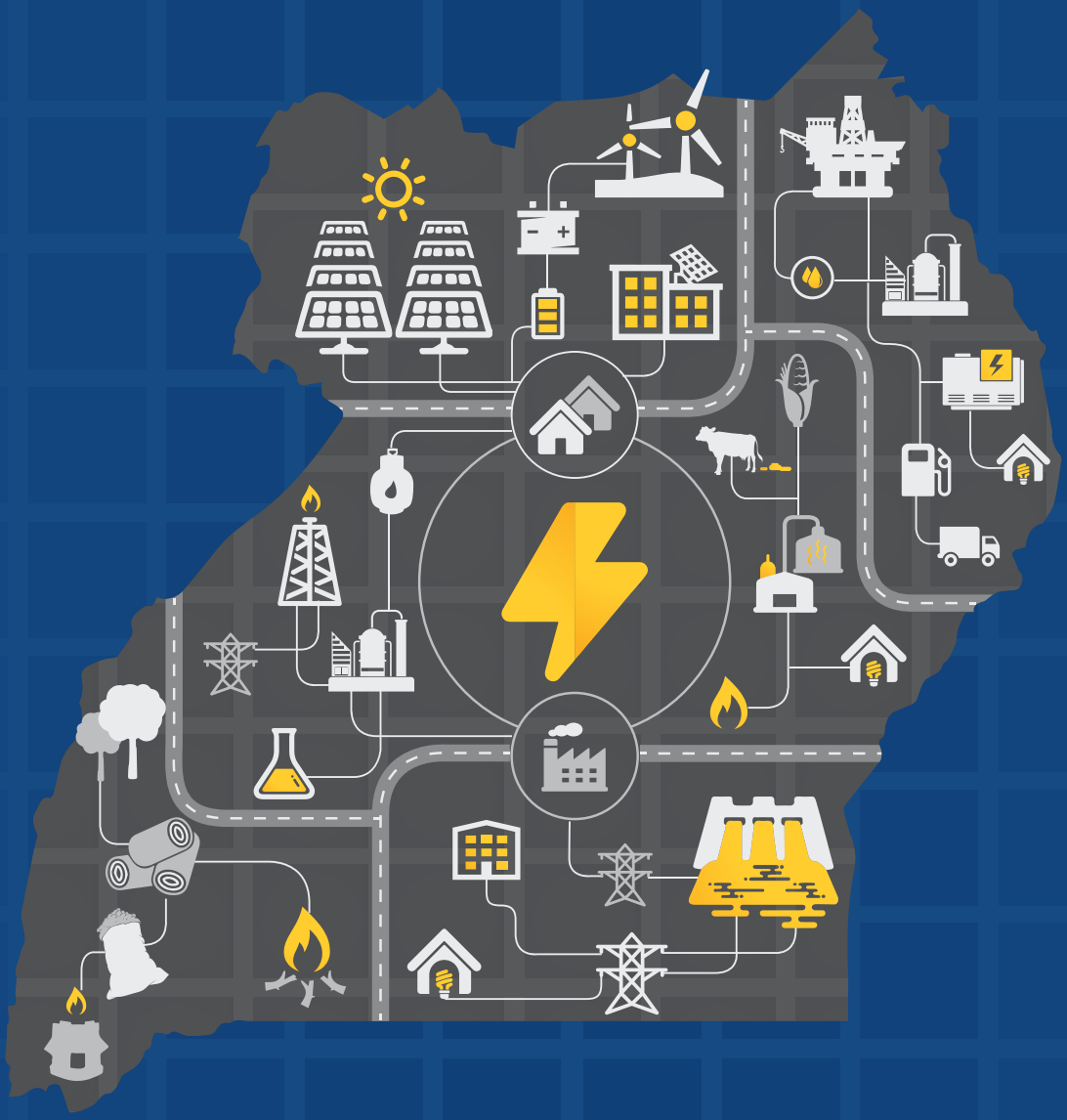
REALITY CHECK

Powering Uganda's Transformation



Centre for Development Alternatives

Konrad Adenauer Stiftung

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REALITY CHECK #10
Powering Uganda's Transformation

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List of Acronyms

ACET: *African Center for Economic Transformation*

COMESA: *Common Market for Eastern & Southern Africa*

DRC: *Democratic Republic of Congo*

ERA: *Electricity Regulatory Authority*

GDP: *Gross Domestic Product*

IEA: *International Energy Agency*

IMF: *International Monetary Fund*

IPP: *Independent Power Producer*

IRENA: *International Renewable Energy Agency*

ITES/BPO: *IT-Enabled Services/Business Process Outsourcing*

JICA: *Japanese International Cooperation Agency*

MEMD: *Ministry of Energy and Mineral Development*

MFPED: *Ministry of Finance, Planning and Economic Development*

NAPA: *National Adaptation Programme of Action*

PAYGO: *Pay-As-You-Go*

REA: *Rural Electrification Agency*

ROI: *Return on Investment*

SDG: *Sustainable Development Goal*

SGB: *Small and Growing Business*

SME: *Small and Medium Enterprise*

SSA: *Sub-Saharan Africa*

UBOS: *Uganda Bureau of Statistics*

UEGCL: *Uganda Electricity Generation Company Ltd.*

UETCL: *Uganda Electricity Transmission Company Ltd.*

UNDP: *UN Development Programme*

UNECA: *UN Economic Commission for Africa*

WWF: *World Wildlife Fund*

1.
INTRODUCTION

Introduction

This study examines the role of energy as a driver and shaper of economic transformation in Uganda. This is based on the premise that while much has been written and said about household energy access, the public discourse on energy for economic transformation has been weak in Uganda. This focus on household access is reflected in the setting of targets by government and development partners and in the advocacy work of civil society.

This publication argues that while household access is crucial to improving the population's quality of life, providing all households with access to modern energy before they can afford to pay for it may be putting the horse before the cart. It is unlikely that access to modern energy is the immediate binding constraint to most households' wellbeing; Ugandan households need income. Even if modern energy is the most urgent need for many Ugandan households, access without purchasing power would do little to change their situation. For example, the rise in electricity customer numbers has not translated into a proportional rise

in electricity consumption. Customers increased by 117% from 2015 to 2016 while the annual growth rate in power sales was only 5%. Stakeholder interviews revealed that energy is overwhelmingly seen as a consumption good by policy and programming in Uganda, with both focusing on households as targets. For sustainable economic transformation, energy targets should be linked to production and industrial growth pathways. For instance, the National Development Plan focuses on key growth sectors, but there is little linkage between energy plans and industrialisation plans.

The Government of Uganda has expressed its commitment towards transforming the country from an agrarian low-income country to a modern upper middle-income status country by 2040[1], thereby lifting the vast majority of households out of poverty, giving them the purchasing power to buy more modern energy, among other things. Such a transition will require a fundamental transformation of the economy, whereby a substantial part of the labour force moves from low productivity into modern, high productivity sectors and activities. Energy is one of the fundamental building blocks of such an economic transformation. All economic activity requires energy; high productivity sectors require more, more reliable and more modern forms of energy.

1 National Planning Authority (2013)

Energy access is not an end in itself. Its benefits extend to all areas of society such as agriculture, commercial activities, health, women economic empowerment, education and welfare for displaced persons. For energy to foster economic growth, its use and benefits will need to be explored independently for each of these sectors[2].

This report explores the relationship between energy and economic transformation in Uganda.

It examines to what extent Uganda's energy system currently drives or hinders economic transformation, identifies the greatest constraints hindering the energy system from being a driver of transformation, and explores opportunities for progress in that regard. In doing so, this report aims to contribute to fostering a richer public discourse on energy in Uganda.

The study is structured as follows. Section 2 describes the study's methodology. Section 3 defines economic transformation and assesses Uganda's economic transformation story and outlook. Section 4 unpacks the role of energy in driving and shaping economic transformation, globally and in Uganda. Section 5 presents an overview of the current status of Uganda's energy sector and its performance in driving economic transformation. Sections 6 - 8 analyse the current status of energy for economic transformation in Uganda in depth, looking at electricity, biomass, and petroleum fuels respectively. Section 9 discusses the binding constraints on energy as a driver of economic transformation in Uganda. Section 10 explores several opportunities to overcome those constraints. Section 11 concludes.

2. Energy4Impact (2017)

2.
METHODOLOGY

Methodology

This study employed an iterative diagnostic methodology following the analytical framework described below:

- **GOAL:** Economic transformation requires an inclusive, sustainable and resilient energy system that drives productivity throughout the economy.
- **PATHWAY**: What will economic transformation look like in Uganda? What does the energy system need to achieve in Uganda in order to drive that transformation?
- **STATUS:** How does the current energy system score against criteria derived from the above goal?
- **CONSTRAINTS:** What are the binding constraints holding Uganda's energy system back from effectively driving economic transformation?
- **OPPORTUNITIES:** What opportunities exist to overcome these binding constraints?

The methodology included the following approaches to information gathering:

- Review of secondary analytical literature from academia, donors and other actors
    - *Sources include academic papers, World Bank, UN Development Programme (UNDP), International Energy Agency (IEA), International Renewable Energy Agency (IRENA), UN Economic Commission for Africa (UNECA), etc.*
- Review of technical studies and planning documents on energy and related fields
    - *Sources include Ministry of Energy and Mineral Development (MEMD), Electricity Regulatory Authority (ERA), Uganda Electricity Transmission Company Limited (UETCL), Umeme, World Wildlife Fund (WWF), Japan International Cooperation Agency (JICA), etc.*
- Review of quantitative data on Uganda's energy system
    - *Sources include ERA, MEMD, Uganda Bureau Of Statistics (UBOS), World Bank, etc.*
- Key stakeholder interviews: 20 semi-structured interviews with government, energy value chain actors, civil society, donors, energy experts and private sector [3]
- Collaboration with academics: University of Bath
    - *Philipp Trotter, an engineer and PhD researcher on electricity planning in Africa at the University of Bath, supported the study with his expertise and data on Uganda.*

3. Organisations interviewed include: World Bank, KfW, GIZ, Geo Gecko, UETCL, UEGCL, UETCL, REA, ERA, MEMD, UMEME, CGGC, Deloitte, NPA, WWF, Tiger Power, Oxford Institute for Energy Studies, Embassy of Norway, Uganda Manufacturers' Association, two anonymous manufacturing firms, donor working group on energy.

3.
ECONOMIC TRANSFORMATION

Economic Transformation

Economic transformation is "a complete overhaul of a country's economic system"[4]. At its heart, it is a structural shift in the economy from traditional agriculture to modern agriculture, industry and services. This shift occurs through (i) moving labour and other resources away from low-productivity and into high-productivity sectors and (ii) upgrading economic productivity within a sector, especially agriculture[5].

The leading literature on the subject broadly characterises economic transformation as follows[6 7] :

- **Productivity:** Farms, firms, governments and other organisations become more productive and efficient through the adoption of more productive inputs (land, labour, agricultural inputs, etc.), technologies and management practices.
- **Resource allocation:** Resources are reallocated away from the least productive organisations towards more productive organisations;
- **Diversification & trade:** Key economic sectors produce and trade a more diverse array of products and services, become more competitive and active in international value chains, adding and capturing more value in these chains;
- **Shared prosperity:** Prosperity is spread through productive work and higher domestic consumption.

The above process is enabled by a number of cross-cutting foundations including [8]:

- **Business climate reforms** to induce the movement of resources from traditional to modern activities - including the protection of property rights, economic liberalisation, and more efficient and inclusive regulatory frameworks;
- **Financial sector deepening** to facilitate transformation-enhancing resource allocation in the economy through macroeconomic stability, robust financial sector rules, market-enabling policies that support competition, technological upgrading and domestic demand growth, and a financial sector that supports effective FDI;
- **Investment in human capital** to encourage and ease the transition of labour from subsistence agriculture and other low productivity activities into higher productivity industry and service sectors;
- **Infrastructure development,** especially energy and transport infrastructure, to power modern production and enable the mobility of people and goods;
- **Effective urbanisation,** which produces

4. Amoako-Tuffour, J., Bachin, N., Calabrese, L., & Mendez-Parra, M. (2016).
5. McMillan, M., Page, J., Booth, D. and te Velde, D.W. (2017).
6. ibid.
7. ACET (2013).
8. McMillan, M., Page, J., Booth, D. and te Velde, D.W. (2017)

the agglomeration of firm capabilities, labour and consumers, producing economies of scale and specialisation, and driving demand for goods and services;

- **Stepwise policy approaches** that tackle the most binding constraints on firm productivity, diversification and value-addition.

Inclusive Economic Transformation

Inclusive economic transformation means that the chances to benefit from transformation are broadly shared among the population[9] [10]. The key pillar of inclusive economic transformation is decent employment for all, complemented by wealth distribution and social safety nets that absorb the shocks resulting from labour market volatility in the process of economic change[11].

Decent and productive employment is created directly and indirectly. When firms grow by producing a higher quantity or value of goods and services, they need more inputs - including capital, land and labour. Firms in labour-intensive sectors and activities require primarily more labour when they grow. Thus, the overall demand for labour increases and more jobs are created. The evidence is consistent across developed and low-income countries: Small and Medium Enterprises (SMEs) provide the largest share of decent employment, and a small number of small but rapidly growing firms create a disproportionately high share of new decent jobs.[12] The direct creation of employment is thus primarily driven by SMEs, especially in labour-intensive sectors. The indirect creation of decent and productive jobs depends on the employment multiplier effect. That is, employment growth in some sectors creates indirect jobs at varying rates in related sectors, for example in firms that supply raw materials and in firms that supply services to wage workers[13] .

Achieving broad-based decent and productive employment also means raising the productivity and conditions of employment in household enterprises. Despite direct and indirect job creation by small and growing firms, it is important to note that in sub-Saharan Africa (SSA), most people are unlikely to be able to gain formal employment in high productivity sectors in the short- to medium-run. They will continue to be employed in micro- to small household enterprises, both in smallholder agriculture and in 'off-farm' activities. These household enterprises are mostly informal and tend to have a limited potential or ambition for growth.

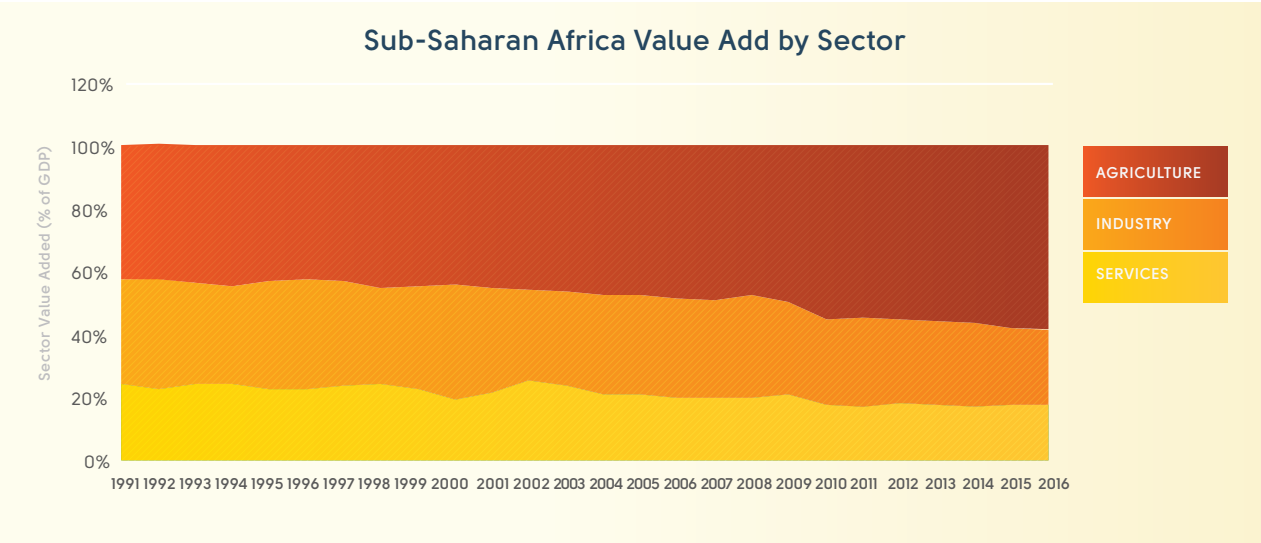
9 Lundstrom, S., & Lanchovichina, E. (2009)
10 Hausmann, R. et al. (2008)
11 Raworth, K. (2017)
12 ANDE (2017)
13 Bivens, J. (2003)

Sub-Saharan Africa's Economic Transformation Story

In recent decades, SSA economies have generally experienced rapid GDP growth coupled with slow economic transformation. Six of the world's 10 fastest growing economies in the 2000s were in Africa[14]. In 2018 again, the World Bank projects that six of the 10 fastest growing economies will be in Africa: Ghana, Ethiopia, Côte d'Ivoire, Djibouti, Senegal and Tanzania. But this growth has not translated into economic transformation. Production in virtually all countries is still dominated by the primary sector, either in agriculture or minerals, productivity across sectors is low and stagnant, and the growth of productive formal sectors has not been labour-intensive.

The graphs below show that there was no major shift in the GDP or labour composition on the subcontinent at the aggregate level. The contribution to GDP of services rose steadily from just over 40% in 1990 to just under 60% in 2015 while that of industry and agriculture fell gradually, from just over 30% and 25% to just under 25% and 20%, respectively. The labour composition remained even more stationary, with only a very slight shift from agriculture to services since 2010. Overall, agriculture hovered at 60% of labour, services at 30% and industry at 10%, throughout the period 1990 – 2015.

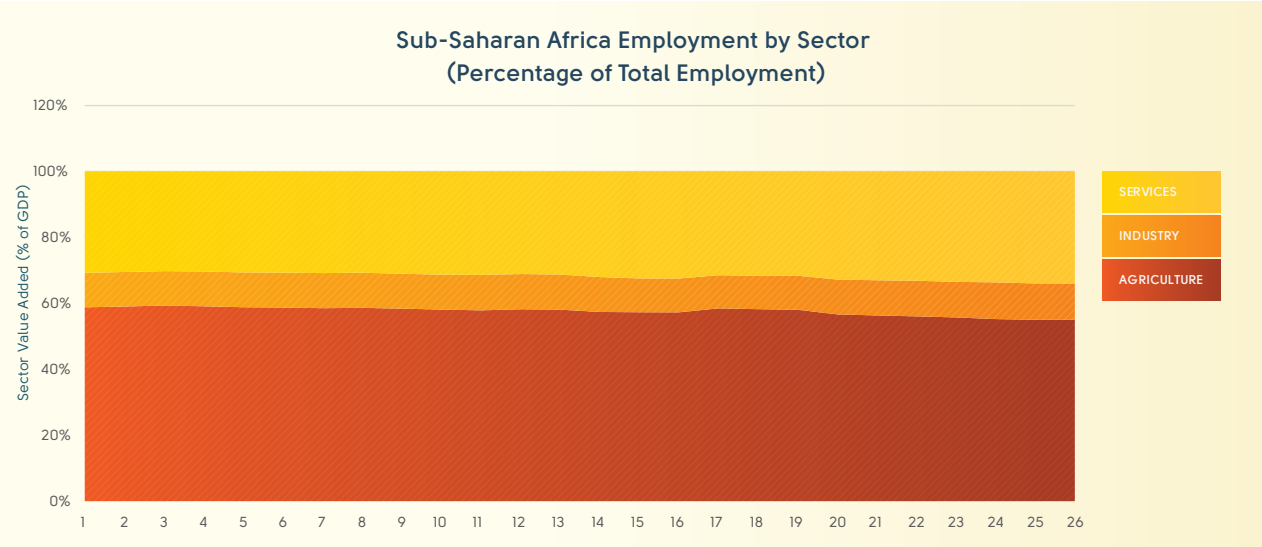
Figure 1: **Sectoral contribution to GDP, Sub-Saharan Africa, 1991-2016.**



Source: World Bank (2018).

14 ACET (2013)

Figure 2: **Sectoral contribution to total employment, Sub-Saharan Africa.**

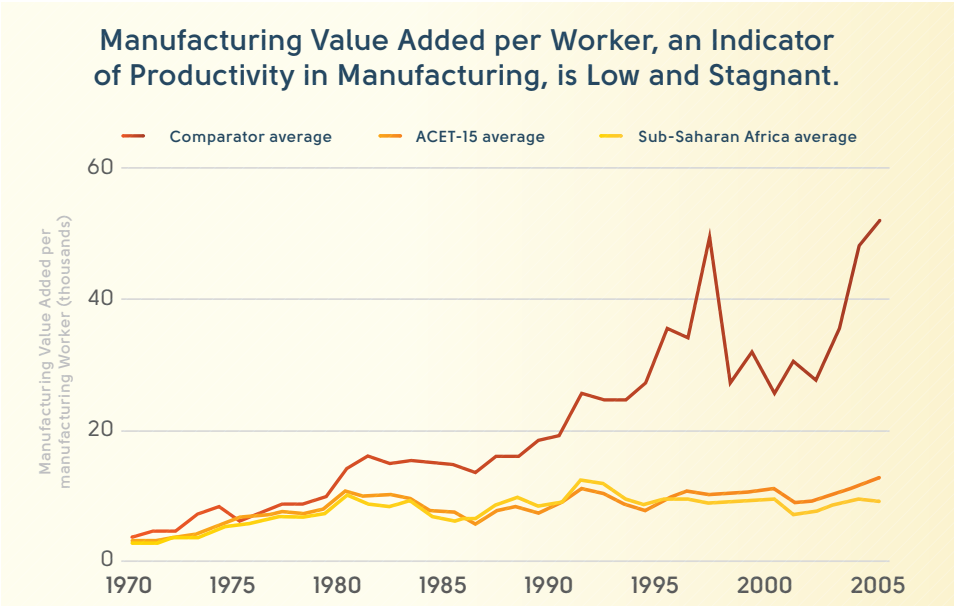


Source: World Bank (2018).

SSA exports have been diversifying, but at a very slow pace. The top five exports in SSA countries represented almost 90% of total exports in 1975. This concentration fell to under 80% in the 1980s and then much more slowly to about 75% in 2010[15].

As illustrated in Figures 3 and 4 below, productivity in manufacturing and agriculture is low and stagnant. The average farmer in SSA produces less than half of what an Indian farmer produces and less than a fourth of a Chinese farmer's production. The Green Revolution and the transformation of the rural sectors between the 1960s and 1990s seen in many Asian countries have not taken off in SSA[16].

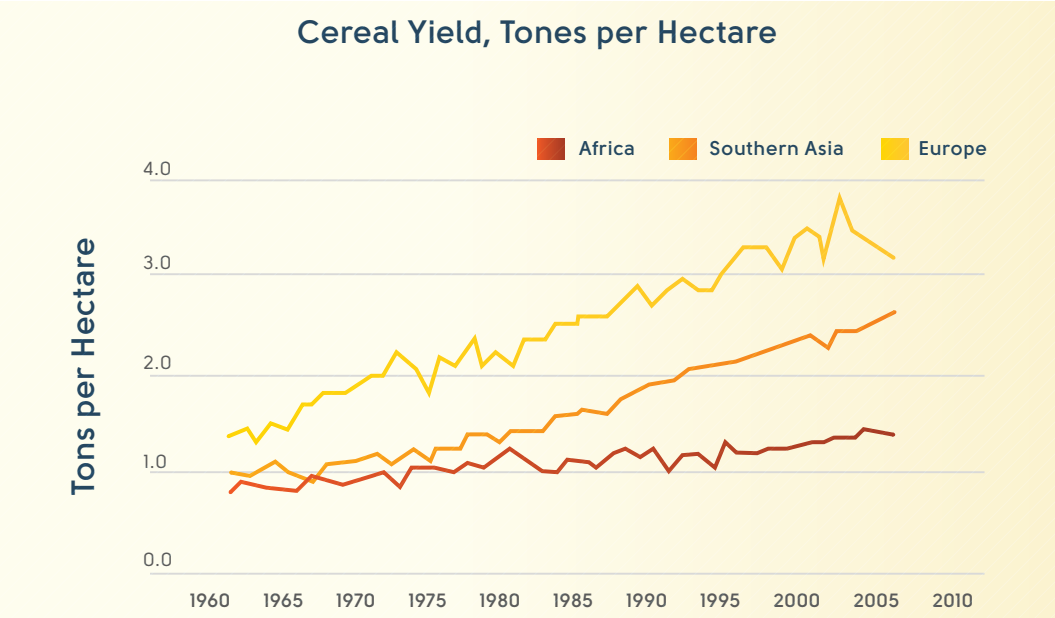
Figure 3: **Manufacturing value added per worker, 1970-2005.**



Source: ACET (2013).

15. ACET (2013)
16. Kiranda, Y., Walter, M., and Mugisha, M. (2017)

Figure 4: **Cereal yield per hectare, 1960-2010.**



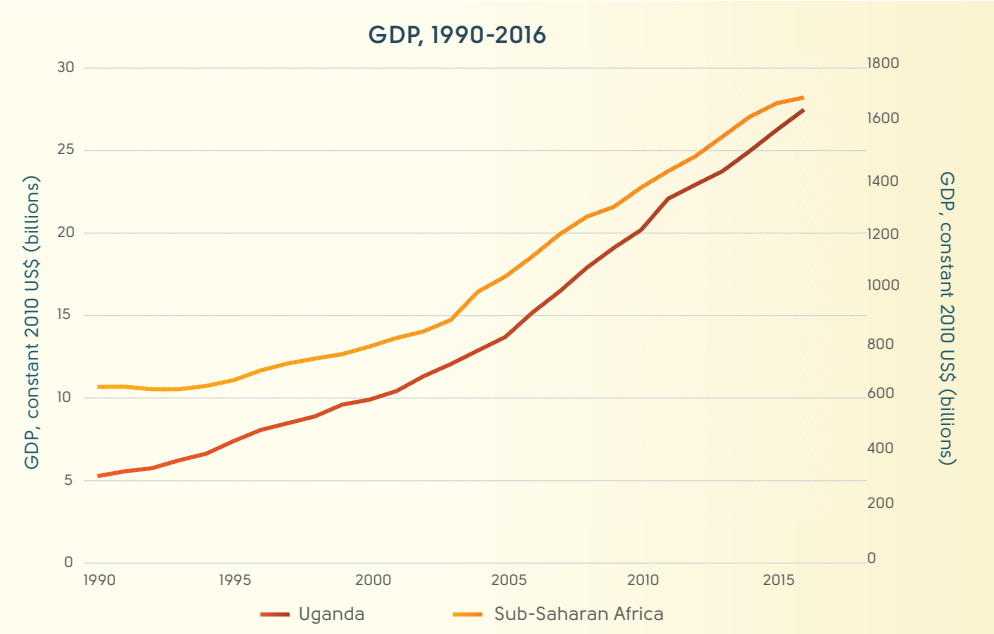
Source: Ministry of Foreign Affairs of Denmark (2009).

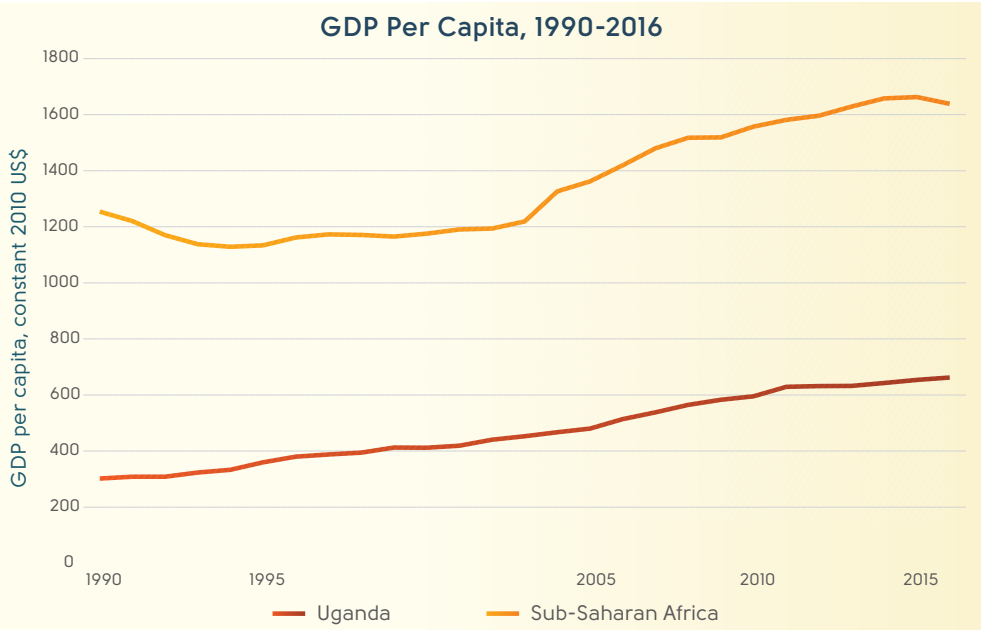
Uganda's Economic Transformation Story

Uganda's economy shifted rapidly during the 1990s, with output shifting from agriculture to services, and to industry to a lesser degree. However, this was not due to, nor accompanied by, a similar shift in labour. From around 2000 onwards, GDP composition has remained constant, with services representing just over half of GDP, followed by agriculture and industry. Nevertheless, in the same period, the economy started to see a significant diversification of exports away from primary commodities to more complex products and services. The data on productivity is sparse and somewhat ambiguous. It is clear that agricultural productivity has stagnated for several decades and that services and industry productivity have grown, but data on services and industry productivity is less reliable than data on agricultural productivity.

The figures below show that Uganda's overall GDP growth closely followed the SSA trend between 1990 and 2015. GDP per capita growth trends show that Uganda saw more even and steady progress than the subcontinent as a whole, but that Uganda still lags far behind the SSA average. All in all, Uganda's economy has been growing relatively quickly and steadily.

Figure 5: **Growth of the Ugandan economy, 1990-2016, measured in GDP and GDP per capita.**



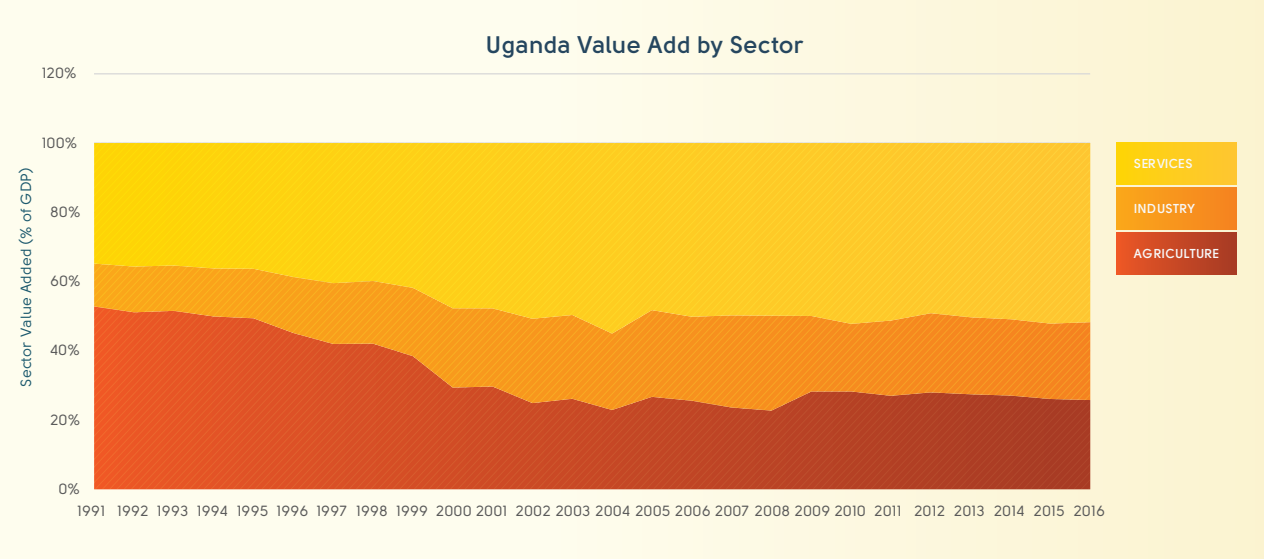


Source: World Bank Databank, World Development Indicators

Uganda's GDP composition shifted rapidly from agriculture to services and manufacturing during the 1990s and early 2000s, but this structural transformation stalled from 2005. Until 1990, agriculture was by far the biggest contributor to Uganda's GDP. In the decade that followed, Uganda's economy saw a major shift in GDP composition. Over the course of the 1990s and early 2000s agriculture's contribution fell from over 50% to under 30%, and services rose from around 35% to around 50% of GDP. Concurrently, the value-

added share of industry grew from just over 10% in 1990 to over 20% at the turn of the millennium. That shift, however, stalled by about 2005, and the GDP composition has hovered at constant levels since then.

