilities, including for renewable and non-renewable energy. RURA is in direct contact with the government to execute energy policies and plays a crucial co-ordinating role among policy makers, energy service providers and consumers.

- The **Energy Water and Sanitation Authority (ESWA)** is a subsidiary of the government and has a de facto monopoly on the majority of Rwanda's energy and water sector activities. It is the sole market actor responsible for energy distribution and transmission and also is involved in generation and retail.

Tanzania

- The **Ministry of Energy and Minerals (MEM)** has the mandate to accelerate development of the country's mineral and energy sector. It is responsible for co-ordinating, supervising and guiding the energy sector and has departments in charge of improving technical efficiency.

- The **Energy and Water Utilities Regulatory Authority (EWURA)** was established in 2001 to promote competition and economic efficiency. Its main function is technical and economic regulation of the electricity, petroleum, natural gas and water sectors. It also is responsible for issuing licences, formulating standards for goods and services, and regulating energy rates and charges.

- **Tanzania Electric Supply Company (TANESCO)**, owned entirely by the government, focuses mainly on electricity generation, transmission and distribution. TANESCO provides approximately 60% of the generating capacity of Tanzania's national grid. After a 2012 corruption scandal, TANESCO is struggling to secure donor confidence and foreign investment for future energy projects.

- The **Rural Energy Agency (REA)** was established to administer the Rural Energy Fund, with the main goal of facilitating rural electrification activities by funding eligible energy projects in co-operation with interested stakeholders.

Uganda

- The **Ministry of Energy and Mineral Development (MEMD)** is in charge of overall management of the energy and mineral sector. It formulates, implements and monitors policies.

> Although a variety of regional energy plans exist, energy strategies and policies in the EAC countries are driven primarily at the national level. Alongside issues related to energy security, improving energy access is at the core of the energy sector in the region and is the main concern of policy makers.

- As in other EAC countries, in Uganda the **Electricity Regulatory Authority (ERA)** has a dominant role in regulating the electricity sector and issuing licences for energy generation. It is the sole actor responsible for transmission, distribution and sales of electricity and establishes an electricity tariff structure and tariff prices and changes.

- The **Rural Electrification Agency (REA)** is responsible for implementing the Rural Electrification Strategy and Plan to improve energy access rates in rural communities.

- The **Uganda Electricity Transmission Company Limited (UETCL)** is the country's system operator and sole actor for all transmission lines above 33 kV. UETCL is both a bulk supplier and the only buyer of power for the national grid and purchases all the power generated by IPPs in the country.

SIDEBAR 5. Importance of data

Timely, accurate and accessible data on renewable energy and energy efficiency are essential for good policy making. As the deployment of renewable energy technologies increases and their geographical spread widens, the complexity of data collection, verification and harmonisation also increases.

A problem of data aggregation has long existed for traditional uses of biomass for heating and cooking, and data on direct consumption of biomass have always been estimated. This challenge now extends to modern renewables, and particularly to distributed and small-scale renewable energy installations, which are difficult to track and are often considered insignificant for inclusion in national energy statistics. This situation needs to change, however , as distributed energy markets continue to grow (see chapter 3).

Renewables in general, and distributed renewables in particular, are playing an increasingly important role across the five EAC partner states. Reliable, accessible and timely data are essential for developing national energy plans. Moreover, data are needed for defining baselines for targets, for monitoring progress and the effectiveness of policy measures, and for attracting investment.

In the EAC region (as in many other regions) renewable energy data are not collected systematically, and, where data do exist, they vary widely in quality and completeness. The timing of data releases varies considerably, and reporting periods differ. The time lag between developments and the availability of data (in many instances two years or longer) can be a barrier to informed decision making, given the rapidly evolving renewable energy landscape.

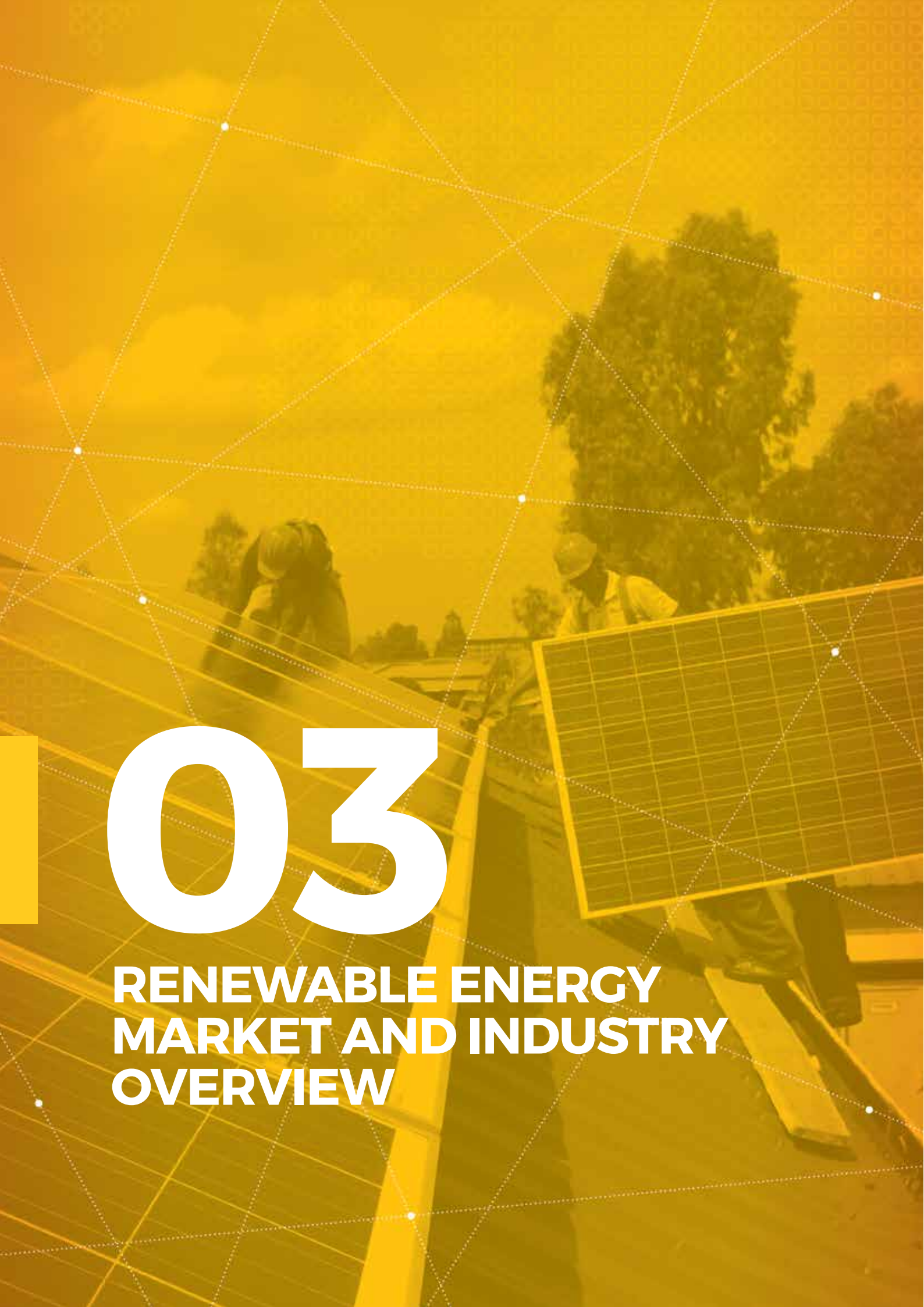
Some challenges are technology- or sector-specific, due to the decentralised nature of installations and of industry structure. Challenges of accounting for distributed energy production occur mainly in the electricity and heating and cooling sectors. Distributed electricity and heating or cooling often are generated on-site for self-use. Except where financial support mechanisms (such as feed-in tariffs) require production accounting, generation data must be estimated based on installed capacity. In many jurisdictions, however, the authorities responsible for energy data collection lack information on the scale of the market, a problem that is particularly acute in the EAC region.

Formal (government) data may command some premium in the hierarchy of data, but informal data also are critical for establishing a more comprehensive view of the global renewable energy sector. The challenge is to effectively bring together data from various institutional and individual sources in a consistent, systematic and transparent context. EACREEE has been formed, in part, to overcome gaps and to improve the quality of renewable energy data by systematically relying on a broader array of both formal and informal sources. For EACREEE to be effective, however, all of the region's governments must commit to providing data to the organisation on a regular basis.

The pico solar market is a case in point. The officially recorded figure for off-grid installed capacity in Kenya is 0.6 MW, despite research demonstrating that a dynamic off-grid market exists. Between the second half of 2014 and the first half of 2015, 947,000 units of global quality-verified pico-solar lighting products were sold in Kenya. Using 2014 customs data for solar PV and cross-checking them with publicly available data from companies such as SolarPower Europe, the IEA Photovoltaic Power Systems Programme and Hanwha Q CELLS reveals that the total installed PV capacity in Kenya is actually closer to 31.6 MW.

The collection and processing of renewable energy statistics can be seen as burdensome. However, inconsistent data collection efforts hamper (and will continue to hamper) the EAC governments' capacity to make informed decisions. Experts agree that systematic and enhanced reporting is critical for increasing financing, establishing policy priorities and improving energy planning over time.

Source: See endnote 74 for this chapter.



03

RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

03 RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

EAC partner states face various challenges relating to energy access, economic development and energy supply security. Renewable energy development in the region thus is determined by broader energy realities (see chapter 2). As shown in table 4, renewable energy sources – in particular biomass and hydropower – already play a dominant role in all five countries in the EAC region.[1]

From a renewable energy perspective, the challenge in the cooking and heating sector is to transform traditional biomass — specifically the use of woody biomass and agricultural wastes – into a more sustainable energy source. To reduce the negative environmental impacts of deforestation and risks to human health, the sustainability of biomass production and use is of major concern.

In the power sector, renewables offer a prime opportunity to increase power generation capacities given the region's high renewable energy potential. Although large-scale hydropower remains the main source of regional electricity supply, focus is shifting to other renewable sources such as geothermal, industrial biomass, and wind and solar technologies.

Renewable energy – particularly solar PV – plays an increasingly important role in providing basic energy access to populations in rural and peri-urban areas that are not connected to the electric grid. Although the overall contribution of off-grid systems in the EAC region is small compared to grid power, off-grid systems provide basic electricity services to a significant number of people. Driven largely by demand for reliable, low-cost power in rural communities and for back-up power in the industry sector, off-grid renewable energy represents a dynamic renewables market.

In the transport sector, rising fuel demand, related greenhouse gas emissions and dependence on fuel imports make it imperative that policy makers in the EAC region develop alternative transport fuels. So far, however, renewables play only a marginal role in the sector, and only a few biofuel pilot projects, using croton nuts or jatropha, exist in the region.[2]

Collectively, declining renewable technology costs, growing power demand from urban populations and industries, expanding local technical capacity, strong foreign investment interest, the impetus for low-carbon climate change mitigation, as well as a recognition by national governments of the role for non-hydro renewable energy sources point to continued renewables growth in the EAC region.

This chapter summarises the renewable energy potential, market and industry development at both the regional and

TABLE 4. Share of renewable energy in total final energy consumption (TFEC) in EAC partner states, 1990, 2000, 2010 and 2012

Share of renewables in TFEC (%)					Share of renewables in TFEC by source, 2012 (%)								TFEC, 2012 (PJ)
Country	1990	2000	2010	2012	Solid biomass, traditional	Solid biomass, modern	Hydro	Liquid biofuels	Wind	Solar	Geo-thermal	Other	
Burundi	82.6	93.2	96.8	96.6	94.9	0.6	1.1	0	0	0	0	0	88
Kenya	77.7	81.8	77.1	78.5	75.2	0.2	2.3	0	0	0	0.8	0	556
Rwanda	84.4	89.4	87.9	86.2	75.3	9.7	1.2	0	0	0	0	0	54
Tanzania	94.8	94.3	90.7	88.2	68.4	19.2	0.6	0	0	0	0	0	800
Uganda	96.1	94.6	88.8	90.0	86.2	2.7	1.1	0	0	0	0	0	403

Note: TFEC = total final energy consumption; PJ = petajoules. "0" entries in the table indicate that the figure is too small to be significant in comparison with TFEC or that no examples of this technology exist at present.
Source: See endnote 1 for this chapter.

national levels. Rather than outlining the developments in each technology, the chapter discusses the contribution of renewable energy technologies in four leading areas of energy demand: cooking/heating, grid-connected electricity, off-grid electricity and transport.

RENEWABLE ENERGY POTENTIAL

The EAC partner states collectively have a vast renewable energy potential, which has been exploited only marginally to date.

For large-scale hydropower, the region has an estimated potential of 13.4 GW, only 16% of which has been exploited.[3] Kenya and Tanzania have the highest potentials, at 4.5 GW and 4.8 GW, respectively.[4] Burundi has an estimated capacity of 1.7 GW, but only around 300 MW is seen as economically viable, and 33.8 MW (2%) has been exploited so far.[5] Rwanda has a large-scale hydropower potential of some 313 MW, and Uganda has a combined large-scale and mini-hydro potential of 2.2 GW.[6] In addition, the EAC region has a small-scale hydropower potential of more than 4 GW, with the majority (3 GW) situated in Kenya.[7]

Geothermal energy is available along East Africa's Rift Valley, with an estimated potential of 15.8 GW.[8] Kenya and Tanzania have the highest geothermal potentials, at 7–10 GW and 5 GW, respectively.[9] In the remaining EAC partner states, assessments of geothermal potential have not been as thorough. In Burundi no feasibility study has been undertaken to date, in Rwanda the potential is estimated at more than 300 MW, and in Uganda no full assessment has been carried out, but preliminary findings indicate a geothermal power potential of 450 MW.[10]

The EAC region has one of the highest potentials for solar power globally. All of the EAC partner states experience high levels of solar irradiance, with year-round insolation between 4 and 6.5 kWh per square metre per day.[11]

The region also has a vast wind energy potential, with sites suitable for large-scale wind farms in Kenya and Tanzania. Kenya has one of the highest and most-studied wind power potentials in Africa.[12] In the country's north-west (Marsabit and Turkana districts) and along the Rift Valley, the potential for grid-connected wind power exceeds 1 GW.[13] Tanzania's Rift Valley areas are known to have promising wind resources as well, with attractive wind regimes for grid-scale electricity generation in Kititimo (Singida) and Makambako (Iringa) and on the islands of Mafia, Zanzibar and Pemba.[14]

RENEWABLES FOR COOKING AND PROCESS HEAT

The cooking and heating sector in the EAC region is dominated by two main energy sources: woody biomass and crop residues. Although these traditional biomass resources are, in principle, renewable, the current level of use is not sustainable and contributes to massive deforestation and negative health impacts. The main challenge is to make the sector more sustainable by developing truly renewable biomass fuels (e.g., through forest management), by increasing the efficiency of both fuel production (e.g., charcoal) and consumption (e.g., cook stoves), and by adopting alternatives to biomass fuel in cooking.

The household cooking sector is key to the development of a sustainable heating sector, as it represents the largest share of final energy consumption in the region. Addressing institutional cooking and process heat also are important, as these sectors consume a large share of the biomass fuel that is traded. Traded woody biomass is the leading contributor to deforestation in the region.

Past attempts in the region to substitute biomass with other renewable fuels for cooking, such as ethanol and solar cookers, have not succeeded for a variety of social, technical and cost reasons. Only a relatively small share of households cooks with electricity, kerosene/gas or solar energy, as these fuels are more expensive than biomass and often require the development of storage and distribution infrastructure.[15] In addition, policy makers have not given sufficient attention to fuel substitution in the household sector, focusing instead on reducing overall demand for solid biomass through the introduction of more-efficient cook stoves (see chapter 5).

In general, policy makers in the EAC region have placed greater priority on strengthening the power sector than on addressing the cooking and heating sector, and many continue to have negative perceptions of biomass energy. Thus, the largely informal biomass sector has not been regulated successfully, although experts agree that such regulation is critical to developing a more sustainable cooking and heating sector.[16] Formalising the biomass sector would make it possible to mobilise private biomass sources, to encourage private players (such as wood producers, charcoal and fuel producers, and investors) to enter the biomass market, to increase efficiency in both fuel production and consumption, and to develop economically viable fuel substitutes.

Nevertheless, EAC partner states are recognising the need to address the biomass challenge in the cooking and heating sector in a more holistic manner. Rwanda (in 2009), Tanzania (in 2014) and Uganda (in 2013) all have developed biomass energy strategies, with support from international organisations such as the European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) and UNIDO. These strategies focus on developing and strengthening the supply of sustainable woody biomass, on developing modern biomass fuels (pellets, modern charcoal), on improving the efficiency of biomass use and on strengthening institutional capacities.[17] In most EAC partner states, these efforts include ongoing programmes to substitute biomass fuel, particularly at the institutional level. Private sector initiatives also exist, such as the fuel and stove provider Inyenyeri in Rwanda (see sidebar 6).[18]

Because woody biomass will remain the region's dominant energy source for cooking and heating for the foreseeable future, the main challenge will be to make it truly renewable. Meanwhile, other renewable fuels such as biogas, waste-to-energy and solar thermal offer potential alternatives – particularly for cooking heat in institutions and small enterprises, as well as for process heat – and are being developed in these sectors, although at a slow pace.

SIDEBAR 6. Inyenyeri – a clean cooking business model from fuel to stove in Rwanda

More than 3 billion people worldwide rely on traditional fuels and inefficient technologies for their daily cooking needs. Each year, 4.3 million people die prematurely from household air pollution (HAP), more deaths than are attributed to malaria and HIV/AIDS combined. Rwanda, where 98% of the population is dependent on cooking with woody biomass, charcoal or crop waste, is no exception. HAP from cooking is a national public health crisis, killing an estimated 7,500 people annually.

Traditional cooking methods in Rwanda are contributing to an environmental crisis as well, as the growing demand for woody biomass is the leading driver of deforestation nationwide. Rwanda soon will be unable to meet its demand for cooking energy without dramatic interventions, such as switching half of the population to LPG almost immediately – a very costly measure.

Despite decades of interventions, sustainable and scalable solutions for this problem are scarce. The most widely distributed "improved" cook stoves in Rwanda are locally made clay stoves that provide some fuel efficiency gains but have few positive health impacts. The government recognises the urgent need to increase the penetration of higher-quality cook stoves, and Rwanda is the first country in the world to grant a VAT exemption to Tier 2–4 cook stoves (the global standard for cook stoves is ISO-IWA 11:2012 Tiers 0 to 4, with Tier 4 being the highest). Despite this support, high-quality cook stoves remain too expensive for most Rwandans.

Against this backdrop of breaking the energy poverty cycle, Inyenyeri, a Rwandan renewable energy company, was started in 2010 with the mission of eliminating death and disease caused by HAP. By focusing on the health impacts of cooking, Inyenyeri provides the highest standard of biomass cooking solutions. Through a combined fuel-and-stove solution, the company is able to provide clean biomass cooking to all levels of households, from the rural poor to urban middle-income homes.

Inyenyeri produces locally sourced, sustainable biomass fuel pellets. Customers buy the fuel pellets with cash, or, if they do not have cash, they may exchange collected raw biomass for fuel pellets. The collected raw biomass is used as feedstock for the pellets. Inyenyeri provides all of its customers with the world's cleanest biomass cook stoves for burning the fuel. The fuel-and-stove system has been found to reduce HAP by 98% (ISO-IWA Tier 4) and wood consumption by 80–90% over traditional methods. Located in Rubavu District of Rwanda's Western Province, Inyenyeri had 1,500 customers under contract as of July 2016 and planned to grow its customer base to 7,000 by the end of 2016.

Source: See endnote 18 for this chapter.

Solid biomass heat

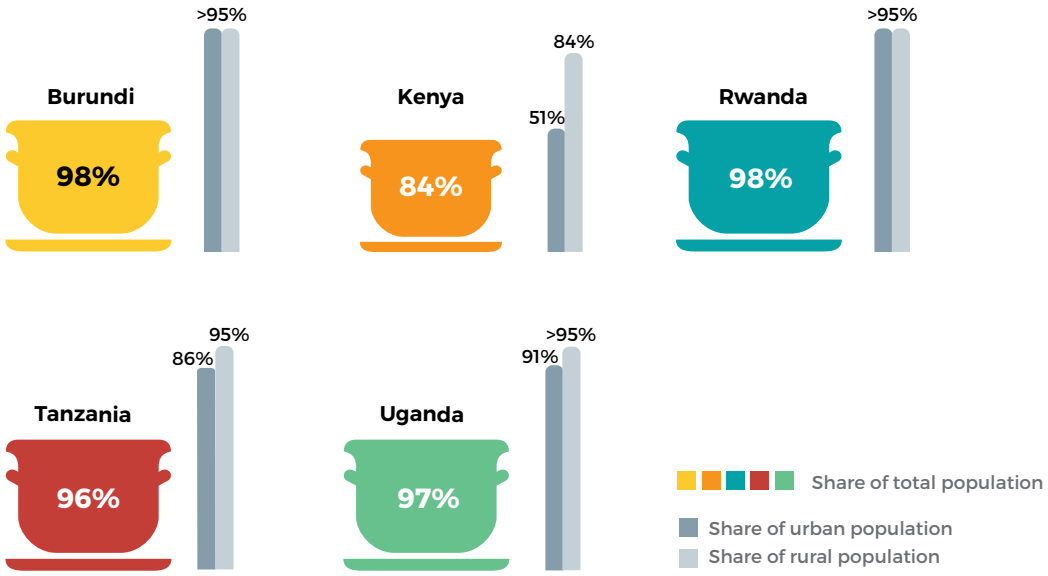
On average solid biomass – primarily fuel wood, charcoal and crop residues – accounts for about 80% of final energy consumption in the region, with country shares ranging from 75% in Kenya to over 95% in Burundi (see table 4).[19] Solid biomass is used for cooking heat predominantly in households, but also at the commercial and institutional levels (such as in small enterprises, schools, clinics, etc.). It also is used for producing process heat in the industrial sector.

