SOLARPLAZA

FACTS & FIGURES

SOLAR ENERGY 2017

ALGERIA
MOROCCO
SENEGAL
GHANA
NIGERIA
CAMEROON
ETHIOPIA
KENYA
UGANDA
RWANDA
TANZANIA
ZAMBIA
NAMIBIA
SOUTH AFRICA

UNLOCKING SOLAR CAPITAL AFRICA

25-26 OCTOBER 2017
ABIDJAN, CÔTE D'IVOIRE

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1. AN EVENT FOR AFRICA, IN AFRICA

Africa is quickly becoming one of the most significant regions in the global expansion of the solar PV industry. The high levels of solar irradiation, extreme (and growing) energy demand, an increasing amount of renewable energy related commitments by governments in the region, and the lack of reliable energy infrastructure are just some of the factors that are sparking growing interest from local businesses and international stakeholders alike.

The purpose of this report is to provide an overview of the key facts and figures related to some of the most prominently developing solar markets on the continent, serving as well as a prelude to the Unlocking Solar Capital: Africa conference Solarplaza will be organizing 25-26 October 2017 in Abidjan, Côte d'Ivoire.

Solarplaza and GOGLA are proud to announce the organization of this second installment of Unlocking Solar Capital: Africa - the unique international platform and 2-day conference focusing on unlocking capital for new solar project development in Africa. This event will connect solar project development and finance & investment in the three leading solar electrification segments (On-grid, micro-grids, off-grid lighting and household electrification).
Unlocking Solar Capital: Africa, Solarplaza's 9th event on the continent, will bring together hundreds of representatives from development banks, investment funds, solar developers, IPPs, EPCs & other solar stakeholders. Learn more about the program, speakers and participants here.

KEY CHARACTERISTICS

- 350+ senior finance and project development executives
- In-depth discussions over separate tracks for on-grid and off-grid/mini-grid solar financing and development
- Guaranteed matchmaking through our customized software, interactive networking breaks and many hours of dedicated networking time
- Taking place in one of Africa's key hotspots, Abidjan

In preparation of the conference, we are bringing you this report to get a more in-depth look into all the facts & figures of the solar PV market in Africa. The report will provide an overview of a range of issues related to solar PV project development, including descriptions of key demographic info, insights into legislation and policy, historic electricity generation capacity, and assessments of the current status of the solar industries in the following countries: Kenya, Nigeria, Cameroon, Ethiopia, Ghana, Rwanda, Senegal, Tanzania, Mali, Uganda, Namibia, Zambia, Morocco, Algeria and South Africa.

2. REGIONAL OVERVIEW

INTRODUCTION

Africa is one of the largest, relatively untapped, territories in terms of energy investment. Even though most countries bear a developing or sub-developing status, the combined GDP of Africa amounts to about 1.4 trillion USD and there are more than half a billion people living on the continent (Table 2.1). Since domestic investment capital availability is very low, the development of Africa's energy infrastructure is largely impacted by external investments. One of the main barriers for the entry of foreign investors into African countries is the limited availability of governmental regulations to promote and protect investors. Often, there is very little transparency, high levels of corruption and few regulatory institutions to ensure businesses' rights.

Facts & Figures - Selected Countries* (CALCULATIONS)	
Combined GDP	Approx. 1,400,000,000,000 USD
Average GDP per Capita	Approx. 2,100 USD
Combined GDP Growth (2015)	Approx. 3.13%
Combined inhabitants	Approx. 663,000,000
Installed Solar PV Capacity (2015)	> 1.7 GW
Electrification rate (2014)	> 50%
Average Horizontal Radiation Africa *(Calculations based on IRENA report, exclusions areas unsuitable for RE taken into account)*	1. Tanzania (Approx. 5.6 kWh/m^2/day) 2. Kenya (Approx. 5.4 kWh/m^2/day) 3. Uganda (Approx. 5.3 kWh/m^2/day)

Table 2.1: Economical figures of selected countries.