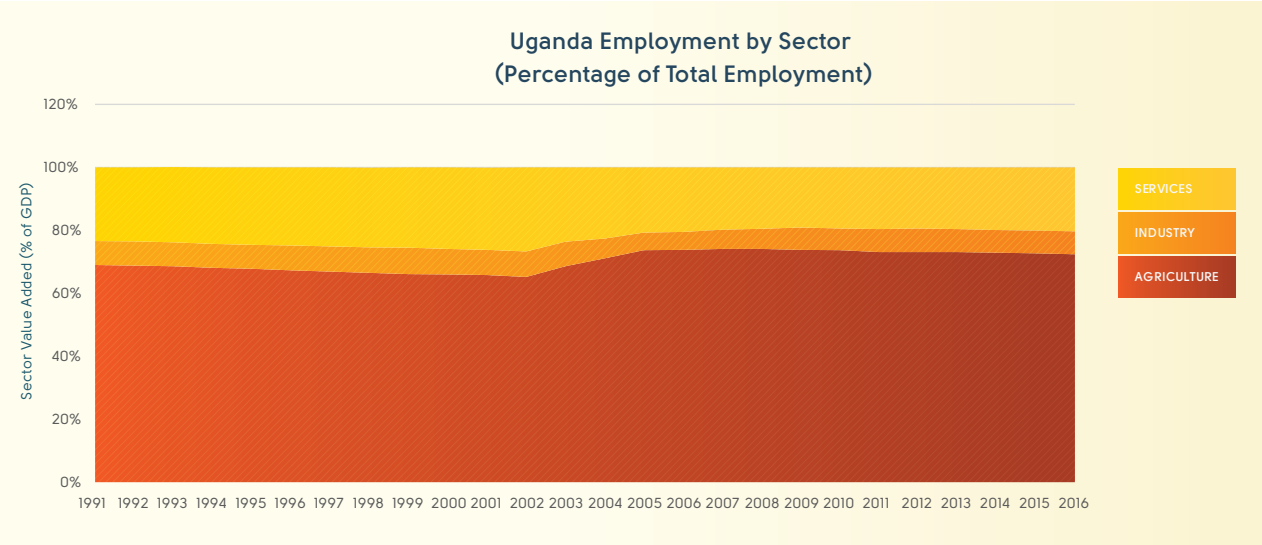
Figure 6: **Uganda value add by sector, 1991-2016.**



Source: World Bank (2018).

However, this shift in value addition has not been accompanied by a shift in labour from low to high productivity sectors and activities. Strikingly, the share of labour in agriculture actually *increased* in the early 2000s and was still above 1990 levels in 2015. Over two thirds of the working age population remains in agriculture. The services sector, which accounts for over half of GDP, employs just over 20% of the working age population. Industry, with a GDP contribution similar to that of agriculture, employs just 7%. In figure 7 it is clearly visible that labour did not shift from agriculture to services. In the context of rapid population (and labour force) growth, the services sector grew at the same pace as agriculture in terms of labour, but much faster in terms of productivity. Economic growth has been largely driven by high-value services such as telecommunications, finance and real estate – activities that rely on a small number of skilled workers. Most jobs have been created in less productive sectors such as small-scale trade and subsistence agriculture.

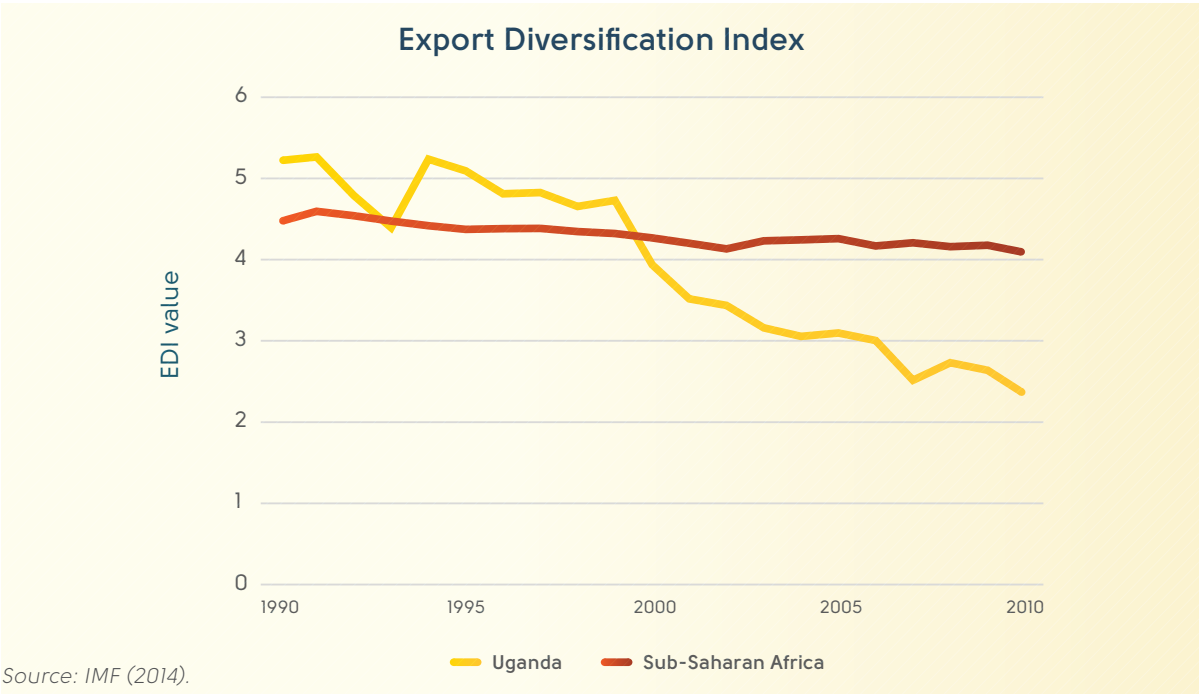
Figure 7: **Uganda employment by sector, 1991-2016.**



Source: World Bank (2018).

Uganda's performance on export diversification has far outshone the subcontinent's average since the late 1990s. The Export Diversification Index (EDI) is a measure of the diversity of an economy's exports: a lower index score represents a more diversified export sector. Uganda's EDI overtook the sub-Saharan African average in the late 1990s and currently rivals those of much more advanced economies such as South Africa, New Zealand and Argentina.

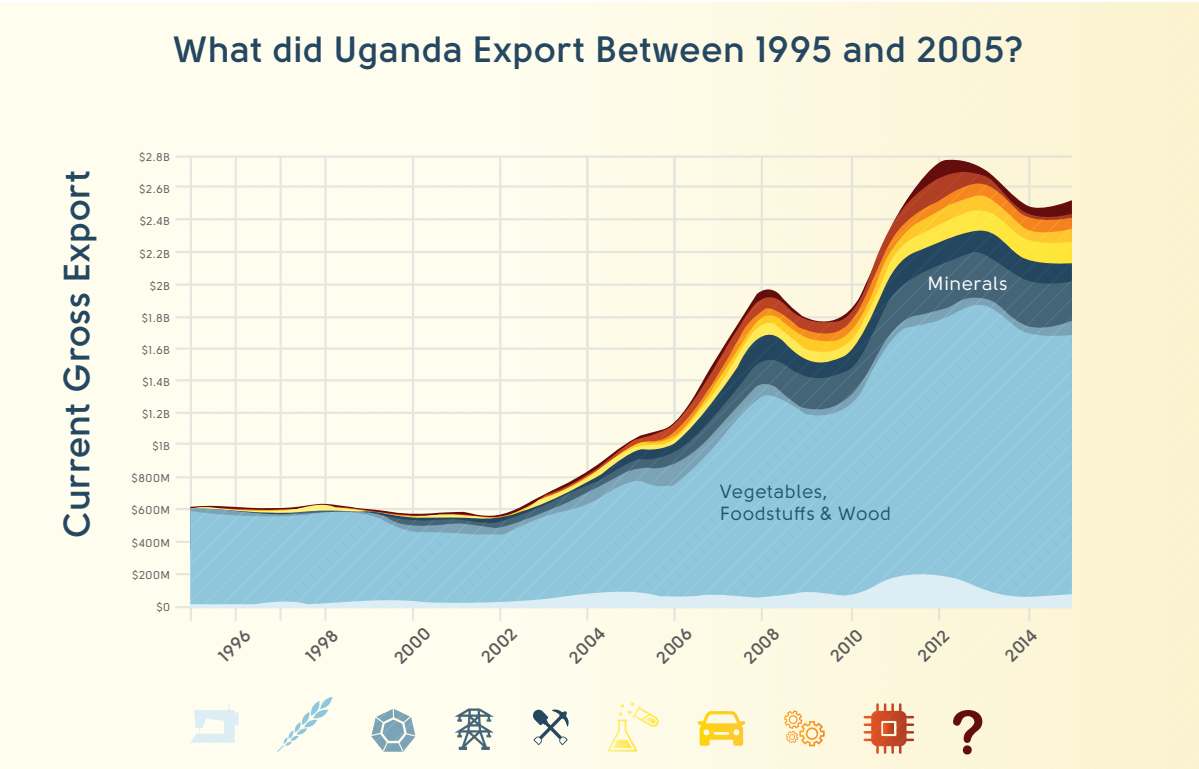
Figure 8: **Export diversification, Uganda and Sub-Saharan Africa average.**



Source: IMF (2014).

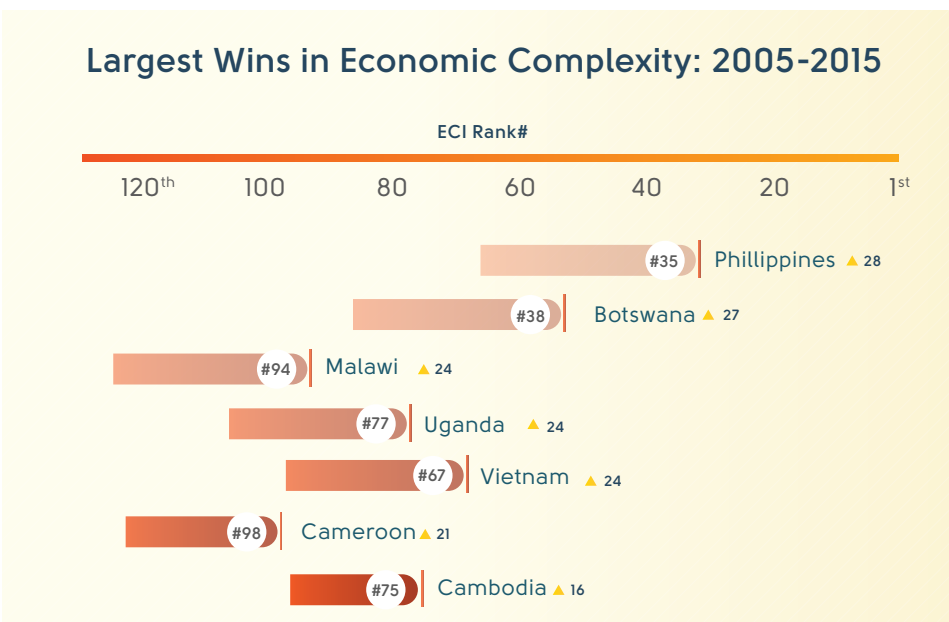
The graph below illustrates the simultaneous growth and diversification of Uganda's exports starting in the early 2000s.

Figure 9: **Gross exports, 1995-2014.**



Source: Hausmann, R. and Hidalgo, C.A. (2015).

Figure 10: **Ranking of countries according to gains in economic complexity, 2005-2015.**



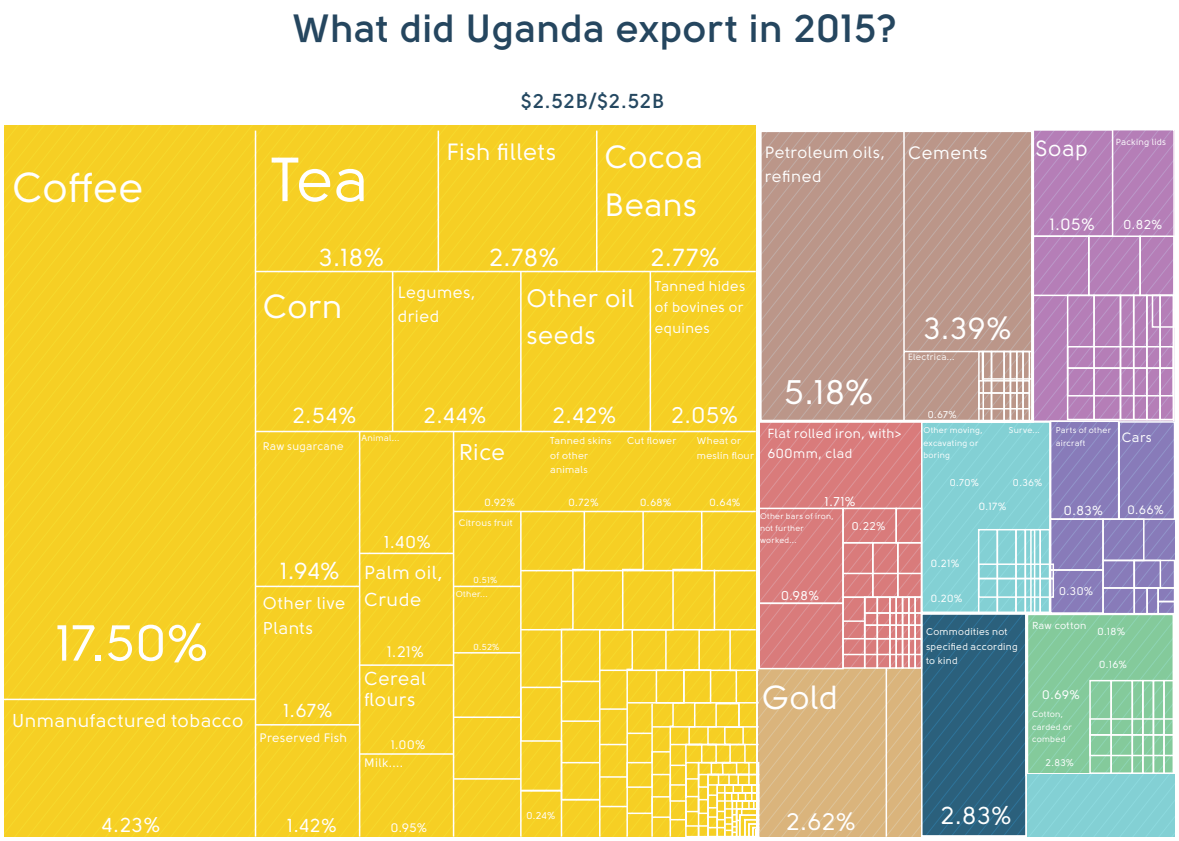
Source: Hausmann, R. and Hidalgo, C.A. (2015).

According to the Atlas of Economic Complexity, Uganda's industrial sector has become rapidly more diversified and sophisticated in the last decade. The Economic Complexity Index (ECI) "combines metrics of the diversity of countries and the ubiquity of products to create measures of the relative complexity of a country's exports" (AEC). As illustrated in Figure 10 Uganda has seen one of the biggest improvements in

ECI between 2005 and 2015. With an ECI rank of 77th, it also comfortably surpasses its regional neighbours.

Despite these gains in diversification, unprocessed products still make up the majority of Uganda's exports[17]. Half of Uganda's exports are sold within the East African Community (EAC) and to other neighbouring countries, while 28% are sold to Europe and 16% to Asia.

Figure 11: **Breakdown of Uganda's exports, 2015.**

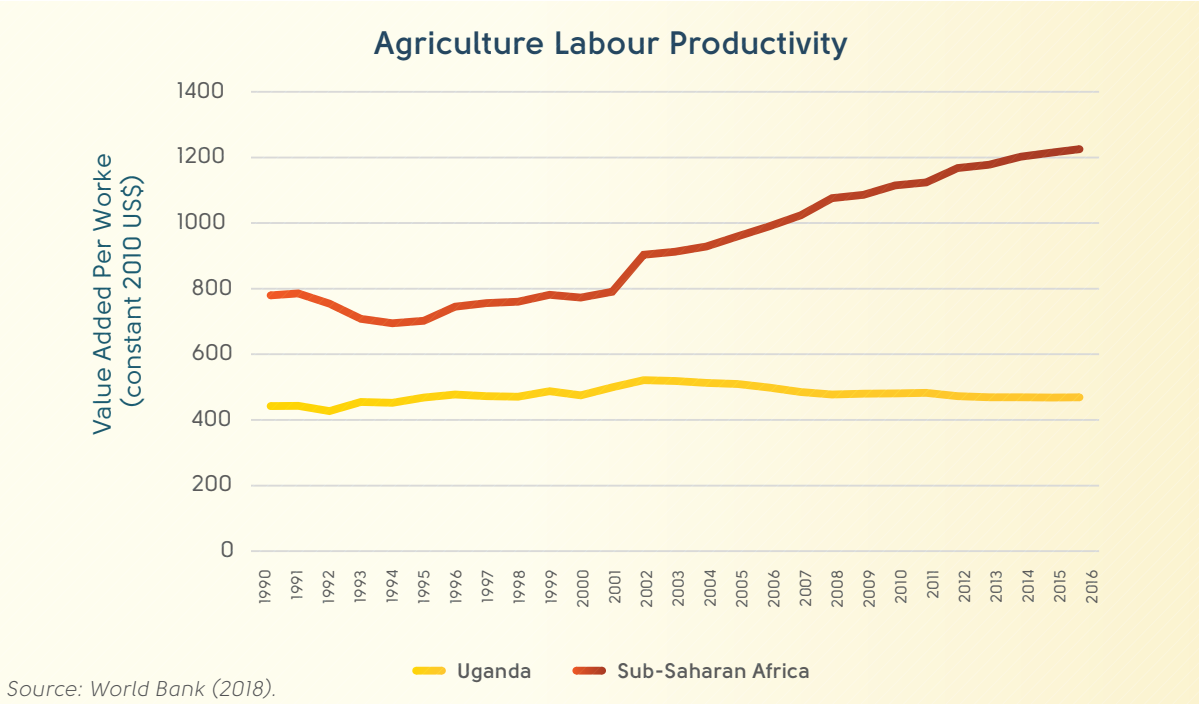


Source: Hausmann, R. and C.A. Hidalgo (2015).

Agricultural productivity in Uganda has stagnated in the past decades and has, like most of Africa and its regional neighbours, lagged far behind the world average. Agriculture, which is predominantly practiced by smallholder farmers in Uganda, employs over 70% of the working age population and contributes about 25% of the country's GDP. Agricultural exports, which dominate Uganda's export sector, include coffee, tea, raw tobacco, raw sugar, cocoa beans, maize, dried legumes, cut flowers and other live plants, oilseeds, rice, wheat and cereal flours, buckwheat, and other vegetables. Uganda's main food crops have been plantains, cassava, sweet potatoes, millet, sorghum, corn, beans, and groundnuts. Cattle, sheep, goats, poultry and fish are also sold largely on the domestic and regional market.

17 Hausmann, R. and Hidalgo, C.A. (2015)

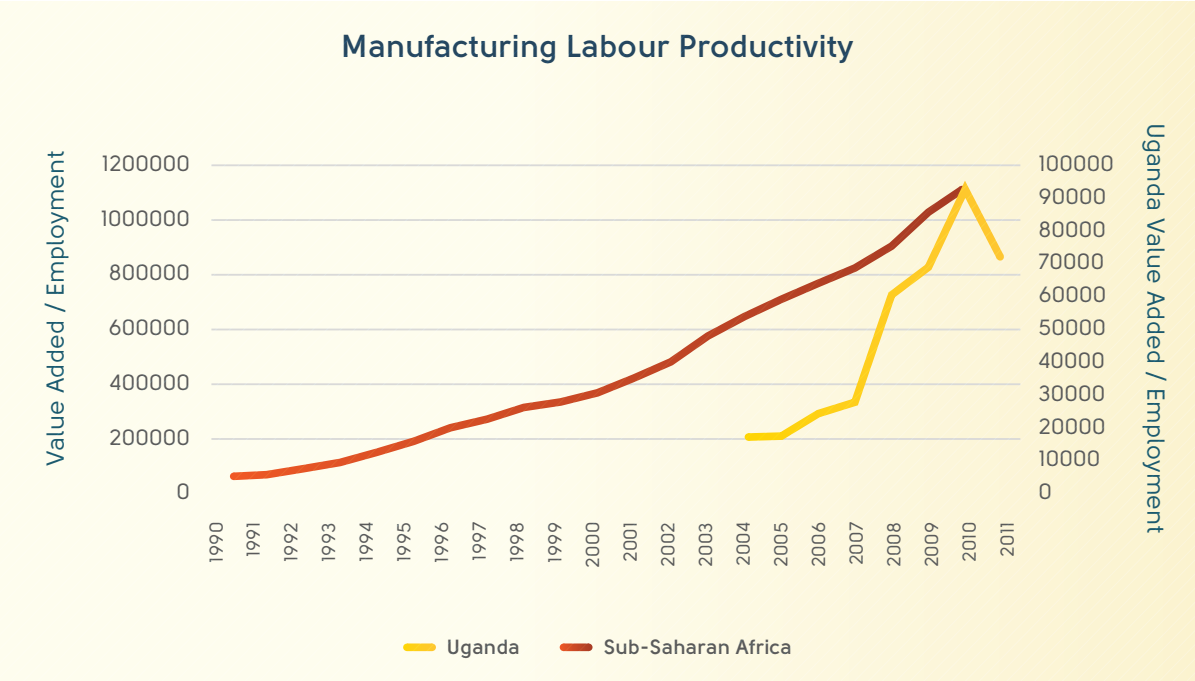
Figure 12: **Agricultural labour productivity, measured in value added per worker, 1990-2016.**



Source: World Bank (2018).

Uganda's industrial sector productivity has risen over time, but exact data is not available. The industrial sector accounts for around 20% of Uganda's GDP but employs only 7% of its workforce. The industrial sector is populated by small-scale firms with limited manufacturing value addition. Uganda has a very small proportion of large-scale manufacturing firms which are predominantly foreign owned, last-stage assembling firms. They arrived with the wave of liberalization of the 1990s and concentrated in the metallurgical, textile, tannery, cement, brewing and bottling activities. Other industry is largely made up of agro-processing factories and other businesses associated with the agricultural sector. The agro-food sector is processing coffee, tea, nuts, dairy products, fruit and vegetables, canning of animal products and forage production. Productivity trends for industry as a whole are not available or have not been found by the authors. However, Uganda's labour productivity in manufacturing is a good indicator of broader productivity." According to available data manufacturing value added per worker has risen rapidly, more than tripling between 2007 and 2010 and effectively catching up with the SSA average. However, the data is sparse and says little about the longer-term trend. Above it was noted that total value added in industry rose gradually between 1990 and 2015 while industry's share of labour did not change substantially, suggesting a gradual increase in labour productivity. However, most of this progress occurred in the 1990s, and the rapid spike in the graph below is not reflected in the longer-term GDP composition data.

Figure 13: **Manufacturing value added per worker, 1990-2011.**



Source: African Development Bank (2014) & De Vries et. al (2013).

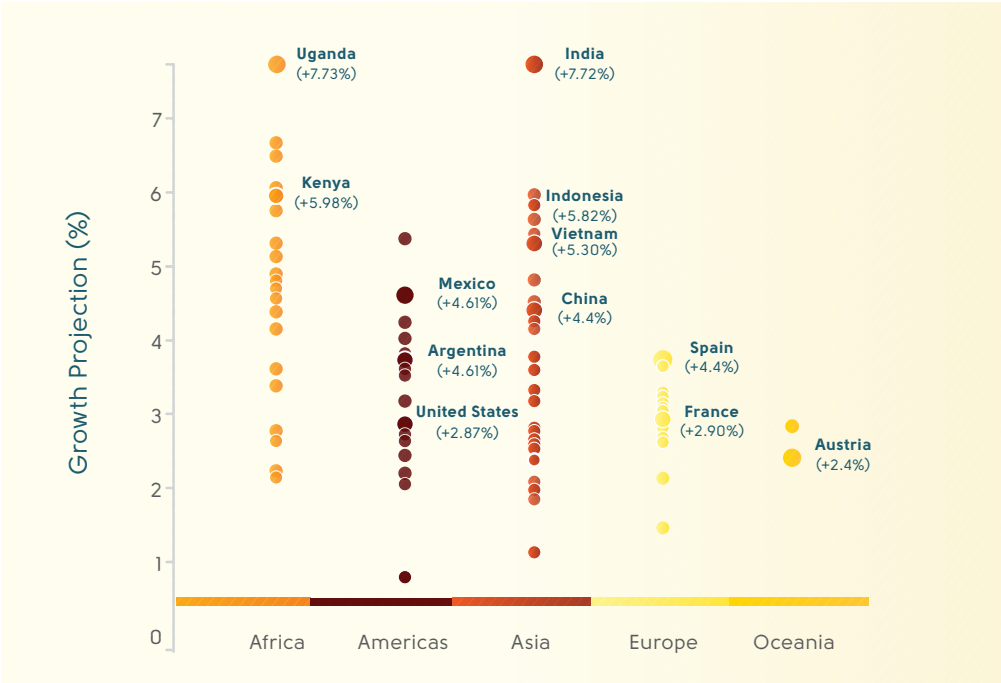
The services sector has driven growth in Uganda's economy in the past two decades, with uneven productivity growth concentrated in high-skill sub-sectors. Uganda's services sector accounts for over half of GDP and employs roughly a fifth of the working population. The 'Trade and Repairs' subsector, heavily dominated by small-scale wholesale and retail trade, employs the vast majority of labour in services, and accounts for a fifth of GDP in services. This is closely followed by the Information and Communications subsector, which accounts for almost as much GDP but employs only a small fraction of labour. This is followed by real estate, which employs an insignificant amount of labour, and education, which employs a high proportion of the country's formal wage labour. Other major service sub-sectors are tourism, health, ICT and related services, financial services, construction and engineering services, and professional services. The services sector is the largest sector of the economy but characterized by small firms and low labour productivity. Growth and productivity across services sub-sectors is uneven: tradeable services sectors and sectors requiring higher skilled labour experience higher growth and productivity. Uganda has a similar productivity ratio and output value per worker to that of Tanzania. Annualized labour productivity growth has slowed over time and is well below the rate of SSA. Growth within the services sector has been skewed towards sub-sectors that predominantly employ highly-skilled people, such as in telecommunications and financial services. This helps explain the limited structural transformation of the economy that has taken place[18].

18 Ssewanyana S., Matovu, J. M., and Twijukye , E. (2011)

Uganda's Economic Transformation Outlook

Uganda is delicately poised to grow quickly and begin a deeper economic transformation trajectory. The country has the potential to leverage both its imminent demographic dividend (a low dependency ratio driven by a youth bulge entering the workforce) and its strategic economic position to become a production and logistics hub serving its own growing consumer population as well as neighboring economies. Stability in South Sudan and the Democratic Republic of Congo (DRC) will, however, be a strong pre-requisite for this to come true. The Harvard Centre for International Development predicted that Uganda has the single highest overall GDP growth potential in the world to 2025, at 7.7% annually. These projections are based on the economic complexity index, which measures an economy's diversity and sophistication and the ease with which it could further diversify by expanding those capabilities. This index has been found to be a more accurate predictor of GDP per capita growth than traditional measures of governance, competitiveness and human capital. A significant proportion of the projected GDP growth is due to rapid population growth. However, Uganda remains in the top 10 in GDP per capita growth projections, at 4.5% annually. [19]

Figure 14: **Growth projections by region.**



Source: Harvard Center for International Development (2018).

19 Center for International Development (2018)

Uganda's transformation will have a strong geographic character. New roads and rail lines along the Northern Economic Corridor are set to transform Uganda's domestic, regional and global linkages. Economic opportunities are likely to closely follow these regional linkages and emerge along infrastructure corridors. Major new fiber-optic cables within Kampala and to urban centers in northern Uganda will revolutionize digital connectivity. In the longer-term, more greenfield efforts to beam down internet through hot air balloons and solar powered planes by the tech giants, notably Google and Facebook, may make internet abundant. Additionally, Uganda is one of the fastest urbanising countries in the world and today's urban population of 6 million is projected to grow to between 20 million (UN) and 36 million (National Planning Authority) by 2040. Transformation will occur primarily in the Kampala metropolitan area and around other emerging urban centres such as Mbarara, Gulu-Lira, Masaka, Hoima and Mbale.

The movement of labour from low to high productivity sectors and activities in Uganda is likely to be driven principally by SMEs in high growth potential industry and services sectors. While large firms often achieve the highest productivity levels, it is smaller firms that tend to absorb most labour in the economic transformation process. Many SMEs in developing countries struggle to survive and grow, but a subset of firms has both the potential and ambition to grow, thereby absorbing labour. Out of these SGBs, a smaller subset often referred to as "gazelles" tends to drive most growth by rapidly expanding in a given sector.[20] These SMEs will drive shifts in inputs from low productivity agriculture into higher productivity services and industry, as well as productivity gains within sectors. Key high growth potential sectors include agrochemicals, agro-processing, construction materials, and service sectors including tourism, construction, and ICT-related/enabled services[21]. Some of these sectors are labour intensive and would thus drive a structural shift in the economy.

Household enterprises - mostly informal family businesses - will continue to employ most labour in Uganda in the next two decades. As elsewhere on the continent, much of Uganda's workforce will continue to be employed by micro- household enterprises operating in agricultural production, wholesale, retail, hospitality and small-scale mechanical/industrial services. Increasing their productivity would thus have potentially the deepest impact on economic transformation. Off-farm household enterprises could benefit from better value chain integration, management skills and access to credit and workspace. On-farm household enterprises - mostly family farms operating close to subsistence level today - could increase their productivity by increasing yields through greater access to good agricultural practices, inputs and markets.

20 ANDE (2012)
21 Hausmann, R., Cunningham, B., Matovu, J., Osire, R. and Wyett, K. (2014) MTIC (2015)

Linkages between formal firms and largely informal household enterprises are important in driving growth on both sides of the equation. In many developing countries forward and backward linkages with high growth wage sectors (especially with export-oriented firms) such as manufacturing, food processing, construction and hospitality, have spurred productivity growth in the off-farm household enterprise sector, particularly through local sourcing of inputs such as raw materials, component parts, outsourced labour, and support services[22].

With the launch of oil exports imminent, Uganda is likely to experience the effects of 'Dutch Disease' at least to some extent. Both tradables and nontradables[23] are likely to see a domestic demand hike, but due to currency appreciation, Uganda's economy will be much better able to meet the domestic demand for non-tradables while it will be outcompeted in tradables. As a result, the greatest opportunities, or lowest hanging fruits, for economic growth with a high domestic multiplier effect will be in non-tradables.

Uganda's agriculture sector has promising transformation potential. First, continued overall economic growth will translate into increased incomes and greater aggregate demand for agricultural products. Second, investments in road and rail infrastructure will improve access to domestic and regional markets. Smallholder farmers could become increasingly market-oriented agricultural producers. The stark productivity gap between Asian and African smallholders presents itself as an opportunity for transformation. East African staple yields (e.g. maize, rice) are only about one-half to one-third of their potential given proper application of fertilisers, irrigation and seeds. Furthermore, specific interventions have proven that smallholder productivity in sub-Saharan Africa can increase rapidly with the right investments[24]. The use of fertilizers for better soil management techniques, the adoption of high- yielding seed varieties, the use of irrigation and land reform could significantly boost agricultural productivity[25]. Several agricultural sectors see a high growth potential for different reasons. Coffee and oil seeds are export-oriented crops that could be expanded to capture more of the global market. Palm oil and rice production could replace imports and capture a higher proportion of the domestic market. Meat production and leather (for both international and domestic consumption) would add particular value to the local economy.[26]

22 Kiranda, Y., Walter, M., and Mugisha, M. (2017)

23 The tradability of goods and services is variable along a spectrum. Generally, the higher the cost of transportation and the shorter the shelf life, the less tradable a good or service is. Tradability is also affected by trade barriers like tariffs, which render goods and services more expensive when traded internationally and thus reduce their tradability. Haircuts and cups of coffee are very close to the non-tradable end of the spectrum. Heavy construction materials which are very expensive to transport over long distances also generally exist on the non-tradable side. High-value luxury goods are close to the tradable end of the spectrum - their cost of transport can easily be justified by the high retail price. Many but not all services are non-tradable due to their high transport cost per unit of value. Some services have become much more tradable, including for Uganda: IT services, Business Process Outsourcing, software, engineering and tourism.