- In Burundi, fuel wood (70.8%), agricultural wastes (18.4%), charcoal (5.8%) and bagasse (1.0%) together account for over 95% of the country's energy consumption.[20]
- In Kenya, charcoal, fuel wood and agricultural wastes account for 75% of final energy consumption, the lowest contribution of solid biomass in the EAC region. However, biomass accounts for more than 90% of the final energy consumption of rural households.[21]
- In Rwanda, approximately 85% of primary energy comes from fuel wood for cooking (57%), charcoal (23%), and maller amounts of crop residues and peat (5%).[22]
- In Tanzania, more than 80% of the population depends on biomass as a source of energy, burning fuel wood, dung or other traditional fuels.[23] Biomass accounts for about 87% of total final energy consumption.[24] Rising electricity prices, load power shedding and a persistent lack of grid connections has prompted increased use of both propane (LPG) and fuel wood for cooking in Tanzania's urban areas.[25]
- In Uganda, fuel wood is the most important primary fuel and accounts for about 89% of total final energy consumption. The household sector accounts for the bulk of biomass use (74% of energy demand), followed by the industrial sector (18%). Institutions and the commercial sector use smaller shares of biomass, at 3% and 5%, respectively.[26]

With population growth, urbanisation and economic development, demand for fuel wood in the EAC region is growing, putting increased stress on wood resources. Population growth alone is resulting in a doubling of the region's biomass consumption every 20 to 25 years.[27]

The **household cooking sector** is the main consumer of solid biomass. In Tanzania, for example, households account for 90% of heat demand, which is supplied primarily by biomass. Figure

FIGURE 11. Share of population using solid fuels for cooking in EAC partner states, 2013



Source: See endnote 30 for this chapter.

11 shows the shares of national, urban and rural populations using solid biomass for cooking in the EAC partner states.[28] As in much of Africa, solid biomass use in the EAC region is more widespread in rural areas (98.6%) than in urban areas (85.7%).[29] Rural households and industries use woody biomass as their primary energy source, whereas charcoal is used more widely in urban areas.

In Burundi, almost all households are dependent on fuel wood for cooking. Kenya, in contrast, has the lowest residential biomass use in the region, as 54% of households practice "fuel stacking", which involves the use of multiple fuels such as wood, charcoal, and kerosene or LPG.[30] This is more common in urban areas, where access to alternatives is facilitated and income levels enable this practice.

Biomass energy also is used widely for **industrial activities**, such as the manufacturing of clay products, brick burning, brewing, steam production and tea processing. In these sectors, initial projects have sought to substitute biomass fuel and/or to develop modern biomass energy sources such as biogas, mainly for power generation (including co-generation) (see section *Renewables and grid-connected electricity*). These initiatives often are introduced as part of sustainable biomass programmes, but they also are driven by rising biomass prices.

Although predominantly informal in nature, the traditional biomass sector represents an economic activity that is responsible for significant income generation and employment for hundreds of thousands of rural and urban wood producers, charcoal producers, transporters, retailers and wood energy sellers. For example:

- In Kenya, the charcoal industry alone employs nearly 1 million people on a part- and full-time basis across the value chain (wood producers, charcoal producers, transporters and vendors), contributing some KES 135 billion (USD 1.3 billion) to the national economy each year.[31]

- In Rwanda, the value of fuel wood and charcoal in 2007[i] was approximately USD 122 million, or 5% of the country's GDP. Half of the revenue is generated in rural areas.[32]

- In Tanzania, fuelwood consumption in 2015 totalled an estimated 41,000 million tonnes (dry air), of which 12,095 million tonnes went to the production of 2,720 million tonnes of charcoal. The traded portion of fuel wood, approximately 16,460 tonnes, generated USD 959 million in revenue and provided nearly 800,000 jobs.[33]

- In Uganda, annual fuelwood consumption totals some 28 million tonnes of woody biomass. Another 16 million tonnes of wood is transformed into 1.8 million tonnes of charcoal each year using inefficient traditional kilns.[34] In addition to woody biomass, about 2.3 million tons of vegetal waste is consumed annually.[35]

Regulating the biomass sector, which is crucial for developing both a truly renewable biomass energy sector and a more sustainable cooking and heating sector, presents many opportunities. These include tax revenue generation, employment, and rural income generation, resulting in reduced migration from rural areas as well as increased energy security.[36] However, past attempts to formalise the sector were not successful due to the lack of high-level policy support, as it is politically sensitive to increase biomass fuel prices and to reduce revenues linked to informal payments or fees[i].[37]

Analyses of biomass energy strategies in the region found that the relevant government agencies often were not well co-ordinated

i Most recent data available.

and failed to put in place a comprehensive regulatory framework that would make it possible to develop a sustainable biomass-based cooking and heating sector.[38] These studies also indicate that all EAC partner states have the potential to develop biomass energy in a sustainable way by addressing the supply side of biomass (biomass sources, production, forest management, etc.), the demand side (fuel substitution, efficient cook stoves, etc.), as well as efficiency in fuel production and transport.

Biogas heat

In many ways, large-scale biogas development is more complex than other forms of renewable energy. The feedstock tends to be scattered over large areas or concentrated in a few specific locations, such as farms, cattle lots, dairies and abattoirs. Biogas in agro-industries offers the possibility of own-use generation, and installations for co-generation exist in some EAC partner states (see section *Biomass and biogas power*).

The potential for domestic biogas digesters in Africa is estimated at 18.5 million installations.[39] Domestic biogas has been developed mainly in Kenya, where biogas technologies have been promoted actively since the early 1950s.[40] Despite its large potential and existing programmes, the overall uptake of biogas has been slow due to low technology awareness, high installation costs and the required inputs (for example, owning enough cattle to produce the required quantity of organic waste; a prepared waste collection site, such as a concrete slab; and access to piped water). Other barriers to biogas in the EAC region include technical failures, lack of technical capacity, inadequate post-installation support, and poor management and maintenance.

National biogas programmes have promoted the use of domestic biogas for cooking in Kenya, Tanzania, Uganda and, to a lesser extent, Rwanda.[41] Most of these programmes are implemented with support from the Africa Biogas Partnership Programme (ABPP)[ii], which serves in part to help countries overcome the barrier of high investment cost. Uganda and Kenya do not provide subsidies for domestic biogas digesters, whereas in Tanzania the Rural Electrification Agency began subsidising investments in domestic digesters in 2016.[42]

The ABPP helps countries address biogas quality and functionality problems by defining quality standards and improving after-sales service. For example, Kenya, Tanzania and Uganda all have established national biogas customer service centres. Design improvements have reduced the investment cost for domestic digesters by 25%, increasing their affordability. The development of biogas loan schemes in co-operation with microfinance institutions, credit and savings organisations, and agricultural co-operatives also has helped to increase uptake.[43]

Between 2009 and 2015, more than 35,000 biogas digesters were installed in Kenya, Rwanda, Tanzania and Uganda (see table 5).[44] In Kenya alone, 16,120 household digesters have been installed under the ABPP programme, and commercial-sized digesters have been installed at a number of institutions, farms and abattoirs.[45] The programme has been extended in a second phase to 2017 and targets the installation of some 27,500 biogas plants in the country.[46]

TABLE 5. Installed biogas digesters in EAC partner states under the ABPP programme, 2009–2015

	2009	2010	2011	2012	2013	2014	2015	TOTAL
Kenya	3	837	2,399	3,510	4,830	2,533	2,008	**16,120**
Rwanda								**3,200**
Tanzania	103	1,021	1,444	2,409	3,819	2,304	1,435	**12,538**
Uganda	43	583	1,276	1,181	2,085	527	721	**6,416**

Source: See endnote 44 for this chapter.

i In a study of charcoal prices in Kenya, for example, informal payments and fees represented 8% of the retail prices.
ii Since 2009, the ABPP has supported governments with programme funding and technical assistance and has addressed existing market barriers to enable the development of a sustainable private biogas sector in Burkina Faso, Ethiopia, Kenya, Tanzania and Uganda. Jointly conducted by Hivos and SNV in collaboration with the partner countries, this market development programme promotes biogas utilisation through training of construction companies and individual masons, implementers, financial institutions and NGOs. Ultimately, 100,000 domestic digesters will be installed under the ABPP before the end of the programme in March 2019.

In 2007, the government of Rwanda launched a National Biogas Programme that provides a 50% subsidy for biogas plants as well as credit through local institutions. Of the targeted 100,000 domestic biogas digesters to be installed by 2018, however, only 3,200 had been installed as of mid-2016.[47] Rwanda also is implementing an Institutional Biogas Programme, which promotes the use of biogas for cooking and heating in schools, hospitals and prisons. As ofmid-2016, the programme had installed 68 biogas digesters in schools and prisons around the country.[48]

Tanzania established its Domestic Biogas Programme under the ABPP in 2009.[49] Given the success of the programme's first phase, which saw the installation of more than 12,000 biogas plants, a second phase was launched in 2014, targeting the installation of another 10,000 plants by 2017.[50]

Under the Uganda Domestic Biogas Programme, a total of 6,169 biogas systems had been constructed by the end of 2015.[51] The programme aims to install 13,000 systems by 2017.[52] The government of Uganda also has developed 10 biogas projects (bio-latrines) in schools.[53]

The presence of national biogas programmes in the EAC partner states has led to the establishment of a biogas industry. Kenya, the region's biogas leader, counts some 500 individual brick masons and small enterprises active in the sector. Partly in response to institutional challenges, approximately 200 of these professionals have created the Association of Biogas Sector of Kenya (ABKS) to regulate the sector, for example by developing quality standards.

There is significant potential to further grow the domestic biogas industry across the region, particularly as domestic biogas provides clean, healthy cooking energy and offers opportunities to improve agricultural revenues through the use of organic fertilisers, possibly saving money spent on chemical fertilisers. However, high upfront costs for installing digesters and limited access to financing among potential customers remain key barriers. At the household level, constraints such as low numbers of livestock or limited access to water supplies impede the operation of domestic digesters.[54]

Direct geothermal heat

Kenya is the only EAC partner state currently exploiting its geothermal potential, which is used mainly for power generation. However, a limited amount of direct geothermal heat also is produced in areas located near existing wells in the country.

In Naivasha, near to the Olkaria geothermal power plant, the Oserian Development Company heats about 50 hectares of rose flower greenhouses in what is now the largest geothermal greenhouse heating project in the world.[55] Similarly, the Kenya Electricity Generating Company constructed a natural spa with four interconnected lagoons which use brine from a nearby well to complement Hell's Gate National Park, located near the Olkaria field.[56]

In the Nakuru Menengai geothermal power project, the Geothermal Development Company plans to divert some of the geothermal resources away from traditional electricity generation and to put them towards heating projects. Additional projects planned in this region include supplying process heat to a milk processing plant, a laundry, horticultural greenhouses and a fish pond powered by heat tapped and channelled through pipes from the 30 MW steam well.[57]

Geothermal sources that are located close to commercial/industrial heat demand present an economic opportunity. However, to date there are relatively few such locations in Kenya, with the result that direct geothermal heat remains a niche market.

Solar thermal heating and cooling

Solar thermal water heating has significant potential to reduce pressure on electricity infrastructure in the EAC region. In Kenya, for example, residential water heating consumes about 820 gigawatt-hours (GWh) of electricity annually, straining existing infrastructure.[58] The use of solar water heating (SWH) reduces the power demand for water heating at peak times, especially during the morning and night hours.

Solar thermal is currently a niche renewable energy market in the EAC region, with Kenya accounting for 80% of the market volume.[59] High power costs are driving demand for SWH in Uganda and Rwanda as well. In Tanzania, the number of SWHs is estimated to be low, as no relevant regulations have been passed, and the country's low electricity prices mean that solar thermal is not economically viable without government support.[60]

The main solar thermal market in the region is urban and peri-urban households, hotels and institutions. Some industrial clients use SWH for pre-heating water, but solar thermal currently is not used for producing process heat. Most SWHs are imported, mainly from Asia.

In Kenya, SWH is used mainly in households, hospitals, hotels and schools. As of 2015, an estimated 140,000 SWHs were in use in the country. Spurred by the Kenya's 2012 Solar Water Heating regulation, the number of installations is projected to reach 800,000 by 2020. [61] The regulation requires all newly constructed buildings that use more than 100 litres of hot water per day to install SWHs. Buildings built before 2012 must be retrofitted with SWHs by April 2017, when the five-year grace period expires.[62] This obligation is expected to cover 60% of hot water demand, reducing pressure on the country's power infrastructure.[63] Kenya's solar thermal market is underpinned by the housing market, with commercial banks offering loans for SWHs.

Uganda has a smaller but growing number of SWHs; by the end of 2012, about 30,000 units had been installed.[64] SWHs are used predominantly by wealthier customers and are installed in urban centres. To spur uptake, the Ugandan government specifically supports energy consumers that have high hot water demand – in particular the hospitality (hotel) and institutional sectors – offering a grant of up to 50% for SWH purchasing and installation costs.[65]

In Rwanda, under the SolaRwanda programme, the government supported the financing of up to 12,000 SWHs between 2012 and 2015. Funded by a consortium of international donors led by the World Bank, SolaRwanda provided financial incentives in the form of a 25% grant and a loan structure and targeted households,

institutions and commercial buildings.[66] The related regulation also established standards for academic qualification for technicians. As of July 2015, however, only 800 SWHs had been installed under the programme, due mainly to a lack of supply and incentives.[67]

GRID-CONNECTED POWER SECTOR

The EAC region has the lowest per capita electricity consumption and electricity access rates in Africa.[68] On-grid electricity provides a small but growing share of final energy consumption (see chapter 2). Increasing the production capacity of grid-connected power is crucial for the EAC partner states to achieve greater electricity supply and access.

Renewable energy already plays a key role in the EAC region's electricity mix, based largely on high installed capacities of hydropower. In 2015, renewable electricity accounted for about 64% of the region's total installed, grid-connected power generation capacity.[69] This compares with shares of 28.5% in the ECOWAS region and 23.5% in the SADC region.[70]

In 2015, the EAC region's installed grid-connected renewable energy capacity totalled some 3 GW.[71] Hydropower accounts for the majority of this capacity (2,188 MW), followed by geothermal (598 MW), biomass co-generation (110.5 MW), wind (25.5 MW) and solar PV (9.2 MW) (see figure 12 and reference table R4).[72]

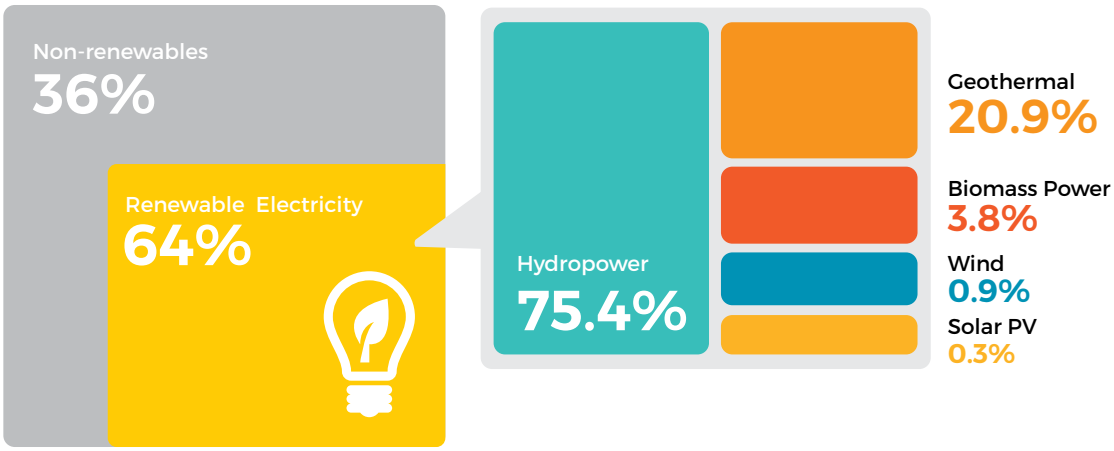
All EAC countries have demonstrated an interest in integrating grid-connected renewable power into their national energy plans as a way to diversify the electricity mix and make it more resilient to fluctuations in petroleum prices. Kenya is investing primarily in hydropower, wind and geothermal power; Tanzania, Uganda and Burundi in hydropower; and Rwanda in hydropower and solar PV. Governments are undertaking new grid-connected renewable power projects predominately through partnerships with project developers, equity investors and international donors, with most efforts building on the involvement of IPPs.

Because of the challenging investment environment, however, grid-connected projects often face difficulties in the finalisation stage. Although supporting policies exist, implementation is uneven, and in some EAC partner states, such as in Tanzania, investors lack trust in the public partner.[73]

In Kenya, where numerous PPA projects are under development, implementation difficulties persist. Project developers report that clear rules and procedures are still lacking, preventing investors from becoming more actively involved. The halt of the 61 MW Kinangop Wind Park, a large and visible project for which the Kenyan government approved a PPA in 2013, does not send an encouraging signal.[74]

Some programmes in the region are designed specifically to create a stable policy environment to attract private investment and to send a clear message of high-level political support for grid-connected renewable power. For example, Uganda's GET FiT programme aims to create an overall enabling environment conducive to attracting private investment in renewable energy through improvements in the feed-in tariff system (see chapter 4).[75] In Rwanda, a presidential decree supported the development of Gigawatt Global's 8.5 MW solar PV project, which was constructed in less than a year's time, illustrating the importance of political support not only in the planning phase, but also during implementation (see sidebar 7).[76]

FIGURE 12. Electricity mix in EAC partner states, 2015



Source: See endnote 72 for this chapter.

Hydropower

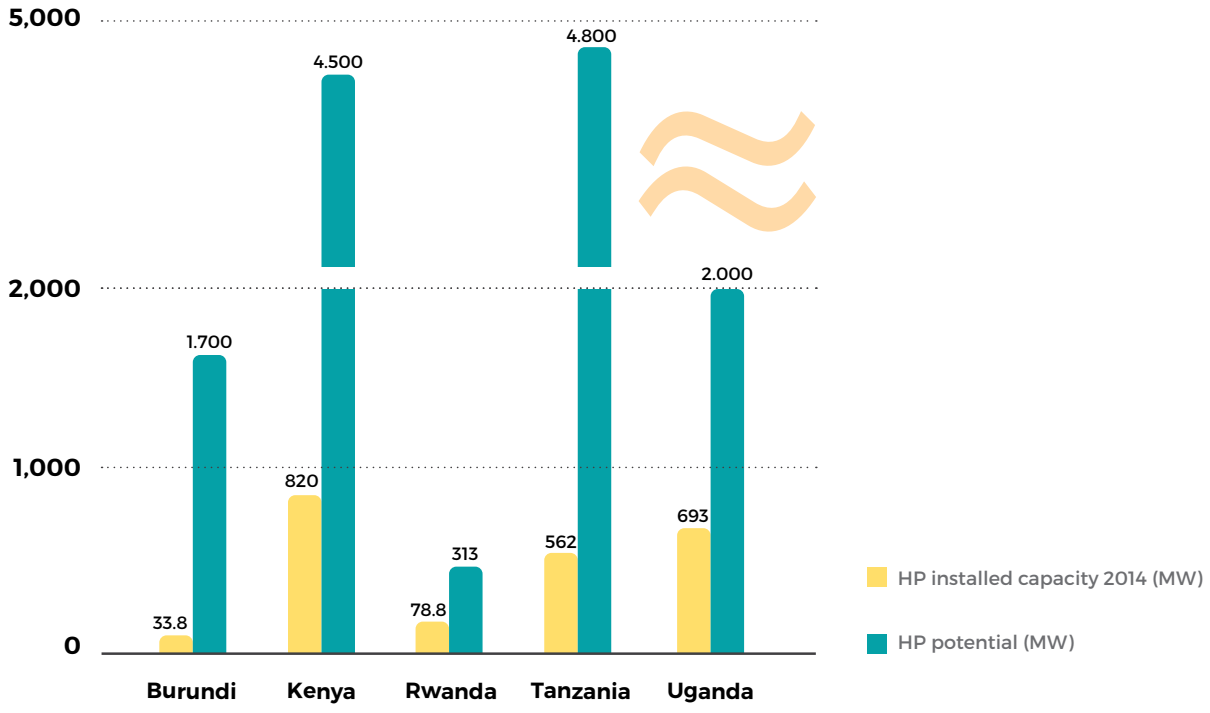
Hydropower is the predominant electricity source in the EAC region, as well as the region's leading source of renewable power. It has the lowest generation cost (tariff) of all electricity energy sources in the region, due primarily to abundant water resources, the high capacity factor of the technology and the fact that the investment costs of many dams has been repaid.[77]

However, challenges to the exploitation and development of large-scale hydropower exist. In recent years, regional hydropower production has been affected adversely by rainfall fluctuations caused by climate change, as well as by the alteration of river flows due to deforested catchment areas.[78] Tanzania and Kenya both suffer from the depletion of water resources during dry periods and are forced to run generators when dams are dry[i]. In Rwanda, where hydropower has generated most of the country's electricity since the 1960s, reduced flows from interconnected lakes due to drought has led to declining production levels and to national electricity shortages.[79]

The EAC region has an estimated 2.2 GW of installed grid-connected hydropower capacity. Kenya has the highest installed capacity, followed by Uganda, Tanzania, Rwanda and Burundi.[80] Although regional integration of the energy sector remains weak, hydropower is a positive example of cross-border energy projects. Existing regional hydropower projects include Rusizi I and II (Burundi, the DRC and Rwanda), and planned projects include the 147 MW Rusizi III (Burundi, the DRC and Rwanda) and the 80 MW Rusumo Falls (Burundi, Rwanda and Tanzania). Given the region's hydropower potential and the low generation costs of the technology, all EAC partner states, and in particular Rwanda, Tanzania and Uganda, are developing new hydropower projects. Because of the relatively large investments and long lead times required by large-scale hydropower projects, these projects are being developed with the support of international donors.

Burundi has an installed hydropower capacity of 33.8 MW, representing 95% of the country's total electricity generation capacity. Burundi also benefits from imports from Rwanda's Rusizi I and II plants.[81] Additional grid-connected hydropower projects in Burundi include Kabu (20 MW), Mpanda (10.4 MW) and regional projects such as Rusizi III and Rusumo Falls.

FIGURE 13. Potential and installed hydropower capacity in EAC partner states, 2014



Source: See endnote 80 for this chapter.

i This issue alone has caused many in the power sector to revisit plans for dam construction.

Kenya's installed hydropower capacity, the largest in the region, ist 820 MW. Notable contributors include the 225 MW Gitaru project and the 168 MW Kiambare plant, both run by KenGen. IPPs are also present, although to a lesser extent than in the country's geothermal sector.[82] Hydropower projects in the pipeline include 59 "expressions of interest" totalling 323 MW, which have been approved for development by private investors. For example, Kenya Tea Development Agency is constructing various hydropower plants in tea-growing areas.