ENERGY DEMAND

Excessive and steadily growing energy demand is a constant challenge which impacts the agenda of African policy makers. Average electrification rates throughout the continent are very low. Often times electricity is only accessible to 30-50% of the population, with a relatively higher percentage of access in urban areas and very low levels in rural regions. Most rural regions do not have access to the main grid of the country. When they do have access, power supply is often intermittent, making it difficult for businesses to work consistently. Malfunctioning grid structures and a lack of reach in the overall infrastructure are

factors that complicate development in the African region. These unfavourable circumstances force rural households to use expensive and polluting fossil fuel generators for power and low quality (dangerous) torches for lighting which. These energy solutions, due to their nature, not only pose a significant financial burden on African households, but also heavily contribute to climate change across the globe.

Solar power, photovoltaic application in particular, has the potential to bring important relief to the continent. As the cost of solar energy systems has dramatically dropped, solar PV application has become more attractive. This has already lead to a widespread spur in the construction of grid-connected solar PV projects all over the continent in the past few years, and an increased adoption of off-grid and microgrid solar applications. The major hurdle that hinders the development of such solar applications is the low level of income that tends to describe the rural African households that are targeted by them. Recent effort to overcome this challenge has resulted in the emergence of various financial models, including the pay-as-you-go and the pay-to-own models.

POTENTIAL FOR RENEWABLES

In many parts of Africa, power is generated by old fossil fuel plants and generators. In 2012, 65% of the total energy production came from coal and/or gas sources (Figure 2.1). These power generation techniques, on top of their highly unsustainable nature, have proven to be very costly for both African governments and consumers, and have urged officials to explore other energy sources. The single most widely adopted renewable energy source in Africa is