24 One Acre Fund (2017)

25 Obwona, M., Shinyekwa, I., Kiiza, J., and Hisali, E. (2016)

26 JICA (2016)

There is vast untapped potential in Uganda's industrial sector. An investigation applying the 'product space' approach found that the areas that provide the best opportunities for developing a competitive advantage in Uganda in the short-term are construction and industrial materials (sawmilling, bricks, cements, plastics, iron and steel, paint and foam products), consumer goods (soaps, detergents, processed food), and chemicals (esp. agro-chemicals and pharmaceuticals).[27] Chemical and pharmaceutical production grew by over 60% in 2015-16, cement and lime production by over 20%, and plastics by 13%.

Evidence on the potential of services sectors is sparse, but there are strong indications of their high potential to drive growth and transformation. Some services sub-sectors have been identified as high potential by the Common Market for Eastern & Southern Africa (COMESA) (2009) and UNCTAD (2011; 2014) studies: transport (including auxiliary to transport), financial (banking, accounting, insurance), construction and engineering, and ICT (including IT enabled services and business process outsourcing). The following sectors are already some of the highest employing service sectors but carry strong potential for further growth (they are each examined by one of the above-mentioned studies): healthcare and education, trade and repairs, and tourism and hospitality. Uganda has also made progress in the move towards IT-enabled services and Business Process Outsourcing (ITES/BPO).[28]

27 Kiranda, Y., Walter, M., and Mugisha, M. (2017).
28 Ibid.

4.
ENERGY & ECONOMIC TRANSFORMATION

Energy

Energy is the potential to do work on, or heat, physical objects. Human societies have extracted energy from countless natural sources in order to carry out work for millennia: for example, we have burned wood to create heat energy that cooks food or keeps us warm, and domesticated animals to create kinetic energy that moves people, goods and tools. Following the processing of primary energy sources (e.g. crude oil, natural gas, coal, biomass, uranium, wind, sunlight, water, wood, animals), energy carriers (electricity, mechanical work, fuel oil etc.) can provide energy services such as lighting, space heating, water heating, cooking, motive power or electronic activity.

Energy For Economic Transformation

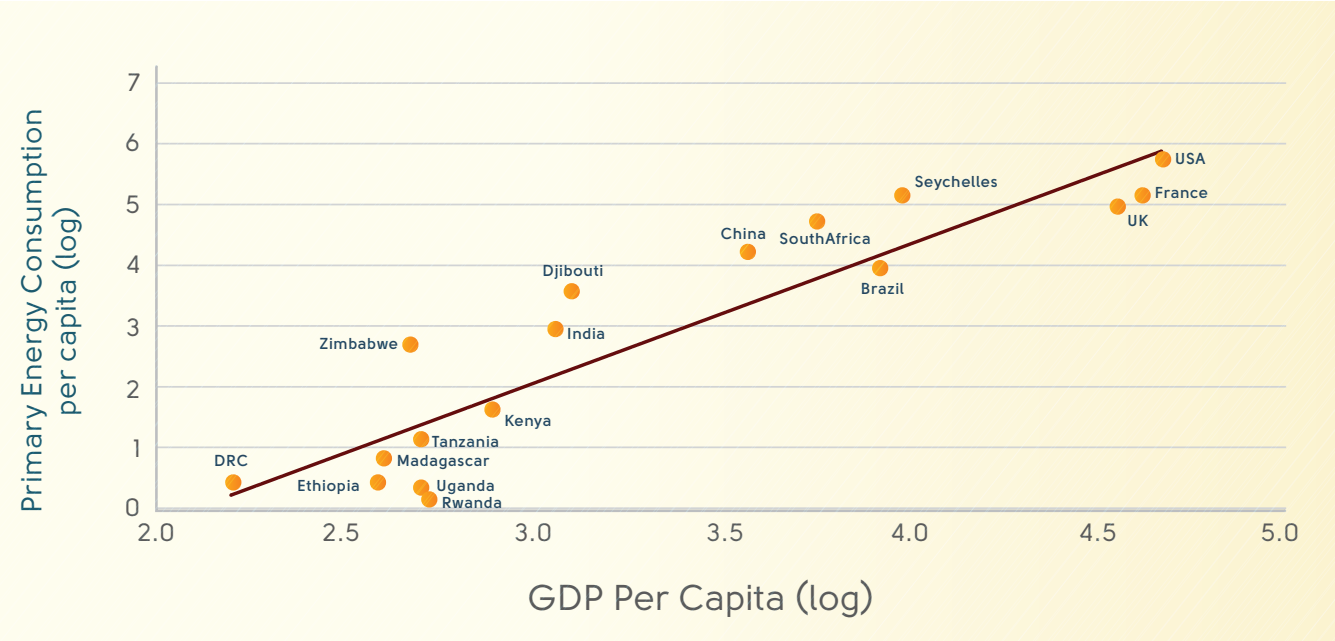
Energy is an essential factor of economic production, along with labour, capital, raw materials and land. The second law of thermodynamics dictates that energy is required to carry out the transformation or movement of matter. All production involves the transformation or movement of matter in some way. Therefore, all economic processes require energy, making energy an essential factor of production [29].

Energy is thus inextricably tied to economic development and transformation[30] [31]. The neoclassical economic growth model developed by Robert Solow in the 1950s assumed that growth results from the productivity gains arising from labour and capital working together more effectively. But applying this model to empirical data in the USA left 87% of historical growth unexplained. This unexplained growth is ascribed to the broad category "technical change" in mainstream economic textbooks. Ayres and Warr showed, in 2009, that adding a third factor to the equation could explain the vast majority of economic growth. That third factor is energy – the proportion of total energy that can be harnessed for useful work instead of being lost as waste heat.

A growing body of literature identifies insufficient electricity supply as a major constraint to economic growth in sub-Saharan Africa[32]. Though academia has not reached consensus on the direction of causality, there is a strong correlation between energy consumption and economic growth[33]. Based on a study of the COMESA region over the period 1980-2005, the graph below[34] clearly demonstrates that energy consumption goes hand in hand with economic development.

29 Stern, D. I. (1997)
30 Apergis and Payne (2009)
31 Toman, M. and Jemelkova, B. (2002)
32 See e.g. Escribano, Guasch and Pena (2009); Dihn and Clarke (2012); La Porta and Shleifer (2014); Scott et al. (2015)
33 Steward Redqueen (2016)
34 Nondo, C., Kahsai, M and Schaeffer, P. (2012)

Figure 15: **Energy consumption and GDP per capita.**



Source: Nando, Kahsai and Schaeffer (2012).

Throughout the history of civilisation, advances in energy have unlocked the productivity of human activities. The development of manual pump systems and the adoption of draft animals drove advances in irrigation and thus productivity in ancient agriculture; the invention of the steam engine and the extraction of coal made cheap energy available for rail transport and mechanised manufacturing, driving the industrial revolution in the 18th century in Great Britain and other economies. In the 19th century, the discovery of abundant oil in the USA and the invention of the internal combustion engine revolutionised the mobility of labour and goods through road transport. The adoption of these sources, carriers and technologies transformed economies around the world.[35]

Energy is a driver of economic transformation. Industrial productivity relies on physical infrastructure including energy to power various industrial processes; agricultural productivity is driven by irrigation, mechanisation and effective inputs, all of which require different forms of energy; and service sector productivity is driven by various types of energy, including electricity, transport and cooking fuels. Higher productivity allows an economy to specialise and diversify by expanding the range of products and services it produces. Energy is also a key driver of international competitiveness, for instance to the extent that cheap energy helps lower production costs compared to other countries, thus influencing firms' investment decisions.

35 Rifkin (2011) .

Energy is also a shaper of economic transformation. How we produce, use and distribute energy is not neutral and bears important economic, social and environmental consequences. The way a country's energy system is shaped influences the pathway and the characteristics of its economic transformation. An energy system that provides cheap and accessible energy to one region and neglects another will create an uneven development process; an energy system that depletes natural resources will render the development process unsustainable; an energy system that relies on one volatile source will put economic development at a high risk of stalling in case of supply shocks.

Progress in the energy sector cannot unlock economic transformation on its own. It is to be expected that access to affordable and reliable energy is the binding constraint on progress in some high opportunity sectors or areas, whereas other constraints are binding in other sectors or areas. Where energy is not a binding constraint, progress in energy will do little to unlock economic development. Where energy is a binding constraint, progress in energy can unlock economic development.

Energy For Social Development

While this study focuses on energy as a driver and shaper of inclusive economic transformation, which leads to poverty reduction and social development, it is important to note that energy access also has a strong direct impact on the wellbeing of the poorest segments of society. At the household level, access to modern energy for cooking and lighting can generate high monetary and time savings, allowing poor households to invest more money and time into income-generating activities and welfare-enhancing capacities.

Energy accessibility is also crucial for broader social development. In the words of former UN Secretary-General Ban Ki-moon "energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive." The conference of the United Nations Rio+20 in 2012 outlined that energy is a crucial component in development, as access to modern energy contributes to poverty reduction, improvement of health and provision of basic human needs. For instance, based on WHO data, the IEA estimates that globally, some 1.3 million lives are lost due to health complications resulting from inhalation of smoke from biomass burning. This health impact is largely felt by women. More modern sources of energy for cooking and lighting can limit such costs. Access to electricity and the services that derive from it (appliances such as TVs, computers, better lighting etc.) can also have positive spillovers such as better access to communication and information, better lighting for studying at night. Therefore, energy lies at the heart of the Sustainable Development Goals (SDGs) - agreed to by the world's leaders in September 2015. The SDG 7 hence states that ensuring access to affordable, reliable, sustainable and modern energy for all is a priority in the development agenda.

Energy For Economic Transformation In Uganda

Uganda's projected patterns of economic transformation have important implications for Uganda's energy system.

Agriculture. Agricultural value chains are geographically diffuse and have a range of energy needs, from transport fuel to powering processing plants, manufacturing agro-chemicals, post-harvest and storage processing, cooling, chilling, drying and large-scale irrigation.

On-farm household enterprises. Mostly remote and far from the grid, they have low purchasing power and need energy for irrigation and mechanisation. Cleaner and reliable energy services can enable farmers and household entreprises to increase their food production and to engage in value-adding processes.

Healthcare services. Healthcare services have a range of energy needs including electricity for cold chains and storage, transport fuels, electricity for lighting and operation of medical machinery, among others.

Education. Schools require electricity for lighting and computers, and cooking fuels for the preparation of meals for pupils.

Industry. There is need for affordable financing models and lower tariffs to lower the cost of doing business and enable industries to break even. Uganda can also leverage its industrialisation on agricultural modernisation from which the majority of the country's population attain their livelihood.

Off-farm household enterprises. Household enterprises that have access to electricity have access to more economic activities. Household businesses such as restaurants and shops can operate for longer hours. In order to transform energy from a luxury to a key business input there is need for creative business financing models to enable household enterprises to attain productive assets and inherently increase their energy consumption.

Urban concentration of economic transformation potential. The energy system will need to cater to rapid demand growth along transport routes and in major urban areas. On the other hand, regional inequality outweighs other forms of inequality in Uganda.

Table 1 below illustrates the framework of criteria applied in this study to assess the energy system and its ability to drive economic transformation.

	Criteria
Inclusive	1. Accessibility 2. Affordability 3. Reliability
Sustainable	1. Greenhouse gas emissions 2. Natural resource depletion
Resilient	1. Diversification 2. Redundancy

1. INCLUSIVE

In the context of energy for economic transformation, an inclusive energy sector is one that enables all firms, from microenterprises to large industries, in all parts of the country, and in all key sectors, to become more productive and grow. This is measured along three axes: accessibility, affordability and reliability:

- **Accessibility** relates to firms' ability to obtain access to appropriate energy carriers, be it firewood for process heating, petrol/diesel for transport, electricity to power machinery, or energy in any other form. Unequal energy access has implications for an economy's economic transformation pathway - often, larger firms in urban growth hubs have easier access to several forms of energy carrier than small firms in peripheral regions, which reinforces unequal development patterns.
- **Affordability** relates to the cost of energy for firms. Cost, too, can vary by geography and firm size: petrol and diesel pump prices, for instance, are generally lower in areas closer to the oil supply chain. The cost of energy is, to varying degrees, a driver of firms' production cost, directly affecting their viability, scalability, and competitiveness.
- **Reliability** refers to the ability of an energy system to provide consistent and expected levels and quality of energy to end users. Unexpected power cuts, power surges, interruptions in the supply or quality of petroleum products, and biomass supply shocks are all symptoms of an unreliable energy system. Reliable energy is key for economic production: interruptions can destroy expensive machines and raw materials, lead to production delays, necessitate costly backup energy solutions, and negatively affect a firm's ability to plan production.

2. SUSTAINABLE

In meeting the above inclusiveness goals, an energy system should be as environmentally sustainable as possible. Sustainability, here, is measured in two ways:

- **Greenhouse gas emissions:** While Uganda is a very minor contributor to global greenhouse gas emissions and the resultant climate change, it is politically and diplomatically committed to certain greenhouse gas emissions targets along with other countries under the Paris agreement. Not meeting the objectives of this agreement would have a minor negative effect on global climate change, but more importantly, severe negative political and diplomatic effects on Uganda.
- **Natural resource depletion:** Energy production and distribution can lead to serious local natural resource depletion. For instance, dams lead to flooding which has effects on the local natural ecosystem and its biodiversity, exhaust fumes from oil-powered vehicles and machinery causes air pollution, and the unsustainable consumption of firewood can lead to deforestation, with its numerous environmental knock-on effects.

3. RESILIENT

Resilience is "the ability to provide required capability in the face of adversity. The means of achieving resilience include avoiding, withstanding, recovering from, and evolving and adapting to adversity".[36] A resilient energy system, then, is one that is able to withstand or recover quickly from shocks that threaten its progress or sustenance. A system that lacks resilience is one that is vulnerable to or unable to cope with shocks. The resilience of the energy system affects its ability to meet the energy needs of the economy in moments of crisis, which can include external or internal supply shocks, breakdowns in the distribution system, or any other risk to the general functioning of the energy system. We assess two key drivers of energy resilience:

- **Diversification:** commonly referred to in the *energy security* discourse, the diversification of energy supply sources directly affects the system's resilience. A system that relies exclusively on imports from one country of origin, for instance, is highly vulnerable to political, technical or other shocks that affect energy supply.
- **Redundancy:** In engineering, redundancy is the duplication of critical components or functions of a system with the intention of increasing reliability of the system, usually in the form of a backup or fail-safe, or to improve actual system performance. Redundancy in the energy system can for instance be found in the form of excess supply (making the system resilient to demand shocks) or redundant distribution or transmission capacity (making the system resilient to localised distribution or transmission faults).

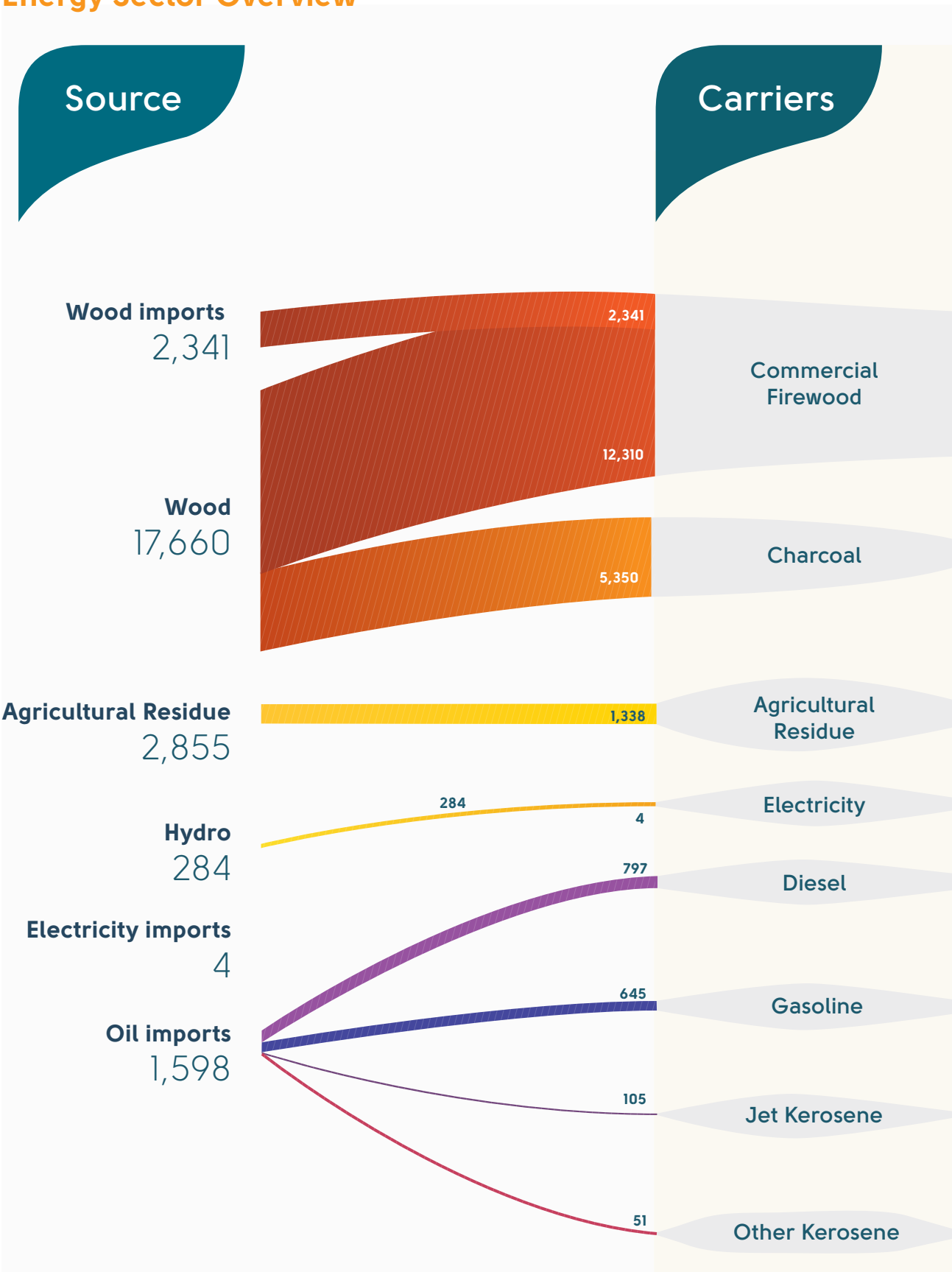
36 https://www.incose.org/ChaptersGroups/WorkingGroups/analytic/resilient-systems

5.
STATUS:
ENERGY SECTOR OVERVIEW

Status: Energy Sector Overview

87% of the total primary energy consumed in Uganda is generated through biomass, including firewood, charcoal and crop residues. Electricity contributes only about 2% to the national energy balance while oil products account for 11%. Households – followed by industry and transportation - are by far the biggest energy consumer group. However, hidden in this statistic is the fact that most businesses are informal micro-enterprises that are not easily distinguishable from households.

Energy Sector Overview



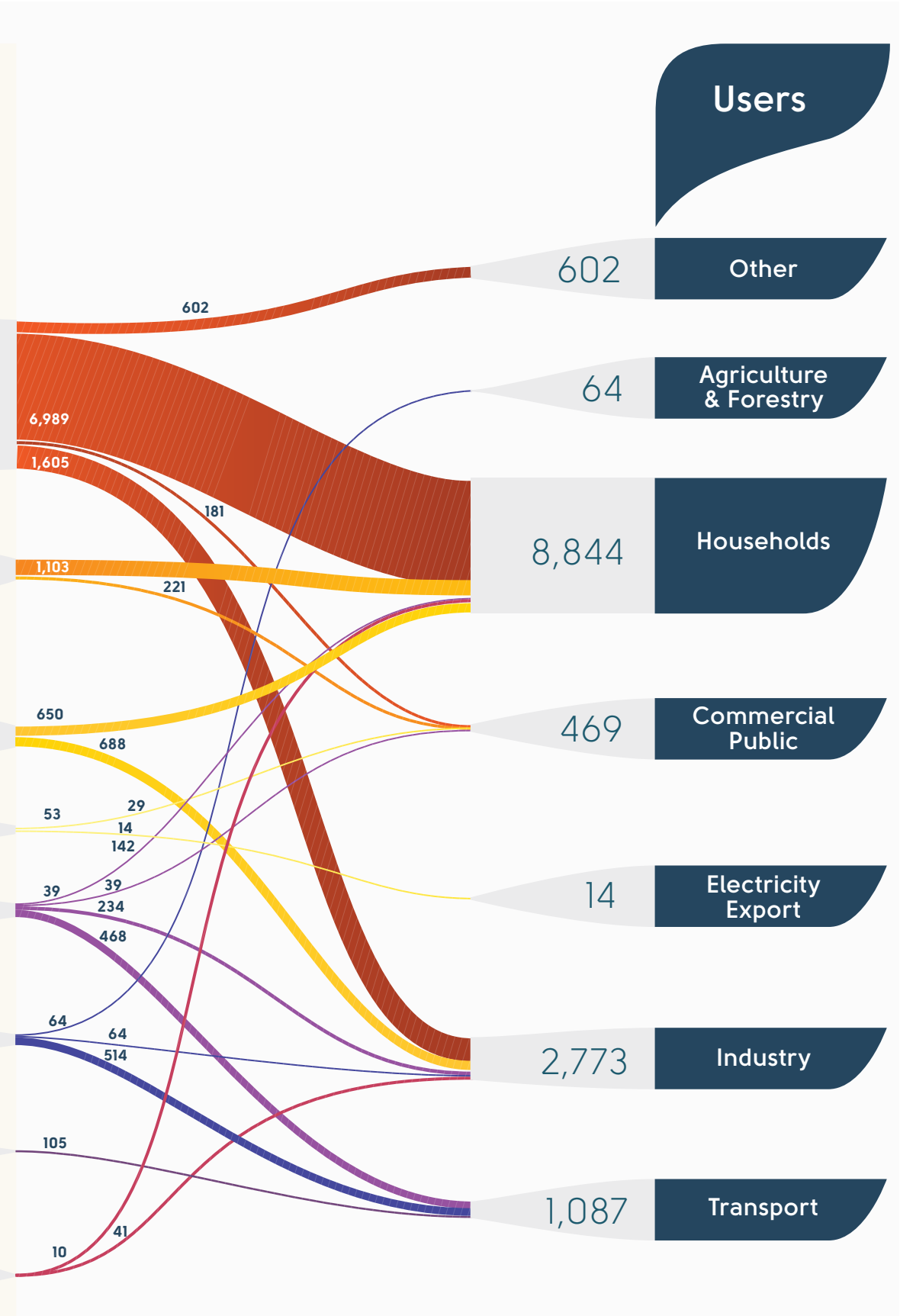

Users
602
Other
64
Agriculture & Forestry
8,844
Households
469
Commercial Public
14
Electricity Export
2,773
Industry
1,087
Transport
602
6,989
1,605
181
1,103
221
650
688
53
29
14
142
39
39
234
468
64
64
514
105
41
10

Table 2: **Sources, carriers and end use applications of energy.**

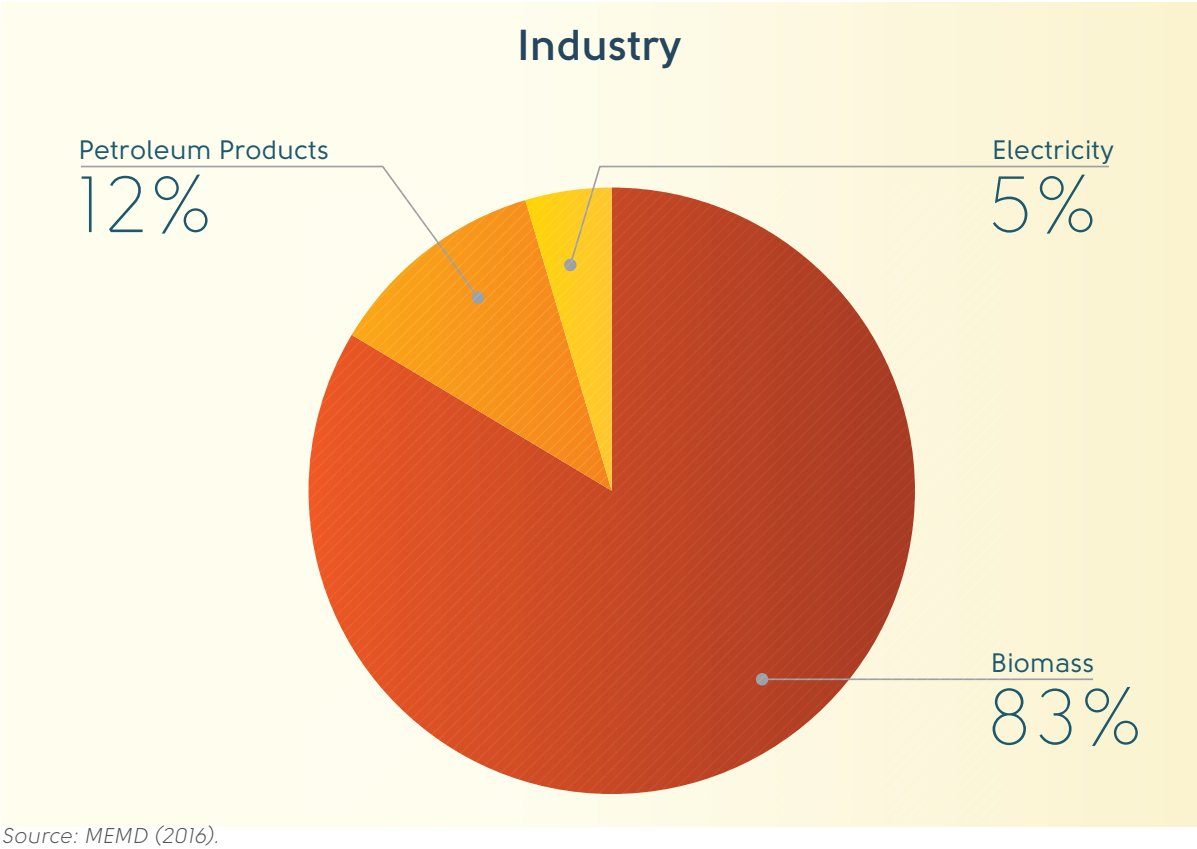
Energy primary source	Energy carriers	End use applications
Biomass Accounts for over 87% of energy demand in Uganda and contributes as much as 6% to the country's overall GDP[37] Especially important in rural areas where it provides both energy and incomes	**Firewood**	• **Cooking and heating in households** (86% of households use firewood for cooking). The per capita consumption of wood is 680kg/year in rural areas and 240kg/year in urban areas. • Firewood represents **58% of total energy needs for industry.** Wood fuel is used extensively for process heat and to fuel brick-burning, tea drying and lime production. • Wood and charcoal make up **86% of energy use in the commercial and institutional sector** (mainly for food preparation and heating water)
	Charcoal	• **Cooking and heating in households** (5.8% of households use charcoal for cooking): mostly in urban areas (high energy density and can be easily transported and stored). Per capita charcoal consumption is 4kg/year in rural areas and 120kg/year in urban areas[38].
	Agricultural residues	• **Cooking and heating in households** (7% of households use agricultural residues for cooking) • Energy supply for industry. E.g. Leftover cane stalks (bagasse) contribute significantly to sugar production **process heat** and **electricity generation.** Industry increasingly using biomass residues and wastes to meet energy needs.
Crude oil	**Diesel and Petrol**	• Mostly used for **transportation** • Some diesel used for on and off grid **electricity generation** (back-up power for peak generation or for remote off grid) • Diesel represents **8% of industry total energy needs**
	Kerosene	• **Household lighting** (wick lamps and hurricane lanterns). Though insignificant in overall quantity, kerosene meets a significant share of household lighting demand. • **Lighting** in small-scale **commercial and institutional sector**
	LPG	• **Cooking for top tier households** (not many) • **Cooking for small number of institutions and industries**
Hydropower	**On-grid Electricity** 85% from hydropower	• Industry consumes 64% of all electricity • But electricity represents only 5% of total energy consumption by industry • Rest of electricity consumed by commercial/institutional sector and households
Solar	Electricity (through PV stand alone, dry cell batteries)	• Electricity services for off grid population (light and appliances)

37 MWE (2013)
38 MEMD (2015)

Energy Consumption By Sector

Industry

Figure 17: **Industry energy consumption by carrier, 2016.**



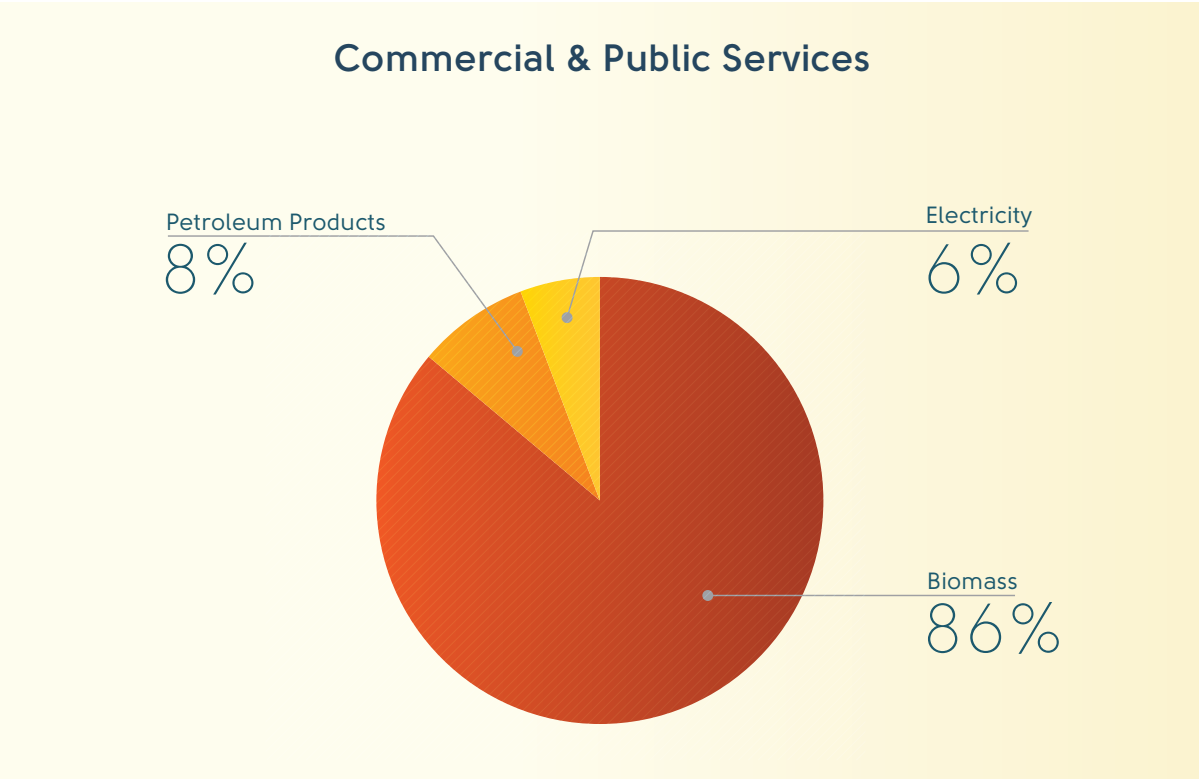
Source: MEMD (2016).

Industry in Uganda is heavily reliant on biomass, which contributes 83% of the sector's energy consumption. Wood fuel makes up most of industry's biomass use. It is used extensively for process heat and to fuel brick-burning, tea drying and lime production. Leftover cane stalks (bagasse) contribute significantly to sugar production process heat and electricity generation. Diesel is used to power back-up power generators and to fuel vehicles and some devices such as pumps. Electricity is used for the operation of industrial motors, machinery, lights, computers, and office equipment, as well as for the heating, cooling and ventilation of facilities and buildings.

Commercial & Public Services

The commercial and public services sectors account for just 3% of overall energy consumption. They include a broad range of services provided by private and public organisations, for instance: retail & wholesale trade, hospitality & food, logistics & transport, ICT, education, health, and all other government bodies.

Figure 18: **Commercial & Public Services energy consumption by carrier, 2016.**



Source: MEMD (2016).