In Rwanda, hydropower represents 78.8 MW of installed capacity and is the country's major source of electricity.[83] Rwanda also benefits from the regional power plants Rusizi I and II (which, with a combined capacity of 15.5 MW, bring the country's total hydropower capacity to 94.2 MW). Rwanda also is actively promoting private sector hydropower activity. Some 45 sites (64 MW in total) are under development, of which 6 plants (16 MW total) are under construction and another 12 (24 MW total) are in an advanced stage with approved concessions.[84] Projects in the pipeline include the 37.5 MW Nyaborongo II plant, regional co-operation on Rusizi III (of which Rwanda's share will be 48 MW out of 147 MW total) and the Rusumo Falls project (27 MW out of 80 MW total).[85]

By the end of 2014, Tanzania had a total hydropower capacity of 562 MW, including 12 MW of small-scale hydropower.[86] TANESCO runs six grid-connected hydropower plants, notably the 204 MW Kidatu and the 180 MW Kihansi power stations.[87] Additional projects are in the pipeline, with feasibility studies ongoing at the Rufiji and Ruhuhu rivers for the construction of 144 MW and 118 MW plants, respectively.[88]

Uganda has the second-largest installed hydropower capacity in the region, at 693 MW. Existing grid-connected projects include the 250 MW Bujagali plant (commissioned in 2012) and the 200 MW Kiira plant. Several IPPs hold licences for generating electricity from small-scale hydropower projects as well, with a combined installed capacity of 46.7 MW[i]. Under Uganda's National Power Development plan, more than 2.4 GW of hydropower is to be added to the national grid by 2030. Two large projects under development are the 600 MW Karuma plant, which is being built with Chinese support and for which ground work started in 2013, and the 180 MW Isimba plant. Feasibility studies are ongoing for another 192 MW located at six sites.

The EAC region also has the potential for more than 4 GW of small-scale hydropower (ranging from 250 kW to 10 MW in size), which can be developed within a shorter time frame. Up until the 2000s, existing capacities were mainly small and isolated pilot projects, typically built by missionaries at hospitals or in proximity to tea factories, which require continuous electricity. However, these systems were prone to breakdowns due to technical difficulties and a lack of skilled personnel.

Currently the region is home to more than 60 small-scale hydropower plants, with a total installed capacity of at least 158 MW.[89] The sector has seen renewed interest given the technical and economic potential, the shorter project development time and the possibility for private investment. A 2015 scoping study concluded that by 2020, 140 new small-scale hydropower installations could be developed in the region, with a total installed capacity of 500 MW.[90]

In Burundi, Kenya and Rwanda, the national utilities own most of the small-scale hydropower plants in operation (see reference table R5). In Uganda and Tanzania, in contrast, private project developers, IPPs and NGOs have driven the market. As countries revise their energy policies and establish PPAs and FITs, small-scale hydropower projects increasingly will be implemented with private sector engagement, helping to overcome the investment bottlenecks.[91] Challenges with capacity development and training in the sector have improved only marginally.[92]

Geothermal power

Geothermal energy is becoming increasingly viable as a large-scale electricity source in the EAC region. Advantages of geothermal include its ability to deliver baseload power with 24-hour availability at relatively low costs and in any weather, and the possibility of siting plants in dryland areas that have relatively low population densities.

Despite its large potential in the region, geothermal power is not a priority of most EAC partner states. This is in part because geothermal projects have a long gestation period (5–10 years from site exploration to power plant commissioning), are capital-intensive, and have high risks in the exploration phase.[93]

Kenya is the only EAC partner state with installed geothermal power capacity: with 607 MW, it ranks eighth in the world for operating capacity.[94] In 2015, geothermal accounted for 26% of Kenya's installed power generation capacity, up from 13% in 2010.[95] Following the 140 MW expansion of the Olkaria I plant in February 2016, geothermal power now accounts for around 47% of electricity consumption in the country, reducing domestic reliance on hydropower.[96] More than 1 GW of additional capacity is under development.[97]

Kenya's geothermal development has been driven largely by the government and by the need to diversify the country's energy mix. The national energy company, KenGen, owns and operates more than 80% of the geothermal power capacity, with the remainder owned and operated by OrPower4 and by IPPs. (See reference table R6 for an overview of Kenya's existing and planned geothermal projects.)

Other EAC partner states are at much earlier stages of geothermal exploration. In Tanzania, despite assistance from the AfDB to assess the feasibility of up to 100 MW of geothermal power, challenges with bankability and developers' confidence in TANESCO's long-term capacity to finance PPAs have contributed to low investment interest. In Rwanda, recent support from JICA to assess geothermal potential has not yet yielded bankable sites, although the Geothermal Development Unit has invited tenders for exploratory drilling in the regions of Kiriambi, Kanigi, Gisenyi and Bugarama. In Uganda, the government is receiving support from the Kenyan government and JICA to look into the sector's potential.[98]

i These are: 1) Kikagati Power Company Ltd. (16 MW) located at Kikagati, Isingiro District, 2) South Asia Energy Management Systems LLC (9.2 MW) at Nyamwamba, Kasese District and 3) Elgon Hydro Siti (21.5 MW) at Siti 1 and Siti 2, Bukwo District.

Biomass and biogas power

Although biomass energy in the EAC region is used primarily for cooking and heat generation (see section *Renewables for cooking and process heat*), it also is being harnessed for power generation and co-generation of heat and power in the industrial sector.[99] In some EAC partner states, large producers of organic wastes (sugar mills, agriculture, food processing) that require a continuous power supply have developed "embedded" biomass power plants (often through a PPA or a FIT) to replace or complement existing diesel generators and to provide additional revenue by feeding surplus energy back to the grid.

Solid biomass, particularly sugarcane bagasse, historically has been the main source of biomass power and co-generation in the EAC region.[100] Kenya, Tanzania and Uganda are all large sugar-producing countries, and the region is home to around 20 sugar production facilities, some of which plan to increase their sugar output and to invest in new mills to meet anticipated demand.[101] Examples of the use of solid biomass for power generation or co-generation in the region's sugar, tea and paper industries include:

- In Burundi, the Moso Sugar Company mill has one embedded biomass co-generation plant with an installed capacity of 4 MW, which is planned to connect to the national grid.[102]

- In Kenya, several tea companies generate electricity from biomass to cover their own energy demand.[103] Mumias Sugar Company has an installed generation capacity of 35 MW, of which 26 MW is fed to the national grid.[104] The country's remaining sugar mills have an estimated potential of 300 MW.[105]

- As of early 2016, Tanzania had three grid-connected solid biomass power plants (at a sugar mill, a textile production facility and a coconut farm) with a total installed capacity of 12 MW. In addition, there are several embedded agriculture and industry-based biomass power units with installed capacities of less than 100 kW each.[106]

- In Uganda, Kakira Sugar Works operates a biomass power plant with an installed capacity of 34 MW.[107]

The potential to develop **biogas power** in the industrial and agricultural sectors (e.g., sisal, flower cuttings, vegetable waste, etc.) is also attracting interest. In Tanzania, 300 kW of biogas power was installed at the Katani sisal processing plant in 2008, and in Kenya some 3.4 MW of biogas power capacity has been installed in agro-industries, with a planned expansion of 8 MW.[108] Biojoule Kenya, for example, operates a 2.2 MW grid-connected biogas plant in Naivasha.[109]

GIZ's Project Development Programme supports biogas power development in Kenya, Uganda and Tanzania under the initiative Renewables – Made in Germany.[110] GIZ, the multi-donor organisation EnDev and UNIDO also have supported numerous pilot installations in the region. The GIZ/EnDev programme Powering Agriculture is promoting two biogas systems for use in agriculture: the Maendeleo system, with a generation capacity of 10–30 kW, and the Umeme system, with a capacity of 40–200 kW.

As the EAC partner states recognise the potential for electricity generation and co-generation from biomass, they are integrating biomass power or co-generation plants into biomass energy strategies. Current policy support is insufficient, however, and barriers, such as low electricity prices in Tanzania and the low FIT for biogas in Kenya, hinder large-scale development.[111]

Solar photovoltaics

The development of solar power in the EAC region has closely followed the declining costs of solar electric equipment worldwide and the rapid development of South Africa's solar PV sector. As of 2015, the EAC region had at least 9.15 MW of installed grid-connected solar PV capacity.[112] Rwanda has emerged as the regional forerunner in utility-scale solar, with an installed capacity of 8.75 MW. The remaining EAC partner states are following suit with several projects in the pipeline.

Rwanda's 8.5 MW solar field at Agahozo Shalom Youth Village is the first utility-scale grid-connected solar PV project in the region. The USD 23.7 million project, funded by an international consortium, increased Rwanda's total power generation capacity by 6% in 2014 (see sidebar 7).[113] In 2006, the Rwandan government signed a contract with the German state of Rhineland-Palatine for the 250 kW Jali Solar plant, which started operations in 2008.[114] More recently, Rwanda signed a deal for a second utility-scale solar PV plant, in the eastern district of Kayonza, in 2014.[115]The 10 MW plant will be constructed on an IPP basis, and PPA negotiations are ongoing.[116]

In Kenya and Tanzania, despite abundant solar resources, grid-connected solar has not been a primary focus of planners due to high perceived capital costs and the prioritisation of larger-scale natural gas, geothermal and wind projects (the latter of which are being implemented in an effort to meet ambitious power development targets).[117] However, recent declining prices of solar PV are making grid-connected PV cost-competitive, leading to increasing interest in the technology.[118]

Technically, Kenya is the regional leader in solar PV, but the majority of this is off-grid (see section *Off-grid electricity*), and many projects are awaiting a PPA to enable them to feed into the national grid. Currently only Strathmore University (600 kW), SOS Mobassa and the United Nations Environment Programme (515 kW) feed excess production into the grid.[119] Kenya also has several grid-connected solar PV PPAs under signature or negotiation, including a 2015 landmark agreement between the Ministry of Energy and Petroleum and SkyPower to develop a 1 GW solar PV plant over the next five years.[120] In 2015, the IPP Greenmillenia was preparing to build a 40 MW solar PV plant in Isiolo County, a project that is being financed by the Export-Import Bank of China, with the AfDB pledging support at a later stage.[121]

Currently Tanzania has no grid-connected installed solar PV capacity, but a vibrant off-grid market exists (see section *Off-grid electricity*).

i These include: Kabulasoke (Gomba District, 20 MW), Nkenda (Kasese District, 10 MW), Nkonge (Mubende District, 15 MW), Opuyo/Offshore on River Awoja (5 MW) and Tororo (Tororo District, 50 MW).

SIDEBAR 7. Agahozo Shalom Youth Village solar PV plant in Rwanda

East Africa's first utility-scale solar PV plant, located at the Agahozo Shalom Youth Village east of Kigali, was developed by the American-Dutch company Gigawatt Global and became operational in February 2015. The 8.5 MW project provides power to more than 15,000 homes in Rwanda and increased the country's power generation capacity by 6% in 2014.

Agahozo Shalom Youth Village, a refuge for orphans of the Rwandan civil war, is leasing the land to Gigawatt Global. This allows the orphanage to not only finance its activities, but also provide 500 students with access to education in engineering and solar PV technology.

The 23.7 million solar project was financed by a consortium of international financing partners including the US Overseas Private Investment Corporation (OPIC), the Energy and Environment Partnership (EEP), Norfund and the Dutch Development Finance Company (FMO). The project is considered a model because it went online only 12 months after signing the PPA with the Rwandan government.

The project also is seen as a clear demonstration that solar power will be a key factor in Africa's energy solution: symbolically, the solar field is laid out in the shape of the African continent. Gigawatt Global aims to connect 1,000 MW of solar power to the African grid by 2020. In May 2016, the company signed a PPA with the government of Burundi to construct a 7.5 MW solar PV plant in Gitega province.

Source: See endnote 113 for this chapter.

However, interest in grid-connected solar is increasing. In 2013, OPIC granted a loan to the US renewable energy firm NextGen Solawazi to finance the construction and operation of a 5 MW plant in Kigoma, and in 2015 the company received support from the US Trade and Development Agency (USTDA) to develop a 60 MW solar PV plant in Shinyanga, in north-western Tanzania.[122] Standard power purchase agreements (SPPAs) have been signed for two additional grid-connected solar PV plants of 1 MW each in Mbinga and Mpanda.[123]

The government of Burundi has partnered with Gigawatt Global to develop a 7.5 MW solar project in Gitega. The project is supported by USTDA and EEP and will provide electricity to some 60,000 households.[124] In 2015, the Ministry of Energy and Mines awarded contracts to build two additional 10 MW solar PV plants, at Gitega and Bubanza.[125]

Although the removal of FITs for solar PV in Uganda – in response to plummeting PV costs – made some investors nervous, the GET FiT-supported auction system has resulted in at least one project moving forward: the 10 MW Soroti plant being developed by Access Uganda Solar/TSK Electronica. The plant was scheduled to be connected to the national grid in 2016 and will power an estimated 40,000 homes.[133] Other projects in the pipeline include feasibility studies carried out by Mola Solar Systems Uganda to develop solar PV plants of 20 MW in Kabulsoke, 10 MW in Lira, 20 MW in Nkenda, 50 MW in Nkonge and 50 MW in Opuyo.[127]

A small market for urban rooftop solar PV systems exists in the EAC region, primarily to provide back-up power for on-grid residential and institutional consumers. More widespread use of distributed urban rooftop PV power production for own-use and for sale to the grid is likely to occur only if net metering regulations come online or if more aggressive distributed generation and auction policies are implemented.

Wind

Kenya is currently the only EAC partner state that has grid-connected wind power, despite the vast wind energy potential in the region. However, interest is growing in other countries, and several projects are in the pipeline.

Kenya's existing wind farms are located in the Ngong Hills near Nairobi. A recent expansion by the operator, KenGen, increased the installed capacity from 5.1 MW to 25.5 MW, meeting part of the government's target to add 5 GW of energy by the end of 2016.[128] Projects in the pipeline include the 310 MW Lake Turkana wind power project, which began construction in 2015 and is expected to provide the equivalent of some 20% of the country's current installed electricity generating capacity.[113] Additionally, the French Development Agency (AFD) signed a EUR 60 million (USD 67 million) loan with KenGen in April 2016 to fund construction of the first phase of a planned 400 MW wind farm in Meru County.[130] In February 2016, investors withdrew from the planned 60 MW Kinangop Wind Park project following delays and resistance from local governments and residents. The government is looking for possibilities to restart and possibly relocate the project.[131]

In Tanzania, the first large-scale, grid-connected wind power plant is under development in Singida. The 100 MW plant is supported by the World Bank and is expected to be connected to the national grid by 2017. A wind resource assessment tender was issued in March 2016 to develop an additional 50–100 MW wind project in Makambako, backed by a USD 200 million AfDB fund.[132] In 2012, a wind study was commissioned for Zanzibar, and in 2013 the islands received a EUR 3 million (USD 3.4 million) grant from the European Union to develop various renewable energy sources, particularly wind power.[133]

In Burundi, Rwanda and Uganda, wind speeds are relatively low and no wind power plants are under construction. Rwanda developed a wind atlas in 2009, identifying six possible wind energy sites; however, the data did not encourage further development. In Uganda, the Electricity Regulatory Authority issued a permit to the German company Mola Solar Systems Limited to undertake feasibility studies to develop five wind plants totalling up to 100 MW[i].[134]

Despite a pipeline of potential projects, wind energy has not been exploited more fully in the EAC region for a variety of reasons, including land use and transportation needs for both turbines and transmission lines, the challenges of integrating intermittent power into the grid, the inability of some utilities to make PPA payments, and political interference.

OFF-GRID POWER SECTOR

Distributed renewable energy (DRE) systems are rapidly becoming the preferred option to provide basic energy services to the millions of people in rural and peri-urban regions that lack energy access. Some 26 million households worldwide are served by DRE systems, primarily with solar systems, renewables-based mini-grids (mainly micro-hydro) and small-scale wind turbines.[135]

The EAC region has emerged in recent years as a thriving place for the deployment of DRE systems, particularly off-grid pico solar. The region accounts for nearly half of all sales of pico solar systems in Africa, and Kenya and Tanzania are among the continent's top markets for solar lighting products.[136] DRE systems play a key role in providing basic energy services for much of the population of the EAC region. Some 15–20% of households in Kenya use solar lighting systems, and more than half of households in Tanzania's Lake region are served by pico solar lighting products.[137]

Increasingly, EAC partner states are considering off-grid and mini-grid options to offer remote districts, businesses and communities the possibility of managing their own electricity generation and access. Kenya and Tanzania are Africa's largest micro-grid markets, and similar momentum is building in these countries for renewables-based hybrid mini-grid systems.[138]

Stand-alone solar PV systems

Off-grid solar PV technologies are wide-ranging and include pico applications (solar lanterns and small mobile phone chargers); solar home systems (SHS) installed in private households; institutional systems (typically several kW in size) installed in schools, clinics, government posts and small businesses; and commercial systems installed at base stations and tourism sites (see table 6). The stand-alone solar PV market is closely associated with the back-up power market that serves households, NGOs and businesses that experience an unreliable power supply.

The off-grid solar market in the EAC region has grown since the 1990s, building on favourable government fiscal policies, innovative business models such as "pay as you go" (PAYG) and a sharp decline in global prices for PV equipment. The region's pico solar market (primarily in Kenya and Tanzania; see sidebar 8) is one of the most mature and well-established, both in Africa and worldwide.[139] Between June 2014 and July 2016, Kenya, Tanzania, Rwanda and Uganda accounted for about half of the reported sales of Lighting Global quality-verified pico solar products in sub-Saharan Africa[i] (see figure 16 on page 44).[140]

TABLE 6. Off-grid solar PV technologies and markets

Technology	Description and market
Pico solar	Very small systems or lanterns of less than 10 W in size that serve basic lighting and phone charging needs.
Solar home systems	Systems of between 10 W and 1 kW that provide lighting, radio, television, mobile charging and sometimes refrigeration services to rural households.
Institutional systems	Systems that serve the needs of governments, refugee camps, NGOs, schools, clinics and offices, and often are sold in competitive tenders issued by projects or rural electrification agencies.
Solar pumping	Systems used primarily for water pumping that do not need batteries and that are finding ready markets as off-grid farmers recognise that solar PV costs are competitive with fuel-based generators.
Commercial/professional	Off-grid systems that supply the needs of tourism, telecom base stations, businesses and large remote households. They are an active niche market for distributors and high-end technicians.
PV-powered streetlights	Lighting units that are increasingly common throughout East Africa in urban centres, in government procurements, in private estates and along roads. They are preferred because they provide secure lighting even when electric grids fail.
Solar PV mini-grids	See page 49

Source: See endnote 1 chapter 4

i Reported sales of Lighting Global quality-verified pico solar products reached 947,000 in Kenya, 530,000 in Tanzania, 97,000 in Uganda and 86,000 in Rwanda.

SIDEBAR 8. Kenya's off-grid solar market

In Kenya, more than 30% of the population without access to the national grid uses off-grid solar PV installations. The country's off-grid solar market was the first to develop In the EAC region due to higher cash incomes and better supply of equipment. Innovative financing and distribution models – such as affordable pay-as-you-go (PAYG) systems that reach consumers at the "bottom of the pyramid" – also have driven uptake. By mid-2015, some 947,000 Lighting Global quality-verified pico solar products had been sold across the country.

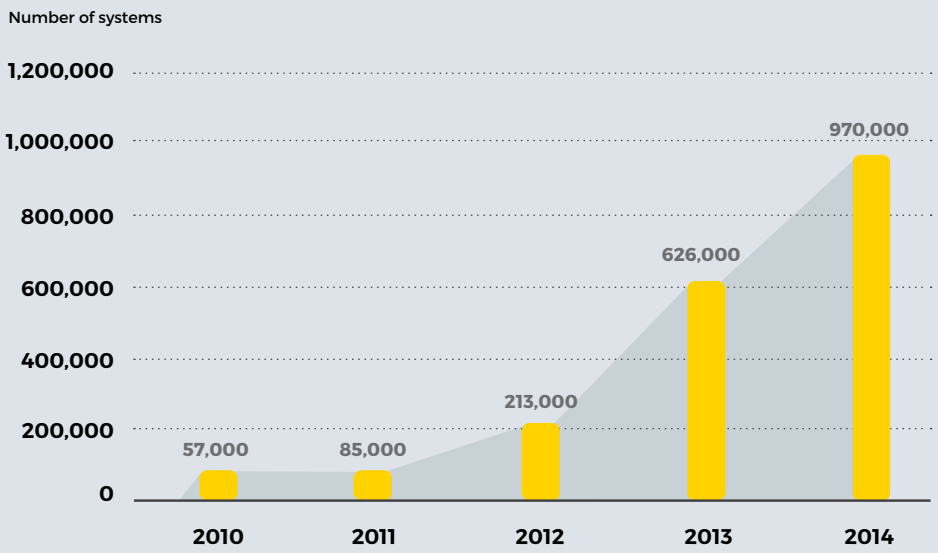
During the pioneer stage of Kenya's off-grid solar development, starting in the mid-1980s (see figure 14), efforts to design off-grid PV systems were driven by demand for television and lighting from high-end customers, leading to the first entrepreneurial activity. During the second stage of development, a market-based distribution system evolved as competing importers built supply chains and sourced products both locally and internationally. Private sector involvement increased in the sale of PV systems to private consumers and institutions.

During the third stage of Kenya's off-grid PV development, smaller and lower-cost pico systems became available due to the reduced cost of solar modules, lithium-ion batteries and high-efficiency LED lights, coupled with a better understanding of the market. During the fourth stage of development, mobile phone technology enabled companies to introduce PAYG strategies that improve the business model for selling energy and address the challenge of high upfront costs, opening up a large market segment and attracting significant international investment in the off-grid sector. Between 2010 and 2014 alone, sales of Lighting Global quality-verified pico solar products in Kenya increased 17-fold (see figure 15).

Today, market development is driven primarily by entrepreneurial initiative, government programmes, private sector investment and donor activity.

FIGURE 14. Overview of off-grid solar PV market development in Kenya, 1985 to present

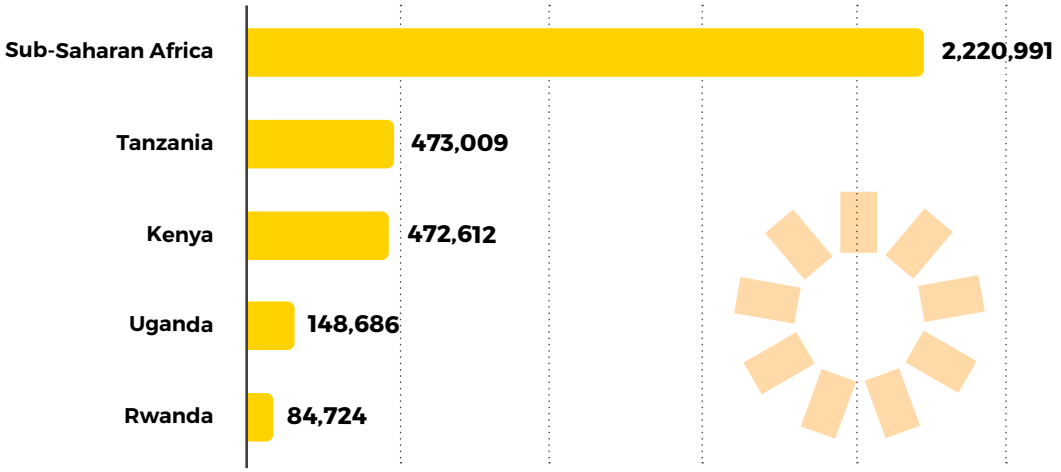
FIGURE 15. Reported sales of Lighting Global quality-verified pico solar products in Kenya, 2010–2014



Source: See endnote 139 for this chapter.