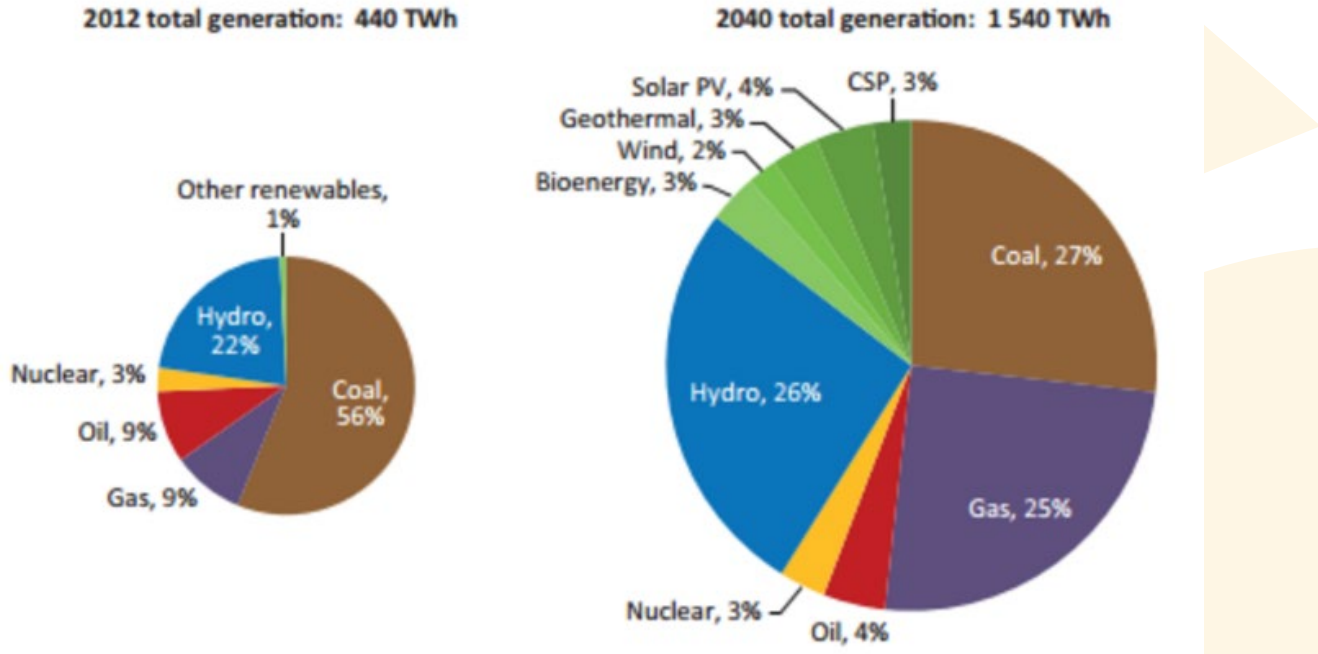


Figure 2.1: Electricity generation by fuel in Africa in the New Policies Scenario, 2012 vs. 2040.

hydroelectricity which accounted for 22% of all energy generation in 2012 (Figure 2.1). These sources have proven to be very competitive alternatives for fossil fuels, due to their high energy yields and low consumer costs. However, not all countries are blessed with a geography that supports hydroelectric facilities (which requires rivers or lakes at higher altitudes). Furthermore droughts and irregular rainfalls have had a severe impact on the production of hydroelectric power plants, causing serious problems in power availability. Additionally, the construction of massive projects like hydro dams have a huge environmental impact. Wind and bioenergy have large potential on the continent as well, but aren't being developed on a large scale. In recent times, many countries have introduced governmental policies geared towards targeting the development of bioenergy, wind and solar sources.

Solar energy can prove to be a viable solution to meet the growing energy demand, due to the region's outstanding natural characteristics. The sub-Saharan region of Africa is home to countries with the highest irradiation levels in the world. These countries experience irradiation levels of up to 2000 kWh/m2/year (Figure 2.3), displaying great potential for both solar PV systems and in some countries concentrated solar power (CSP) applications. This potential is already being tapped on a small scale via mini-grid and off-grid initiatives. Presently, 37% of all minigrid and off-grid initiatives have a solar energy component, and this is expected to grow towards 47% in 2040 due to the new policies throughout the region (Figure 2.2).

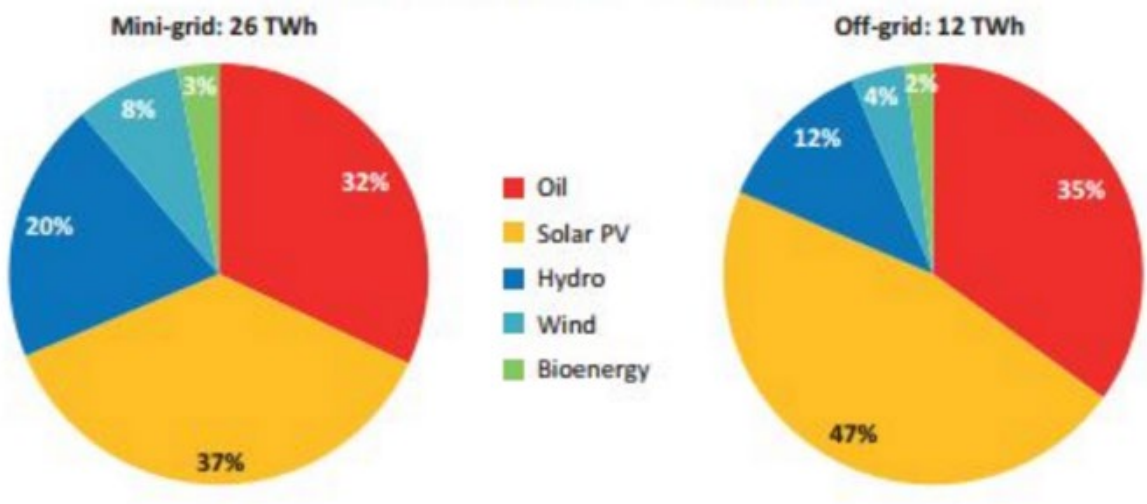


Figure 2.2: Technology mix for mini-grid and off-grid power generation in Africa in the New Policies Scenario, 2040