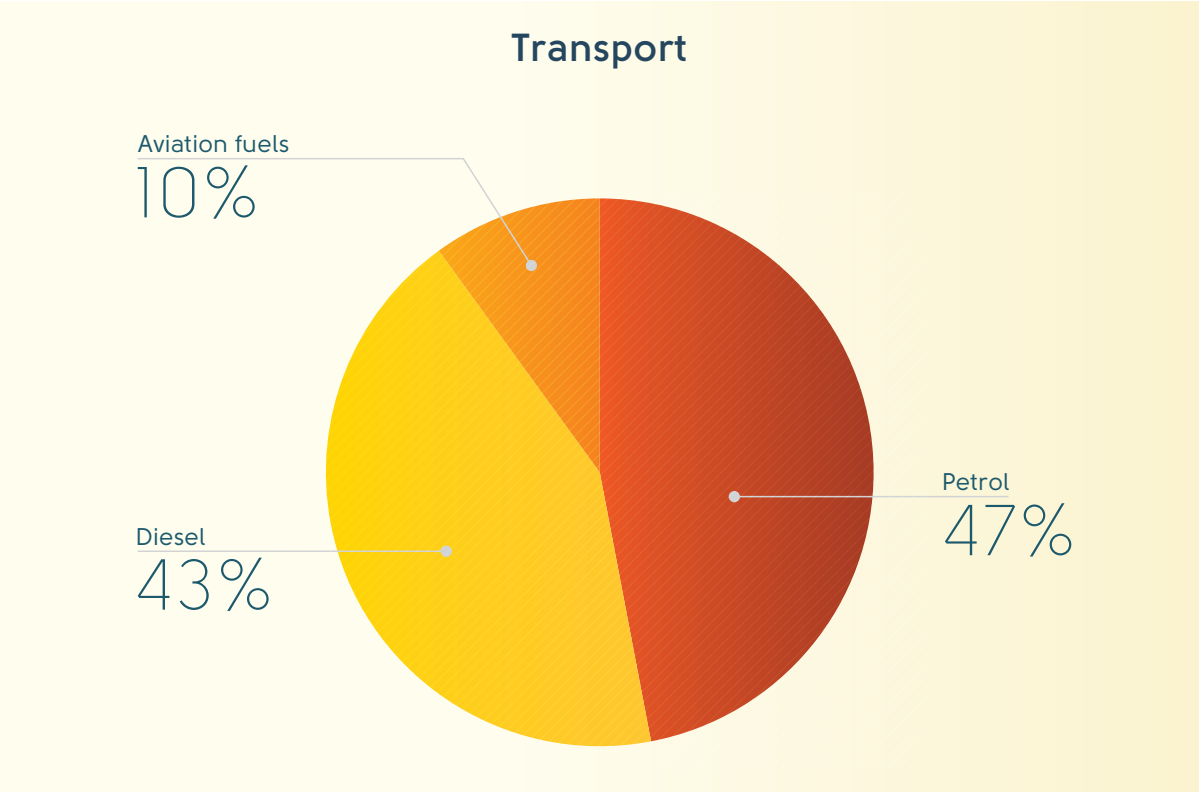
Wood and charcoal constitute 86% of energy use in the commercial and public sector, used mainly for food preparation and heating water. Electricity and kerosene are used for lighting and powering appliances. In terms of overall energy use, this sector takes up a larger portion of demand than industry because of the vast number of small players.

Agriculture

There is no reliable data on energy consumption in Uganda's agricultural sector. The vast majority of agricultural activity in Uganda, as noted above, is carried out by smallholder farmers, also referred to as on-farm household enterprises. These household enterprise are indistinguishable from households in the official data. Smallholder farms use varying amounts of fertilizers which have a high degree of 'embodied energy' as the production of fertilizers requires energy - this embodied energy is captured in the industrial sector which produces fertilizers rather than in the agricultural sector. The direct energy used by smallholder agricultural activities (as distinct from household consumption) is generally concentrated in mechanised irrigation and traction. In Uganda, both the rates of irrigation and mechanisation in smallholder farming are low compared to most countries. Where they are present, mechanisation occurs through petrol or diesel fuelled tractors and irrigation through diesel-powered pumps. Larger plantations depend more heavily on petroleum products for the same uses, as well as some electricity produced largely off-grid by agricultural residues or solar systems.

Transportation

Figure 19: **Transport energy consumption by carrier, 2016.**

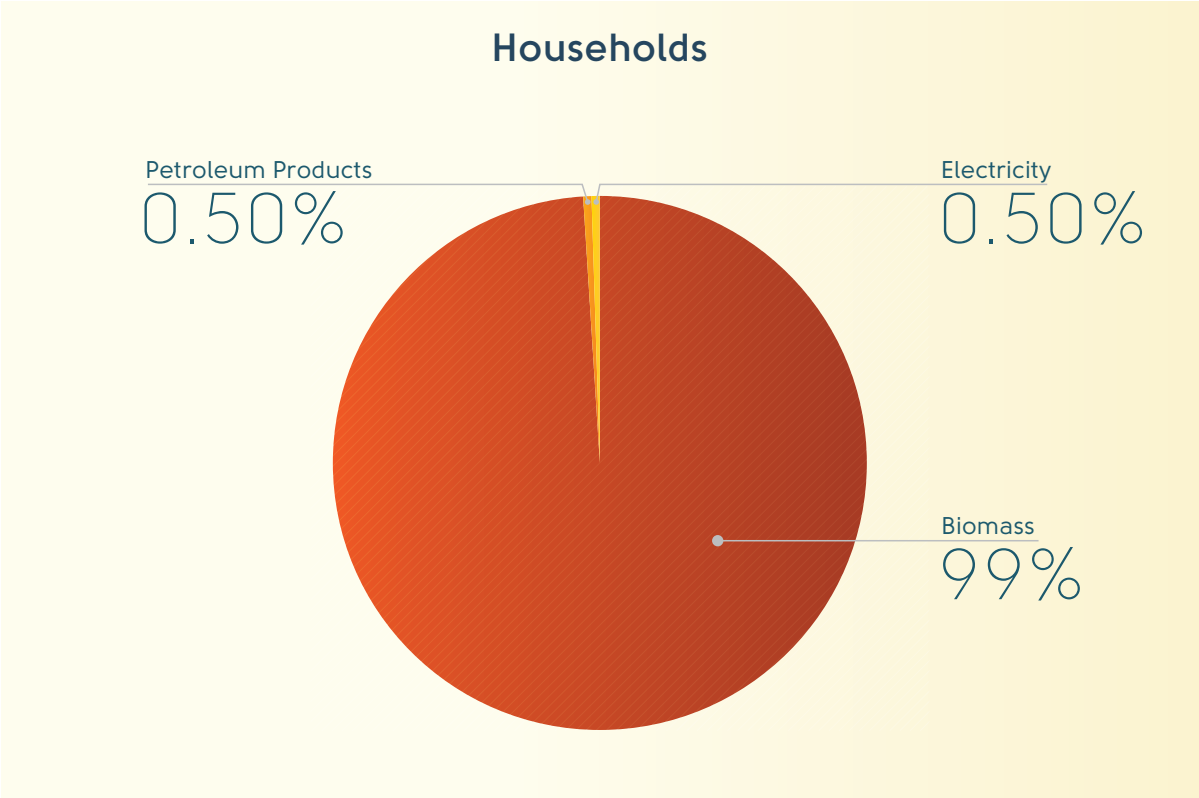


Source: MEMD (2016).

Transportation is a cross-cutting economic sector, including private use, in-house transportation carried out by industrial firms, and transportation as a service offered by commercial firms and public institutions. Transport is often treated separately from other sectors because of its unique energy profile. The transport sector relies entirely on crude oil-based products: there are no trains, planes, ships or road vehicles powered by anything other than gasoline, diesel or aviation fuels in Uganda.

Households

Figure 20: **Household energy consumption by carrier, 2016.**



Source: MEMD (2016).

The energy mix of private consumption by households, not discussed in detail here, is nevertheless telling: at the aggregate level, households rely almost entirely on biomass (charcoal and wood fuel, mainly for cooking). The use of electricity and petroleum products, while more widespread among urban households, is almost negligible at the national aggregate level.

6.
STATUS:
ELECTRICITY

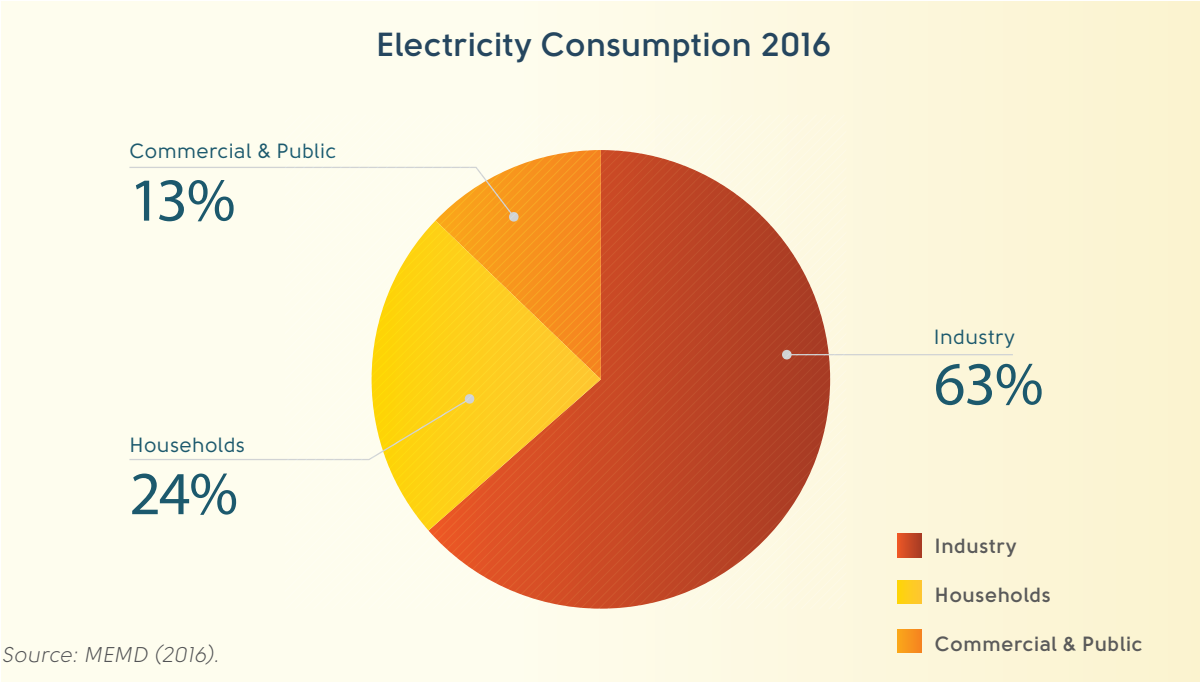
Status: Electricity

Electricity accounts for only **1.6% of all energy consumed in Uganda.**

Consumption

Uganda has one of the lowest electrification rates in Africa, at 20% of the population, and one of the lowest per capita electricity consumption rates in the world, at 71 kWh per capita per year. This is compared to the SSA average of 552 kWh per capita and the world average of 2,975 kWh per capita[39].

Figure 21: **Electricity consumption per sector, 2016.**



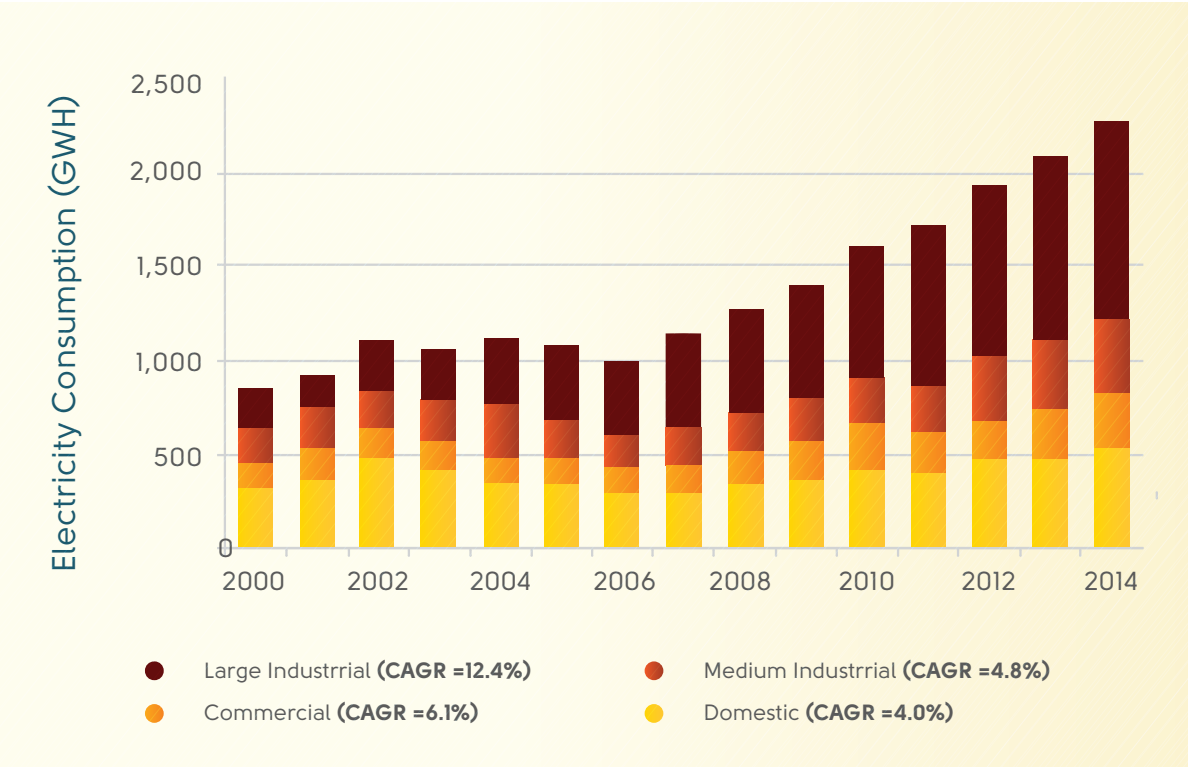
Source: MEMD (2016).

Since the early 2000s, large industry has been the biggest end-user category of electricity. In 2017, large industry consumed 38% of all electricity, followed by domestic users (27%), medium industry (20%) and the commercial sector[40] (15%). This means that industries consume almost 60% of the generated power. Growth in electricity use has been fastest in the large industrial sector and slowest in the domestic sector. The low electricity consumption of domestic users stems from the general low electrification rate, as well as limited electricity consumption by connected households, likely due to purchasing power constraints.

39 Export.gov (2017)

40 Commercial sector includes not only trade and services companies, but also small industrial firms as tariffs are based on the size of the connection and not on the economic sector.

Figure 22: **Electricity consumption per user group.**



Source: ERA (2016).

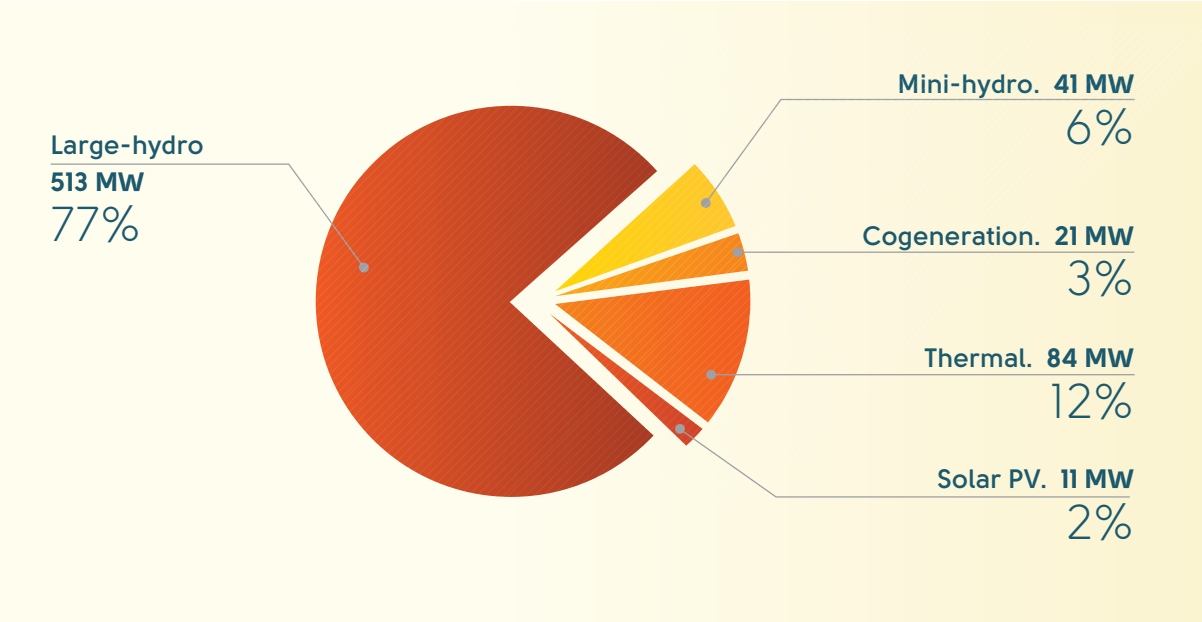
Organisation of The Sector

Uganda's electricity sector is unbundled, with a number of government agencies, parastatals and private companies involved in the chain. Electricity is produced by government-owned power stations owned by Uganda Electricity Generation Company Limited (UEGCL), and by a number of licensed Independent Power Producers (IPPs). Power transmission is a natural monopoly in Uganda in the hands of the fully government-owned Uganda Electricity Transmission Company Limited (UETCL), which owns, maintains, expands and operates the transmission network. UETCL is also the single buyer of power from the grid-connected generation companies and is in charge of power import and export. Umeme, a private company with a 20-year concession from the government-owned Uganda Electricity Distribution Company Limited (UEDCL), purchases 98% of all power sold by UETCL, alongside a number of smaller distribution companies serving peripheral areas.

Generation

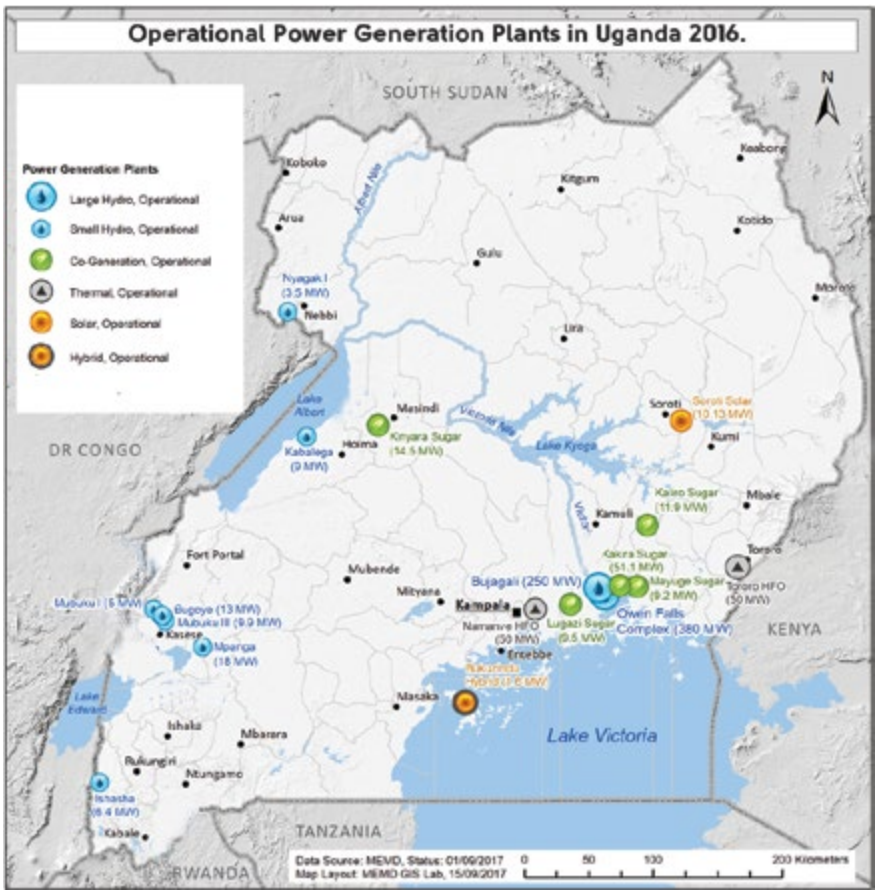
Uganda has a total installed electricity generation capacity of 947 MW. Hydropower stations accounted for 88% of installed capacity, followed by cogeneration, thermal (heavy fuel oil stations used as stand-by sources), solar, and hybrid. Three large hydro stations make up for the bulk of electricity production: Nalubaale (180 MW), which was built in 1954 under colonial rule and was virtually Uganda's sole source of electricity for five decades, Kira (built 2000, 200 MW) and Bujagali (built 2012, 255 MW). There are two heavy fuel oil thermal power stations, both used as stand-by sources as a backup for hydropower: Tororo (built 2009, 86 MW) and Namanve (built 2008, 49 MW). Five sugar manufacturers in Uganda have total cogeneration capacity of about 110 MW, of which about 50% is available for sale to the national grid. The largest of these is Kakira Power Station (built 2007, 52 MW), a bagasse-fired thermal power plant designed and built around the sugar manufacturing plant of Kakira Sugar Works, which uses about one third of the power generated to run its factory and sells the rest to the grid. Soroti Solar, Uganda's first solar plant, has just 10 MW of generation capacity.

Figure 23: **Composition of electricity supply, Uganda.**



Source: Umeme (2018).

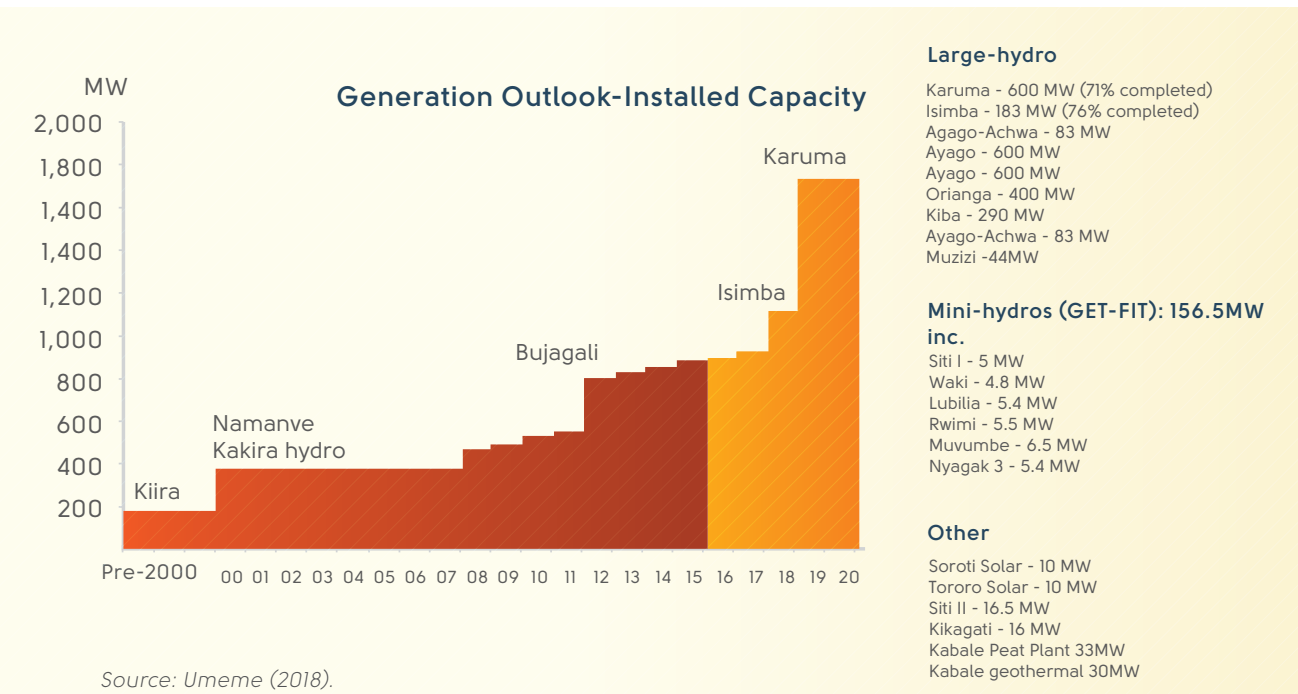
Figure 24: **Operational Power Generation Plants in Uganda 2016.**



According to the current ongoing projects, by 2020, Uganda's actual installed electricity generation capacity will have expanded to 1,683 MW, giving it a significant oversupply of electricity. In the forthcoming years, the Government of Uganda will fast-track the construction of the Karuma and Isimba Hydropower Projects (600 MW and 183 MW respectively) and a number of smaller hydropower projects.

Source: MEMD (2016).

Figure 25: **Installed generation capacity, Uganda.**



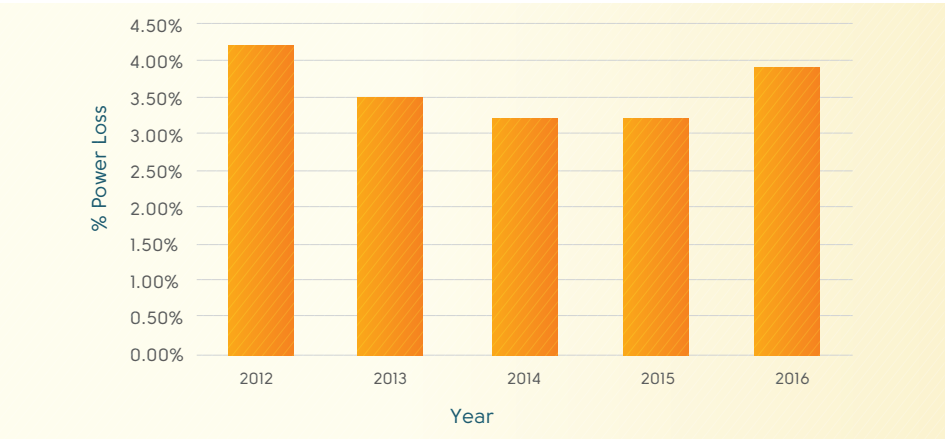
Source: Umeme (2018).

Transmission

UETCL bought 3,539 GWh from all power producers and sold 3,392 GWh, implying a transmission loss of 147 GWh. The Government of Uganda has plans to fast-track construction of transmission lines under the Rural Electrification Programme and construct a total of 2,002 Km of transmission lines across the country.

In addition, there are new transmission substations under construction and others under upgrade to match the increased generation capacity.

Figure 26: **Transmission Power Losses, 2012-2016.**

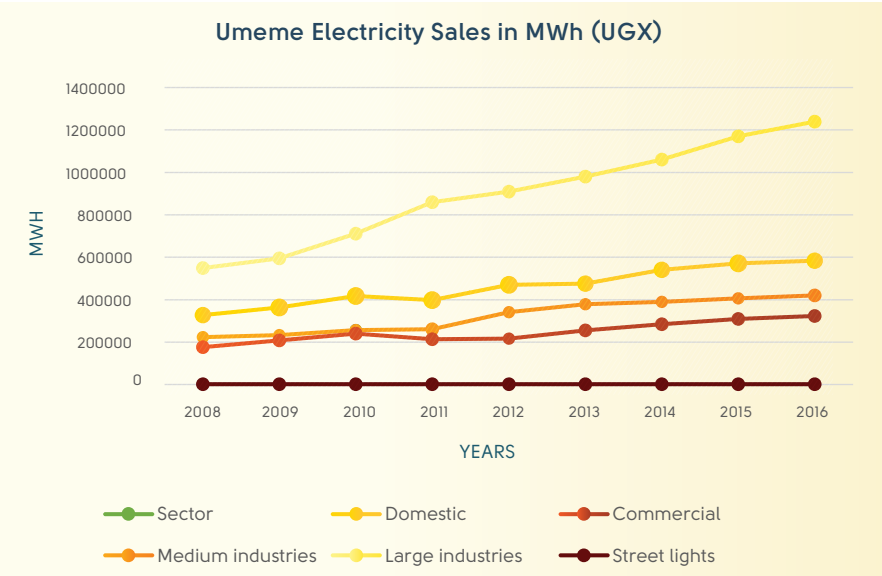


Source: MEMD (2016).

Distribution

Power sales by Umeme to different consumer categories in 2016 totalled to 2,567 GWh. Large industries were Umeme's biggest customers consuming 48% of the total power sales, followed by domestic consumers at 22.8%, medium industries at 16.3%, and commercial consumers at 12.6%.

Figure 27: **Umeme annual power sales by customer category, 2008-2016.**

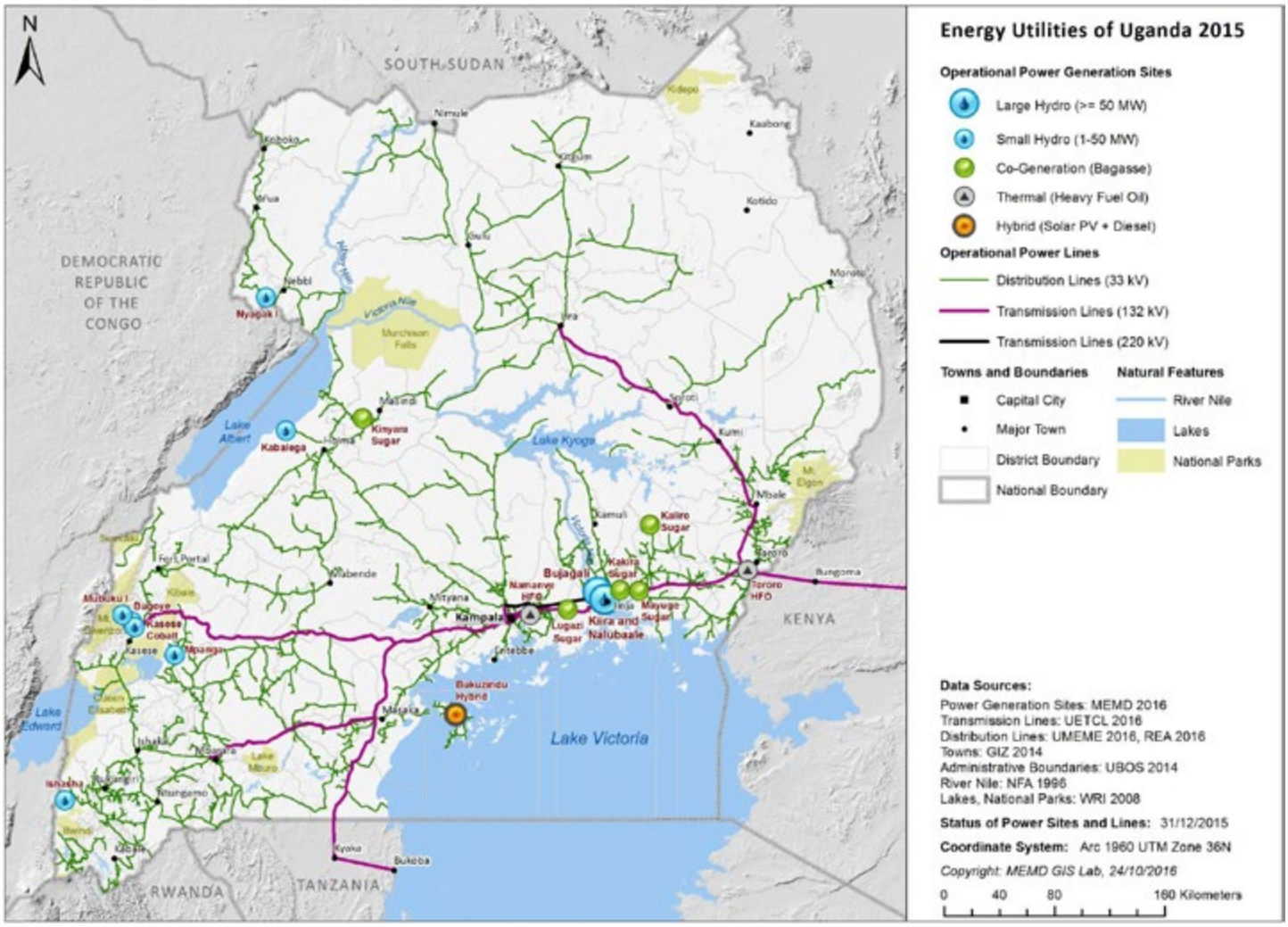


Source: ERA, UMEME, Ferdsult Engineering Services Limited, UECTL, Pader Abim Community Multipurpose Electric Cooperative Society Limited (2016).

Electricity consumption by large industries has also grown faster than the other categories.

At 19% of total output, Uganda's distribution losses lag only slightly behind regional neighbours Kenya, Tanzania and Ethiopia, who all stood at 18% in 2014[41]. Umeme and other distribution companies bought 3,243 GWh and sold 2,618 GWh in 2016, implying losses worth 625 GWh or 19% of total power bought. Although these losses are still high, they have come down sharply from 36% in 2009. This improvement is to a considerable extent due to capital investment in the distribution network to the tune of over USD 300 million since 2009.