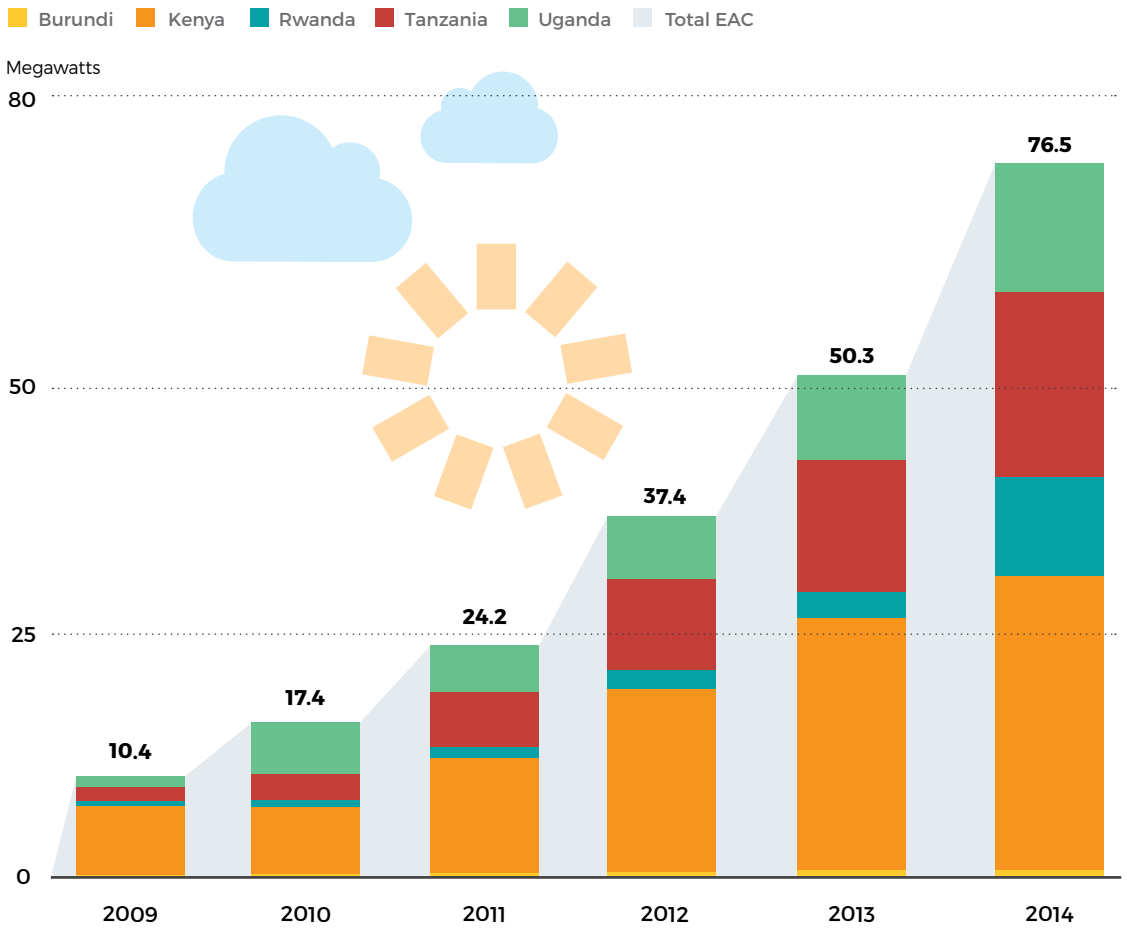
SOLAR PV IN THE EAC

FIGURE 16. Off-grid pico solar systems sold in EAC partner states and sub-Saharan Africa, 1 July 2015 to 31 December 2015



Source: See endnote 140 for this chapter.

FIGURE 17. Cumulative installed solar PV capacity in EAC partner states, 2009–2014



Source: See endnote 141 for this chapter.

The total capacity of off-grid solar PV units sold annually in the EAC market is estimated at between 25 MW and 40 MW[i]. The region's cumulative capacity is likely much higher. Based on analysis of publicly accessible data – including the international customs database as well as market data on cell and module production, PV installation rates, etc. – the total cumulative installed solar PV capacity in EAC partner states was 76.5 MW in 2014 (see figure 17).[141] This illustrates the difficulty in obtaining an accurate assessment of the installed capacity of off-grid, and in particular stand-alone PV systems[ii].

Through the PAYG model, customers benefit from solar lighting and energy services by paying in small and affordable instalments rather than with a large lump-sum payment. Companies such as Germany's Mobisol, Kenyan start-up M-KOPA and Tanzania-based Off Grid Electric are successfully rolling out PAYG mechanisms using mobile money technologies. As of June 2016, Mobisol had installed 50,000 solar systems in Tanzania and Rwanda, providing the equivalent of 5 MW of solar power to some 250,000 beneficiaries.[142] M-KOPA was serving some 250,000 households across Kenya, Tanzania and Uganda by the end of 2015.[143] And as of mid-2016 Off Grid Electric was providing energy access to some 50,000 people monthly.[144] Other companies are piloting business models that charge not for the product (SHS) or energy (kWh), but for energy-based services such as phone or battery charging, agricultural value-addition and IT services. (See sidebar 9 and reference table 7 for an overview of some of the most active and innovative solar PV players in the EAC region.[145])

The emergence of middle-class interest in solar PV in the EAC region has come alongside greater market choice, new financing options and improved quality standards. In some instances, however, the rapid growth in the largely unregulated off-grid market has led to an influx of low-quality and/or counterfeit products.[146] Overall, solar PV continues to be the primary power source for off-grid clinics, schools, NGOs, border posts and refugee camp and is often supported by bodies such as the World Bank, GIZ, GIZ/EnDev, Sida, the US President's Emergency Plan for AIDS Relief (PEPFAR), the Clinton Foundation and the UN Foundation.

SIDEBAR 9. Ubbink

Founded in 2009, Ubbink East Africa is a joint venture between the Dutch mother company and Kenya-based Largo Investments. Its core activity is providing solar module solutions of 13–125 Watts that are particularly suitable for small, off-grid systems and low-consumption energy users. Among other applications, these solutions are used to provide lighting to rural communities, schools and hospitals, as well as power for water supply and telecommunication needs.

The solar modules are designed based on Ubbink's experience of the European solar market but are produced in a company-owned facility in Naivasha, Kenya. This allows the company to tailor its products to the needs of the African market. As of 2016, Ubbink was employing more than 30 workers and producing over 100 solar modules a day. The company's goal is to increase production to approximately 30,000 modules annually.

Source: See endnote 145 for this chapter.

Mini-grids

"Green mini-grids" (GMG) use renewable power to provide energy for off-grid communities. They can offer more stable and economical power than stand-alone renewables-based systems and are, in many cases, a preferred option for meeting off-grid power needs. Where the national utility is unable to economically extend the grid, and where there is sufficient demand density, mini-grids have been reliable, innovative and customised to provide access to multiple households and institutions in rural areas. The IEA estimates that to achieve universal electricity access globally, mini-grids will have to provide more than 40% of the new capacity needed by 2030, with a market potential estimated at USD 4 billion per year.[147]

In the EAC region, approximately 25% of the un-electrified off-grid population could be electrified through mini-grids. Mini-grids can generate power from diesel, hydro, wind, solar PV and bagasse. In some cases, these technologies are complemented with storage capacity (through the use of batteries) and diesel generators to ensure the reliability of the system as a whole. Already, dozens of mini-grids in the EAC region power remote towns, communities and missionary settlements.

Globally, a variety of ownership models exist for mini-grids. The most common in the EAC are utility-owned and private sector mini-grids.

i Off-grid capacity numbers are based on the following: In 2015, Ubbink supplied 4.5 MW to the Kenyan market and 0.5 MW to other EAC partner states. Ubbink has about 50% of the Kenyan market, so Kenya's capacity totals some 9 MW. Tanzania's market is likely to be the same or larger than Kenya's (assume 9 MW). Uganda has a similar level of activity, although local buying power is less (assume 6 MW). Rwanda and Burundi combined probably have 1–3 MW in sales per year.
ii A 2012 survey by the Uganda Bureau of Statistics reported that 12.1% of the 10,000 households surveyed were using solar PV, versus 6.9% that were connected to the grid. A similar survey in Tanzania in 2011 found that 2% of rural households use solar systems. Note that data on the operational status of installed solar systems are not available.

Government/utility-owned mini-grids. National governments are operating isolated mini-grids in Kenya and Tanzania, although these are predominantly diesel-powered. In Tanzania, for example, 21 TANESCO-managed stations supply isolated mini-grids with diesel generator capacities ranging from 400 kW to 12 MW.[48] There also is movement in the region to "hybridise" the diesel with solar or wind capacity.

Private sector mini-grids. A variety of companies – CarbonX, Devergy, INENSUS, Jumeme, Steamaco, TTA, Powergen, Powerhive and others – are actively piloting business models for mini- and micro-grids in the EAC region. These include the "Anchor-Business-Consumer (ABC)" model whereby a location is sought that has one or more larger energy consumers that can provide a base load to be supplemented by commercial and household consumers.

There is a growing recognition of the importance of mini-grids to achieve rural electrification. Although the majority of mini-grids in the region are donor-based, some private sector success stories exist, especially in Tanzania and Uganda. Community-managed and hybrid (such as government-private or private-community) models are not yet common in the region but may present additional opportunities.

In Kenya, the total installed mini-grid capacity was estimated at 19.2 MW in 2014; this consists primarily of thermal (diesel-fuelled) capacity (18.1 MW) and includes only 5% renewable energy capacity (0.55 MW wind and 0.5 MW solar PV), installed in seven pilot hybrid mini-grids developed by the national utility KPLC.[149] This hybrid approach is expected to be scaled up once funding is secured from donors or investors. The Kenyan government acknowledges the crucial role of mini-grids in achieving universal electrification by 2020 and has invited the private sector to participate in additional hybrid projects under the country's FIT, which applies to renewable-based mini-grids of above 500 kW.[150]

So far KPLC has owned and operated Kenya's mini-grids, but two companies – Powerhive and Talek Power Company Ltd. – have been licensed for generation and distribution, opening the market for additional private sector involvement. The Talek Power Company Ltd. pilot project, implemented by GIZ, serves to demonstrate financial feasibility and to showcase a business model for solar hybrid mini-grids. A results-based financing scheme set up by EnDev and financed by the UK's Department for International Development (DFID) aims to finance up to 20 green mini-grid sites in Kenya, and Germany's KfW is financing three green mini-grid sites in the country's north. With support from France's AFD, efforts are being made to hybridise the existing state-owned diesel mini-grids with solar PV.

In Rwanda, mini-grids are a major component for reaching the country's target of 22% rural electrification by 2018. Hydro-powered mini- and micro-grids currently provide 4.5 MW of off-grid capacity, and there are plans to develop an additional 18 MW of small-scale and mini-hydro projects by 2025.[151] Among other initiatives, EnDev is supporting 20 green mini-grids in Rwanda that will reach an estimated 18,750 beneficiaries by mid-2018. Additionally, the Scaling Up Renewable Energy Programme (SREP) fund aims to install 250 green mini-grids targeting 38,000 households.[152] In 2015, the Sustainable Energy Fund for Africa (SEFA) awarded Rwanda a grant of USD 840,000 to finance feasibility studies for green mini-grids as well as a roll-out plan to enable the systems to contribute to the country's rural electrification target of 145,000 households by 2018.[153]

In Tanzania, the Rural Energy Agency (REA) has lined up the implementation of 90 off-grid power projects, many of which involve mini-grids. Examples include Malolo in the country's southern highlands, where four mini-grid projects are planned with a combined capacity of 300 kW.[154] Additionally, UNIDO is financing six solar hybrid mini-grids.[155] Another project, under development by Jumeme Rural Power Supply Limited, aims to electrify 16 villages, totalling 82,000 residents, in its first phase.[156] In addition, in 2014, the REA granted funds to private companies to develop 20 solar hybrid mini-grids in rural areas.[157]

A successful privately run mini-grid in Tanzania is the Tanganyika Wattle Company (TANWAT), a private owner-operator that runs a biomass co-generation plant as well as the Njombe off-grid biomass mini-grid. With an installed capacity of 2.5 MW, the mini-grid is connected to a regional mini-grid and ultimately to the national grid, and it sells any excess power generated to TANESCO.[158] Other mini-grid examples in Tanzania include Mwenga Hydro (which connects 17 villages), three mini-hydro systems run by the Italian NGO CEFA, the Stanley's biomass plant on Mafia Island and the TPC bagasse generation plant in Moshi (which connects a number of villages, with excess capacity sold to TANESCO).

In Uganda, the SREP programme will use mini-grids to electrify island communities on Lake Victoria and will install ten 25 kW solar PV rooftop systems in national buildings around Kampala, Jinja, Mbale and Entebbe. Also, under the World Bank-funded ERT Additional II, the Kagondo Hospital mini-grid will be upgraded to 64 kW, and the country's REA is constructing two 13.5 kW solar PV micro-grids at Kanyegaramire in western Uganda.[159] Meanwhile, the Kalangala Infrastructure Services Project is developing a 1.6 MW solar PV mini-grid project integrated with an island water utility and transport infrastructure that will impact 35,000 people.[160] In addition, Uganda has a hydropower mini-grid, owned and operated by Kisiizi Hospital Power Ltd. as an independent company, that supplies 24-hour electricity to the hospital and to more than 300 nearby households, serving some 2,500 people.[161]

Despite the clear opportunities that mini-grids can bring to remote and off-grid communities, implementation in the EAC partner states is still in the early stages. This is primarily because the regulatory environment and business models needed to make mini-grids sustainable are not yet viable. Challenges to scaling up these technologies include the following:[162]

- High upfront capital expenditures can make initial investment prohibitive in the absence of financing support. Commercial lending is not yet common, as local banks struggle to understand and mitigate the specific risks associated with this type of project.

- Capacity to pay and very low power needs by remote populations must be understood as part of early-stage feasibility work, and tariffs must be developed accordingly.

- Tensions exist between the norms of "unified" consumer tariffs (e.g., in Kenya, where rural consumers expect to pay the same for power as their urban counterparts) and the greater cost of producing power in remote areas that requires either subsidies or cost-reflective tariffs to recover.

- Regulatory uncertainty in most EAC partner states around allowable consumer tariffs, national grid extension plans, asset taxation and depreciation, and other issues, which leaves private mini-grid developers to shoulder additional risk.

- Unanswered questions concerning what happens after the grid reaches the region covered by the mini-grid.

Despite slow uptake, governments and the private sector alike are paying increasing attention to the potential for green mini-grids in rural electrification. International initiatives such as the "High Impact Opportunity" under the SEforALL global initiative provide further motivation. Rapidly advancing technologies (for remote monitoring, metering and payments), innovative business models (payment for appliances not watt-hours, or capped daily allowances to manage loads) and significant new foreign investments in EAC-based mini-grid developers all point to continued growth in this sector.

Stand-alone wind power

Stand-alone wind power projects in the EAC region have not experienced the same success as off-grid solar PV due mainly to the complexity of the technology and to higher costs. The market is yet to develop, and only a small number of suppliers and installers operate in the region. The variability of wind speeds also makes small-scale wind a less attractive option, particularly when a consistent level of solar radiation is available. It is estimated that a few hundred stand-alone wind electricity turbines are installed In the EAC region, primarily in Kenya and Tanzania. These off-grid, stand-alone wind systems power rural households and institutions and usually are integrated into small mini-grids.[163]

TRANSPORT SECTOR

Driven by population growth and rising economic prosperity, the EAC region is experiencing rapid growth in the number of cars, motorcycles, trucks and other vehicles. As a result, fossil fuel demand in the transport sector is increasing, as are associated greenhouse gas emissions. These trends, combined with the region's dependence on fuel imports, make it imperative that policy makers encourage a shift to alternative transport fuels. So far, however, national governments have prioritised grid-connected electricity and have given relatively little attention to the need to shift the transport sector to renewable sources.[164]

Efforts in the last decade to promote the use of biofuels – spurred by concerns about energy security and energy independence, and more recently by a low-carbon imperative – have met with limited success in the region. This is in part because of the regulatory uncertainty (and absence of any regulatory discussion at all) surrounding blending requirements, the lack of assured feedstocks, and the existence of multiple end-markets for ethanol (such as for alcoholic beverage consumption and large-scale power generation). Moreover, in response to growing fuel demands, EAC partner states are making investments in the petroleum sector[i], further reducing the impetus to invest in biofuel alternatives.

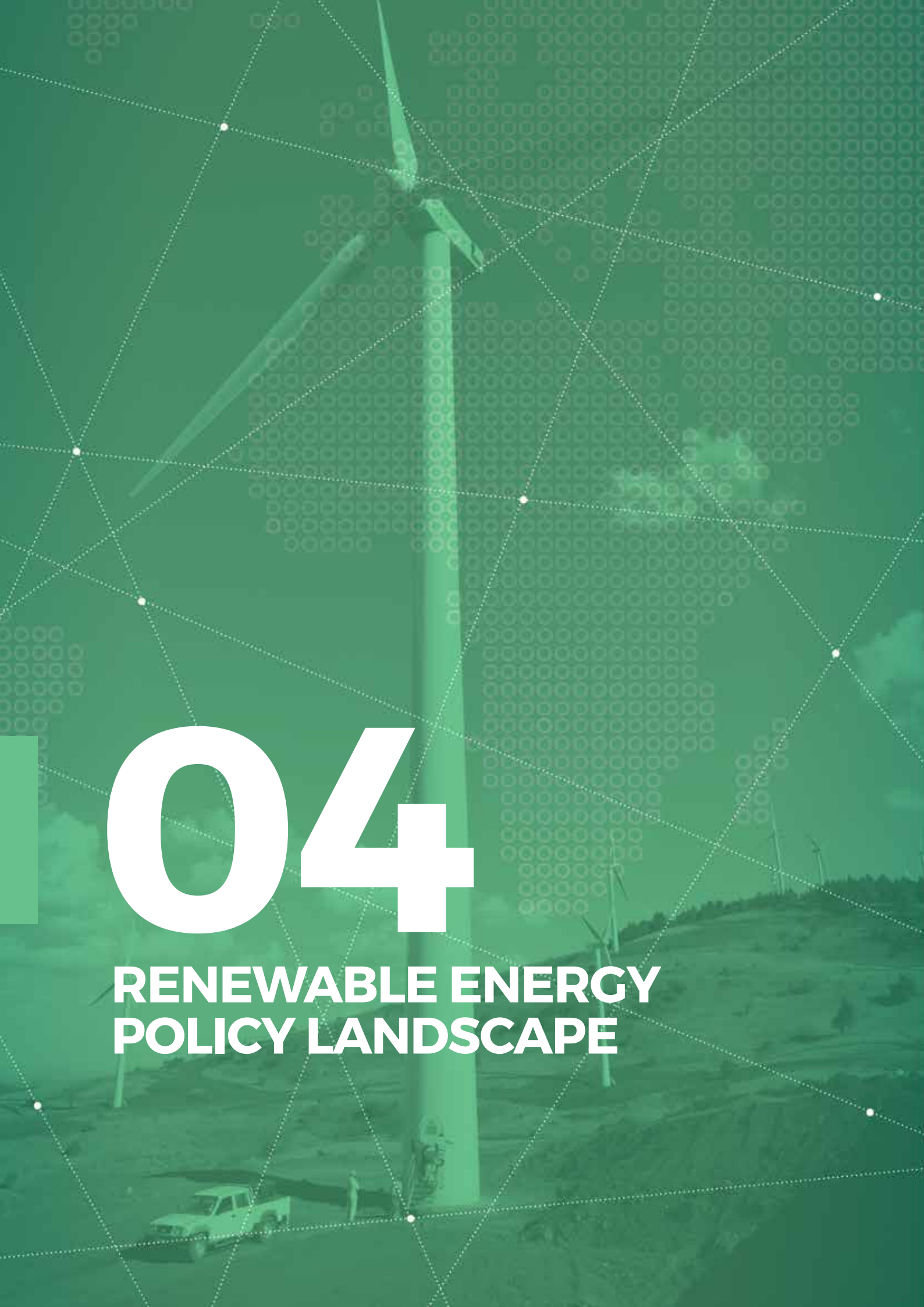
As a result, production of liquid biofuels is occurring only on a pilot and research basis (for example, ethanol in sugar plantations, biodiesel from jatropha and other feedstocks), and there have been no substantial biofuel investments or industrial developments in the region. In order for biofuels to be competitive, strong policies and regulations must be in place to ensure both markets for producers as well as quality and fair prices for consumers. Although EAC partner states have discussed the development of biofuel industries, policy support for this has yet to emerge. Some plans exist for a renewably powered transport sector in Kenya, using liquid biofuels (ethanol and biodiesel) and electric vehicles (EVs), but efforts remain small-scale or in the pilot stage of development.

Private sector initiatives to grow biodiesel crops such as croton, sorghum and jatropha have not yet succeeded on a large scale in the region, although some limited efforts exist. For example, since 2012, Eco Fuels Kenya has been extracting fuel oil from croton nuts. The biofuel sells for approximately USD 1 per litre and is used mainly by local small and medium-sized businesses to run off-grid generators. The leftover pulp is sold as fertiliser to industry. During the two-year pilot project, more than 25,000 litres of biofuel and 150 tonnes of organic fertiliser were sold, enabling the company to expand in 2015.[165]

Electric vehicles have seen very little market development in the region. Challenges include the lack of reliable power sources in urban, grid-based markets, a lack of local EV production capacity, and long distances between potential charging stations in rural areas. Despite these challenges, in Uganda the Makerere University Vehicle Design Project and Kiira Motors Corporation recently developed the first solar-powered bus in Africa. The bus has a seating capacity of 35 passengers and a power capacity of 150 kW (204 horsepower).[166] The project is currently in the pilot stage.

In addition to meeting rising fuel demand, there is an urgent need to improve transportation infrastructure throughout the EAC region, including the presence of efficient mass transit, city and road planning, and the inclusion of renewable fuel stations to power vehicles.

i The only refinery in the EAC region was closed in 2013, leaving the region with no pipelines, delivery infrastructure or refining capacity. The discovery of major oil reserves in 2012 and 2014 has accelerated infrastructure development plans, including the investment in an oil pipeline linking Uganda to the Kenyan coastal town of Lamu. Uganda also aims to start oil extraction by 2017.