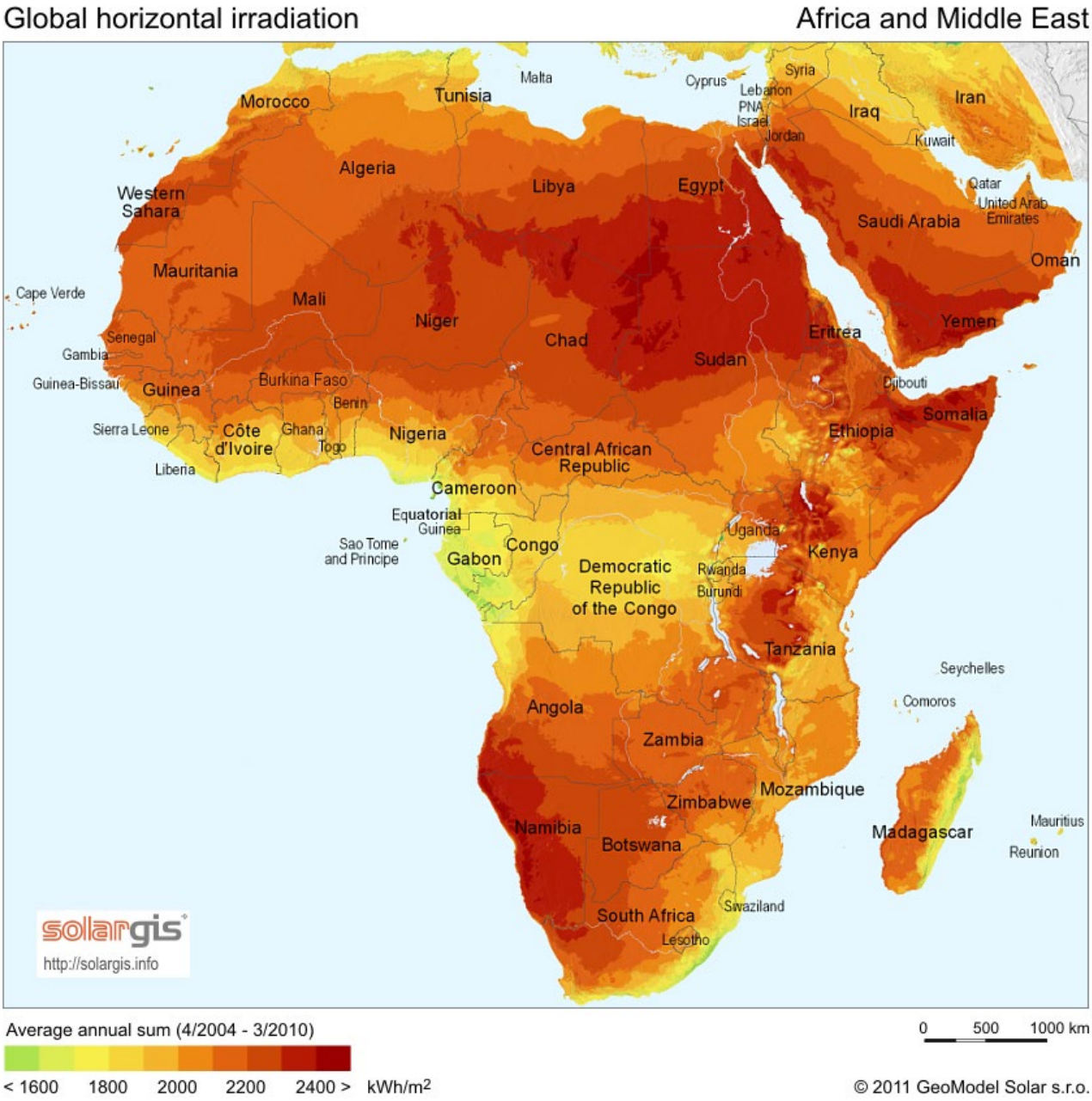


Figure 2.3: Global horizontal irradiation map of Africa.