Figure 28: **Energy utilities of Uganda, 2015.**



Source: MEMD (2016).

Extension of the distribution grid is being undertaken in part by UEDCL and in part by donor-funded projects of the REA.

41 OECD/IEA (2014).

Electricity For Productive Use: Assessment Snapshot

Table 3: **Assessing status of electricity for productive use.**

Inclusiveness	**Accessibility**		• Geographically uneven across the country • Grid mostly accessible to large size industries • High connection costs. Connection costs range from $36 for domestic users (subsidised by the tariff) to $560 for industrial customers. These are costs for inspection and meter installation. Additional scope for example transformer and network extension are costed separately. • Little off-grid alternatives with regards to energy for productive use
	Affordability		• Tariffs are competitive in relation to Kenya and Rwanda, but higher than Tanzania and Ethiopia, which benefit from Government subsidies[42].
	Reliability		• Geographically uneven across the country and largely depends on the age of the network and distance from the service centres. Decrease of power outages (load shedding) but transmission and distribution challenges remain
Sustainability	**Resources depletion**		• Environmental impacts of big dams
	Greenhouse gas emissions		• Electricity generation mostly based on hydropower
Resilience	**Diversification of Supply**		• Overreliance on hydropower → vulnerability to climate change
	Redundancy		• Oversupply of electricity generation with the 600MW Karuma hydro power plant and 183 MW Isimba hydro power plant • Reasonable redundancy in generation, transmission and distribution systems

42 UMEME (2017)

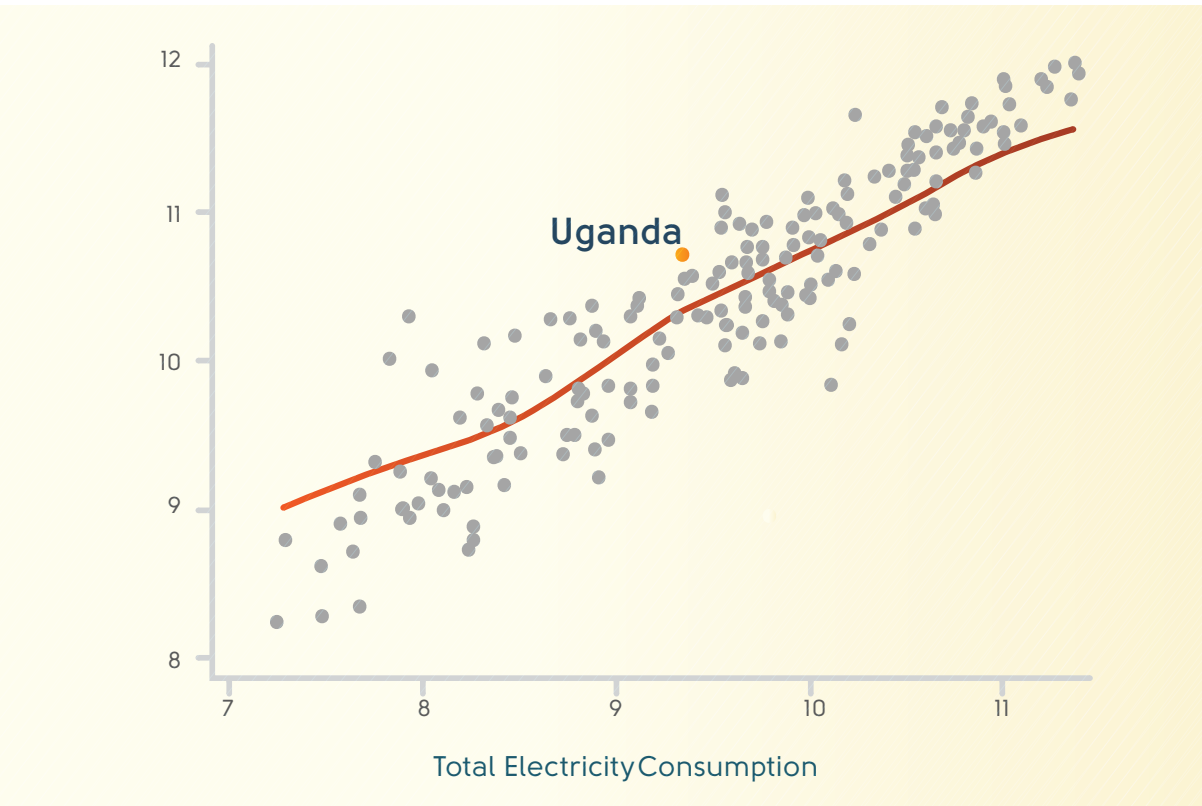
Table 4: **Main constraints and opportunities, electricity.**

Main constraints	Main opportunities
Accessibility: • Grid is not accessible across the entire territory and is more reliable around big urban / industrial areas; • Off grid solutions for energy for productive use are at an embryonic stage; • Distribution and transmission systems are now lagging behind generation; • According to the World Bank "ease of doing business", connection costs for businesses are high.	*For the businesses very likely to remain off the grid in the coming years:* • **Investigate and develop off-grid opportunities for productive use:** Strong public-private partnerships, pico-solar solutions, solar home systems and microgrid solutions
Affordability: • Increasing tariff of electricity for all types of consumers. This situation is particularly detrimental for electricity intensive businesses. E.g. manufacturing; • Unlikely going to decrease due to costs of new generation capacity coupled with distribution and transmission challenges. Today, the demand is not meeting the supply.	• Support Electricity efficiency measures for firms • Spur demand through targeted action: large-scale investments • Refinance large power generation projects • Target tariff subsidies could lower the cost of power • Prioritise transmission & distribution
Reliability • Despite significant reductions in power outages after the operationalisation of Bujagali Dam, outages and fluctuations due to technical weaknesses in the power transmission and distribution system frequently damage machinery and raw materials and lead to lost time and money	• Prioritise transmission & distribution: Higher quality networks to reduce technical faults

Electricity As A Binding Constraint For Economic Transformation

Power is consistently identified as a top binding constraint to firm growth in Uganda[43]. A slowdown in total factor productivity growth in the mid-2000s was ascribed by the World Bank to underinvestment in physical infrastructure, especially electricity[44]. The World Bank Enterprise Survey of 2013 showed that firms perceive electricity to be the biggest constraint to business growth. Hausmann et al (2014) agree, in general terms, with the National Development Plan, that electricity is a key constraint on firm growth. When compared with other countries, Uganda's electricity consumption is low relative to its GDP. This suggests that "the economy is getting the maximum production out of its current level of electricity consumption and that electricity provision will need to improve for GDP to grow further"[45].

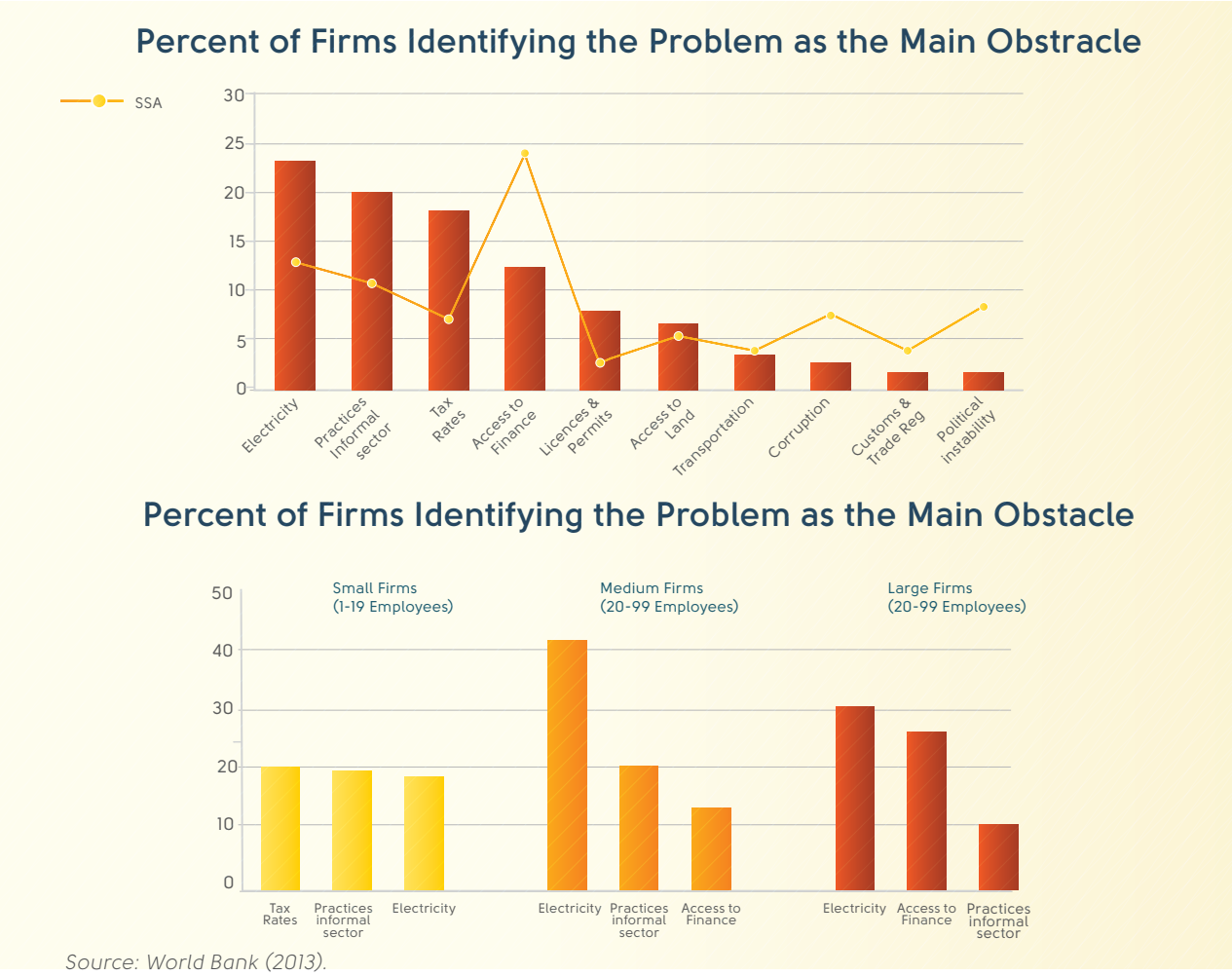
Figure 29: **Electricity consumption and GDP.**



Source: CIA World Factbook (2012).

43 DFID (2014)
44 Kiranda, Y., Walter, M., and Mugisha, M. (2017)
45 Hausmann et al (2014)

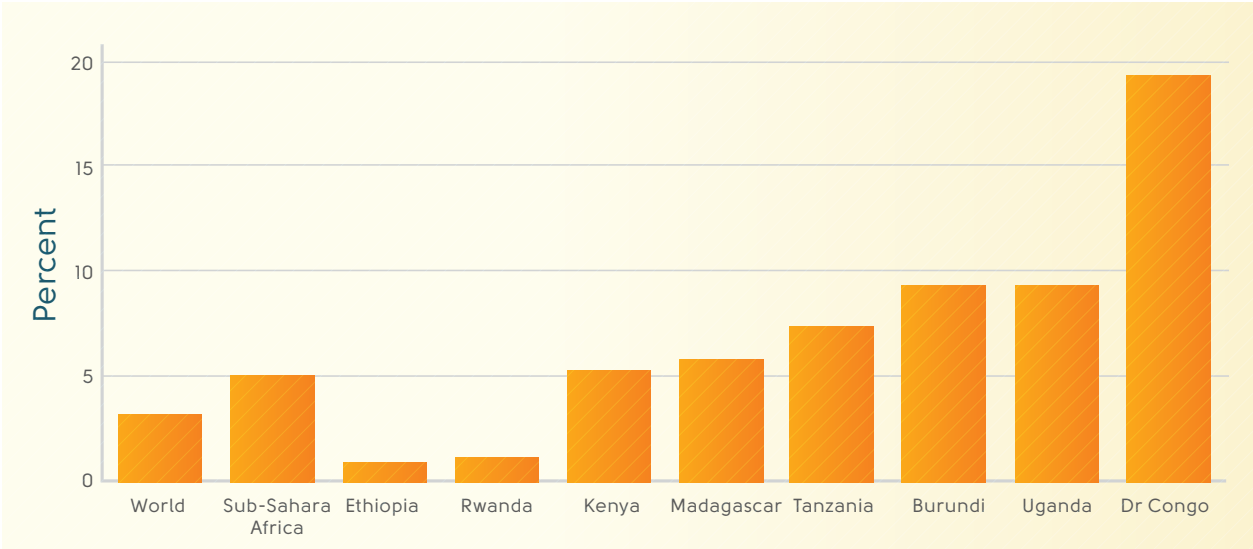
Figure 30: **Snapshot of the business environment in Uganda.**



Source: World Bank (2013).

Figure 31 shows that Ugandan firms experience some of the highest losses from foregone sales revenue due to electrical outages.

Figure 31: **Losses due to electrical outages, in % of annual sale of firms.**



Source: UNECA (2013), World Bank (2013).

Electricity For Productive Use: Detailed Assessment

1. INCLUSIVENESS: Accessibility, affordability, reliability

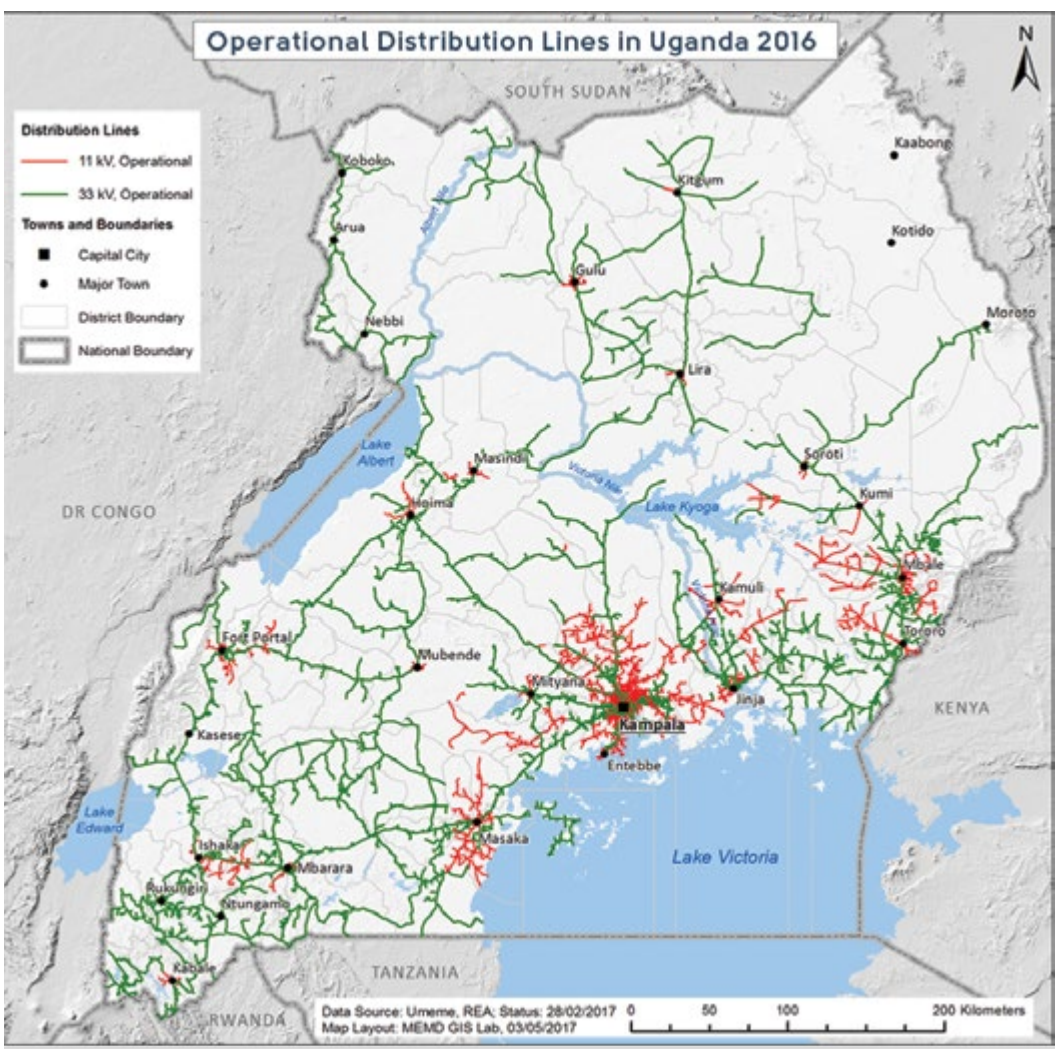
a. Accessibility of electricity for firms

Statistics from Umeme show the customer breakdown for commercial/industrial and domestics as 8% and 92% respectively. In terms of revenue contribution, large and medium industries and commercial customers contributed 73% of total revenue from electricity sales in 2016 with domestics contributing 27%.

This trend remained constant in 2017.[46 47]

The map of operational distribution lines clearly demonstrates that the distribution network does not evenly serve the national territory, with a large concentration around a few urban economic hubs in the central and south-western regions.

Figure 32: **Operational Distribution Lines in Uganda, 2016.**



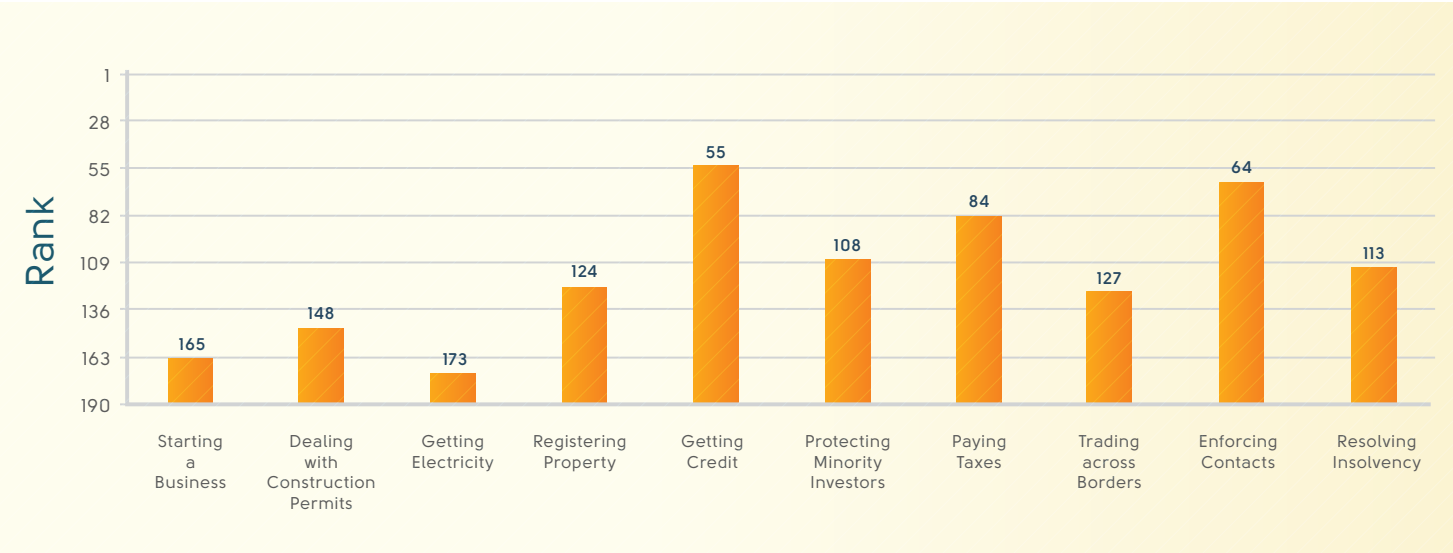
Source: UBOS (2016).

46 UMEME (2015)
47 UMEME (2016)

No data was available on electrification rates by firm size or sector. It can be assumed that the existing large industries are all connected to the grid, as electricity access is usually a precondition for their operation. For household enterprises in the informal sector, this information would be very difficult to obtain as these microenterprises are not normally registered as commercial power users, making them impossible to distinguish from households. For SMEs, access to electricity would be a helpful metric in electricity network planning for economic transformation going forward.

The World Bank Doing Business indicators show that Uganda performs very poorly on 'Getting Electricity'. In fact, at 173 out of 190 countries, this is Uganda's lowest score out of all Doing Business indicators[48]. According to the World Bank, it takes six procedures and an average of 66 days for a company to get connected to the grid. The number of procedures is slightly above the SSA average, but the time taken is well below the average, and is in fact lower than the number of days taken in OECD high income countries. The cost of connection is the biggest driver of Uganda's low score on the World Bank Doing Business indicator "Getting Electricity". Among the procedures to get access to electricity, hiring a private electrical contractor to carry out external works is by far the costliest [49].

Figure 33: **Uganda's ranking on World Bank's Doing Business indicators.**



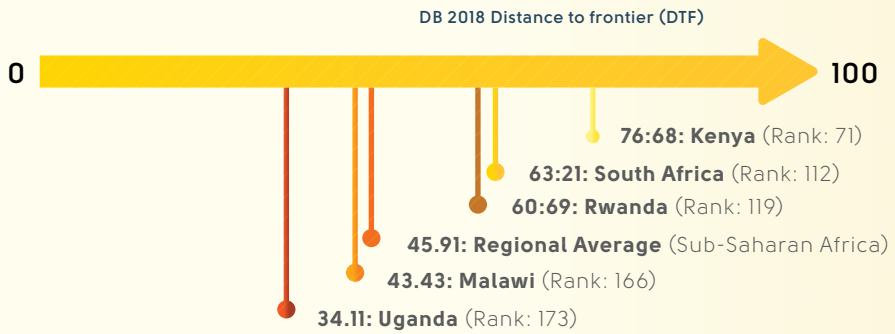
Source: World Bank (2013) .

48 *World Bank (2013).*
49 *Ibid.*

Figure 34: **How Uganda compares on World Bank's getting electricity indicator.**

Indicator	Uganda	Sub-Saharan Africa	OECD high income	Overall Best Performer
Procedures (number)	6	5.3	4.7	2 (United Arab Emirates)
Time (day)	66	115.3	79.1	10 (United Arab Emirates)
Cost (% of income per capita)	7508.4	3737.0	63.0	0.00 (Japan)
Reliability of supply and transparency of tariff index (0-8)	0	0.9	7.4	8.00 (28 Economies)

Getting Electricity in Uganda and Comparator Economies-Raking and DTF



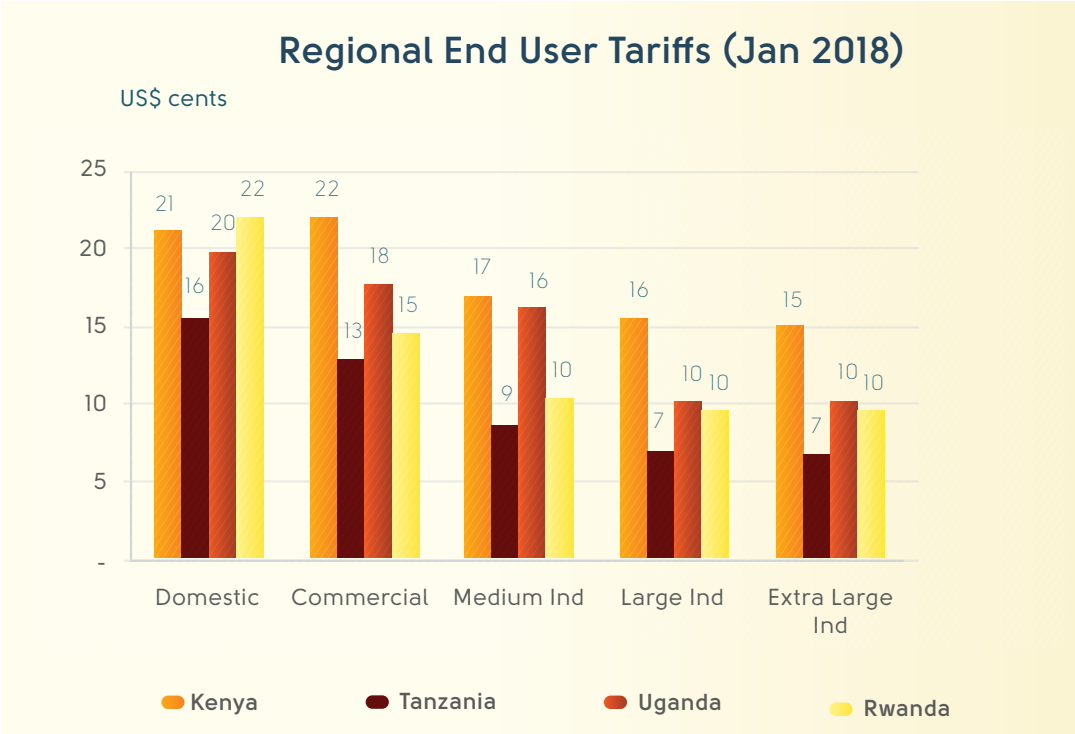
Note: The rankings of economies on the ease of getting electricity is determined by sorting their distance to frontier scores for getting electricity, These scores are the simple average of the distance to frontier scores for each of the component indicators.

Source: World Bank (2013).

It is clear that a large number of microenterprises currently operate without a grid connection, and likely that more microenterprises and SMEs would exist in peripheral areas if power was accessible. Despite efforts to expand the grid, it will be several years before access is expanded countrywide. In the meantime, off-grid power solutions could be tapped. In fact, some analysis shows that off-grid or mini-grid solutions are more viable than the expansion of the national grid in several locations, largely depending on the distance from the grid. While the potential value of productive use technologies is acknowledged by key players in the Ugandan market, the number of actors currently offering off-grid or mini-grid solutions for productive use is still limited in Uganda.

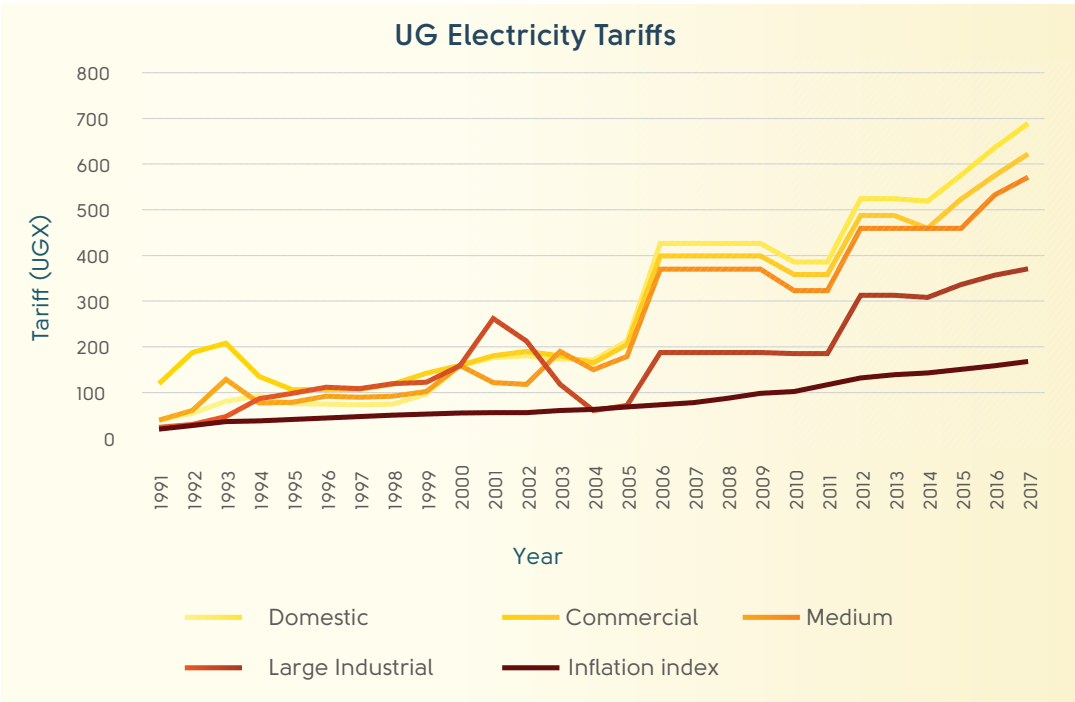
b. Affordability of electricity for firms

Figure 35: **Comparing end user tariffs in East Africa, 2018.**



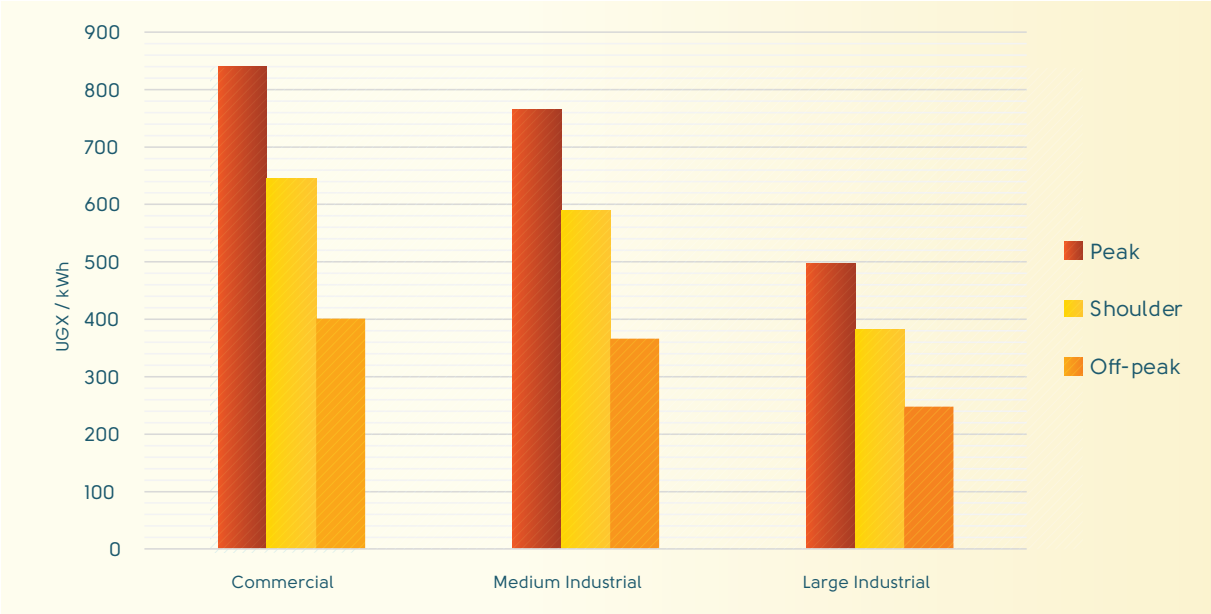
Source: EAC (2018).

Figure 36: **Ugandan Electricity Tariffs, 1991 - 2017.**



Source: Umeme; World Bank (2018).

Figure 37: **Ugandan Electricity Tariffs: Peak, Shoulder & Off-peak.**



Source: Umeme (2018).

Uganda's electricity tariffs are competitive with most regional neighbours, but not with Ethiopia, the regional leader in providing cheap electricity for industries. ERA runs a cost-reflective tariff that is adjusted quarterly. For example, in Q1 2018, it announced that the major drivers of increased tariffs in the quarter were (i) increased investment related costs, (ii) transaction costs related to the debt refinancing of Bujagali Hydro Power Plant, and (iii) the depreciation of the Uganda Shilling against the US Dollar. For energy dependent industries, such as the manufacturing sector, where the cost of electricity according to industry executives currently accounts for 20-35% of total operational costs, and the steel, cement industry or cold storage sector where the cost can account for up to 65% of the operational costs, electricity tariffs are a game changer in competitiveness[50 51].