04

RENEWABLE ENERGY POLICY LANDSCAPE

04 RENEWABLE ENERGY POLICY LANDSCAPE

As countries worldwide seek to capitalise on their renewable energy potential, they are continuing to adopt policies to support renewables deployment. In total, some 146 countries had in place renewable energy support policies in the power, heating and cooling, and transport sectors as of the end of 2015.[1]

Within the past decade, the EAC partner states, endowed with significant renewable energy resources, all have implemented (to varying extents), policies and strategies to spur renewable energy development.[2] This interest in renewables at both the national and regional levels has been driven by the need to greatly improve access to modern energy services.

Each EAC partner state has developed its own set of specific renewable energy policies and instruments, with a view towards attracting private investment in the sector. In 2008, Kenya pioneered renewable energy policies both in the region and across sub-Saharan Africa with the introduction of its feed-in tariff policy for wind, solar, biomass and small-scale hydropower.[3] To date, all five EAC partner states, with the exception of Burundi, have introduced FIT policies. Kenya and Tanzania also have adopted innovative zero-VAT and tariff policies on solar products to boost private sector participation in off-grid solar lighting – a success story that is being advocated in many countries worldwide.[4]

The main focus of renewable energy policy frameworks across the EAC region has been on developing the electricity sector, with less attention being paid to the transport and heating and cooking sectors. As in other regions of the world, policy developments in the biomass sector remain challenging in the absence of an integrated approach for improving the sustainability of biomass energy resources.[5]

All EAC partner states, with the exception of Burundi, have introduced renewable energy support policies to help address the various barriers to the development of renewables in the region (see table 7).[6]

TABLE 7. Renewable energy targets and support policies in EAC partner states

	Regulatory Policies								Fiscal Incentives and Public Financing				
Country	Renewable energy targets	Feed-in tariff/ premium payment	Electric utility quota obligation/ RPS	Net metering	Biofuels obligation/ mandate	Heat obligation/ mandate	Tradable REC	Tendering	Capital subsidy, grant or debate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT or other taxes	Energy production payment	Public investment, loans or grants
Burundi											X		
Kenya	X	X		N		X		X			X	X	X
Rwanda	X	O						X		X	X		X
Tanzania	X	X							X		X	X	X
Uganda	R	X						X	X		X		X

X - Existing national N - New R - Revised O - Removed / expired

Note: Net metering is part of the new Energy Bill of Kenya approved by the National Assembly in May 2016. The bill will become a law once signed by the president. Burundi has put in place import duty exemptions for renewable energy technology.
Source: See endnote 6 for this chapter.

FIGURE 18. Renewable energy targets in EAC partner states

Kenya

Renewable energy capacity

Targets:
By 2033
- Geothermal: 7,264 MW
- Hydropower: 835 MW
- Wind: 2,186 MW

Tanzania

Renewable energy capacity

Targets:
By 2025
- Geothermal: 200 MW
- Hydro: 2,090 MW
- Solar: 100 MW
- Wind: 200 MW

Rwanda

Renewable energy capacity

Targets:
Between 2013 and 2018
- Hydropower: 85 MW
- Methane: 75 MW
- Solar: 40 MW

Biomass

Targets:
Increase penetration of clean cook stoves to 80% by 2018 (from 50% currently)

Uganda

Share of modern renewables in total energy consumption

Targets:
61% modern renewables in total energy consumption by 2017 (compared to 25% in 2014)

Renewable energy capacity

Targets:
By 2017
- Geothermal: 45 MW
- Hydro (large): 1,200 MW
- Hydro (mini and micro): 85 MW
- Solar home systems: 700 kW

Biogas

Targets:
By 2017, 100,00 household biogas systems installed

Biofuels

Targets:
By 2017, 2,160,000 m^3 of ethanol/biodiese produced annually

Source: See endnote 7 for this chapter.

RENEWABLE ENERGY TARGETS

The EAC partner states, with the exception of Burundi, are among the 173 countries worldwide that have set targets for renewable energy (see figure 18).[7] Although target setting is an important step towards an integrated renewable energy policy, the lack of clarity on how those targets are to be implemented, and the absence of adequate financing plans and a proper monitoring and evaluation process, have greatly hampered the ability of EAC countries to achieve their objectives. The existing renewable energy targets thus highlight the partner states' ambition rather than achievable goals.

Kenya, for example, has set very ambitious renewable energy goals under its Least-Cost Power Development Plan 2013–33, with a target of having renewables account for nearly 50% of the country's 22.7 GW of power generating capacity by 2033, primarily from geothermal, wind and hydropower. In 2013, Kenya also launched its 5,000+ MW project targeting the addition of some 5,000 MW of power capacity by the end of 2016, with cumulative power capacities of 1.9 GW of geothermal, 635 MW of wind, 794 MW of hydropower and 44 MW of biomass.[8] As of the end of 2015, however, the country had added only 586 MW to the grid.[9]

Financial constraints, inadequate infrastructure and a lack of public buy-in have jeopardised Kenya's ability to meet its 2016 target.[10] In early 2016, it was announced that the 60.8 MW Kinangop wind park would not be implemented because funds had run out, and the flagship Lake Turkana wind project will not be fully operational when it goes live in October 2016 due to inadequate electricity transmission infrastructure.[11] Furthermore, the 2015 Draft National Energy and Petroleum Policy for Kenya, which outlines the country's national energy sector policy and strategy, does not set out new targets for renewables.

Under its 2015 Energy Sector Strategic Plan 2013–2018, Rwanda has set renewable energy targets to support an overarching goal of increasing electricity access from 18% in 2012 to 70% by 2018.[12] The country targets adding some 450 MW of power capacity by 2018, including 85 MW of hydropower, 75 MW of methane power and 40 MW of solar power.[13] This contrasts sharply with targets set under the 2011 National Energy Policy and Strategy, calling for the addition by 2018 of 340 MW of hydropower, 310 MW of geothermal, 300 MW of methane and 20 MW of solar.[14] With two years remaining until the 2018 deadline, and installed power capacity in 2015 standing at 156 MW, the feasibility of the revised energy targets is in question, especially given the political and commercial risks in Rwanda that may hinder private investments.[15]

Tanzania has set more modest renewable energy capacity targets under its 2014 Electricity Supply Industry Reform Strategy and Roadmap.[16] The Roadmap aims to reduce the country's dependence on hydropower and to diversify its energy supply with an additional 4,000 MW of natural gas capacity and 2,900 MW of coal capacity by 2025. Meanwhile, the Roadmap envisages adding only 200 MW of wind, 100 MW of solar and 200 MW of geothermal during the same period.[17] In addition to a fading hydropower sector, lack of planning is harming the deployment of other renewable energy sources in Tanzania. For example, the implementation of a biomass power plant recently came to a halt because of land and environmental disputes.[18]

Uganda has set a target of increasing the renewable energy share in total energy consumption to 61% by 2017, as ascribed in the country's 2007 Renewable Energy Policy.[19] Uganda plans to meet this target by further exploiting its hydropower sector and by developing other renewable energy sources, including some 100 MW of biomass and geothermal capacity that is expected to be installed by 2017.[20] The implementation of various projects has enabled the country to be on track to meet its target, with the share of renewables in Uganda reaching 25% in 2014 (up from only 4% in 2007).[21]

TABLE 8. Feed-in tariffs for renewable energy projects in Kenya, 2012

Technology	FIT for projects < 10MW (USD/kWh)	FIT for projects > 10MW (USD/kWh)
Wind	0.11	0.11
Hydropower	0.105	0.0825
Biomass	0.10	0.10
Biogas	0.10	-
Solar (grid-connected)	0.12	0.12
Solar (off-grid)	0.20	-
Geothermal	-	0.088

Source: See endnote 25 for this chapter.

> The main focus of renewable energy policy frameworks across the EAC region as been on developing the electricity sector.

TABLE 9. GET FiT premium payments in Uganda, 2013

Technology	REFIT tariff (USD/kWh)	GET FiT premium (USD/kWh)
Hydropower (<9 MW)	0.085	0.014
Hydropower (9–20 MW)	0.082–0.092	0.014
Bagasse	0.081	0.005
Biomass	0.103	0.01

Source: See endnote 30 for this chapter.

RENEWABLE POWER SUPPORT POLICIES

Feed-in tariffs

One instrument that has greatly incentivised renewable energy development in the EAC region is the feed-in tariff (FIT). All EAC partner states, except Burundi, have established FIT policies. Because of the strong element of predictability offered by FITs in the EAC region, investor interest has in some cases outpaced the signing of PPAs, namely in Tanzania and Uganda.[22] This has led most EAC partner states to review and revise their respective policies to reflect market changes, and also to expand the range of renewable energy technologies eligible for FITs.

Kenya pioneered FIT development in the region and accross sub-Saharan Africa in 2008, setting a predetermined fixed tariff over a 20-year period to spur the development of three renewable energy technologies: wind (below 50 MW plant size), small-scale hydropower (below 10 MW) and biomass (municipal waste and cane bagasse below 40 MW).[23] Kenya's FIT policy was revised in 2010 to include geothermal, biogas and off-grid solar technologies and to review existing tariffs, which were revised again in 2012 to provide for grid-connected solar and to address market changes.[24] The 2012 review provided for SPPAs for projects less than 10 MW in size and also for those greater than 10 MW in order to reduce the transaction costs associated with negotiating and signing a PPA for small producers (see table 8).[25]

The adjustments to Kenya's FIT policy have set the tone for the deployment of renewables by private producers in the country, with more than 1.2 GW of wind, 272 MW of geothermal, 221 MW of solar and 28 MW of hydropower already operational or in the pipeline as of 2015.[26] The next revision exercise was set to begin at the end of 2015, with the aim of addressing investor concerns that the proposed tariffs for solar (USD 0.12/kWh) need to be increased to cover the capital, operation and maintenance costs of projects.[27] Kenya also is making provision for net metering in its new Energy Policy Act.

Uganda introduced its Renewable Energy Feed-in Tariff (REFIT) in 2007 under the country's Renewable Energy Policy and proposed a fixed tariff based on the levelised cost of production for renewable energy technologies.[28] The policy encountered little success, however, mainly because the tariff was perceived as insufficient to cover the cost. The FIT was revised, but with similar bleak results.[29] Then, in 2013, in collaboration with development partners, Uganda established its GET FiT programme, providing extra payments per kWh over and above the REFIT tariffs (see table 9).[30] The GET FiT programme has helped greatly to improve the financial stability of renewable energy projects in Uganda and has successfully attracted private investment in the sector.[31] Three rounds of proposals have been launched under the programme in three years, funding 17 projects totalling 157 MW of hydropower, solar and bagasse technologies.[32]

Following the example of Kenya and Uganda, in 2012 Rwanda introduced a FIT policy for hydropower, with tariffs ranging from USD 0.16 per kWh for 50 kW systems to USD 0.067 per kWh for 10 MW systems.[33] The FIT policy scheme was valid for three years and expired in 2015. The FIT currently is being revised and should provide for an SPPA as well as a FIT for solar PV, which was drafted but never implemented.[34]

Tanzania also recently reviewed its FIT system. In 2008, the country had introduced a FIT together with an SPPA for projects below 10 MW, but with no consideration for specific technologies.[35] The regulatory framework thus benefited only mini-hydro and biomass projects, with investors overlooking wind and solar PV projects due to the low tariff.[36] Under the 2008 SPPA, it is estimated that some 15 projects are operational and another 60 or so are the pipeline, for a total installed capacity of some 50 MW.[37] In April 2015, the Energy and Water Utilities Regulatory Authority (EWRU) approved a review of the SPPA framework and the tariffs proposed for hydropower and biomass technologies up to 10 MW.[38] For wind and solar projects, it was determined that a competitive bidding approach would be adopted.

Renewable energy auctions

Renewable energy auctions have gathered considerable momentum in recent years and are being used as a popular policy tool to deploy renewable energy technologies worldwide. To date, some 60 countries have adopted renewable energy auctions, with South Africa pioneering this policy instrument on the African continent. In the EAC region, renewable energy auctions are gaining prominence and have been used mainly in Rwanda and Uganda. In 2015, Tanzania announced that it would be using competitive auctions for wind and solar projects under its revised SPPA framework, and Kenya is working towards implementation of the same approach.[39]

Rwanda, through its Rwanda Energy Group (REG), has kick-started its solar PV sector through renewable energy auctions. The country's landmark 8.5 MW solar PV project (implemented by Gigawatt Global) was commissioned following a government competitive tendering process for 18.5 MW of solar.[40] Energising Development (EnDev), together with REG, conducted a tendering process in 2014, through a call for proposals, for nine hydropower generation sites.[41] Rwanda is understood to be using competitive bidding as its main instrument for developing large renewable energy projects.[42]

TABLE 10. Status of import duty and VAT exemptions on solar devices in EAC partner states

Country	Import duty exemptions	VAT exemptions	Specificities
Burundi	√		
Kenya	√	√	VAT exemptions apply to specialised solar equipment and accessories, including solar water heaters and batteries.
Rwanda	√	√	VAT-exempted goods include solar water heaters, solar appliance products (fans, water pumps, refrigerators, chargers, etc.), PV modules and batteries.
Tanzania	√	√	VAT-exempted goods include solar panels, modules, vacuum tube collectors and batteries.
Uganda	√	√	VAT exemptions apply to solar PV, solar water heaters, solar refrigerators and solar cookers.

Source: See endnote 49 for this chapter.

i 2 x 5 MW plants each in Tororo and Soroti.

Uganda awarded contracts to two private companies in 2014 for the installation of a total capacity of 20 MW[i] of solar PV systems, following a competitive tendering process.[43] This was achieved through a reverse auction under Uganda's GET FiT solar facility, under which the country's Energy Regulatory Authority would offer the REFIT tariff of USD 0.11 per kWh while potential bidders would have to tender for the gap payments to these tariffs (the GET FiT premium).[44] The average rate for solar PV proposed by successful bidders was USD 0.1637 per kWh.[45]

Fiscal incentives

Fiscal incentives – in the form of duty and VAT exemptions – have been popular in the EAC region in recent years. Worldwide, such initiatives are considered as best practice for tackling energy access issues and for spurring the development of off-grid solar PV in the developing world, with Kenya and Tanzania often cited as models.[46]

In 2006, the EAC Customs Management Act was amended to provide for customs duty exemptions for solar equipment and accessories.[47] The Act was further amended in 2014 to extend these exemptions to wind technologies.[48] Kenya, Rwanda, Tanzania and Uganda also have introduced a VAT exemption on solar products that has considerably reduced the price of solar products, particularly pico solar systems (solar lighting products and solar home systems) (see table 10).[49]

Although the fiscal incentives in place in the EAC partner states have had a positive impact on the development of renewable technologies, the lack of clarity and the uncertainty surrounding the VAT exemption policy have been a matter of concern for

> Despite its importance, the cooking, heating and cooling sector in the EAC region has received little attention from EAC partner states.

investors.[50] Kenya, for example, classified solar PV, solar water heaters and solar equipment as "zero-rated" in 2009, but overturned that decision to make solar products again subject to a VAT of 16%. Six months later, the country made provisions for solar products to be VAT-exempted, providing mixed signals to private investors and adding uncertainty in the market.[51]

Regulatory uncertainty also is present in Rwanda, where the regulation stipulating that solar products were VAT-exempted was amended to restrict this measure to solar PV modules of at least 25 W. This added to the lack of clarity regarding which solar products are exempted from VAT and import duties.[52] VAT exemptions in Rwanda also apply to clean cook stoves and biodigesters.[53]

RENEWABLE COOKING AND HEATING SUPPORT POLICIES

Despite its importance, the cooking, heating and cooling sector in the EAC region has received little attention from EAC partner states. This is due mainly to the complexity of the sector and to the predominant focus on electrification policies and programmes in the region. However, several countries have put in place regulations and policies for the promotion of biogas production and for the use of solar thermal heating, helping to increase the uptake and use of these technologies in a growing sector.

A major achievement by an EAC partner state in the heating sector is the enactment of Kenya's Energy (Solar Water Heating) Regulation in 2012. Under the regulation, all premises with hot water needs of greater than 100 litres per day are required to install a solar water heating (SWH) system by May 2017.[54] This has greatly spurred the demand for SWH in homes, hotels, hospitals and learning institutions. The number of installations was an estimated 140,000 SWHs in 2015, and demand is projected to reach 800,000 by 2020.

Similarly, in 2012 Rwanda launched the SolaRwanda programme[i], with the goal of installing some 12,000 SWHs by the time of the programme's end in 2015.[56] A leading feature of the programme was the provision of a subsidy for the purchase and installation of SWHs that amounts to about 25% of their cost.[57] The remaining costs were covered through a loan provided by the country's Energy and Water Sanitation Authority (now the Rwanda Energy Group, REG). In 2015, Rwanda adopted a Solar Water Heater Regulation that provides the licensing and regulatory framework for the installation, operation and maintenance of SWHs in the country.[58] Rwanda also is planning to make SWHs mandatory for all hotels and major residences, as well as to extend the subsidy scheme provided under the SolaRwanda programme.

The use of biogas digesters is gaining prominence in the region, primarily in Kenya, Rwanda, Tanzania and Uganda, where the Africa Biogas Partnership Programme (ABPP) is being implemented (see *Biogas* section in chapter 3). In addition, the Kenyan government has removed the VAT on plastic bags used in biogas digesters and is looking into adopting a Biogas Regulation that would streamline the installation and maintenance of biogas plants.[59]

RENEWABLE TRANSPORT SUPPORT POLICIES

Although the EAC region has huge potential for the production and use of biodiesel and (in particular) ethanol, the use of liquid biofuels in the transport system has yet to take off. Policies to properly incentivise biofuels production and use have been scarce in the region, with some exceptions in Kenya and Uganda.

As part of its 2007 Renewable Energy Policy, Kenya introduced an obligation for the blending of biofuels, followed by the country's Energy (Gasohol Blending) Act.[60] The Act provides a framework for 10% ethanol blending. However, the policy has not been made properly operational due to an insufficient supply of ethanol in the local market.[61] Kenya also has drafted a Biodiesel Licensing Regulation to promote the blending of biodiesel up to 5%, as prescribed by the Kenya 2008 Roadmap for Biofuels, but the regulation has yet to be approved.[62]

Uganda has promoted the use of biofuels as well. In 2015, the Cabinet approved a Biofuels Blending Bill that calls for the blending of 20% biofuels. The Bill also provides tax rebates and other financial incentives to potential biofuels developers in the country. However, it has not yet been enacted at the parliamentary level.[63] Such a policy would require producing some 176 million litres of biofuels per year in Uganda, which is not feasible at the current capacity. During the early stages of drafting the Bill, a less strenuous blending mandate of 2% was preferred, but it was later revised to the more ambitious 20%.[64]

Tanzania, building on its 2010 Guidelines for Sustainable Liquid Biofuels Development, has endeavoured to promote the use of biofuels and has developed a Draft Liquid Biofuels Policy.[65] Such a policy would lead the way for regulations on blending of biofuels; however, the draft policy has yet to be approved.

i Financed through the GEF and the Nordic Development Fund.

05

ENERGY EFFICIENCY IN THE EAC REGION

05 ENERGY EFFICIENCY IN THE EAC REGION

As the region experiences rapid economic growth and increasing levels of development, the lack of energy resources is becoming a major obstacle for many EAC partner states. Several countries have implemented measures to meet their rising demand for energy, such as installing thermal power plants and accelerating the development of new hydropower plants.[1] Tapping into the huge renewable energy potential of the region will be crucial in bridging the current gap between energy supply and demand; however, energy efficiency is equally vital.

Implementing energy efficiency measures and activities is more than just an issue of cost savings; it is in itself a low-cost energy resource. The rational use of scarce energy sources allows the delivery of more services for the same energy input. Energy efficiency also can reduce the need to install new peak capacity and can support the development of an energy supply based on renewable energy.

EAC partner states have started to adopt energy efficiency measures primarily in the power and cooking and heating sectors. For example, nearly all EAC countries have implemented the switch to compact fluorescent lamps (CFLs) as well as the promotion of more-efficient clean cook stoves. Kenya and Uganda have made energy audits mandatory for some industries. On the policy side, all five EAC partner states have prepared, or are in the process of preparing, their energy efficiency policy frameworks, highlighting the growing attention that energy efficiency is receiving in the region.

ENERGY INTENSITY

The level of energy efficiency varies widely among the EAC partner states. Using energy intensity as a measure of energy efficiency (see sidebar 10), in 2012 Burundi had the highest energy intensity at 13.0 megajoules per USD (MJ/USD) of GDP, while Rwanda had the lowest, at 5.6 MJ/USD (see figure 19).[4] Energy intensity across the EAC region – with the exception of Rwanda – is above both the world average of 5.8 MJ/USD and the sub-Saharan African average of 8.2 MJ/USD, illustrating the potential of energy efficiency in the region.[5]

Although GDP has increased across the region, energy intensity has been decreasing steadily. Between 2005 and 2012[i], energy intensity fell by an average of 3% per year. Rwanda saw an average decrease of 5.2% annually, and Uganda experienced a 3.9% drop. Tanzania's average energy intensity fell by 2.6%, Burundi's by 2.3%, and Kenya's by 1.1%.

Energy efficiency measures at the household level – namely, the adoption of clean cook stoves and biogas digesters – may explain the improvement in the region's energy intensity during 2005–12. In the case of Rwanda, the higher decline in energy intensity could be attributed to structural changes in the economy that resulted in an increase in economic activity without corresponding growth in energy demand.[6] Rwanda also is benefiting from its recent move towards the use of energy-efficient lighting products.

SIDEBAR 10.