POLICIES AND TARGETS

With the intention of moving from costly fossil fuel sources towards renewable sources and meeting the growing energy demand, many countries have implemented policies that either limit the usage of fossil fuels or promote renewable energy sources. An overview of several policies is shown in table 2.3. Cumulative, continent-wide, solar capacity is projected to exceed 6 GW by 2020 and is set to reach 45 GW in 2040, with solar PV accounting for three-quarters of the total and CSP accounting for the rest. The solar capacity additions

increase from an average of 0.9 GW per year until 2020 to an average of 2.2 GW per year thereafter. This growth rate translates into the biggest compounded average annual growth rate out of all energy sources, both in electricity generation and electrical capacity, corresponding to 22.1% and 26% respectively, within the projected time frame of 2012-40 (Table 2.2). Policies promoting the use of solar energy will be crucial in the country-wide adoption process as solar powered products bear relatively high upfront costs compared to other renewable energy sources.

	Electricity generation (TWh)							Shares (%)		CAAGR (%)
	2000	2012	2020	2025	2030	2035	2040	2012	2040	2012-40
Total generation	**449**	**741**	**1 023**	**1 241**	**1 504**	**1 835**	**2 217**	**100**	**100**	**4.0**
Coal	209	259	303	336	361	402	451	35	20	2.0
Oil	59	89	93	88	81	83	85	12	4	-0.1
Gas	92	262	383	472	573	694	853	35	38	4.3
Nuclear	13	13	13	13	25	37	47	2	2	4.7
Hydro	75	112	182	235	300	372	442	15	20	5.0
Bioenergy	1	2	11	21	31	42	53	0	2	12.9
Solar PV	0	0	11	24	42	61	83	0	4	22.1
Other renewables	1	4	27	52	91	143	202	1	9	15.1

	Electrical capacity (GW)						Shares (%)		CAAGR (%)
	2012	2020	2025	2030	2035	2040	2012	2040	2012-40
Total capacity	**165**	**253**	**313**	**384**	**469**	**558**	**100**	**100**	**4.5**
Coal	42	56	65	72	80	90	26	16	2.7
Oil	34	36	36	36	37	38	20	7	0.4
Gas	60	100	122	146	174	207	37	37	4.5
Nuclear	2	2	2	4	5	7	1	1	4.5
Hydro	25	41	54	70	87	104	15	19	5.3
Bioenergy	0	2	4	6	8	11	0	2	15.5
Solar PV	0	7	15	25	36	48	0	9	26.0
Other renewables	1	9	16	27	40	54	1	10	14.1

Table 2.2: Projected total energy generation and total electricity capacity of Africa under new policy scenario.

POLICY OVERVIEW IN FOCUS COUNTRIES

Country	Sector	Policies and Targets

Algeria	Efficiency / Renewables / Nuclear	• Renewable Energy and Energy Efficiency Program
		  • Solar, wind, biomass, geothermal and hydropower
		  • 2011 – 2013: pilot projects and testing period for various technologies with a goal to install 110 MW of RE power capacity
		  • 2014 – 2015: beginning of the deployment program. Installed RE power capacity to reach 650 MW by the end of this period;
		  • 2016 – 2020: large scale REs plants deployment. Installed power capacity to reach about 2600 MW the end of this phase.
		  • Renewable Energy Feed-in-Tariff (REFiT) scheme
		• Supply energy to the Desertec Industrial Initiative