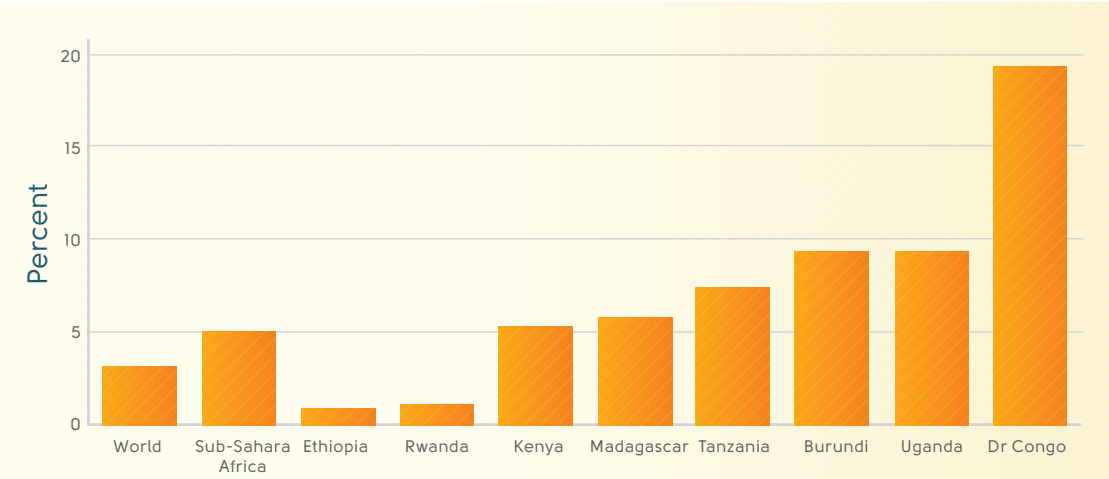
c. Reliability of electricity for firms

2013 World Bank Enterprise Survey data shows that Ugandan firms experienced some of the highest losses from foregone sales revenue due to electrical outages.

The same report also finds that informal firms, which struggle more to have backup power, suffer over 3 times more sales losses due to power outages as compared to formal firms[52].

50 Khisa (2017)
51 Key Stakeholder Interviews
52 UNECA (2013)

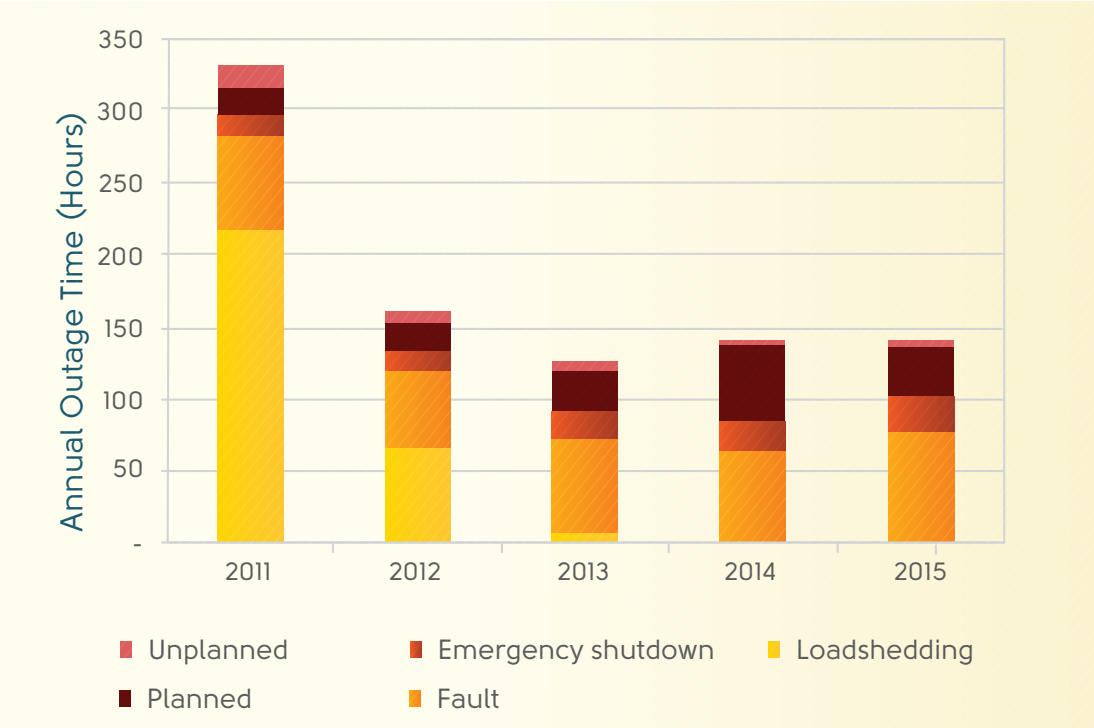
Figure 38: **Losses due to electrical outages (% of annual sales of firms).**



Source: World Bank (2013).

This changed shortly thereafter as Bujagali Hydro Power Station came online, creating an overcapacity and eliminating load-shedding. The graph below shows that with the elimination of load-shedding, the number of hours of electricity outage per year decreased by more than half but remained at just under 150 hours / year due to technical issues in the transmission and distribution system.

Figure 39: **Annual outage duration time in hours 2011-2015.**



Source: Umeme (2016).

This trend in the outage data is recognised by local firms, but outages and fluctuations still have a significant detrimental effect on business operations. During a survey of 119 Ugandan companies, all firms acknowledged the elimination of load shedding, but many were concerned with ongoing distribution issues. Even though respondents recognised that most outages were due to maintenance and planned in advance, in their experience the number of blackouts that are not communicated in advance increased in 2015 and 2016[53]. In key stakeholder interviews, manufacturers have noted that power fluctuations and outages have a serious detrimental effect on their operations as they cause expensive machinery to break down, lead to time losses in cleaning, repairing and resetting machines, and mean that raw materials are lost.

2. SUSTAINABILITY

a. Natural resource depletion

The largest environmental impact of Uganda's electricity sector is the impact of dams on local ecosystems. Dams are frequently a primary cause of the loss and degradation of river ecosystems and the services these ecosystems provide to society. For example, Uganda's largest dam - Karuma - has raised concerns about various negative environmental impacts including the submergence of vegetation through flooding, river water divergence leading to lack of water for plants and animals, earth material dumping destroying existing ecosystems, and air and water pollution[54].

b. Greenhouse gas emissions

Being dominated by hydropower, Uganda's electricity sector is not carbon intensive and therefore does not present a sustainability risk with regards to global greenhouse gas emissions.

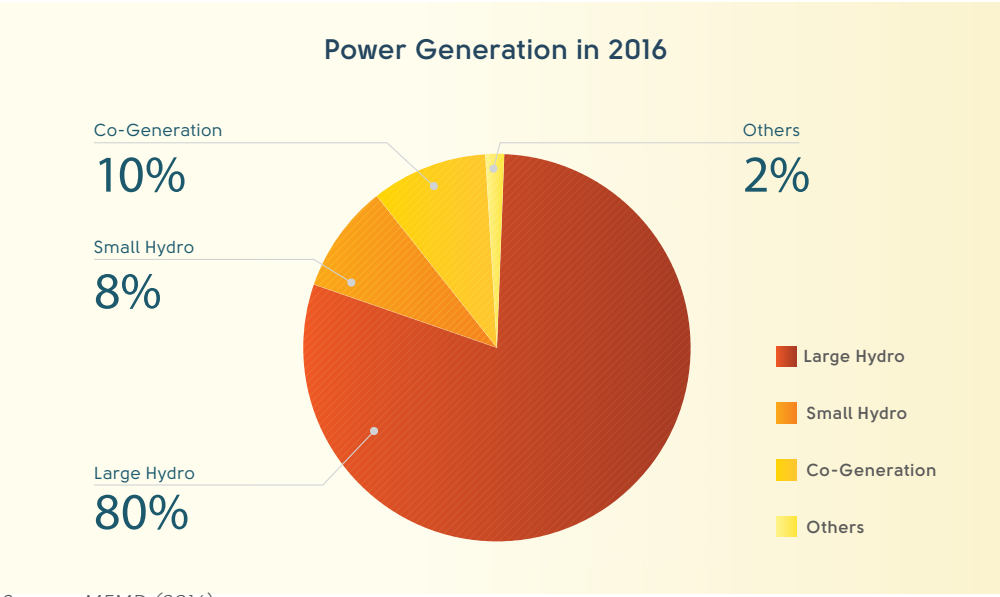
53 Steward Redqueen (2016)
54 NAPE (2013)

3. RESILIENCE of the electricity supply

a. Diversification of sources

Uganda's electricity supply depends almost entirely on hydropower, making the system vulnerable to climate-related shocks. As witnessed in 2006, rainfall variability affects dams' capacity to generate electricity and drought can thus lead to severely diminished power generation capacity. Lake Victoria, from which the White Nile and the three largest hydro power stations receive all their water, has a unique hydrology. A remarkable 85% of the lake's inflow comes from rain rather than river inflows. Because the shallow lake has limited storage capacity, this means that water levels are sensitive to changing climate patterns.[55] Climate projections predict a potential 20% drop in rainfall over Lake Victoria. Uganda's National Adaptation Programme of Action (NAPA) suggests a trend of increasing frequency of drought events and also increased rainfall variability in recent years, linking them to climate change[56]. Between 2004 and 2006, the reduction in water levels at Lake Victoria resulted in reduction in hydropower generation by 50 MW and led to the adjustment of the GDP growth rate from 6.2% to 4.9%. The government was compelled to add thermal energy into its energy mix to fill the gap. This led to an electricity price increase of 100% in two years and obliged businesses to purchase backup diesel generators[57].

Figure 40: **Power generation by source, 2016.**



Source: MEMD (2016).

55 Steward Redqueen (2016)
56 FAO (2017)
57 UNECA (2013)

However, the increase in generation capacity means that generation, even though still dependent on hydropower, will be less of a bottleneck in the years to come. Two additional large hydro power plants – Karuma (600 MW) and Isimba (183 MW) are planned to be operational in 3-4 years. At a 70% capacity factor (the same as Bujagali), these plants will almost double Uganda's generating capacity, although they will also increase the country's dependency on the volatile hydrology of Lake Victoria. A number of small hydro plants, with a cumulative capacity of around 100 MW, are also being planned, as well as three larger run-of-river hydro plants (together 130 MW) on other rivers than the White Nile. Capacity additions from the current 600 MW to the expected 1,600 MW by 2020 mean that Uganda will have plenty of room to grow its electricity use and still have excess capacity. It also means that generation will not be a bottleneck in the next decade[58].

b. Redundancy of electricity supply

The electricity network has not achieved full redundancy because of economic considerations but over time more of the network will have built-in redundancy to mitigate against potential power interruptions. As part of this contingency, some co-generation and thermal projects have been configured to operate in Island mode in the event of a system failure.

58 Steward Redqueen (2016)

7.
STATUS:
BIOMASS

Status: Electricity

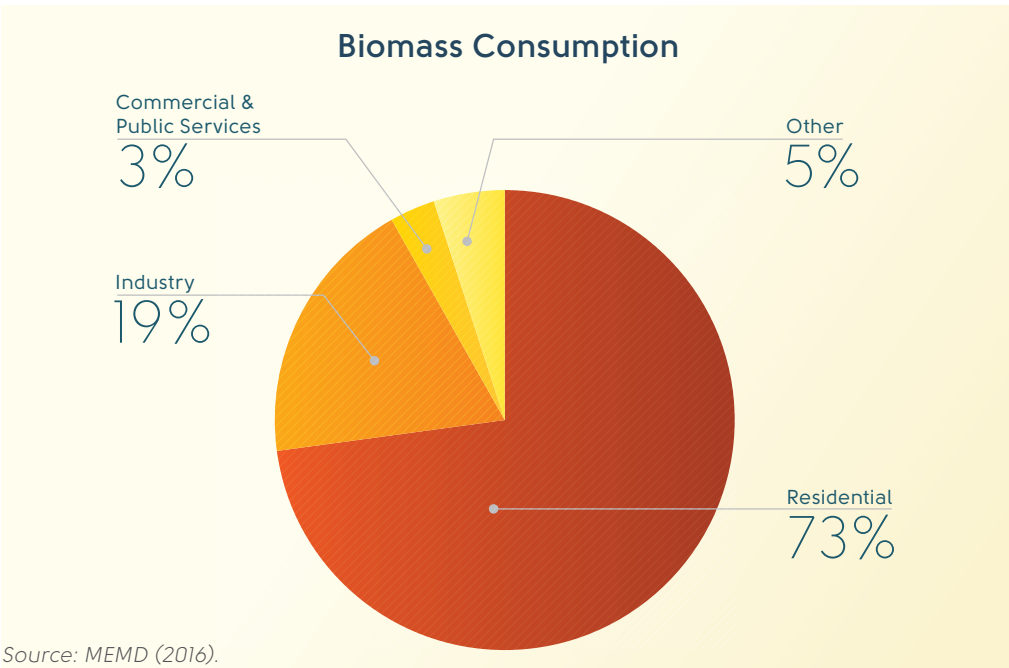
Biomass is material from plants and animals. It is most commonly derived from waste residues in several forms such as scrap wood, mill residues, and forest resources. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel.

CONSUMPTION

Biomass is the overwhelming source of energy in Uganda, accounting for almost 90% of all energy consumed in the country. Of the total biomass consumed, wood fuel accounts for more than 80%, charcoal for 10% and crop residues for 4%. Firewood and crop residues are majorly consumed in rural areas while charcoal is consumed in urban areas. Limited storage space in urban areas, high standards of living, higher calorific value of charcoal than for wood and easier handling by vendors makes charcoal the favoured fuel over firewood in urban areas[59].

Collectively, households are by far the biggest consumers of biomass. However, industrial and commercial firms are significant users too[60]. Industrial and commercial firms use 5.3 million tonnes of firewood, 1.8 million tonnes of agricultural residues, and 0.3 million tonnes of charcoal annually[61]. This amounts to 9.2 million tonnes of total wood equivalent, that is to say around 20% of total biomass use for energy.

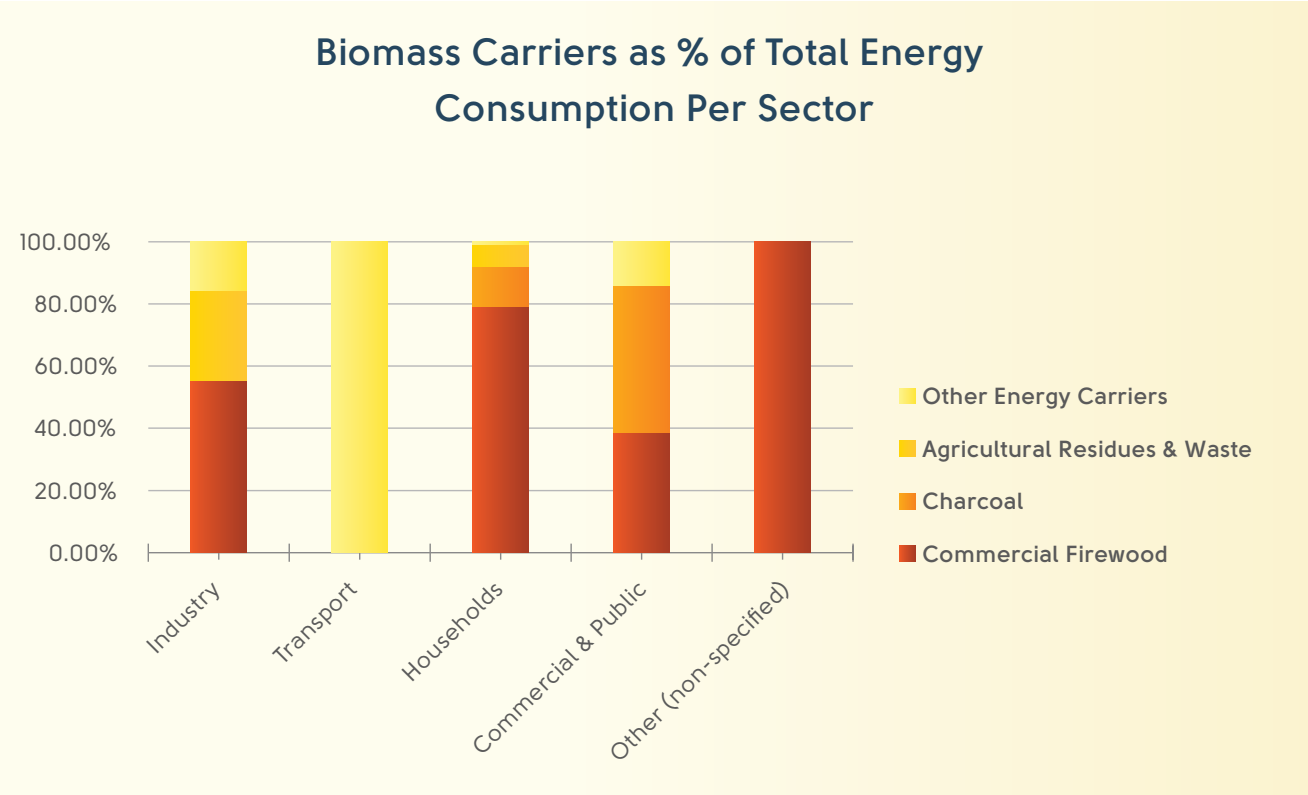
Figure 41: **Biomass consumption in Uganda by sector, 2016.**



Source: MEMD (2016).

59 MEMD (2015)
60 UNDP (2014)
61 UNDP (2014)

Figure 42: **Biomass as a percentage of consumption in Uganda.**

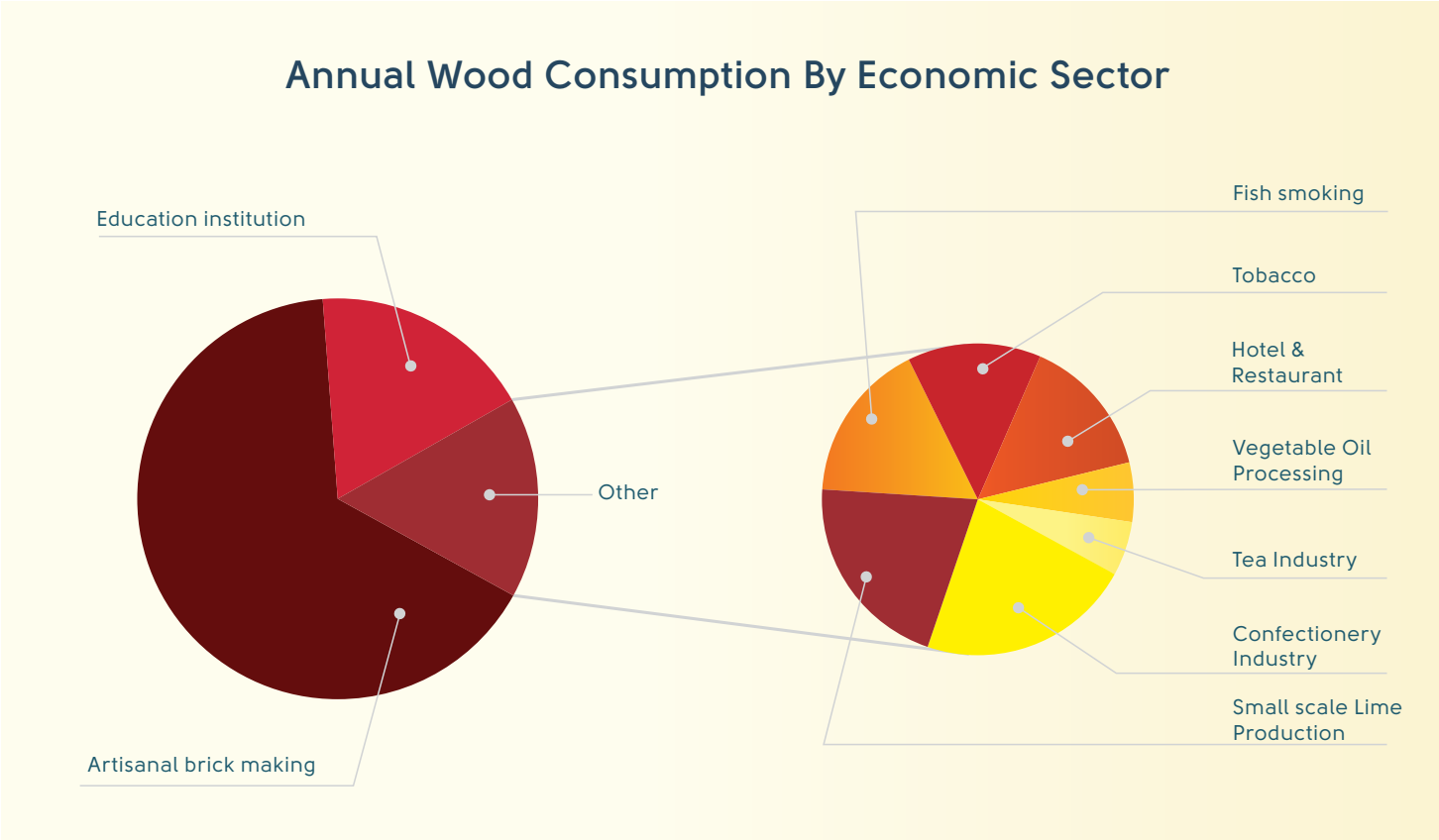


Source: MEMD (2016).

Industry in Uganda is heavily reliant on firewood. Wood fuel is used extensively for process heating and to fuel artisanal brick-burning (0.6 kg of wood/kg of product), tea drying (1.5 kg of wood/kg of product), small scale lime production (1.5 kg of wood/kg of product) and tobacco (8 kg of wood/kg of product). The graph below shows the annual consumption of wood fuel by industrial and commercial sectors (excluding charcoal production)[62].

62 Ibid

Figure 43: **Annual wood consumption by economic sector.**



Source: UNDP (2014).

It is striking that artisanal brickmaking accounts for about two thirds of all wood fuel consumption by firms. Educational institutions (mostly primary and secondary schools) are a distant but unrivalled second. Therefore, introducing energy efficient devices and practices and encouraging the substitution of wood in these two sectors has the potential to considerably reduce overall consumption of wood by firms. The only sub-sector that currently utilizes biomass residues for electricity production is the sugar industry. A small amount of coffee and rice husks is also utilized for heat production in cement and tile manufacturing and the production of briquettes but the potential of biomass residues for electricity production remains untapped.

Organization of the biomass sector

Firewood and charcoal constitute a significant proportion of Uganda's GDP and employment. The contribution of firewood and charcoal to Uganda's GDP is estimated at USD 48 million and USD 26.8 million respectively.

The charcoal subsector for instance provides employment to many semi-skilled and unskilled labourers at different stages of production, transportation and distribution.

However, the firewood and charcoal sectors are dominated by small-scale, informal cottage industries, resulting in inefficiencies and unsustainable production practices. Despite the economic importance and significance as a major fuel, biomass has received little recognition in terms of government prioritization and funding[63]. Existing policies and regulatory frameworks in Uganda are focused on recognising the role of forestry in national development. The Constitution of Uganda obligates government to "promote and implement energy policies that will ensure that people's basic needs and those of environmental preservation are met." However, the level of compliance to the policies around sustainable use of natural resources including forests is still very low: the results are misuse and degradation of the environment. The sector is thus characterized by a lack of interest from investors, an inadequate enforcement of regulation, a poor organisation of players, the use of inefficient technologies, the lack of standards and unsustainable production practices.

63 MFPED (2015)

Biomass For Productive Use: Assessment Snapshot

Table 7: **Assessing status of biomass for productive use.**

Inclusiveness	**Accessibility**		• Currently accessible even though some sectors highly dependent on fuelwood such as brickmaking already consider scarcity of fuelwood as one of their main challenges (see reliability section) • Agricultural residue sector (in the form of briquettes) not well organised due to limitations in production capacity, untapped demand, and challenges faced by briquette enterprises in accessing business finance.
	Affordability		• Fuelwood is still affordable but the price of charcoal keeps increasing at UGX 75,000 a bag, charcoal is now priced competitively with LPG
	Reliability		• Demand is likely to outstrip supply in the near future unless quick interventions are undertaken. The diminishing supply of wood will make charcoal and fuelwood increasingly inaccessible and unaffordable
Sustainability	**Resources depletion**		• The loss of forests often results in serious environmental consequences in terms of soil erosion, flash floods and depletion of a global carbon sink.
	Greenhouse gas emissions		• Biomass burning and deforestation are major contributors to Uganda's greenhouse gas emissions. Unabated growth in biomass use would put Uganda at risk of not meeting its INDC commitments
Resilience	**Diversification of Supply**		• The wood (47%) for charcoal production in Uganda is sourced mainly from privately owned forests (47%), central forest reserves (22%) and on-farm trees (20%). Privately owned forests are not replenished as they are used for purposes such as farming and construction
	Redundancy		• Increasing scarcity of supply for wood and charcoal that are the main biomass energy carriers • Potential for agricultural residues still untapped

Table 8: **Main constraints and opportunities, biomass.**

Main constraints	Main opportunities
Sustainability: • Forest depletion leading to serious environmental consequences that can affect the economy.	*The focus of stakeholders including government and donors has been on reducing the dependency of households on firewood and charcoal. Less attention has been paid to the dependency of firms on these biomass fuels.* ***Opportunities include:*** • increasing the efficiency of charcoal production; • increasing the efficiency of charcoal and firewood conversion for productive use; • switching to alternative fuels for process heating and cooking by firms (briquettes; LPG); • make firewood and charcoal supply chains more sustainable; • switching to alternative fuels for cooking in households; and • replenishing forest reserves.
Reliability: • Demand for fuelwood and charcoal will soon outstrip supply, negatively affecting accessibility and affordability. The vast majority of the energy consumption is based on biomass sources, which are being depleted at a fast pace.	

Biomass For Productive Use: Detailed Assessment

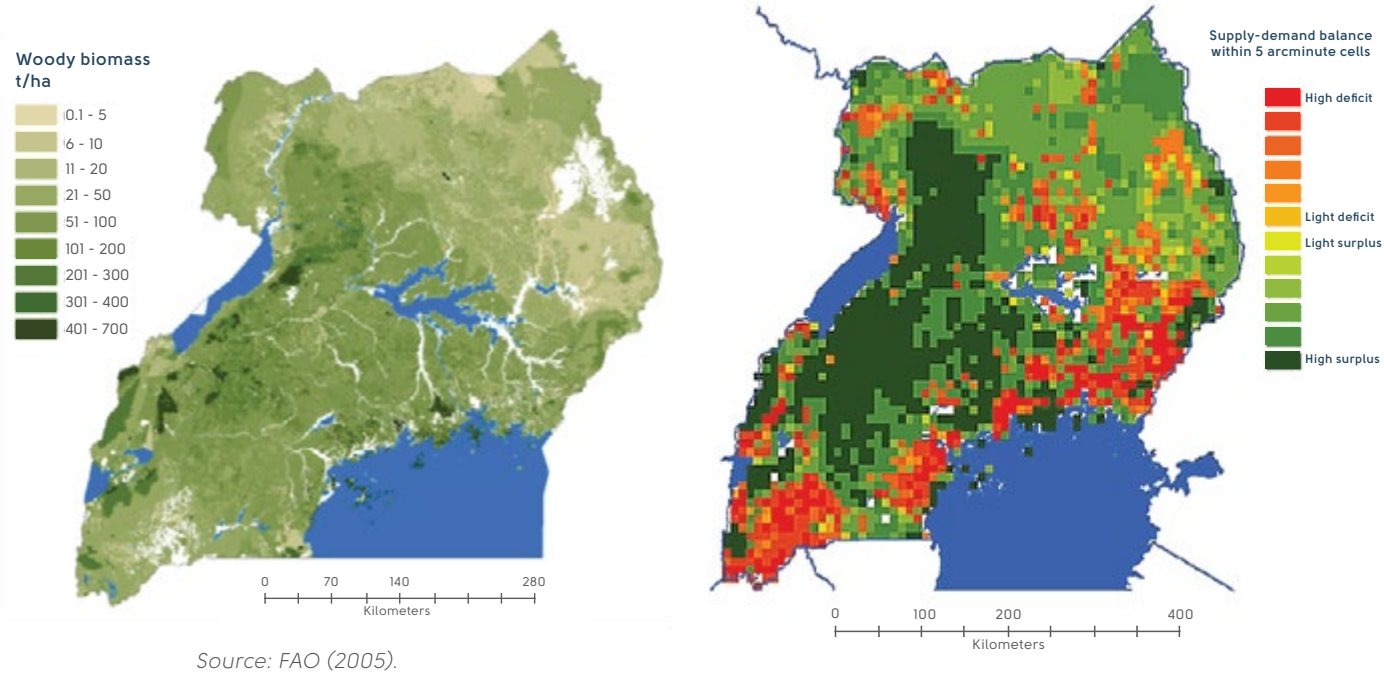
1. INCLUSIVENESS

a. Accessibility of biomass for firms

The existing evidence is scarce on the accessibility of biomass for firms. Biomass is a diverse resource and is easy to harness because unlike some other forms of energy, it is not site specific. It is available in many forms such as trees, bush, grass and forbs, papyrus and reeds and vegetal waste.

Generally, it can be assumed that firms have relatively easy access to fuel wood and charcoal. However, the maps below highlight that there are regional differences in the availability of woody biomass due to variation in both supply and demand. Areas that experience a high deficit of woody biomass are likely to face higher wood fuel and charcoal costs as well as potential supply shortages affecting production. For example, small scale lime producers in both Tororo and Kasese – both in areas marked red in the map below but located at opposite ends of the country - are worried about future sources of fuel wood.

Figure 44: **Woody biomass cover and fuel wood supply consumption balance in Uganda.**



Source: FAO (2005).

The availability of agricultural residue on the other hand is highly concentrated in industries that produce their own residue as the market for agricultural residue is embryonic at most. In the sugar industry for instance, large sugar plantations use their own agricultural residue to generate electricity and process heat on-site, but its use outside of agribusiness is minimal.

b. Affordability of biomass supply for firms

Biomass is becoming increasingly scarce and expensive for Ugandan firms. In a MEMD – UNDP study on biomass energy, all brickmakers visited presented fuelwood scarcity as their biggest challenge and were worried about future wood supplies. The study found that the price of fuel wood has gone up as distance to source has increased.[64] The price of charcoal in Kampala rose by 30% between 2016 and 2017, and in the space of a few years, the dominant source of charcoal supplies shifted from nearby districts to the far north of the country. This shift is mainly due to deforestation in the Cattle Corridor (Luweero, Nakasongola, Kyankwanzi and Masindi), where forest land has been opened up for plantation agriculture and livestock rearing.[65] Biomass briquettes are in theory cheaper than charcoal, but their availability and uptake have been slow due to supply-side weaknesses in the sector.

64 UNDP (2014)
65 Musoke, R. (2017)

c. Reliability of biomass supply for firms

Little data is available on the reliability of biomass supply for firms in Uganda, but it can be assumed to be highly variable. A number of factors can affect the supply of biomass for firms. For example, the seasonal growth of biomass carriers, droughts, as well poor road conditions due to heavy rains and flooding can impede its availability. Large scale storage facilities would be needed by industrial firms to be able to guarantee the constant and year-round supply of biomass. However, the study did not find data on the reliability of biomass supply for firms in Uganda.

2. SUSTAINABILITY

a. Resource depletion

Firewood and charcoal demand is likely to outstrip supply in the coming decades, making them unsustainable sources of energy for productive use. Projections by the MEMD put the growth of biomass energy demand, mainly wood and charcoal, at a mean annual rate of 50 million tonnes. Demand is likely to soon outstrip supply unless quick interventions are undertaken, and the country may well run out of biomass energy resources in the coming decades[66].

Uganda's forest reserves are rapidly being depleted. Uganda's forest area fell from 4.8 million hectares in 1990 to 2.1 million hectares in 2015 and the rate of deforestation increased steadily throughout that period[67]. Due to the ever-increasing pressure and demand exerted by rapid population growth and economic activities, Uganda's vegetation cover (trees, forests and woodlands) has fallen from 45% in 1890 to about 11.7% in 2013. Districts rapidly losing vegetative cover include Masindi, Nakasongola, Luweero and other districts surrounding the three major consuming cities Kampala, Jinja and Entebbe.

The use of wood fuel and charcoal for process heating in industry and cooking in the services sector is a significant contributor to deforestation, even though the deforestation effect of biomass use for energy is lower than that of land clearing for cultivation and construction. Wood for charcoal production in Uganda for instance is mainly sourced from privately owned forests (47%) that are generally not replenished but are cut as a form of land clearing for other purposes such as farming and construction. The rest of the wood supply for charcoal production comes from central forest reserves (22%) and on-farm trees (20%). Whether caused by the demand for fuels or land clearing, deforestation will soon render wood-based fuels an unsustainable source of energy for productive use as the growing demand is unlikely going to be met by supply in the near to medium future.

66 UNDP (2014)
67 FAO (2017)

Charcoal production in Uganda is dominated by inefficient practices and technologies. Almost all charcoal burners do not sort wood according to species prior to carbonization. Charcoal is often produced from slow-growing species that are therefore particularly vulnerable to overexploitation. According the 2015 National Charcoal Survey, 48% of charcoal producers burn the wood when still wet, which is highly wasteful and inefficient, while commonly used traditional earth kilns have an efficiency of 10- 15%.