Energy intensity - definition and challenges

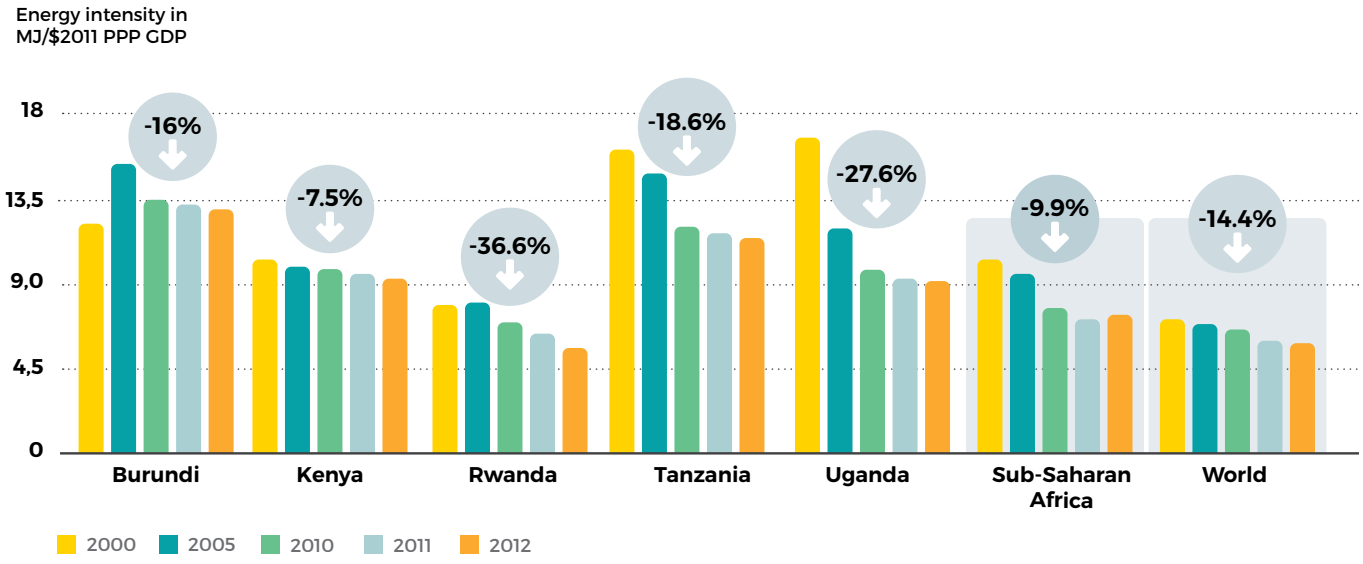
Due to a lack of better indicators, reduction in the energy intensity of national economies typically is used as a proxy for improvements in energy efficiency at the national or global level.[2]

Energy intensity is calculated as units of energy consumed per unit of economic output, or GDP. Changes in energy intensity can reflect changes in the energy efficiency of an economy, but they also reflect the impact of other factors, such as structural changes in the economy to less energy-intensive activities and the effect of fuel substitution, particularly with renewable energy.[3]

i Reflects the latest available figures for comparable energy intensity ratios in the EAC region.

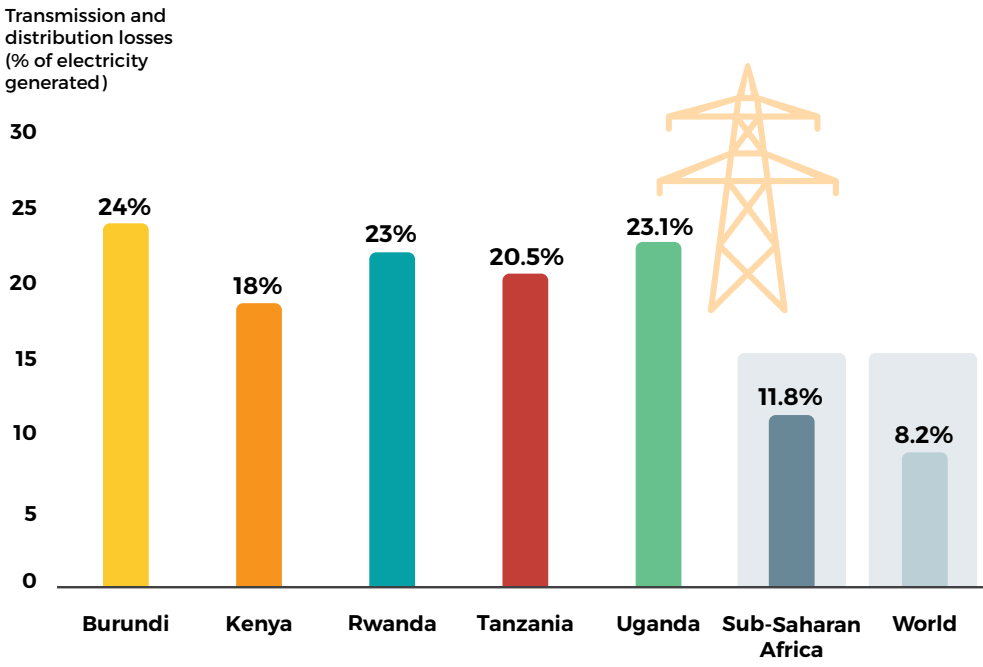
ENERGY EFFICIENCY IN THE EAC

FIGURE 19. Energy intensity (primary energy) in EAC partner states, 2000, 2005 and 2010–12.



Source: See endnote 4 for this chapter.

FIGURE 20 . Transmission and distribution losses as a share of power output in EAC partner states, sub-Saharan Africa and the world, 2013



Source: See endnote 7 for this chapter.

POWER TRANSMISSION AND DISTRIBUTION

As the EAC partner states seek to increase their electrification rates and to provide the energy supply needed to fuel development, the region's utility companies are implementing programmes to reduce power losses during transmission and/or distribution. The aim is to help ensure the reliability of the power supply as well as to provide significant cost savings.

Power network losses in the EAC region are significant, with average losses of 22% region-wide and losses of 18% in Kenya (see figure 20).[7] This is comparable to the power loss average in the ECOWAS region (21–25%) but is higher than the averages in both sub-Saharan Africa (12%) and worldwide (8%). The losses in the EAC region are attributable to non-optimal configuration of the power network (i.e., technical losses) as well as to commercial losses through power theft and billing anomalies.[8] These losses are reflected in the financial balance sheets of utilities and subsequently are passed on to consumers in the form of higher pricing.[9]

Recently, EAC partner states have begun implementing measures to minimise technical and commercial power losses, with a view towards conserving energy, protecting revenues and saving consumers from rising tariffs.[10] In 2013, Rwanda developed a loss reduction plan to reduce power system losses from the current level of 23% to 15% over the coming years. This will require an investment of approximately USD 60 million over this period, culminating in potential savings of USD 180 million.[11] Tanzania also has established a Loss Reduction Programme under the utility company TANESCO, with the goal of reducing losses from the power network to 15% by the end of 2016, as per the Ministry of Energy and Minerals' 2011 Strategic Plan. Similarly, Kenya aims to reduce losses to below 15% by 2020. Regular maintenance of existing power plants to ensure optimum productivity and reduce technical losses also is occurring throughout the region.

Several EAC partner states have created dedicated units within their utilities to address losses. Rwanda's unit is housed within a revenue collection department of the utility, an indication of the importance of recovering costs. In Tanzania, Power Africa is supporting the Energy and Water Utilities Regulatory Authority (EWURA) and TANESCO to improve load management and reduce losses.[12]

ENERGY EFFICIENCY POLICIES AND PROGRAMMES

Energy-efficient lighting

One of the most popular and significant energy efficiency programmes in the EAC region has been the replacement of inefficient incandescent light bulbs with either linear fluorescent tubes or CFLs.[13]

Kenya, through its utility company KPLC, launched in 2010 the first CFL Exchange Programme (Basilisha Bulb), resulting in the free distribution of 1.25 million CFLs. The programme, which cost USD 5 million, claims to have reduced peak electricity demand by 60 MW and saved the country USD 195 million in avoided new generating capacity.[14] Kenya currently is embarking on a second phase of this exchange programme, funded by the French Development Agency (AFD). The programme will target the distribution of 3.3 million CFLs and aims to achieve 100% efficient lighting products throughout Kenya by 2020.[15]

Uganda, under the World Bank's Energy for Rural Transformation project, distributed 800,000 free CFLs between 2008 and 2010 to reduce peak electricity demand faced by the national utility UMEME.[16] The project has yielded USD 100 million in savings and has reduced peak electricity demand by about 30 MW.[17] To encourage the further use of efficient lighting products such as CFLs, the government has waived import duties and VATs on these items. Uganda also is implementing an LED distribution programme with the goal of distributing 1 million LED bulbs.[18]

The World Bank has supported Rwanda in the distribution of some 800,000 CFLs in exchange for incandescent bulbs under the country's Electrogaz CFL Distribution Project.[19] The first 50,000 CFLs were distributed for free in a pilot phase, and the remainder were sold at a subsidised price equivalent to that of an incandescent bulb (USD 0.37/lamp).[20] The exchange resulted in annual power savings of 64 GWh and in a reduction in power demand of 30 MW.[21] Efficient lighting is now being considered for public institutions and street lighting in Rwanda.

In Tanzania, TANESCO plans to implement an Efficient Lighting (CFL) Retrofit programme to replace 3.2 million incandescent bulbs with CFLs in Arusha, Dar es Salaam, Kilimanjaro and Mwanza in order to reduce the evening peak load.[22] In Burundi, 200,000 CFLs were distributed between 2011 and 2013.[23]

Energy efficiency in industry

In view of both reducing the energy demand of industries and improving industrial energy efficiency, EAC partner states are starting to devise and implement energy management programmes, specifically energy auditing. For example, Tanzania is currently implementing a National Energy Audit Programme led by the Danish development agency DANIDA.

In Kenya, the Energy Management Regulation of 2012 requires that large-scale energy consumers[i] (those consuming more than 180,000 units of electricity per year) carry out energy audits every three years.[24] The regulation targets industrial and commercial activities such as commercial buildings, hotels, industries and educational institutions, among others. To carry out these audits, Kenya now has 20 licensed energy audit firms and 39 energy auditors.[25] By the end of 2015, however, only 1,000 out of the 3,000 industries affected by the regulation had carried out energy audits.[26]

i Large power consumers (comprising mainly industries located around Nairobi) account for about 60% of Kenya's total electricity consumption.

In Uganda, the Ministry of Energy and Mineral Development and the German Development Agency (GIZ) have jointly set up an Energy Audit programme for the industrial sector, which includes staff training on energy management and ISO 50001. The programme aims to perform energy audits at 50 of the country's energy-intensive companies by 2017. By 2015, 15 companies had carried out an energy audit of their premises and process.[27] In parallel, Uganda has developed an Energy Efficiency and Conservation Bill which provides the legal framework and institutional set-up for energy management in the country.

The AFD, through its flagship programme SUNREF[i], is financing energy audits and implementing the associated recommendations in the region. The programme, which provides loans at lower market rates for energy efficiency and renewable energy projects, has been active mainly in Kenya but also has a presence in Tanzania and Uganda.

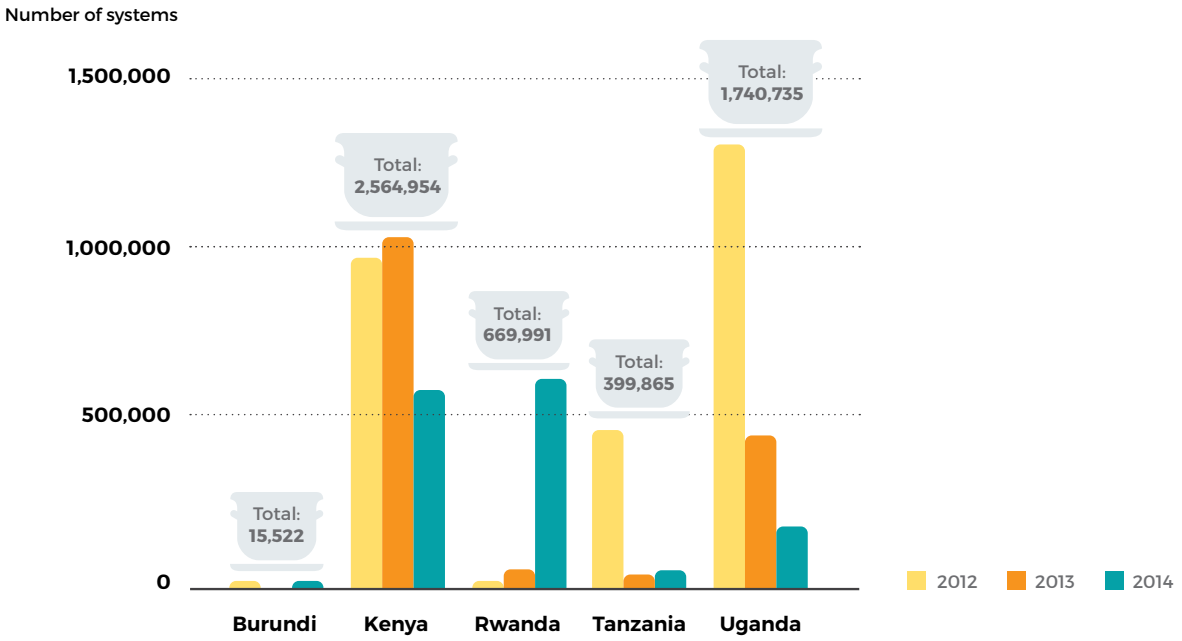
In addition to energy auditing and adherence to energy management practices, countries such as Uganda have implemented Minimum Energy Performance Standards (MEPS) using a labelling system for certain appliances. Currently the labelling system applies to five appliances: lighting, refrigerators, freezers, motors and air conditioners. Implementation of this system is still at a nascent stage.

Energy efficiency in the cooking sector

A high proportion of the EAC population relies on biomass for cooking, which is burned via inefficient and polluting cooking methods that cause significant health problems in communities. Traditional biomass cook stoves in the EAC region have an estimated heat loss of 75%.[28] Commercial use of biomass for heating and cooking (in schools, clinics, restaurants, etc.) leads to deforestation because of the larger quantities of biomass consumed.

Since the 1980s, EAC governments and international organisations have been promoting the use of improved, more-efficient cook stoves, with a typical efficiency of at least 50%. Between 2012 and 2014, an estimated 5.3 million clean cook stoves were distributed in the region, through either private companies or government programmes (see figure 21).[29] Kenya is the leader in clean cook stove distribution in Africa, with the sale and use of the stoves concentrated mainly in urban and peri-urban regions.[30]

FIGURE 21 . Number of clean cook stoves distributed in EAC partner states, 2012–2014



Source: See endnote 29 for this chapter.

i Sustainable Use of Natural Resources and Energy Financing

Part of Kenya's success has been the development and use of the ceramic Jiko cook stove[i]. Since the stove's introduction in the 1980s, an estimated 40% of the population has adopted it for use, with the majority of users concentrated in urban areas (e.g., Nairobi and Mombassa).[31] Kenya has drafted the Improved Biomass Cook Stoves Regulation, which makes it mandatory for institutions and large consumers of biomass energy to use energy-efficient cook stoves. The regulation also stipulates standardisation and performance requirements for those stoves.[32] Together with co-ordinating partners in Kenya – namely GIZ and SNV – the Global Alliance for Clean Cookstoves (GACC) has developed an action plan for the country to support the adoption of clean cook stoves in 7 million households.[33] As of July 2016 the regulation had yet to be enacted.

Uganda also developed its market for clean cook stoves in the 1980s, but it is not as robust as Kenya's. Only an estimated 9% of households in Uganda use clean cook stoves despite promotion interventions by the government and donors. As in Kenya, clean cook stoves are concentrated in urban regions (mostly in Kampala), where the penetration rate reaches 20%.[34] Uganda recently created the Uganda National Alliance for Clean Cook Stoves (UNACC) to catalyse the dissemination of clean cook stoves to more than 5 million households by 2020. If successful, 64% of households in the country would be using modern cooking solutions by this date.[35]

With the support of the World Bank, the Government of Tanzania has promoted the adoption of the Kenyan ceramic Jiko stove. To date, an estimated 12% of Tanzanian households (1.2 million) use clean cook stoves, including 40% of households in Dar es Salaam and 20% of households in other urban areas.[36] As in Kenya and Uganda, use of the stoves occurs mainly in urban areas. The market for clean cook stoves in Tanzania is developing quickly and is supported by the government and by donor organisations such as GIZ (which implements the EnDev programme). The Tanzanian Improved Cook Stoves programme, implemented mainly in the country's Lake Zone region, surpassed its target of 50,000 beneficiaries by July 2015, and further expansion of the project is expected by 2017.[37] Together with donor organisations such as SNV, TAREA and the Clean Cookstoves and Fuels Alliance of Tanzania (CCFAT), an action plan for the deployment of clean cook stoves in the country was developed in 2014.

Rwanda has developed its Improved Cook Stoves Programme with the goal of combating deforestation. The penetration rate of improved cook stoves in the country is estimated at around 40–50%.[36] According to the Rwanda Energy Sector Strategic Plan, the country aims to ensure that 80% of households use clean cooking technologies. In addition, the government has set a target of having 63% of rural households in the country make use of improved cook stoves by 2020.[39]

Burundi, too, has initiated a series of clean cook stoves projects, targeting mainly the capital city of Bujumbura. However, Burundi's market for clean cook stoves is still nascent and is not as advanced as in neighbouring countries.

In addition to introducing clean cook stoves, some EAC partner states – Kenya, Rwanda and Uganda – have launched a series of initiatives to improve the efficiency of charcoal production through innovative techniques. Rwanda, for example, has been promoting the use of modern and improved charcoal kilns.[40] Similarly, Uganda launched a four-year green charcoal project in 2014 that promotes the roll-out of new charcoal kilns that have an efficiency of 40%.[41]

With their relatively high energy intensities, the EAC partner states have significant potential for energy efficiency gains. Although many of these countries have initiated energy efficiency measures and policies in recent years, the focus has been mainly on the lighting and cook stoves sectors, emphasising the replacement of traditional appliances with more-efficient ones. There is a need to pursue other energy efficiency measures in all EAC partner states through an integrated and holistic programme addressing all sectors.

i The Jiko stoves are 30–50% more efficient than traditional cook stoves.

06

INVESTMENT FLOWS

06 INVESTMENT FLOWS

Despite the sustained decline in fossil fuel commodity prices, investment in renewable energy continues to grow. Global investment in renewables, excluding large-scale hydropower projects, reached a record USD 258.9 billion in 2015, more than twice the investment in coal and natural gas power projects.[1] For the first time ever, investment in renewables in developing countries surpassed that of industrialised countries. Africa attracted USD 12.5 billion in renewable energy investment in 2015, up from USD 8 billion in 2014, driven mainly by the success of South Africa's Renewable Energy Independent Power Procurement Programme (REIPPP) and solar thermal projects in Morocco.[2]

Despite encouraging investment patterns for Africa as a whole, the EAC region still faces significant private investment challenges. In 2015, the region accounted for approximately 4% of renewable energy investments in Africa – down from 31% in 2010 and 18% in 2014, when one-time investments were made in large-scale grid-connected wind and geothermal projects in Kenya. Despite the drop in investment, Kenya retains a dominant position in the region. Increasingly, other EAC countries are attracting new investors as a result of a favourable regulatory and investment climate. For example, Uganda's GET FiT programme has helped considerably to reduce investment barriers in the country, with some 17 renewable energy projects (157 MW total capacity) now in the pipeline.[3]

EAC countries also have seen increased investments in the off-grid sector, primarily in Kenya and Tanzania. With the emergence of innovative business models such as "pay as you go" (PAYG), companies operating in the region have raised more than USD 10 million in investments, expanding their activities in the off-grid solar sector.

RENEWABLE ENERGY INVESTMENTS

Between 2010 and 2015, the EAC region attracted approximately USD 4 billion of investment in utility-scale renewable energy (see figure 22 and reference table R8).[4] This represents just under 10% of all investments in renewables for the African continent over this period. With more than 80% of EAC investments being channelled into geothermal and wind projects in Kenya, the country is frequently ranked among the top five on the continent for renewable energy investment.[5]

From 2010 to 2015, Kenya achieved a national record of USD 3.3 billion in renewable energy investment, with investments in renewables exceeding USD 1 billion in both 2010 and 2014.[6] Renewable energy investments in other EAC countries also have been increasing, albeit at levels lower than Kenya's (see figures 22 and 23). Uganda surpassed the USD 100 million mark for the first time in 2015, with investments of USD 134 million in renewables.[7]

Between 2010 and 2015, the EAC region attracted approximately USD 4 billion of investment in utility-scale renewable energy.

Burundi set a national record of USD 274 million in renewable energy investment in 2014 and also had the highest investment in renewables per unit of GDP in the world that year.[8]

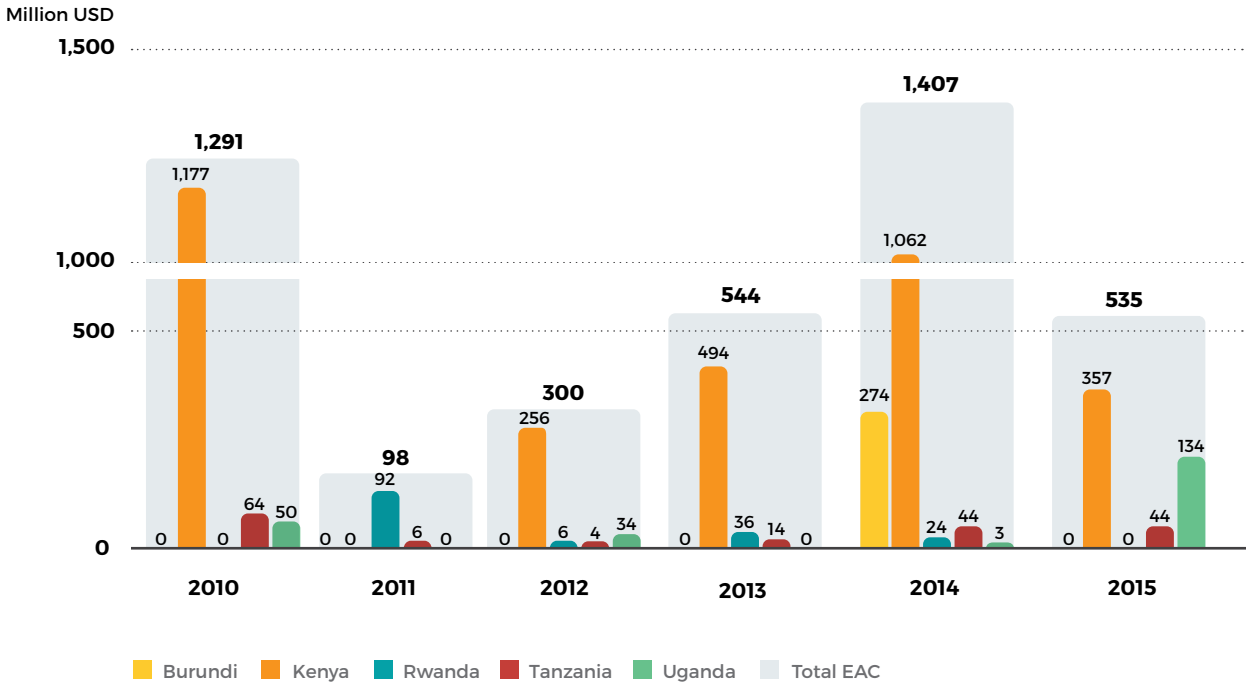
Investment in the region's renewable energy sector traditionally has flowed towards hydropower and geothermal projects. Uganda's GET FiT programme has enabled significant investment to be channelled to the country's hydro sector: in 2015, USD 95 million was secured for construction of the 44.7 MW Muzizi project, and in early 2016 the Netherlands Development Finance Company (FMO) announced that it would finance a 5.4 MW hydropower project in Uganda for USD 10.2 million.[9] In 2012, the FMO injected USD 24 million in the construction of a similar 14 MW facility in the country.[10]

In addition, funding through Chinese capital of USD 500 million and USD 1.4 billion, respectively, has been secured for two of the region's largest hydropower projects, both located in Uganda: the 188 MW Isimba Dam and the 600 MW Karuma project.[11] Burundi saw most (USD 270 million) of its national investment in renewables in 2014 go to the Bi-Jiji (31.5 MW) and Mulembwe (16.5 MW) hydropower projects.[12] Tanzania is expecting more than USD 500 million in financial support from the AfDB for a variety of hydropower projects, as highlighted in Tanzania's recently approved *Country Strategy Paper*.[13]

Kenya is the clear leader in geothermal investments in the region, due primarily to the expansion of its flagship Olkaria project since 2010. The planned 280 MW Olkaria IV geothermal plant enabled the country to increase its investment in renewable energy from nearly zero in 2009 to approximately USD 1.2 billion in 2010, paving the way for subsequent investments in the sector.[14] Kenya's Geothermal Development Company secured USD 109 million financing in 2014 for the development of additional geothermal projects, and in 2015 a further USD 387 million was invested in the Olkaria V geothermal plant.[15] Tanzania also is anticipating exploiting its geothermal potential in the Rift Valley and plans to secure some USD 563 million in funding from the AfDB for development of a 100 MW geothermal project.[16]

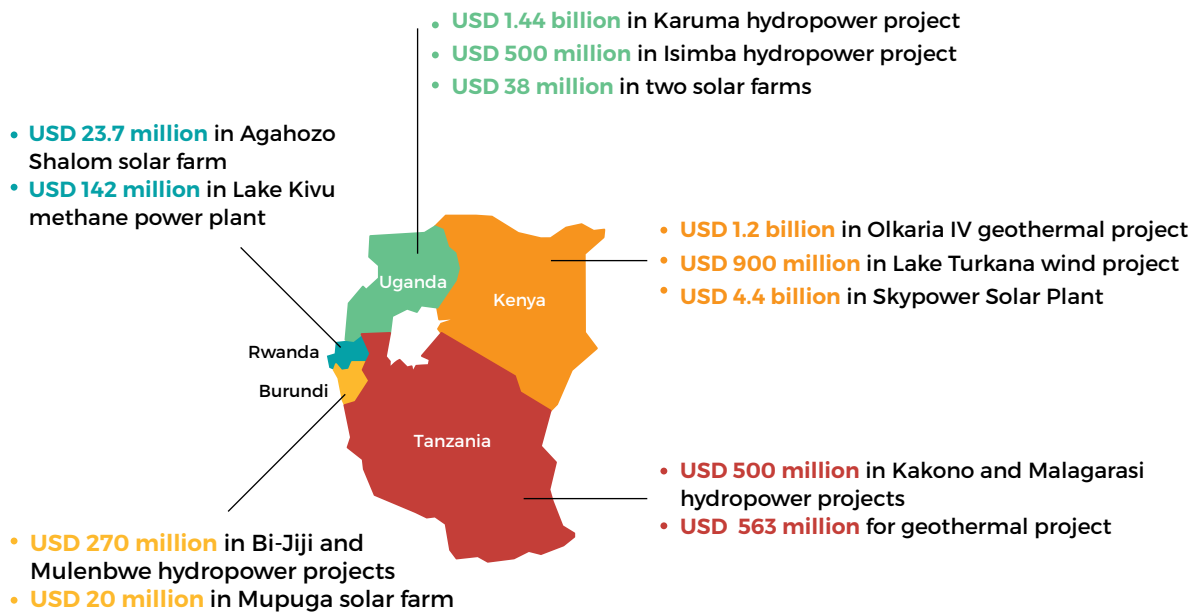
INVESTMENTS IN RENEWABLE ENERGY

FIGURE 22. Investment in renewable energy in EAC partner states, 2010–2015



Note: See reference table R8 for more information.
Source: See endnote 4 for this chapter.

FIGURE 23. Selected major investments announced for renewable energy projects in the EAC region



Source: See endnote 5 for this chapter

Over the past five years, the EAC countries have been gradually diversifying their renewable energy portfolios, tapping into their wind, solar and even biomass potentials (see figure 22). In 2014, the wind energy sector in Kenya made headlines with the 310 MW Lake Turkana wind project and associated transmission infrastructure, accounting for some 90% (USD 900 million) of the country's renewable energy investment that year.[17] In 2015, Kenya received USD 233 million in financing from the US Overseas Private Investment Corporation (OPIC) for the construction and operation of the Kajiado wind project.[18]

Wind energy development in the four other EAC countries is still at a nascent stage, with only Tanzania and Uganda currently looking to unlock their wind potential. In 2015, Uganda received a USD 50 million grant from the Climate Investment Funds (CIF) to conduct a wind assessment project and to support the construction of two 10 MW pilot wind projects.[19] Tanzania has actively raised funding for its 100 MW Singida wind project through a USD 123 million non-concessional loan from the Export-Import Bank of China and through equity investment from the International Finance Corporation (IFC)[i].[20] Utility-scale solar PV projects also are gathering momentum in the region and are receiving their fair share of investments. Rwanda was the first EAC country to attract significant investment for its on-grid solar PV sector, obtaining USD 23.7 million in 2014 for the commissioning of an 8.5 MW solar farm.[21] Burundi and Uganda have since followed in Rwanda's footsteps. Burundi, as part of its strategy to move away from reliance on hydropower, is set to invest USD 20 million in the construction of a 7.5 MW solar farm to be developed by the Netherlands-based company Gigawatt Global.[22] In 2015, Uganda secured USD 38 million of investment for two 10 MW solar plants in the eastern part of the country.[23]

To date, investment in the biomass sector has occurred primarily in Kenya and Rwanda, using off-the-shelf technologies. In 2010, Kenya invested USD 45 million in construction of the Mumias Sugar ethanol plant with a capacity of 22 million litres per year, and an anticipated USD 142 million will be invested in a 25 MW methane power plant at Lake Kivu in Rwanda, currently in the pipeline.[24]

OFF-GRID RENEWABLE ENERGY INVESTMENTS

In addition to significant investments in utility-scale renewable energy projects, the EAC region has seen rising interest among private investors in off-grid systems, particularly for solar PV (e.g., solar lanterns and solar home systems, SHS). Increasing acknowledgment from governments of the important role of off-grid power solutions, combined with the evolution of supportive business models (PAYG micro-financing and productive power applications), have spurred substantial international investment in the sector.

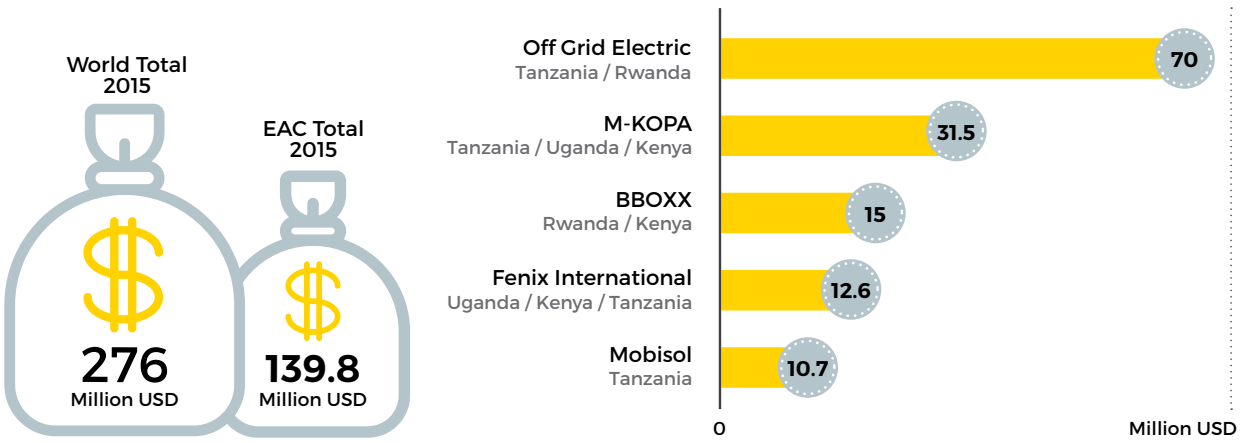
In 2015, global investment in off-grid solar reached a record USD 276 million, roughly half of which (USD 139.8 million) was raised by companies expanding their activities in the EAC region (see figure 24).[25] Already in 2014, off-grid solar companies had raised a reported USD 63.9 million, nearly 70% of which went to support off-grid activities in Kenya and Tanzania.[26]

Two companies, Off Grid Electric and M-KOPA, have attracted the largest share of investment in off-grid solar in East Africa, building on the success of their PAYG business models. Investment in Off Grid Electric, the Tanzania-based solar energy provider, totalled USD 70 million in 2015, nearly three times the amount the company raised in 2014 (USD 23 million).[27] These investments will help support Off Grid Electric's partnership with the Government of Tanzania to provide energy to 1 million households over the next three years, as well as efforts to expand the company's activities in Rwanda.[28]

i As of the writing of this report in May 2016, the Singida wind project is still to take place.

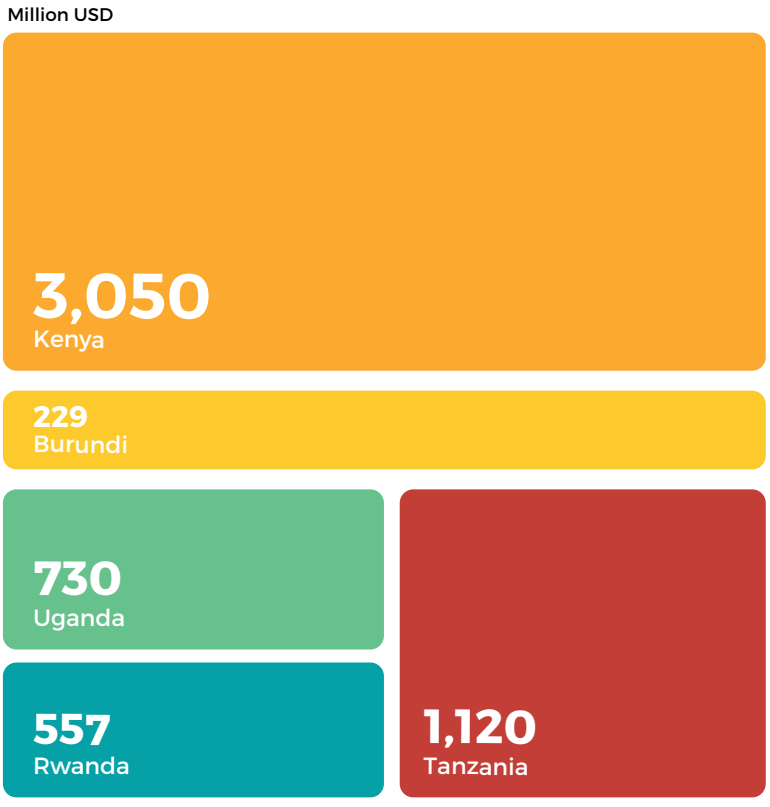
OFF-GRID AND DEVELOPMENT FINANCE

FIGURE 24. Capital raised by off-grid solar companies, world and EAC totals and by company, 2015



Source: See endnote 25 for this chapter

FIGURE 25. Development finance for renewable energy projects in the EAC region, 2009–2013



Between 2009 and 2013, **the renewable energy sector in the EAC region attracted an estimated USD 5.8 billion in aid from the international community** in the form of technical assistance, grants and soft loans.

Source: See endnote 25 for this chapter

In parallel, M-KOPA – the Kenyan PAYG solar energy start-up, which aims to bring solar power to 1 million off-grid homes in Kenya, Tanzania and Uganda – secured USD 31.5 million in 2015, up from USD 20 million in 2014.[29] Other substantial investments in off-grid solar in the region in 2015 included USD 15 million to BBOXX for its activities in Kenya and Uganda; USD 12.6 million to Fenix International, working with off-grid communities in Uganda; and USD 10.7 million to Mobisol, providing off-grid solar systems in Tanzania and Rwanda.[30]

In addition to off-grid solar PV investments, the mini/micro-grid sector is attracting significant investments. Powerhive (United States) and Enel Green Power (Italy) plan to invest USD 12 million in the construction of 100 solar-powered micro-grids throughout rural Kenya in the coming years.[31] Mini-grid development also has received financial support in recent years from donor organisations and funds such as the IFC and the AfDB's Sustainable Energy Fund for Africa (SEFA). For example, Tanzania secured a USD 0.42 million grant in 2014 to support the development by Jumeme Rural Power Supply of 30 solar hybrid mini-grids, complementing the USD 8.44 million already secured from the EU for implementation.[32] In parallel, the IFC launched a USD 5 million programme in 2015 to spur the development of renewable energy based mini-grids in Tanzania.[33] Rwanda is benefitting from USD 840,000 in SEFA support for the development of 20 hydro-based mini-grids.[34]

The commercialisation of clean cookstoves – primarily in Kenya, with the success of the Jiko stove – has attracted significant investment in recent years. For example, Kenya-based BURN Manufacturing secured USD 4 million in 2013 to establish its first cookstove manufacturing facility, and obtained an additional USD 800,000 in 2015 to expand its activities in Kenya and Tanzania.[35]

DEVELOPMENT FINANCE FOR RENEWABLE ENERGY

Financing of the renewable energy sector in the EAC region has been met predominately through the support and assistance of various development partners, including donor countries, development banks, international organisations and development assistance agencies. Between 2009 and 2013, the sector attracted an estimated USD 5.8 billion in aid from the international community in the form of technical assistance, grants and soft loans; 50% of this went to finance projects in Kenya (see figure 25).[36]

The World Bank, the French Development Agency (AFD) and the Japanese International Cooperation Agency (JICA) traditionally have been the main development partners financing renewable energy projects in the region. These three development finance institutions (DFIs) currently represent 60% of the total international financing aid for the development of renewable energy projects and related infrastructure in the region.[37] Other key institutions include the AfDB, the German Investment and Development Corporation (DEG), the EU and Norway's Norad.

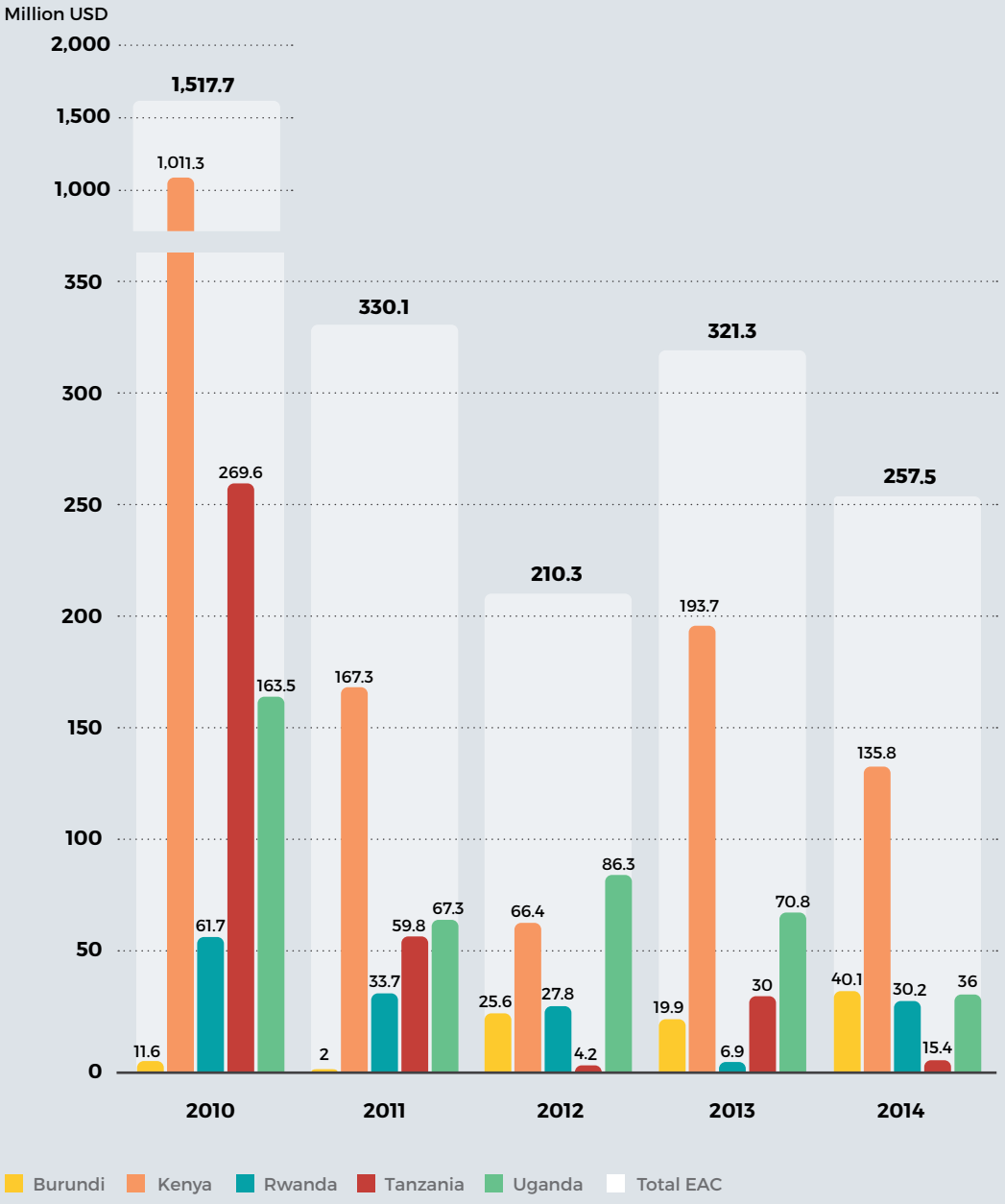
The World Bank has been a key catalyst for the development of renewable energy projects in the region. In 2010, it provided a USD 330 million loan for the development of Kenya's Olkaria IV geothermal plant[i].[38] Other recent World Bank support has included

i Other donors for the project include the AFD (USD 220 million), Germany's KfW (USD 84 million) and JICA (USD 323 million).

SIDEBAR 11. Climate-related finance for the EAC region

Over the past decade, the international community has established a variety of funds to support climate mitigation and "low-carbon" or "clean technology" developments, greatly expanding opportunities for financing renewable energy and energy efficiency projects. In 2014, total bilateral commitments of climate-related official development assistance (ODA) by members of the OECD's Development Assistance Committee to the EAC region reached USD 898 million (see figure 26). Of this total, 41% (approximately USD 368 million) targeted climate change mitigation, 35% (USD 314 million) targeted adaptation objectives, and the remaining 24% (USD 215 million) targeted both mitigation and adaptation activities.

FIGURE 26. Total bilateral climate-related overseas development assistance by country in the EAC region, 2010–2014



Source: See endnote 48 for this chapter.

a grant of USD 100 million to hydropower projects in Burundi and assistance in securing USD 150 million in grants and loans from other key DFIs[i].[39] The World Bank also is financing a USD 135 million loan for the Uganda Energy for Rural Transformation project, which will install solar PV systems at rural public institutions and provide support for market development of SHS.[40]

France's AFD has established itself as a key player in the region with its flagship SUNREF[ii] programme, which provides concessional credit facilities to local banks to support renewable energy and energy efficiency activities. With a credit line of USD 39 million during the first phase, local banks in Kenya have mobilised finance for the installation of some 22 MW of renewable energy in the country.[41] In its second phase, the programme will provide USD 68 million to local banks in Kenya, Uganda and Tanzania, together with USD 2.4 million in technical assistance from the EU-Africa Infrastructure Trust Fund (EU ITF).[42] The AFD also has participated in the financing of the Lake Turkana wind project in Kenya and the Muzizi hydropower in Uganda, providing loans of USD 56 million and USD 50 million, respectively.[43]

AfDB financing and support for renewable energy projects in the region has proven to be a decisive lever for raising additional funding. For example, in support of the Lake Turkana wind project in Kenya, the AfDB has arranged for USD 493 million of loan facilities from various DFIs as well as grants totalling some USD 40 million from the Government of the Netherlands and the EU ITF.[44] In 2015, the AfDB approved USD 138 million in loans and grants to fund the Rusizi III hydropower projects that would benefit Burundi and Rwanda[iii], in addition to a separate USD 22 million grant for hydropower plants in Burundi.[45]

Other DFIs also have begun to play major roles in financing renewable energy projects in the EAC region. OPIC, as part of its Power Africa programme, has committed USD 233 million in debt financing to support the Kipeto Wind Power Project in Kenya, in addition to awarding grants of USD 100,000 each to solar, biogas and biodiesel projects.[46] The UK Department for International Development (DFID) announced in 2014 that it will provide USD 86 million in funding to the Green Mini-grids programme in Kenya and Tanzania.[47] Meanwhile, the newly operational Green Climate Fund (GCF) has provided USD 25 million to the KawiSafi Ventures Fund to invest and leverage private investments for energy companies promoting off-grid solar systems in Kenya and Rwanda (see sidebar 11 on climate-related finance).[48]

i Grants of USD 22 million and USD 36 million from the AfDB and the European Commission, respectively, as well as a loan of USD 95 million from the European Investment Bank.
ii Sustainable Natural Resources and Energy Financing
iii The Rizizi Hydropower project will provide electricity to Burundi, the Democratic Republic of the Congo and Rwanda.

REFERENCE TABLES

Reference Table R1. Key statistics of EAC partner states, 2014

	Population (million)	Share of total EAC population (%)	Land area (thousand km²)	Population density (people per km²)	Population growth rate (%)	Urban population (% of total)	Urbanisation rate (%)
Burundi	10.8	6.9	25.7	421	3.3	12	5.8
Kenya	44.9	28.6	569.1	79	2.6	25	5.9
Rwanda	11.3	7.2	24.7	460	2.4	28	5.5
Tanzania	51.8	33.1	885.8	59	3.2	31	4.3
Uganda	37.8	24.1	200.5	188	3.3	16	5.4
EAC	156.6	100	1,823.4	84.7	3	22.4	5.4
Sub-Saharan Africa	973.4	16.1 (EAC share of SSA population)	21,213.8	41	2.7	37	

Note: Data on population density, population growth rate, urban population and urbanisation rate for the EAC and sub-Saharan Africa reflect averages for these regions.
Source: See endnote 14 for this chapter.

Reference Table R2. Per capita electricity consumption in EAC partner states, 2011/2013

Partner state	Electricity consumption (kWh/per capita)	Year
Burundi	23	2011
Kenya	168	2013
Rwanda	80	2012
Tanzania	89	2013
Uganda	62	2010

Source: See endnote 2 for this chapter.