Uganda's forests and woodlands provide numerous environmental services and direct benefits for many sectors such as agriculture, water and fisheries. These include the value of watershed and groundwater protection, erosion control and carbon sequestration. Uganda's forests contribute significantly to the protection and stabilization of the environment. Further, forests in Uganda play a broader role in the maintenance of environmental quality such as soil and water conservation and carbon sequestration. The loss of forest cover often results in serious environmental consequences such as soil erosion, floods and, of course, the depletion of a global carbon sink. Forests and the biodiversity they contain also serve as an important tourist attraction, driving economic development in this sector. Beyond economics, forests and trees hold significant cultural and symbolic functions, as well as being crucial to the maintenance of ecosystems that produce medicinal plants, on which the vast majority of the rural population depends for the treatment of a wide range of ailments.[68]

68 FAO (2017)

b. Greenhouse gas emissions

Biomass burning and deforestation are major contributors to Uganda's greenhouse gas emissions. Thus, unabated growth in biomass use would put Uganda at risk of not meeting its INDC commitments[69]. For example, the manufacture of coal from wood in low-efficiency traditional kilns are substantial. A shift from traditional charcoal kilns with an energy transformation efficiency of around 15-25% to more modern systems with increased yields would be necessary to transforming charcoal into a modern biomass fuel.[70]

3. RESILIENCE of biomass supply for firms

Sudden shocks to the supply of biomass for process heating and cooking are unlikely. The increasing scarcity of supply is a highly predictable and gradual process that is discussed under ***Sustainability.***

69 USAID (2015)
70 WWF (2015)

8.
STATUS: PETROLEUM PRODUCTS

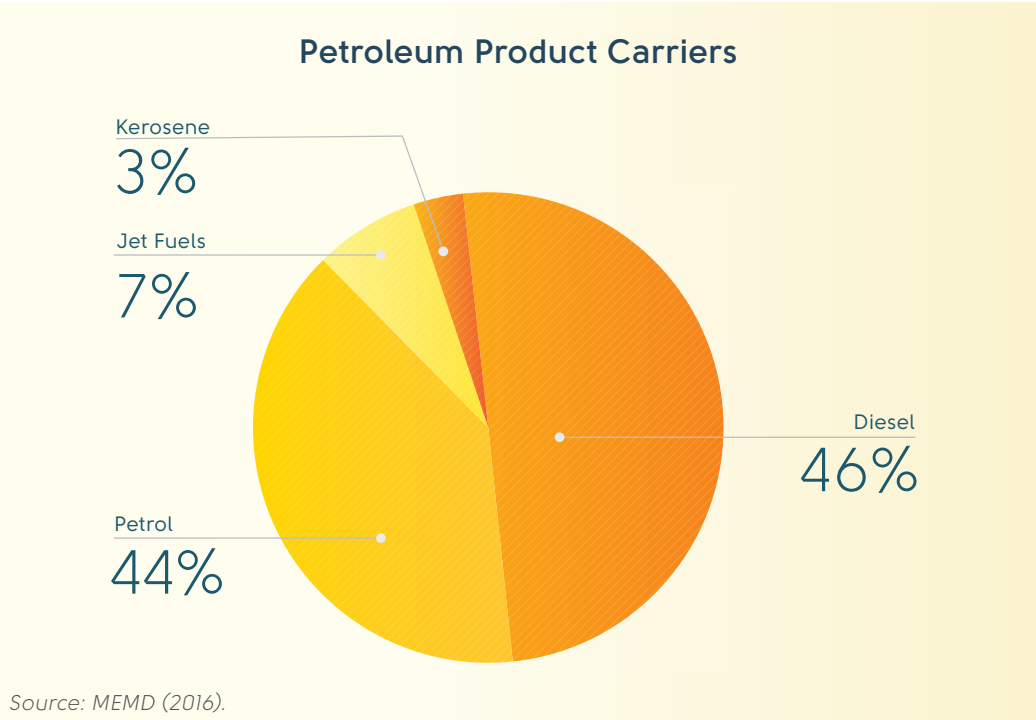
Status: Petroleum Products

Petroleum products are materials derived from crude oil (petroleum) as it is processed in oil refineries. The largest share of oil products is used as energy carriers in the form of various grades of fuel oil and gasoline. These fuels include or can be blended to give gasoline, jet fuel, diesel fuel, heating oil, and heavier fuel oils.

CONSUMPTION OF PETROLEUM PRODUCTS IN UGANDA

Petroleum products account for about 11% of all energy consumed in Uganda. Demand is growing at 7% and requires a fuel import expenditure of USD113 million per month. Petroleum imports rose by 35% from 2011 to 2015, totalling 1.76 billion litres in 2015.

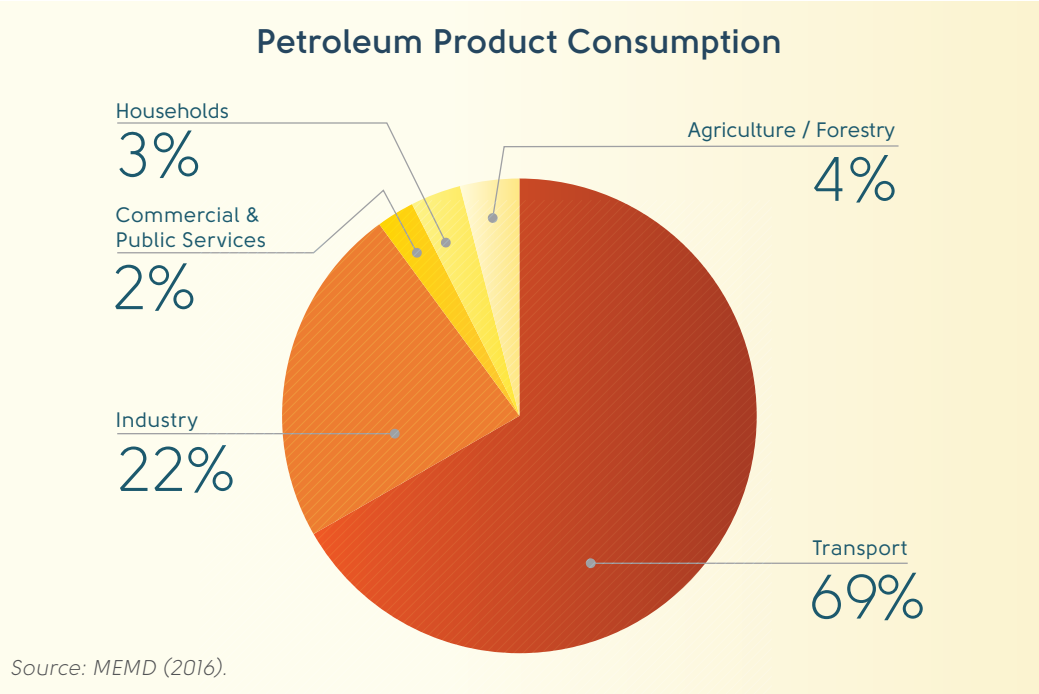
Figure 45: **Petroleum product carriers.**



Source: MEMD (2016).

Diesel and petrol account for 90% of the overall imported and consumed petroleum products in the country and are mainly used for transportation. Some diesel is used for on and off grid electricity generation, either as a source of backup power or for remote off-grid power production. Jet kerosene is used for air transport. Though insignificant in overall quantity, kerosene meets a significant share of household lighting demand (wick lamps and hurricane lanterns). Liquid petroleum gas (LPG) is used for cooking for a small number of wealthier households as well as institutions and industries.

Figure 46: **Petroleum product consumption by sector.**



Organization of the petroleum sector

Currently, all petroleum products consumed in Uganda are imported through Kenya (90%) and Tanzania (10%). As a result of the discovery of significant oil reserves in the Albertine region, the Government of Uganda has advanced plans and negotiations for the financing and construction of an oil pipeline to the port of Tanga, Tanzania as well as an oil refinery with a capacity of 60,000 barrels per day (which is more than twice Uganda's current consumption).

PETROLEUM PRODUCTS FOR PRODUCTIVE USE: Assessment Snapshot

Table 9: **Assessing status of petroleum for productive use.**

Inclusiveness	**Accessibility**		• Accessible
	Affordability		• Prices of petrol and diesel have increased recently but are still on par with regional prices
	Reliability		• Generally unproblematic, though supply shocks due to supply chain bottlenecks have in the past disrupted the reliable availability of petroleum products
Sustainability	**Resource depletion**		• Air pollution and its effects on health
	Greenhouse gas emissions		• Transportation is projected to become the largest driver of growth in energy sector emissions through 2035
Resilience	**Diversification of Supply**		• Virtually all petroleum products currently imported
	Redundancy		• Weak strategic reserve capacity and dependency on Kenya import route (90% of its import) make economy vulnerable to supply shocks and price volatility

Table 10: **Main Constraints And Opportunities, Petroleum Products.**

Main constraints	Main opportunities
Resilience: • Air pollution • Greenhouse gas emissions	• *Alternative transport fuels (e.g. biofuels, electricity)* • *Transport energy efficiency (e.g. mass transit systems)* • *Vehicle emissions regulations in regards to aging vehicles with incomplete combustion*
Resilience: • Over-reliance on price-volatile imports • Over-reliance on one import route prone to supply chain bottlenecks	• *Refinery could help diversify and secure supply* • *Import route diversification (e.g. Tanzania)*

1. INCLUSIVENESS

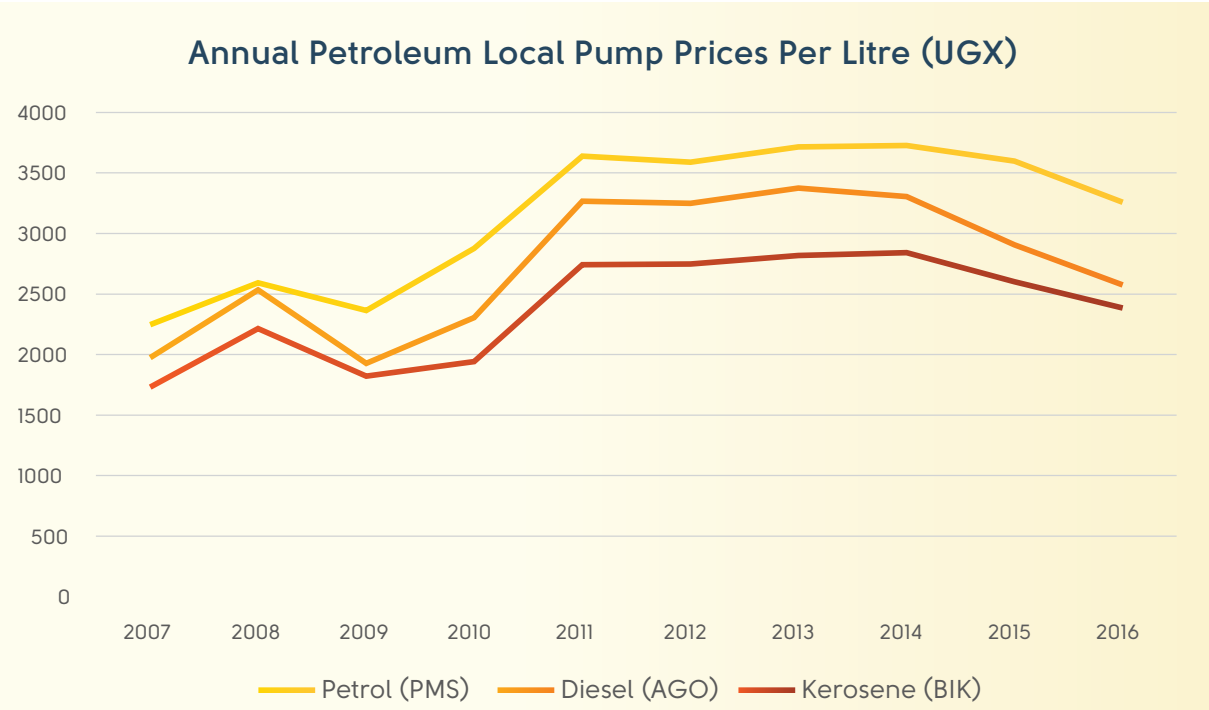
a. Accessibility of petroleum products

Despite the absence of data on firm access to petroleum products, we can assume that differences in access are driven by geography and manifested through price variability, discussed under *Resilience* below.

b. Affordability of petroleum products

The price of petroleum products directly affects businesses in their operations. As their energy costs increase, products and services become more expensive which can in turn affect competitiveness. Since heavy fuel is also used for backup electricity production (both for utility-scale power stations and for generators by individual heavy manufacturing plants), the price of oil products affects electricity tariffs as well as industry production costs. Businesses are affected by both average price trends and short-term price volatility. Petroleum product price volatility makes businesses, aggregate domestic demand, and government budgets vulnerable to price shocks.[71] High petroleum product prices drive up production costs by increasing the cost of running backup power generators (an issue related to the reliability of electricity) and by increasing the cost of raw materials and other inputs.

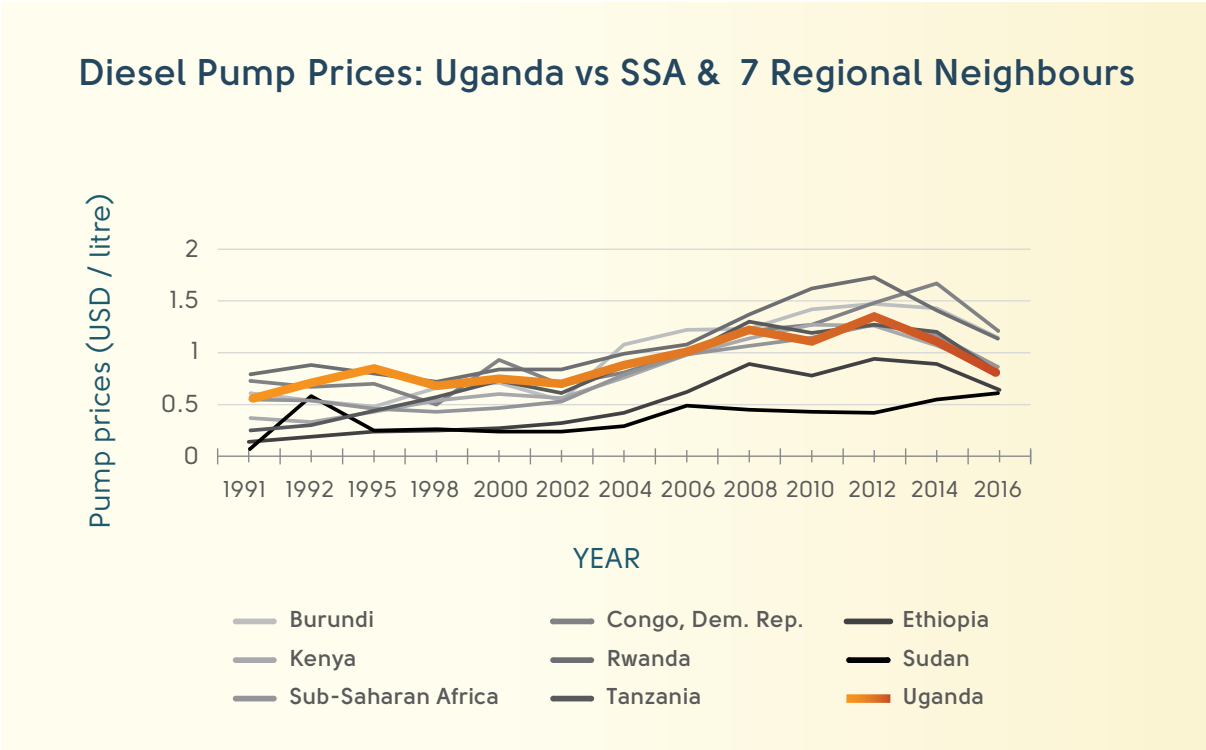
Figure 47: **Annual Petroleum Local Pump Prices per Liter in UGX.**



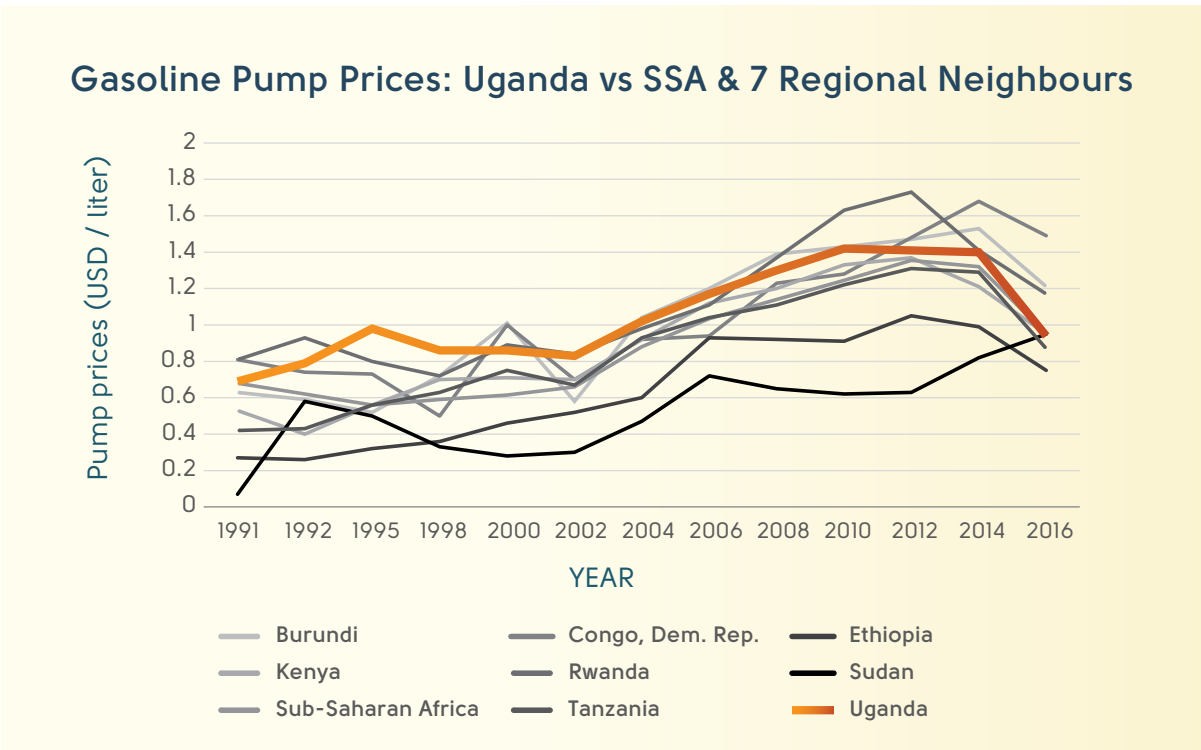
Source: MEMD (2016).

71 UNECA (2013)

Figure 48: **Uganda's regional competitiveness in petroleum product prices.**



Source: World Bank (2018).



Petroleum product prices in Uganda are competitive with regional neighbours but are driven upwards by several avoidable factors. The graphs show that Uganda has become increasingly competitive with regional neighbours and SSA more broadly. However, more progress could be made if some key drivers of fuel prices in Uganda were addressed. Fuel prices in Uganda are driven by the volatile international oil price (crude oil prices had dropped as low as USD37 / barrel in December 2015 but were rebounding towards USD70 / barrel in early 2018[72]), The UGX-USD exchange rate (which has been depreciating steadily for years), and supply chain bottlenecks between Mombasa and Kampala.

c. Reliability of petroleum products supply

Much as there have been efforts like implementation of the fuel marking programme by MEMD and UNBS, fuel adulteration and dumping remains a big challenge to the sector. In 2016 Uganda National Bureau of Statistics (UNBS) and MEMD in a collaborative investigation identified and named 140 fuel stations with adulterated fuel, leading to their penalization and sealing by the ministry's enforcement team.

72 Macrotrends (2018)

2. SUSTAINABILITY

a. Resource depletion

The exploitation of oil in the Albertine Graben in western Uganda will have significant effects on the local environment. This region is recognized as one of the most bio-diverse areas in the world. The environmental impacts of oil exploitation are many and can include noise and light pollution at drilling sites; loss of habitat to drill pads, roads, and infrastructure; pollution from oil spills and collection pits; increased human presence causing animals to move away or people getting involved in illegal activities; and increased traffic of vehicles with associated road kills and pollution.

The increasing use of petroleum products for transportation, especially due to the rapid motorization experienced in cities such as Kampala, is also leading to air pollution. Today, air pollution has become one of the biggest challenges faced in Kampala[73]. According to a WHO report, about 75% of air pollution in Uganda is due to transport-related activities. According to UNBS, Uganda's current motor vehicle fleet is estimated at 800,000. This is up from 53,000 in 1992 and 247,000 in 2004. More than 70% of these vehicles are registered in Kampala.

b. Greenhouse gas emissions

Currently, the growing number of cars and motorcycles powered by fossil fuels in Kampala is not aligned with the path described in Uganda's plan for low carbon development and requires specific attention from public authorities. In its Second National Communication of the UNFCCC in 2010, Uganda projected that transportation would be the largest driver of growth in energy sector emissions through 2035, followed by residential, manufacturing and construction.[74] In its plan for low carbon development, Uganda submitted six action points to the United Nations Framework Convention on Climate Change (UNFCCC). One of these is a Bus Rapid Transit system for Kampala which aims to improve the efficiency of public transport, reduce pollution as well as transport emissions in the Kampala metropolitan region from a business-as-usual baseline. This action point typically demonstrates how urban planning and policy transport sector strategies can be linked with climate change policy, particularly through the promotion of modes of transport that take GHG emission reductions into account and are climate-resilient.

73 Kirenga, B.J., Meng, Q. van Gemert, F., Aanyu-Tukamuhebwa, H., Chavannes, N., Katamba, A., Obai, G., van der Molen, T., Schwander, S., Mohsenin, V. (2015)

74 USAID (2015)

3. RESILIENCE

a. Diversification of supply

Uganda depends on petroleum imports through Kenya (90%) and Tanzania (10%), making it vulnerable to supply shocks. For instance, following the 2008 post-election violence in Kenya, oil imports from Eldoret to Uganda were interrupted and Uganda was hit by severe short-run supply disruptions, along with Rwanda and Burundi[75]. In 2018 again, supply chain bottlenecks in Kenya have been a key contributor to a price hike in fuel products in Uganda[76]. When supply shocks hit Uganda, even when they are minor, they disproportionately affect more peripheral areas. For example, a minor shortage in 2014 caused mainly by confusion over new import regulations led to price hikes of 100 UGX in Kampala versus several thousand UGX in Gulu - where the brief shortage was so severe that fuel was only available on the black market at hugely inflated prices[77].

b. Redundancy

Uganda now has sufficient fuel reserves to be able to adequately respond to severe supply shocks in the short-run. The 2008 fuel shortages following the post-election violence in Kenya led to fuel price hikes in the country, motivating the Government of Uganda to develop a plan with the aim of restocking the strategic fuel reserves in Jinja and also completing the construction of the Nakasongola and Gulu reserves[78 79]. Despite delays in re-stocking and improving management of the Jinja Storage Terminal[80], fuel reserves kept in the facility increased from 0.36 million litres in June 2017 to 13.64 million litres in October 2017, higher than the 12 million litres directed by the government to One Petroleum and Uganda National Oil Company[81].

75 UNECA (2013)
76 Muhame, G. (2018)
77 Mwesigwa, A. and Nangonzi, Y. (2014)
78 New Vision (2010)
79 MFPED (2015)
80 URN (2018)
81 Businge, J. (2017)

9.
CONSTRAINTS

Constraints Overview

Table 11. **Constraints Overview**

	Electricity	Biomass	Petroleum Products
Inclusiveness	1. Unequal accessibility across geographies 2. Reliability 3. Affordability: high & increasing tariffs		
Sustainability		4. Over-reliance on depleting forest reserves	5. Urban air pollution & greenhouse gas emissions caused by transport
Resilience			6. Vulnerability to petrol product price & supply shocks

Electricity

1. UNEQUAL ACCESSIBILITY ACROSS GEOGRAPHIES

Many Ugandan SMEs do not have access to the grid. Consequently, the increase in output that could be derived from having access to electricity remains untapped. This access issue can be explained by several factors. Today, the grid remains mostly accessible in the urban areas of the country. While large industries have the capacity to access industrial hubs or negotiate to gain access to the grid, most SMEs are not located in these areas. While the increase in generation capacity all but eliminated load shedding and led to a situation of electricity surplus, the transmission and distribution systems are lagging behind.

Distribution and transmission systems are now lagging behind generation. According to several key stakeholders interviewed, land compensation is the biggest binding constraint on the expansion of transmission and distribution lines across the country. By some reports there are over 200 land compensation cases in the courts currently, and the Land Commission's inquiry into land compensation is a burning issue in the public discourse. The expansion of transmission and distribution lines requires government to take control of the land on which lines are to be constructed. However, two intertwined issues are slowing this process and making it prohibitively expensive. First, Ugandan law currently protects landowners

to the extent that the government cannot seize control of the land until the landowner agrees to a compensation price. Second, there is widespread suspicion of the speculative purchase of land by people who gain access to information about planned electricity infrastructure projects. Combined, these two factors are likely to be leading to distorted land prices and severe delays in land acquisition by government for electricity lines.

In parallel to the difficulty to access the grid for many businesses in Uganda, the lack of supply of off-grid technologies for productive use is also a limiting factor. Probable reasons for the slow growth of off-grid solutions for productive use range from the impact per dollar invested to the Return on Investments (ROI) of mini-grids in comparison with other renewable technology options. Indeed, mini-grids ROI do not sit well compared with other models such as solar pay-as-you-go (PAYGO) and large-scale electricity infrastructure projects.

PAYGO models have the capacity for rapid scale-up since households can easily become owners of a system and repay the technologies in 1-2 years, but cannot yet enable household enterprises to move up the energy ladder. The systems are low cost initial investments per unit and can deliver significant impact on the productivity of household enterprise. There are more than 150,000 households on PAYGO in Uganda and such solutions attract a lot of actors and investors. However, the use of such devices is mostly limited to lighting, phone charging and small appliances (hair clippers, salon dryers etc.) that deliver low organic consumer demand growth and cannot enable microenterprises to move up the energy ladder.

On the other end, larger-scale mini-grid projects are steeped in arduous regulations and heavy investments that require developers to secure large chunks of capital backed by long-term payment periods. Because of the significant preparatory stages involved in large energy infrastructure projects, the investors have enough information to work with in assessing risks, ROI and other development and economic factors. Mini-grids have relatively higher initial setup costs compared to the number of customers each mini-grid can supply. A mini-grid servicing 200 households can cost more than USD 200,000. The same amount of money could supply more than 1,000 households with pico-solar photovoltaics (PV) solutions providing basic energy needs. If the aim of the project is to reach the maximum number of people to provide them with basic energy services for domestic uses, mini-grids systems will not necessarily be chosen. Instead, mini-grids can be developed for projects that aim to provide "near grid-style" solutions that can meet domestic, social but also productive energy needs. Mini-grids tend to be designed one at a time as opposed to lump sums or bulk developments. There are few examples where a single investor is awarded 5-10 locations of mini-grids licensed to them. The case for mini-grids thus becomes even more unpalatable for the investors. Indeed, the ROI from a single mini-grid is too small to attract big investors.

2. RELIABILITY

Despite significant reductions in power outages after the operationalisation of Bujagali Dam which all but eliminated load-shedding, the reliability of electricity continues to be a severe constraint on firm productivity. Power fluctuations and unplanned outages due to technical issues in the transmission and distribution networks have numerous negative effects on firms, especially those in manufacturing and agricultural processing. Unforeseen outages and surges frequently cause the breakdown of machinery, the slowdown of production processes and the loss of raw materials. According to interviews with manufacturing firms, unscheduled and unexplained power outages persist even in industrial parks.

3. AFFORDABILITY: HIGH & INCREASING TARIFFS

The affordability of electricity is increasingly eroding for businesses, increasing their production costs and making them less competitive. Even for larger industries that are energy dependent, the rise in electricity tariffs in the last years is a growing concern and some of them are trying to develop innovative energy models (combining autonomous production and grid electricity for instance) to reduce their dependency on the grid. Costly power is particularly detrimental for electricity intensive businesses such as heavy manufacturing and cold storage.

In the coming years, it seems unlikely that the price of electricity will reduce significantly for the following reasons:

a. The government is locked into some contracts with IPPs meaning that even if they do not purchase power, they will still pay. The government for instance is locked into an agreement and guarantee with Bujagali that on an annual basis, money must be paid to the dam even if power is not purchased. Capital recovery has to take place for Bujagali and the government can't stop paying the producers.

b. Tariff increased in the last years because of the new generation capacity. The structure of the tariff is 70% generation cost. The construction of new dams is reflected into the current tariff. The new dams will generate electricity at almost half the cost of older dams. If all electricity generated in the country was to be sold, tariffs could decrease. Billions of USD have been committed to large new hydropower stations whose loan servicing will continue to drive high tariffs as long as tariffs are cost reflective. Stakeholder interviews have revealed that Uganda has potentially lost an opportunity to rely partly on very cheap electricity from the region, especially Ethiopia, where power could be sold for as little as 3 USD cents per kWh once the Grand Renaissance Dam is operational.

c. Transmission and distribution are lagging far behind generation, meaning consumption is not growing as quickly as it could.

Biomass

4. OVER-RELIANCE ON DEPLETING FOREST RESERVES

Demand for fuelwood and charcoal will soon outstrip supply, negatively affecting accessibility, affordability, resilience and sustainability. Forest depletion results in change of rainfall patterns, increased erosion and lower water tables. Because of the depletion of wood resources, the overall resilience of the energy system on which economic activities depend is at risk. Demand for fuelwood and charcoal will soon outstrip supply, negatively affecting accessibility and affordability.

As of today, the focus of stakeholders including government and donors has been on reducing the dependency of households on firewood and charcoal while less attention has been paid to the dependency of firms on these biomass fuels. Activities that are dependent on wood and charcoal need to anticipate the situation. Measures should be implemented to reduce their demand through energy efficient practices or energy efficient devices and to encourage the substitution of wood biomass by other energy carriers. However, the limited availability of electricity and high prices of petroleum products constitute real barriers to a reduction in the demand for biomass. The fact that the current use of biomass especially charcoal contributes to the rural economy in terms of tax revenue and employment is also another difficulty to change the system in the short term.

The biomass market is also affected by regional dynamics. For example, charcoal exports to Kenya have skyrocketed recently following the introduction of tougher regulation on to slow deforestation in Kenya causing a charcoal shortage there. With imports from Uganda meeting the demand, the pressure has effectively shifted from Kenyan forests to Ugandan forests.

Petroleum Products

5. URBAN AIR POLLUTION & GREENHOUSE GAS EMISSIONS CAUSED BY TRANSPORT

Kampala is already one of the African cities with the worst air quality in many parts of the urban metropolitan area. Air pollution, induced mainly by the growing number of petrol and diesel vehicles, is a growing health hazard. With the growth of a middle class that can afford to buy vehicles and the rapid pace of urbanization, transport is one of the main drivers for air pollution.

6. VULNERABILITY TO PETROL PRODUCT PRICE & SUPPLY SHOCKS

The lack of diversification in the supply of petroleum products in Uganda presents a resilience issue in the energy sector. Like many countries that are not oil producers, Uganda is dependent on the importation of petroleum fuels. To exacerbate the resilience issue, the country is dependent on a single import route from Mombasa for 90% of its importation - a route that has proven prone to supply chain bottlenecks. Ordinarily, fuel is transported from Mombasa through a pipeline to Eldoret and Kisumu from where it is supplied by road to Nairobi and other cities throughout East Africa. Transportation issues have always been a problem in the region and Uganda frequently faces fuel shortages due to supply logistics problems, leading to high fuel prices and black markets.

10.
OPPORTUNITIES

Opportunities: Snapshot

Table 12: **Opportunities: Snapshot**

Electricity	**1. Unequal accessibility across geographies**	**1A:** Off-grid solutions for productive use
	2. Reliability	**1B:** Prioritise transmission & distribution
	3. Affordability: high & increasing tariffs	**3A:** Electricity efficiency **3B:** Refinance generation projects **3C:** Spur demand through targeted action **3D:** Targeted electricity subsidies
Biomass	**4. Over-reliance on depleting forest reserves**	**4A:** Increase efficiency of biomass production **4B:** Increase efficiency of biomass conversion for productive use **4C:** Switch to alternative fuels for process heating and cooking by firms **4D:** Replenish forest reserves **4E:** Switch households to alternative cooking fuels
Petroleum Products	**5. Urban air pollution & greenhouse gas caused by transport**	**5A:** Alternative transport fuels **5B:** Transport energy efficiency **5C:** Vehicle emissions regulations
	6. Vulnerability to petrol product price & supply shocks	**6A:** Import route diversification **6B:** Refinery

Leveraging Global Trends

Globally, three major evolutions are currently reshaping the energy sector:

- **Decarbonisation:** even though 40% of the global energy mix is still from coal, the dynamics of the investments are in favour of low carbon technologies and especially renewable energy. The cost of solar and wind energy has dramatically decreased in recent years and will continue to do so. More and more investors are considering the carbon footprint of their portfolio and some major actors have already chosen to divest from fossil fuels, fearing the risks associated with holding "stranded assets". With the severe and irreversible impacts of climate change, carbon emissions need to be dramatically decreased. In this context, financing markets are also more and more pressurized to stop investing in fossil fuels such as oil and coal and focus on renewables.

- **Decentralisation:** the traditional model for the electricity sector was to have a central power plant, distributing power through the central grid. This model is currently shifting with the evolution of technologies and the proliferation of smaller devices.

- **New financing models such as crowdfunding:** Crowdfunding for energy access refers to the donation, reward, debt and equity campaigns launched by social enterprises, charities and other organisations raising capital for off-grid energy projects[82].

- **Digitalisation & Innovation:** digital solutions such as smart metering are opening a new frontier of energy efficiency and new ways to consume energy as well as innovative new services that will enhance consumer participation in the energy system.

- **Net metering:** In a bid to encourage uptake of renewable energy, particularly solar power, net metering allows residential and commercial customers who generate their own electricity to feed electricity they do not use back into the grid. Electricity customers become prosumers as opposed to consumers. The advantage of this policy move is that it reduces the financial burden of creating new large scale generation and incentivises customers to invest in renewable energy to supplement energy from the grid. This trend is discussed in line with citizen science.

- **Data analytics:** Use of disparate data sources such as mobile credit purchases to create credit scores for rural unbanked customers in order to determine default rates before rolling out asset financing for electrical appliances.

- **Blockchain and energy:** The advent of net metering enabled those who have rooftop solar have a slightly more

82 *Energy4Impact (2017)*

reciprocal energy relationship. Excess energy produced by solar panels is sold back to the utility. Blockchain is set to advance this two-sided relationship. Blockchain is a decentralized ledger technology. When applied to the energy sector, it will enable people to trade energy among themselves and have more control over the energy consumed.[83]

- **Internet of Things (IoT):** Under the general concept of smart homes and smart cities, IoT aids in energy management and optimization. As more devices get connected, it creates new opportunities to better manage supply with demand and change consumer behavior. IoT is however a push technology driven mostly manufacturers.

Opportunities: Detail

1A: Off-grid solutions for productive use

There are untapped opportunities for low capital investment solar infrastructure and portable solar technological innovations through public-private and private-private partnerships (PPPs) in strategic productive use sectors. Several solar companies already deploy PAYGO solar solutions that target off-grid domestic users. These could be scaled up to address more than domestic energy needs. Solar energy is capable of doing significantly more than lighting, charging gadgets, and running a few entertainment systems. It can be put to productive uses such as irrigation, agro-processing, and running cold storage systems. Through fostering strong PPPs in the solar sector, pico PV solutions, solar home systems and microgrids solutions can all be implemented to increase energy access for small enterprises in peripheral areas. The Renewable Energy Fund established by Government of Uganda could be critical in achieving rapid scaling up of access to solar and other renewable energy solutions.

Crowdfunding has been successfully applied by off-grid companies like SolarNow[84]. A number of asset financing companies are also emerging to fill the appliance financing gap supported by emerging fintech companies who are developing data analytics tools and back-end systems for PAYGO. In order to harness maximum benefits from the emerging developments, the government will need to put in place favourable policies to promote private investment.

Off-grid companies could explore the diversification of their products to include slightly bigger systems that enable productive use[85], such as hair clippers and refrigerators. This is also an opportunity to distinguish its product line from other off-grid companies. In agriculture, the

83 Maloney, P. (2018)
84 SolarNow (2016)
85 Solar Now Water Pump System, www.solarnow.eu/solar-solutions/farming-solutions

deployment of solar irrigation and water pumping would have direct impact on the productivity of on-farm household enterprises. Another notable application would be solar appliances specifically for the coffee industry: for example, farmers would be able to add value to the product if they had access to coffee pulpers to separate the bean from the skins and pulp[86]. A further potential market could be for the SME business level in the agricultural sector for instance, with the development of solar irrigation or water pumping for fish farms. The development of technologies to enhance the cold chain of food products could also help to limit some of the losses incurred by many SMEs. An example is a biogas refrigeration project by Green Heat to reduce post harvest losses in milk production in Soroti and Kumi[87].

Public-private partnerships could spur the development of mini-grids and increased penetration of solar photovoltaic (PV) systems. To increase the commercial viability of rural electrification, in 2017, the Government of Uganda in collaboration with GIZ welcomed bids from the private sector to electrify Lamwo District in the Northern region. The mini-grid developer is granted a 10-year concession and is responsible for commercializing energy services to end customers in those villages. Such initiatives enable reaching isolated villages far away from the grid by providing immediate energy access and boosting demand for energy.

The development of off-grid and mini-grid power solutions for productive use needs to go hand-in-hand with the uptake of electrical appliances from irrigation pumps to hair clippers. One mini-grid developer was forced to dump 50% of the electricity produced shortly after the grid was complete, due to low demand. The company set up a finance system for customers to pay for electric appliances with long loan payback periods in order to spur demand. There are opportunities to further interactions and business relationships between market leaders in the country. For example, coffee aggregators which are buying coffee beans could actively contribute to increase local productivity and income of farmers by providing education to farmers on technologies for productive use. As such, they could partner with an off-grid solar company to inform on the needs of the farmers and help develop energy solutions that would increase farmers' ability to add value to their product. By joining forces, industry leaders would contribute to accelerate access to electricity, and build the demand for solar appliances for productive use. A case in point is Mandulis Energy which has organised local farmers to collect post-harvest waste, convert it to energy that benefits rural industries and communities[88].

86 GIZ (2016)
87 Green Heat International.
88 Mandulis Energy, www.f6s.com/mandulisenergy

An analysis per sector could help to identify which technologies for productive use have the most potential to help a sector to increase its productivity and limit its losses. The potential constraints hindering this market also need to be well understood to develop targeted solutions to lift them. Indeed, constraints can be of different sorts: regulations might not be supportive enough, initial investment costs might be too high for SMEs to be able to buy these technologies, lack of awareness could hinder their diffusion, market could be too limited or dispersed at local level for private companies to enter it.

1B: Prioritise transmission & distribution

This is a solution to the accessibility, reliability and affordability question. Expanded networks would mean grid electricity reaches more businesses and peripheral areas, reducing regional inequalities in electricity access; higher quality networks would improve reliability by reducing technical faults; affordability would be improved through (i) further reaching transmission lines reducing losses in distribution by enabling shorter distribution lines and (ii) expanding customer base which would enable the same revenue to be collected through lower tariffs.

Transmission lines and substations are particularly crucial for improving the reliability of electricity and need to be politically prioritised.

In order to speed up the expansion and improvement of the transmission and distribution network, three constraints will have to be overcome:

- Financing gap: USD 4.5 billion dollars are needed to improve the distribution and transmission system. This could be achieved by reprioritising government funds, negotiating additional donor support, or attracting private investment in transmission and distribution.
- Acquisition of right of way which not only increases project budgets but can cause delays to project completion. The government is proposing land reform policies to prioritise the use of land for national development projects.
- A shortage of competent technicians and engineers. The sector is cognisant of this challenge and has developed apprenticeship programmes to train technicians and graduate engineers.

3A: Electricity efficiency

There are untapped opportunities, politically and programmatically, to enhance electricity efficiency. At a policy level, energy efficiency has not been greatly pursued. Uganda does yet not have standards on the importation of energy efficient appliances and vehicles. It is largely left to consumer discretion. Given that the demand of electricity is less than its supply and will continue to be so in the medium term, there is not much visibility on energy efficiency programmes. There are few private players and equally few donor funded programmes notably implemented by GIZ.[89]

3B: Refinance generation projects

Refinancing large power generation projects could decrease the debt-servicing burden, thereby reducing tariffs, in the short- to medium-run. The Government of Uganda's international development finance partners have approved a plan to refinance more than USD 400 million of loans to Bujagali Energy Limited and provide up to USD 423 million in guarantees in support of Bujagali dam, which contributes about 45% of Uganda's annual electricity generation. The refinancing package will extend the tenure of loans originally provided in 2007 by various development finance institutions and commercial banks. This refinancing will reduce Bujagali Energy Limited's annual debt-servicing payments and make it possible for the company to reduce the cost of electricity produced by the hydropower plant over the next five years. The longer repayment timeframe comes at the cost of significantly higher interest rates, which means that the agreement will exacerbate the financial burden on the Government of Uganda's coffers in the medium- to long-run. In the short-term, however, it will lead to a 15% reduction in tariffs for a select group of 39 large industries which consume a significant proportion of Uganda's electricity. It is important to note that the refinancing of Bujagali dam is very significant today as the plant currently makes a large contribution to the total electricity supply, but that this significance will drastically fall once Isimba and Karuma dams become operational. These two large dams will account for the vast majority of Uganda's total electricity supply, so it is their cost and debt-servicing that will be the primary deciding factor in the country's cost-reflective electricity tariffs.

89 See GIZ, www.giz.de/en/worldwide/19268.html.

3C: Spur demand through targeted action

Targeted large-scale investments could spur electricity demand. Umeme's current maximum demand is 580 MW, at least 70% of which is consumed by industrial customers. In order to uptake the upcoming supply from new dams, the Government of Uganda has designated 22 industrial parks[90]. The sector growth strategy is for UETCL to establish substations close to these industrial parks and UMEME/UEDCL to invest in integration infrastructure from these substations. Industrial parks are also an opportunity to target high quality high reliability power to high potential industrial sectors that are energy-intensive. However, stakeholder interviews point to severe implementation challenges in populating industrial parks, especially corruption in the process of granting land to companies, leading to inefficient allocation of land to unproductive companies or delays in attracting serious investors. The Government of Uganda also has plans for several projects that will consume large amounts of electricity such as the Standard Gauge Railway, Kampala Light Rail, and the Osukuru Phosphate Fertiliser Factory. Further, catalysing investment in secondary towns as growth centres could have the two-fold positive impact of spurring power demand through the aggregation of production and alleviating regional inequality by driving development in peripheral areas.

3D: Targeted electricity subsidies

Targeting electricity-intensive sectors with tariff subsidies could lower the cost of power where it is the binding constraint to firm productivity and growth, without causing a prohibitively heavy financial burden on government coffers. Electricity costs are not likely to be a binding constraint for companies whose operating expenditure (OPEX) is dominated by other cost drivers, such as raw materials, labour or stock: these include services sectors, agriculture, and even some manufacturing sectors such as chemicals. It is more likely to be a binding constraint for some industrial sectors in which electricity does represent a high proportion of OPEX: some examples are steel, cement, plastics, textiles, beverages. What more could be done to carefully target cheap electricity at those firms for whom the price (as opposed to reliability or accessibility) of electricity is a binding constraint on productivity and growth?

90 See Uganda Investment Authority, www.ugandainvest.go.ug/parks.

4A: Increase efficiency of biomass production

Stronger regulation, coordination and private investment in the production of charcoal and firewood products for commercial customers could lead to a step-change in efficiency. Greater efficiency in biomass production would slow the depletion of biomass reserves, with thereby slowing natural resource depletion and improving the sustainability of the energy sector. It is important to note that biomass efficiency, while necessary, may not be sufficient, as forest reserves will become critically depleted even if use is significantly slowed. Charcoal production is dominated by inefficient practices and technologies[91]:

- Almost all charcoal burners do not sort wood according to species prior to carbonization
- Charcoal is often produced from slow-growing species that are therefore particularly vulnerable to overexploitation
- 48% of charcoal producers burn the wood when still wet, which is highly wasteful and inefficient
- Traditional earth kilns are commonly used technologies with an efficiency of 10 - 15%

This inefficiency is in large part due to the lack of investment, organisation and consolidation of the charcoal sector, which contributes an estimated USD 26.8 million to Uganda's annual GDP. Despite its significant contribution to the national energy supply and economic development, the sector is characterized by low interest from investors, inadequate enforcement of regulations and poor organisation of players. The same is true of firewood, which is estimated to be worth USD 48 million annually, but whose collection, processing and distribution is done almost exclusively by small, informal and unregulated actors using rudimentary technologies and practices.

4B: Increase efficiency of biomass conversion for productive use

Apart from biomass production, its conversion into useful energy is also an area of large untapped efficiency potential. As noted above, some of the sectors consuming the most fuelwood and charcoal are artisanal brickmaking, small-scale lime production, and the sugar industry. Today, all the baked bricks utilized in the construction industry are produced by individuals or small groups of artisans using inefficient technologies and processes that require the cutting of big trees to fuel kilns. This causes deforestation and land degradation. Small, inefficient kilns for baking bricks register high heat losses and require relative large amounts of energy. The consumption of wood and depletion of forest reserves in brickmaking could be substantially reduced through the widespread adoption of efficient kilns, which

91 UNDP (2014)

in turn would be driven by economies of scale. There are untapped opportunities for larger brickmaking plants to capture market value while improving the efficiency of the sector.

The same applies to industries such as lime production and sugar crop processing. About 10% of the small-scale lime production in Uganda uses more efficient vertical shaft charcoal kilns while 90% use fuelwood either in highly inefficient traditional earth kilns (about 70%) or improved firewood kilns (30%). Improving burner technology and the use of wood pellets instead of round wood are some of the plausible interventions for reducing consumption. Sugar crop processing is energy intensive, requiring both steam and electricity. High efficiency boilers would not only provide sugar processing with cheaper heat but could also produce electrical output much higher than the internal processing needs (captive consumption). The excess could be sold to the national grid if the electricity market regulations and rules allow it, as is the case in Uganda.

4C: Switch to alternative fuels for process heating and cooking by firms

Biomass will remain a cornerstone of Ugandan energy supply for some time; key to modernisation is the transition by industry and service firms to efficiently produced biomass fuels. There is need to modernise the biomass sector so that use of firewood, charcoal and agricultural by-products is done efficiently and biomass is managed holistically. There are significant untapped business opportunities in turning agro-residues from rice husks, sugarcane, maize, matooke and others into energy through briquettes.

Biomass energy from non-woody biomass/ feedstocks has a significant potential for energy production in Uganda. Crops can produce biomass energy from agricultural residue made available from growing, harvesting and processing food crops such as cereals and roots as well as cash crops such as tea, cane sugar and coffee. In addition, common energy carriers like briquettes can be made from waste agricultural residues and/or dried organic municipal solid waste. Reports indicate that about 1.2 million tonnes of agricultural wastes are available each year and an additional 1,500 tonnes of municipal solid waste are estimated to be produced in Kampala on a daily basis. Assumptions are that these two sources combined could produce enough briquettes to replace 6% of the country's total wood consumption and up to 50% of the charcoal trade. Importantly, however, practical limitations such as seasonal variations, competing uses and collection significantly lower the amount of raw material available for commercial opportunities. Therefore, briquettes are only a part of the solution to the looming biomass crisis in Uganda.

Under the Biomass Energy Strategy, supporting industries that will sustainably increase use of non-traditional biomass in the energy mix is recognized as one of the ways of supporting a sustainable biomass energy production system. Uganda has a

an abundance of vegetal waste, shrubs, and bushes that can sustainably supply industrial briquette making with capacity to supply 40% of required biomass at sustainable level. Depending on the business model adopted, it is possible for briquettes to capture a substantial portion of the biomass market. Introduction of industrial grade briquettes and matching burner technologies are plausible interventions which could eliminate the use of fuelwood in industries such as oilseed milling and lime-scale production. Briquettes come in varied shapes and characters. They are suitable for domestic use, institutional use like schools and prisons, or for commercial use such as in hotels and restaurants.

Biogas energy for cooking is a growing alternative as it reduces dependence on water resources, reliance on non-sustainable biomass and helps to mitigate deforestation. There is increased uptake of biogas digesters for institutional cooking especially in schools due to increased funding from Government and donor institutions. Another key player is Biogas Solutions Uganda Limited, funded under the African Biogas Partnership Programme (ABPP) that is contributing to the nurturing of the biogas sector by setting standards, training and certifying firms in construction methods and training farmers to attain maximum yields.[92]

The main reasons why briquette supply has failed to grow include limitations in production capacity, untapped demand, and challenges faced by briquette enterprises in accessing business finance. Customers who buy charcoal are interested in good quality and affordable alternative fuel. Briquettes are cheaper than charcoal. For example the price of a kilogram of carbonised stick briquettes ranges from UGX 1,000 UGX 1,500, non-carbonised briquettes between UGX 600 and UGX 1,000, 2.5 kilograms of honeycomb briquettes ranges from UGX 1200 and UGX 1,600 and a 25 kg of pellet style briquettes is between UGX 20,000 and UGX 25,000. Depending on the type and quantity of briquettes, you should be able to save UGX 500 per kg in comparison to purchase of charcoal. [93]

4D: Replenish forest reserves

One way of increasing the sustainability of firewood consumption is to replenish forest reserves. Vision 2040 recognises this strategy and set a target of 24% vegetation cover by 2040. This will require promoting intensified, concerted and sustained forest restoration efforts (afforestation and reforestation programmes, including in urban areas, potentially leveraging carbon credits); encouraging agroforestry; development of an enabling environment for forestry management to ensure the conservation of existing forests[94]. Stricter forest protection and logging regulations would slow down the unsustainable depletion of forest reserves. Dedicated woodlots at high consumption industries could present a win-win case, securing industries' firewood supply in a sustainable manner.

92 See Biogas Solutions Uganda, Ltd., www.biogassolutions.co.ug/index.php/about-bsul
93 See ReInvest Africa, reinvestafrica.com/
94 FAO (2017)

4E: Switch households to alternative cooking fuels

LPG is becoming a competitive alternative solution to clean cooking. With a bag of charcoal currently costing UGX 75,000/- on average within Kampala and its surrounding districts, it is now possible to pay for cooking gas at the same price as one would pay for charcoal. For instance, one pricing innovation for LPG is being tested by Wana Energy Solutions (WES). Under this scheme, a prospecting user simply needs to indicate willingness to purchase a complete cooking set comprising a gas cylinder, stove, and accessories including a gas hose pipe and a gas regulator. The set includes a fully connected digital smart meter. Under this innovation, customers are able to use their mobile phones to pay for their gas, and have the capacity to pay for the amount of gas they use for cooking at an instant i.e. it is possible to pay for the gas used to cook each meal.[95]

5A: Alternative transport fuels

Technological advances in energy storage are making electric cars competitive in advanced economies and could eventually lead to broad based adoption even in Uganda. This in turn could have a major positive impact on the efficiency of energy for transport. However, alternatives to petroleum transport like electricity, ethanol and hydrogen still need to improve financial viability. Vehicles that use these alternatives cost way more than the ones which run on petroleum.

5B: Transport energy efficiency

The development of mass transit systems such as the Kampala Light Rail and Bus Rapid Transit could make transport energy drastically more efficient in Kampala.

5C: Vehicle emissions regulations

One factor contributing to transport air pollution is aging vehicles whose combustion is incomplete. Today, there are no regulations with regard to the age of motor vehicles and the majority of imported vehicles in the country are not fitted with catalytic converters that reduce carbon emissions. The Government of Uganda has introduced rules banning the importation of cars older than 15 years[96] as well as a new pre-import inspection standard[97]. These are steps towards reducing the aggregate effect of vehicles on air pollution and greenhouse gas emissions.

95 Atwine, M. (2018)
96 Gyagenda, M. (2018)

6A: Import route diversification

Developing the oil import route through Tanzania would enhance the energy sector's resilience by reducing Uganda's dependence on petroleum product imports from a single route through Kenya. The Government of Uganda is offering a subsidy for fuel imports through the southern corridor to Tanzania, amounting to UGX 150 per liter, to diversify import routes and reduce excessive reliance on the Kenya route. However, this has its challenges, such as axle regulation on Tanzanian roads and the relative cost of using the route.

6B: Refinery

An oil refinery in Uganda would boost resilience and reliability, but probably not reduce the price of petroleum products. Stakeholder interviews with sector experts revealed that a refinery in Uganda is unlikely to significantly reduce pump prices. A refinery of the size planned in Uganda would struggle to compete on price with mega-scale refineries in other countries, even when transport and import costs are factored in. Nevertheless, a locally produced supply of petroleum products would massively reduce or eliminate Uganda's dependence on oil imports, boosting the resilience and reliability of the petroleum product subsector.

Uganda has proven crude oil reserves of 6.5 billion barrels, about 2.2 billion of which is recoverable. Oil production is expected to reach a peak of 200,000 – 250,000 bpd. In November 2017, the Government launched the construction of an oil export pipeline to the port of Tanga in northern Tanzania. Uganda's oil has a high wax content, making it difficult and costly to process and transport. The pipeline must be heated throughout. This export pipeline is expected to be the longest heated pipeline in the world at 1,445km. Its capacity should be 216,000 barrels per day. It should be completed in 2020. Also in November 2017, Uganda chose the Albertine Graben Refinery consortium to build a $4 billion oil refinery to be located at Kabale in Hoima District. The planned capacity of 60,000 barrels per day would be more than double Uganda's current consumption. A Memorandum of Understanding (MoU) between Government and the Licensed Oil Companies which provides for the commercialization of the discovered oil and gas resources was concluded in 2014. The MoU provides for use of the petroleum resources discovered in the country for power generation, supply of crude oil to the refinery to be developed in Uganda and export of crude oil through an export pipeline or any other viable options to be developed by the industry.[98]

Oil companies operating in Uganda favour exporting production over refining – a position also echoed by several donors but one which goes against the government's preference. The government commissioned

97 Kiprop, V. (2017)
98 MEMD (2016)

a study in 2010 to determine the feasibility of a large-scale refinery in Uganda. The study, completed in 2011, found that "an oil refinery in the country to supply the Ugandan and regional markets rather than constructing a pipeline to export crude oil in the medium-term" was a preferred and feasible option. The fact that the oil is waxy is another reason for some to advocate for local refining and efficient multi product liquids production.

11. CONCLUSIONS & FURTHER RESEARCH

Conclusions

This study has shown that energy is a key driver and shaper of economic transformation and argued that more attention needs to be paid to energy in the context of economic transformation in Uganda. On this premise, it has endeavoured to provide a big picture overview of energy for economic transformation in Uganda. First, it traced Uganda's economic transformation story to-date as well as the future outlook. Second, it assessed what energy means for economic transformation in Uganda. Third, it analysed the performance of Uganda's energy system in driving economic transformation today. Third, it distilled the key binding constraints in the energy system in the context of economic transformation. Finally, it presented several opportunities - policy, programming or business opportunities - that warrant further exploration to overcome these binding constraints.

This study examined the role of energy as a driver and shaper of economic transformation in Uganda. This publication argued that while household access is crucial to improving the population's quality of life, providing all households with access to modern energy before they can afford to pay for it may be putting the horse before the cart. The Government of Uganda has expressed its commitment towards transforming the country from an agrarian low-income country to a modern upper middle-income status country by 2040[99], thereby lifting the vast majority of households out of poverty, giving them the purchasing power to buy more modern energy, among other things. This report explores the relationship between energy and economic transformation in Uganda. Economic transformation is a fundamental shift of labour and other inputs from low to high productivity activities and sector. Inclusive economic transformation means that the chances to benefit from transformation are broadly shared among the population. Decent and productive employment is at the core of this transformation process.

Uganda, like much of SSA, has been growing quickly but transforming slowly. Uganda's economy shifted rapidly during the 1990s, with output shifting from agriculture to services, and to industry to a lesser degree. However, this was not due to, nor accompanied by, a similar shift in labour. The services sector has driven growth in Uganda's economy in the past two decades, with uneven productivity growth concentrated in high-skill sub-sectors.

Uganda is delicately poised to grow quickly and begin a deeper economic transformation trajectory. The movement of labour from low to high productivity sectors and activities in Uganda is likely to be driven principally by SMEs in high growth potential industry and services sectors. However, household enterprises - mostly informal family businesses - will continue to employ most labour in Uganda in the

99 National Planning Authority (2013)

next two decades. Therefore, raising the productivity of household enterprises will be key to driving economic transformation in Uganda.

Energy is inextricably tied to economic development and transformation. Energy is an essential factor of economic production, along with labour, capital, raw materials and land. Throughout the history of civilisation, advances in energy have unlocked the productivity of human activities. Energy is a driver as well as a shaper of economic transformation.

About 90% of the total primary energy consumption in Uganda is generated through biomass; electricity accounts for just 1.4% of the national energy balance. Oil products account for the remaining 9.6%. The agricultural sector needs energy for multiple activities such as irrigation, storage, cold chains and milling. Transportation, which depends on oil products, is a cross-cutting economic sector, including private use, in-house transportation carried out by industrial firms, and transportation as a service offered by commercial firms and public institutions. Ugandan households, on aggregate, rely almost entirely on biomass (charcoal and wood fuel, mainly for cooking). Large industries rely heavily on electricity, but small-scale cottage industries such as brickmaking and lime-scale production use mostly biomass. The commercial and institutional sectors also use biomass, mainly for cooking, as their predominant energy source.

Power reliability is consistently identified as a top binding constraint to firm growth in Uganda. Ugandan firms experience some of the highest losses from foregone sales revenue due to electrical outages. Despite significant reductions in power outages after the operationalisation of Bujagali Dam which all but eliminated load-shedding, the reliability of electricity continues to be a severe constraint on firm productivity.

The distribution network does not evenly serve the national territory, with a large concentration around a few urban economic hubs in the central and south-western regions. It is clear that a large number of microenterprises currently operate without a grid connection, and likely that more microenterprises and SMEs would exist in peripheral areas if power was accessible. Distribution and transmission system are now lagging behind generation. In parallel to the difficulty to access the grid for many businesses in Uganda, the supply of off-grid technologies for productive use remains limited.

Uganda's electricity tariffs are competitive with most regional neighbours, but not with Ethiopia, the regional leader in providing cheap electricity for industries. With rising tariffs, the affordability of electricity is increasingly eroding for businesses, increasing their production costs and making them less competitive. In the coming years, it seems unlikely that the price will fall significantly.

The largest environmental impact of Uganda's electricity sector is the impact of dams on local ecosystems. Being dominated by hydropower, Uganda's electricity sector is not carbon intensive and therefore does

not present a sustainability risk with regards to global greenhouse gas emissions. Uganda's electricity supply depends almost entirely on hydropower, making the system vulnerable to climate-related shocks. However, the increase in generation capacity means that generation, even though still dependent on hydropower, will be less of a bottleneck in the years to come.

Biomass - material from plants and animals - is the overwhelming source of energy in Uganda. Collectively, households are by far the biggest consumers of biomass. Industry in Uganda is heavily reliant on firewood. It is striking that artisanal brickmaking accounts for about two thirds of all wood fuel consumption by firms. Firewood and charcoal constitute a significant proportion of Uganda's GDP and employment. However, the firewood and charcoal sectors are dominated by small-scale, informal cottage industries, resulting in inefficiencies and unsustainable production practices.

Uganda's forest reserves are rapidly being depleted, and firewood and charcoal demand is likely to outstrip supply in the coming decades, negatively affecting accessibility, affordability, resilience and sustainability. As of today, the focus of stakeholders including government and donors has been on reducing the dependency of households on firewood and charcoal while less attention has been paid to the dependency of firms on these biomass fuels. The MEMD should lead with a clear medium- to long-term vision to transform the biomass sector, leveraging both regulation and investment to drastically increase biomass efficiency and move to alternative fuels while protecting and replenishing Uganda's forest reserves.

Petroleum products - materials derived from crude oil - account for about 9% of all energy consumed in Uganda. Diesel and petrol account for about 90% of the overall imported and consumed petroleum products in the country and are mainly used for transportation. The lack of diversification in the supply of petroleum products in Uganda presents a resilience issue in the energy sector. In addition, air pollution caused by vehicles using petroleum fuels means that Kampala is already one of the African cities with the worst air quality in many parts of the urban metropolitan area.

Several opportunities are explored to overcome the binding constraints in electricity. Prioritising transmission and distribution is a solution to the accessibility, reliability and affordability question. In order to speed up the expansion and improvement of the transmission and distribution network, a number of underlying constraints will have to be overcome. There is significant potential, politically and programmatically, to enhance electricity efficiency. Further, there are untapped opportunities for low capital investment solar infrastructure and portable solar technological innovations through public-private and private-private partnerships in strategic productive use sectors. The development of off-grid and mini-grid power solutions for productive use needs to go hand-in-hand with the uptake of electrical appliances from irrigation pumps to hair clippers. Refinancing large power generation projects could decrease the debt-servicing burden, thereby reducing

tariffs, in the short- to medium-run. Targeted large-scale investments could spur electricity demand. Finally, targeting electricity-intensive sectors with tariff subsidies could lower the cost of power where it is the binding constraint to firm productivity and growth, without causing a prohibitively heavy financial burden on government coffers.

In biomass, too, a number of opportunities are explored. Stronger regulation, coordination and private investment in the production of charcoal and firewood products for commercial customers could lead to a step-change in efficiency. This inefficiency is in large part due to the lack of investment, organisation and consolidation of the charcoal sector, which contributes an estimated USD 26.8 million to Uganda's annual GDP. Apart from biomass production, its conversion into useful energy is also an area of large untapped efficiency potential. The same applies to industries such as lime production and sugar crop processing. Biomass will remain a cornerstone of Ugandan energy supply for some time; key to modernisation is the transition by industry and service firms to efficiently produced biomass fuels. Biomass energy from non-woody biomass/feedstocks has a significant potential for energy production in Uganda. Under the Biomass Energy Strategy, supporting industries that will sustainably increase use of non-traditional biomass in the energy mix is recognized as one of the ways of supporting a sustainable biomass energy production system. Biogas energy for cooking is a growing alternative as it reduces dependence on water resources, reliance on non-sustainable biomass and helps to mitigate deforestation. The main reasons why briquette supply has failed to grow include limitations in production capacity, untapped demand, and challenges faced by briquette enterprises in accessing business finance. One way of increasing the sustainability of firewood consumption is to replenish forest reserves. Finally, LPG is becoming a competitive alternative solution to clean cooking.

Finally, the study explored opportunities to overcome the binding constraints in the petroleum sector. Technological advances in energy storage are making electric cars competitive in advanced economies and could eventually lead to broad based adoption even in Uganda. The development of mass transit systems such as the Kampala Light Rail and Bus Rapid Transit could make transport energy drastically more efficient in Kampala. One factor contributing to transport air pollution is aging vehicles whose combustion is incomplete. Developing the oil import route through Tanzania would enhance the energy sector's resilience by reducing Uganda's dependence on petroleum product imports from a single route through Kenya. An oil refinery in Uganda would boost resilience and reliability, but probably not reduce the price of petroleum products.

Further Research

In Hausmann et al.'s (2014) analysis of binding constraints to growth in Uganda, the authors' strongest and overarching conclusion was that stronger national-level mechanisms are needed to continuously identify sector-specific binding constraints. Kiranda, et. al (2017) echoed this call in "Reality Check: Employment, Entrepreneurship and Education in Uganda", finding that such an ongoing and granular analysis of constraints was still absent. Progress in energy can unlock economic transformation potential where energy is a binding constraint on firm productivity and growth.

As such, the next step in the analysis is to assess for which firms energy is a binding constraint, and what the specific nature of this energy constraint is in each case. For instance, for heavy manufacturing firms, the cost of electricity is likely to be a major constraint as it constitutes a large proportion of their operating expenditure, thus affecting their competitiveness more than other factors. For light manufacturers, raw materials and machinery may constitute the lion share of costs, but the reliability of power is likely to be a binding constraint as power surges and outages have serious cost implications. For rural household enterprises, the lack of access to basic energy services such as electricity for refrigerators, and the increasing cost of charcoal for cooking, are likely to be binding constraints to productivity. Further sector-specific analysis is required to efficiently prioritise scarce resources and lift specific energy constraints to unlock firm productivity and growth.

In the analysis of the current status of Uganda's energy system, it became clear that there is a dearth of data, which impedes rigorous analysis and, consequently, evidence-based planning and prioritisation. More reliable and time-series data on firm productivity is needed in order to better assess progress in economic transformation. In the electricity sector, no systematic data is available on the percentage of registered firms who are connected to the grid (let alone by sector, district or firm size), on regional variation in power outages, or on the frequency of power fluctuations. Similarly, there is a lack of data on the availability and cost of biomass carriers for firms. Finally, no data was identified on the variability in the availability, quality and cost of petroleum products in different parts of the country.

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