Reference Table R3. EAC interconnection projects

From	To	Length (km)	Size and type	Capacity (MW)	Earliest year in operation	Status	Financing	Comments
Tanzania	Kenya	507	400 kV (AC)	1,520	2019	Feasibility study completed, detailed design and tender documents being prepared	AfDB, World Bank, JICA	To be connected to the Ethiopia–Kenya transmission system through the Isinya–Suswa 400 kV line. Bidding for line construction was to commence at end-2011.
Rusumo	Rwanda	119	220 kV (AC)	320	2020	Feasibility study and design completed	AfDB, World Bank, KfW, Government of the Netherlands	Lines associated with the Rusumo Falls hydropower plant connecting the project to the grids of Tanzania, Rwanda and Burundi.
Rusumo	Burundi	161	220 kV (AC)	280	2020			
Rusumo	Tanzania	98	220 kV (AC)	–	2020			
Uganda	Kenya	254	229 kV (AC)	300	2016	Under construction	AfDB, JICA, KfW, EU-Africa Infrastructure Trust Fund	Line runs from Lessos substation in Kenya to Bujagali substation in Uganda, duplicating the existing 132 kV line.
Uganda	Rwanda	172	220 kV (AC)	250	2016	Uganda scope: Under construction. Rwanda scope is complete		Line runs from Mbarara to Mirama Hills (Uganda/Rwanda border) to Birembo/Kigali, Rwanda.
Burundi	Rwanda	143	220 kV (AC)	330	2016	Design and tender preparation		Line runs from Rwegura in Burundi to Kigoma, Rwanda. Previous feasibility study had recommended 110 kV line. Update will re-examine proposed 220 kV option and rerouting to feed intermediate locations.

Note: This is an extract from EAPP/EAC ongoing interconnection projects and hence includes interconnection projects between EAC countries and non-EAC countries. For full overview, see source.
Source: See endnote 3 for this section.

Reference Table R4. Installed grid-connected renewable energy capacity in EAC partner states, 2014

	Hydropower	Wind	Solar PV	Biomass power	Geothermal
	MW				
Burundi	33.8[i]	0	0.4	0	0
Kenya	820	25.5	0	26[ii]	598
Rwanda	78.8[iii]	0	8.75	0	0
Tanzania	562	0	0	27	0
Uganda	693	0	0	57.5	0
EAC Total	**2,187.6**	**25.5**	**9.15**	**110.5**	**598**

i Including imports from the regional power plants Rusizi I and II, total installed capacity rises to 50.1 MW.
ii Mumia Co-generation is the only biomass-connected plant.
iii Including imports from the regional power plants Rusizi I and II, total installed capacity rises to 94.2 MW.
Source: See endnote 4 for this section.

Reference Table R5. Number, capacity, and ownership of small-scale hydropower plants (250 kW–10 MW) in EAC partner states, 2015

	Existing hydropower plants (as of 2015)		Approximate plant ownership by stakeholder group, in %[3]	
	No. of plants	MW installed	Utility	Private
Burundi	7	14.7	100%	0%
Kenya	16	35.1	85%	15%
Rwanda	14	27	75%	25%
Tanzania	12	16.2	15%	85%
Uganda	13	65.9	0%	100%
Total	**62**	**158.9**		

Source: See endnote 5 for this section.

Reference Table R6. Existing and planned geothermal projects in Kenya, 2015

Geothermal station	Capacity (MW)	Operator	Operational status
Olkaria I	185	KenGen	Operational
Olkaria II	105	KenGen	Operational
Olkaria III	110	IPP, OrPower4 Limited	Operational
Olkaria Mobile Wellheads	55		Operational
Olkaria IV	140	KenGen	Operational
Eburru Hill	2.5	KenGen	Operational
Menengai	460		Expected completion of phase 1 (100 MW) December 2016
Suswa	150		Projected completion between 2016 and 2018
Baringo-Silali	200		Expected completion between 2016 and 2017
Total Installed Capacity	**597.5**		

Note: This table includes all geothermal projects until 2015. It does not include 9 MW that came online in late 2015/ early 2016.
Source: See endnote 6 for this section.

Reference Table R7. Selected off-grid solar PV players in EAC partner states

Company	EAC partner states	Market segments	Comments
BBOXX	Kenya, Rwanda, Uganda	Portable SHS	Monitoring and remote payment systems, 50 W home systems, high-end PV systems.
Chloride Exide/ Ubbink	Kenya, Tanzania, Uganda, Rwanda	Manufacturing (batteries, modules), SHS, institutional, commercial	Major regional distributor and retailer of over-the-counter systems.
Davis Shirtliff	Kenya, Rwanda, Tanzania, Uganda	Solar pumping, SHS, street lights, institutional, commercial	Major regional distributor and retailer of over-the-counter systems.
M-KOPA SOLAR	Kenya, Uganda	Pico solar	Introduced the mobile-money Pay As You Go system to finance pico solar.
Mobisol	Tanzania, Rwanda	SHS	
Off Grid Electric	Tanzania, Rwanda	Pico solar, SHS	Distributes solar LED systems to rural communities and collect monthly payments using mobile money platforms.
SolarKiosk	Kenya, Tanzania, Rwanda	Pico solar	Solar-powered shops retail fast-moving goods and pico products in rural areas.
SolarNow	Uganda	Pico solar, SHS	Offers financed systems to rural customers.
Solar Sisters	Uganda, Rwanda, Tanzania	Pico solar	A direct sales network of women entrepreneurs, selling pico solar to women in rural households.
SunnyMoney/SolarAid	Kenya, Tanzania	Pico solar	Social entrepreneurs working with pico solar suppliers to distribute products to last-kilometre markets.
JumemeRex Energy	Tanzania	Mini-grids, SHS and institutional systems; also developing pilot mini-grid	One of the two largest solar companies in Tanzania.
Zara Solar	Mwanza, Tanzania and Lake Zone	Pico solar and SHS	One of the two largest solar companies in Tanzania.

Note: This table provides only a selection of solar PV players and is not meant to be comprehensive.
Source: See endnote 7 for this section.

Reference Table R8. Investment in renewable energy in EAC partner states (million USD), 2010–2015

	2010	2011	2012	2013	2014	2015	Total
Burundi	0	0	0	0	274	0	274
Kenya	1,177	0	256	494	1,062	357	3,346
Rwanda	0	92	6	36	24	0	158
Tanzania	64	6	4	14	44	44	176
Uganda	50	0	34	0	3	134	221
Total EAC	**1,291**	**98**	**300**	**544**	**1,407**	**535**	**4,175**
Africa	4,100	3,000	10,200	9,300	7,900	12,500	47,000
%	31.5%	3.3%	2.9%	5.8%	17.8%	4.3%	

Source: See endnote 8 for this section.

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01 . REGIONAL OVERVIEW

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04 . RENEWABLE ENERGY POLICY LANDSCAPE

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8 **Table R8** from BNEF, BNEF Desktop database, country data obtained 29 February 2016. Data include the following renewable energy projects: all biomass and waste-to-energy, geothermal and wind generation projects of more than 1 MW; all hydropower projects of between 1 and 50 MW; all solar power projects, with those less than 1 MW estimated separately and referred to as small-scale projects or small distributed capacity; all ocean energy projects; and all biofuel projects with an annual production capacity of 1 million litres or more. The data does not include any small-scale solar as reliable country-by-country figures are still missing.

LIST OF ABBREVIATIONS

ABPP	Africa Biogas Partnership Programme
AFD	Agence Française de Développement
AfDB	African Development Bank
CFL	Compact fluorescent lamp
CIF	Climate Investment Funds
CO_2	Carbon dioxide
COMESA	Common Market of Eastern and Southern Africa
COP21	21st Conference of the Parties
DFID	UK Department for International Development
DRC	Democratic Republic of the Congo
EAC	East African Community
EACREEE	East African Centre for Renewable Energy and Energy Efficiency
EAPP	Eastern Africa Power Pool
ECOWAS	Economic Community of West African States
EnDev	Energising Development
EPP	Emergency power producer
EU	European Union
EU-ITF	EU-Africa Infrastructure Trust Fund
FIT	Feed-in tariff
GACC	Global Alliance for Clean Cookstoves
GDP	Gross domestic product
GIZ	German Agency for International Co-operation
GW/GWh	Gigawatt/Gigawatt-hour
HAP	Household air pollution
HDI	Human Development Index
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent power producer
JICA	Japan International Cooperation Agency
KenGen	Kenya Electricity Generating Company
KfW	German Development Bank (Kreditanstalt für Wiederaufbau)
km/km²	Kilometre / Square kilometre
KPLC	Kenya Power and Lighting Company
kV	Kilovolt
kW/kWh	Kilowatt/Kilowatt-hour
kWp	Kilowatt peak
LED	Light-emitting diode
LPG	Liquefied petroleum gas
MEPS	Minimum Energy Performance Standard
MJ	Megajoule
MW/MWh	Megawatt/Megawatt-hour
NAMA	Nationally Appropriate Mitigation Action
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OPIC	US Overseas Private Investment Corporation
PJ	Petajoule
PPA	Power purchase agreement
PV	Photovoltaic
REA	Rural Energy/Electrification Agency
REEEP	Renewable Energy and Energy Efficiency Partnership
REFIT	Renewable energy feed-in tariff
REN21	Renewable Energy Policy Network for the 21st Century
RERA	Regional Electricity Regulators Association
RPS	Renewable portfolio standard
SADC	Southern African Development Community
SEforALL	United Nations Sustainable Energy for All initiative
SEFA	AfDB's Sustainable Energy Fund for Africa
SHS	Solar home system(s)
SME	Small and medium-sized enterprise
SNV	Netherlands Development Organisation
SPPA	Standard power purchase agreement
SWH	Solar water heating/heater
TANESCO	Tanzania Electric Supply Company Limited
TFEC	Total final energy consumption
UN	United Nations
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USD	United States dollar
VAT	Value-added tax

GLOSSARY

BIODIESEL . A fuel produced from oilseed crops such as soy, jatropha, rapeseed (canola) and palm oil, and from other oil sources such as waste cooking oil and animal fats. Biodiesel is used in diesel engines installed in cars, trucks, buses and other vehicles, as well as in stationary heat and power applications.

BIOENERGY . Energy derived from any form of biomass, including bio-heat, bio-power and biofuel. Bio-heat arises from the combustion of solid biomass (such as dry fuel wood) or other liquid or gaseous energy carriers. The heat can be used directly or used to produce bio-power by creating steam to drive engines or turbines that drive electricity generators. Alternatively, gaseous energy carriers such as biomethane, landfill gas, or synthesis gas (produced from the thermal gasification of biomass) can be used to fuel a gas engine. Biofuels for transport sometimes also are included under the term bioenergy (see Biofuels).

BIOFUELS. A wide range of liquid and gaseous fuels derived from biomass. Biofuels – including liquid fuel ethanol and biodiesel, as well as biogas – can be combusted in vehicle engines as transport fuels and in stationary engines for heat and electricity generation. They also can be used for domestic heating and cooking (for example, as ethanol gels). Advanced biofuels are made from sustainably produced non-food biomass sources using technologies that are still in the pilot, demonstration or early commercial stages. One exception is hydro-treated vegetable oil (HVO), which is now produced commercially in several plants.

BIOGAS/BIOMETHANE. Biogas is a gaseous mixture consisting mainly of methane and carbon dioxide produced by the anaerobic digestion of organic matter (broken down by micro-organisms in the absence of oxygen). Organic material and/or waste is converted into biogas in a digester. Suitable feedstocks include agricultural residues, animal wastes, food industry wastes, sewage sludge, purpose-grown green crops and the organic components of municipal solid wastes. Raw biogas can be combusted to produce heat and/or power; it also can be transformed into biomethane through a simple process known as scrubbing that removes impurities including carbon dioxide, siloxanes and hydrogen sulphides. Biomethane can be injected directly into natural gas networks and used as a substitute for natural gas in internal combustion engines without fear of corrosion.

BIOMASS . Any material of biological origin, excluding fossil fuels or peat, that contains a chemical store of energy (originally received from the sun) and is available for conversion to a wide range of convenient energy carriers. These can take many forms, including liquid biofuels, biogas, biomethane, pyrolysis oil or solid biomass pellets.

BIOMASS PELLETS . Solid biomass fuel produced by compressing pulverised dry biomass, such as waste wood and agricultural residues. Torrefied pellets produced by heating the biomass pellets have higher energy content per kilogram, as well as better grindability, water resistance, and storability. Pellets are typically cylindrical in shape with a diameter of around 10 millimetres and a length of 30–50 millimetres. Pellets are easy to handle, store and transport and are used as fuel for heating and cooking applications, as well as for electricity generation and combined heat and power.

BRIQUETTES. Blocks of flammable matter made from solid biomass fuels, including cereal straw, that are compressed in a process similar to the production of wood pellets. They are physically much larger than pellets, with a diameter of 50–100 millimetres and a length of 60–150 millimetres. They are less easy to handle automatically but can be used as a substitute for fuelwood logs.

CAPACITY . The rated capacity of a heat or power generating plant refers to the potential instantaneous heat or electricity output, or the aggregate potential output of a collection of such units (such as a wind farm or set of solar panels). Installed capacity describes equipment that has been constructed, although it may or may not be operational (e.g., delivering electricity to the grid, providing useful heat, or producing biofuels).

CAPITAL SUBSIDY . A subsidy that covers a share of the upfront capital cost of an asset (such as a solar water heater). These include, for example, consumer grants, rebates or one-time payments by a utility, government agency or government-owned bank.

CLEAN COOK STOVE . Clean cook stove technologies address the negative health and environmental impacts associated with traditional cooking technologies, typically through improved combustion efficiency. While a number of clean cooking technologies meet this definition, there is currently no definitive standard for what constitutes a clean cook stove.

CONCENTRATED SOLAR THERMAL POWER (CSP) (also called concentrated solar power or solar thermal electricity, STE) . Technology that uses mirrors to focus sunlight into an intense solar beam that heats a working fluid in a solar receiver, which then drives a turbine or heat engine/generator to produce electricity. The mirrors can be arranged in a variety of ways, but they all deliver the solar beam to the receiver. There are four types of commercial CSP systems: parabolic troughs, linear Fresnel, power towers and dish/engines. The first two technologies are line-focus systems, capable of concentrating the sun's energy to produce temperatures of 400 °C, while the latter two are point-focus systems that can produce temperatures of 800 °C or higher. These high temperatures make thermal energy storage simple, efficient, and inexpensive. The addition of storage – using a fluid (most commonly molten salt) to store heat – usually gives CSP power plants the flexibility needed for reliable integration into a power grid.

DISTRIBUTED GENERATION . Generation of electricity from dispersed, generally small-scale systems that are close to the point of consumption.

ENERGY . The ability to do work, which comes in a number of forms including thermal, radiant, kinetic, chemical, potential and electrical. Primary energy is the energy embodied in (energy potential of) natural resources, such as coal, natural gas and renewable sources. Final energy is the energy delivered to end-use facilities (such as electricity to an electrical outlet), where it becomes usable energy and can provide services such as lighting, refrigeration, etc. When primary energy is converted into useful energy, there are always losses involved.

ETHANOL (FUEL) . A liquid fuel made from biomass (typically corn, sugar cane or small cereals/grains) that can replace gasoline in modest percentages for use in ordinary spark-ignition engines (stationary or in vehicles), or that can be used at higher blend levels (usually up to 85% ethanol, or 100% in Brazil) in slightly modified engines such as those provided in "flex-fuel vehicles". Note that some ethanol production is used for industrial, chemical and beverage applications and not for fuel.

FEED-IN TARIFF (FIT) . The basic form of feed-in policies. A guaranteed minimum price (tariff) per unit (normally kWh or MWh) is guaranteed over a stated fixed-term period when electricity can be sold and fed into the electricity network, normally with priority or guaranteed grid access and dispatch.

FINAL ENERGY . The part of primary energy, after deduction of losses from conversion, transmission and distribution, that reaches the consumer and is available to provide heating, hot water, lighting and other services. Final energy forms include electricity, district heating, mechanical energy, liquid hydrocarbons such as kerosene or fuel oil, and various gaseous fuels such as natural gas, biogas and hydrogen. Final energy accounts only for the conversion losses that occur upstream of the end-user, such as losses at refineries and power plants.

FISCAL INCENTIVE . An economic incentive that provides individuals, households or companies with a reduction in their contribution to the public treasury via income or other taxes, or with direct payments from the public treasury in the form of rebates or grants.

GENERATION . The process of converting energy into electricity and/or useful heat from a primary energy source such as wind, solar radiation, natural gas, biomass, etc.
GEOTHERMAL ENERGY. Heat energy emitted from within the earth's crust, usually in the form of hot water or steam. It can be used to generate electricity in a thermal power plant or to provide heat directly at various temperatures for buildings, industry and agriculture.

HYDROPOWER . Electricity derived from the potential energy of water captured when moving from higher to lower elevations. Categories of hydropower projects include run-of-river, reservoir-based capacity and low-head in-stream technology (the least developed). Hydropower covers a continuum in project scale from large (usually defined as more than 10 MW of installed capacity, but the definition varies by country) to small, mini, micro and pico.

INVESTMENT . Purchase of an item of value with an expectation of favourable future returns. In this report, new investment in renewable energy refers to investment in: technology research and development, commercialisation, construction of manufacturing facilities and project development (including construction of wind farms, purchase and installation of solar PV systems). Total investment refers to new investment plus merger and acquisition (M&A) activity (the refinancing and sale of companies and projects).

INVESTMENT TAX CREDIT . A taxation measure that allows investments in renewable energy to be fully or partially deducted from the tax obligations or income of a project developer, industry, building owner, etc.

JOULE/KILOJOULE/MEGAJOULE/GIGAJOULE/TERAJOULE/ PETAJOULE/ EXAJOULE . A Joule (J) is a unit of work or energy equal to the energy expended to produce one Watt of power for one second. For example, one Joule is equal to the energy required to lift an apple straight up by one metre. The energy released as heat by a person at rest is about 60 J per second. A kilojoule (kJ) is a unit of energy equal to one thousand (10^3) Joules; a megajoule (MJ) is one million (10^6) Joules; and so on. The potential chemical energy stored in one barrel of oil and released when combusted is approximately 6 GJ; a tonne of oven dry wood contains around 20 GJ of energy.

MANDATE/OBLIGATION. A measure that requires designated parties (consumers, suppliers, generators) to meet a minimum, and often gradually increasing, target for renewable energy, such as a percentage of total supply or a stated amount of capacity. Costs are generally borne by consumers. Mandates can include renewable portfolio standards (RPS); building codes or obligations that require the installation of renewable heat or power technologies (often in combination with energy efficiency investments); renewable heat purchase requirements; and requirements for blending biofuels into transport fuel.

MINI-GRIDS. Small electric grids that serve entire communities through distribution networks. Until recently, most mini-grids relied on diesel fuel. Hydro-powered mini-grids are mature technologies, whereas gas- red generator mini-grids, powered by agricultural waste or biogas, are maturing technologies. The use of inverter-connected mini-grids that incorporate a variety of renewable and other technologies (including battery banks) is developing rapidly.

MODERN BIOMASS ENERGY. Energy derived from combustion of solid, liquid and gaseous biomass fuels in efficient, small domestic appliances to large-scale industrial conversion plants for modern applications of space heating, electricity generation, combined heat and power, and transport (as opposed to traditional biomass energy).

NET METERING . A regulated arrangement in which utility customers who have installed their own generating systems pay only for the net electricity delivered from the utility (total consumption minus on-site self-generation). A variation that employs two meters with differing tariffs for purchasing electricity and exporting excess electricity off-site is called "net billing".
POWER. The rate at which energy is converted per unit of time, expressed in Watts (Joules/second).

PRIMARY ENERGY . The theoretically available energy content of a naturally occurring energy source (such as coal, oil, natural gas, uranium ore, geothermal and biomass energy, etc.) before it undergoes conversion to useful final energy delivered to the end-user. Conversion of primary energy into other forms of useful final energy (such as electricity and fuels) entails losses. Some primary

energy is consumed at the end-user level as final energy without any prior conversion.

PUBLIC COMPETITIVE BIDDING (ALSO CALLED AUCTION OR TENDER) . A procurement mechanism by which public authorities solicit bids for a given amount of renewable energy supply or capacity, generally based on price. Sellers offer the lowest price that they would be willing to accept, but typically at prices above standard market levels.

REGULATORY POLICY . A rule to guide or control the conduct of those to whom it applies. In the renewable energy context, examples include mandates or quotas such as renewable portfolio standards, feed-in tariffs, biofuel blending mandates and renewable heat obligations.

RENEWABLE ENERGY TARGET . An official commitment, plan or goal set by a government (at the local, state, national or regional level) to achieve a certain amount of renewable energy by a future date. Some targets are legislated while others are set by regulatory agencies or ministries.

RENEWABLE PORTFOLIO STANDARD (RPS) . An obligation placed by a government on a utility company, group of companies, or consumers to provide or use a predetermined minimum renewable share of installed capacity, or of electricity or heat generated or sold. A penalty may or may not exist for non-compliance. These policies are also known as "renewable electricity standards", "renewable obligations" and "mandated market shares", depending on the jurisdiction.

SOLAR HOME SYSTEM (SHS) . A stand-alone system composed of a relatively small power photovoltaic module, battery and sometimes a charge controller, that can power small electric devices and provide modest amounts of electricity to homes for lighting and radios, usually in rural or remote regions that are not connected to the electricity grid.

SOLAR PHOTOVOLTAICS (PV) . A technology used for converting solar radiation (light) into electricity. PV cells are constructed from semi-conducting materials that use sunlight to separate electrons from atoms to create an electric current. Modules are formed by interconnecting individual solar PV cells. Monocrystalline modules are more efficient but relatively more expensive than polycrystalline silicon modules.

SOLAR WATER HEATER (SWH) . An entire system – consisting of a solar collector, storage tank, water pipes and other components – that converts the sun's energy into "useful" thermal (heat) energy for domestic water heating, space heating, process heat, etc. Depending on the characteristics of the "useful" energy demand (potable water, heating water, drying air, etc.) and the desired temperature level, a solar water heater is equipped with the appropriate solar collector. There are two types of solar water heaters: pumped solar water heaters use mechanical pumps to circulate a heat transfer fluid through the collector loop (active systems), whereas thermo-siphon solar water heaters make use of buoyancy forces caused by natural convection (passive systems).

SUBSIDIES . Government measures that artificially reduce the price that consumers pay for energy or reduce production costs.

TRADITIONAL BIOMASS . Solid biomass, including gathered fuel wood, charcoal, agricultural and forest residues, and animal dung, that is usually produced unsustainably and typically used in rural areas of developing countries by combustion in polluting and inefficient cook stoves, furnaces or open fires to provide heat for cooking, co mfort and small-scale agricultural and industrial processing (as opposed to modern biomass energy).

WATT/KILOWATT/MEGAWATT/GIGAWATT/TERAWATT-HOUR . A Watt is a unit of power that measures the rate of energy conversion or transfer. A kilowatt is equal to one thousand (10^3) Watts; a megawatt to one million (10^6) Watts; and so on. A megawatt electrical (MW) is used to refer to electric power, whereas a megawatt-thermal (MW_{th}) refers to thermal/heat energy produced.

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