Morocco	Efficiency / Renewables / Nuclear	• National Energy Strategy (NES) adopted in 2009 and renewed in 2015/2016
		  • 42% RE by 2020
		  • 52% RE by 2030
		• Moroccan Agency Solar Energy
		  • Moroccan Solar Plan
		• Renewable Energy Law passed in 2010
		  • Introduced IPPs

Senegal	Efficiency / Renewables / Nuclear	• Ensuring energy security and increasing the energy access for all • Developing a policy mix combining thermal generation, bio-energy, coal, gas, and renewables and seizing the opportunities of regional interconnections • Continuing and accelerating the liberalization of the energy sector by encouraging independent production and institutional reform of the sector • Improving the competitiveness of the sector in order to lower the cost of energy and reduce sector subsidies • Strengthening regulation of the sector
Ghana	Efficiency / Renewables / Nuclear	• Feed-in tariff established by the Renewable Energy Act in 2011.
Nigeria	Efficiency / Renewables / Nuclear	• Make reliable energy available for 75% of the population by 2020 and 100% by 2030 by connecting an average of 1.5 million households per year

Table 2.3: An overview of the policy in each of the focus countries.

Country	Sector	Policies and Targets
Cameroon	Efficiency / Renewables / Nuclear	• Vision 2035 • Increase production and deliver electricity with an emphasis on renewable energy. • New framework to promote the implementation of renewable energy sources • Exemption of value-added tax for solar panels • Electrification Master plan • Electrification of rural areas • By 2020, the government aspires to reach electrification rates of 48% countrywide, with 75% electrification in urban areas and 20% in rural ones.
Ethiopia	Efficiency / Renewables / Nuclear	• Increasing energy generation capacity from 2.26 GW to 17,34 GW and increasing the country's electricity service coverage from 60% to 90% • New law to focus on the proliferation of Power Purchase Agreements the development of off-grid systems, and the enactment of more efficient on-grid management policies. • Power Africa initiative • Establishing 30,000 MW of energy generation capacity. • Eastern Africa Power Pool (EAPP) • Facilitates cross-border grid connections and mandates the establishment of common codes and standards
Kenya	Efficiency / Renewables / Nuclear	• Set standards for electrical appliances • Set energy efficiency obligations for utilities • Energy bill 2014 provides for the creation of Energy Efficiency and Conservation Agency to enforce energy efficiency standards • Eliminate kerosene as a household fuel by 2022. • Requirement to install solar water heaters in buildings connected to the grid

Uganda	Efficiency / Renewables / Nuclear	• Global Energy Transfer Feed-in Tariff program
		  • Premium payment mechanism
		  • Security for facilities against off-takers and political risk
		  • Private financing mechanisms from Deutsche Bank

Rwanda	Efficiency / Renewables / Nuclear	• Increase access to electricity from 17% to at least 60% by 2020 and provide energy access to all schools and hospitals by 2017 • Reduce share of bioenergy in energy demand to 50% by 2020. • Expand the transmission network by 2100 km by 2017

Table 2.3: An overview of the policy in each of the focus countries.

Country	Sector	Policies and Targets
Tanzania	Efficiency / Renewables / Nuclear	• National Energy Policy • Reduce the dependence of the energy sector on fossil fuels; • Proliferate renewable energy, particularly non-hydro alternatives, due to Tanzania's frequent droughts; • Achieving 100% national electrification rate by 2030; • Adding 8,990 MW of electrical generation capacity by 2035. • Standardized Power Purchase Agreements to private investors under the Electricity Act of 2008

Zambia	Efficiency / Renewables / Nuclear	• National Energy Policy (NEP94)
		• Poverty Reduction Strategy Paper (PRSP)
		  • Increase RE especially hydro power
		• National Development Plans (NDPs)
		  • Transmission access regime
		  • FiT
		• Electricity Act and Energy Regulation Act
		• Office for Promoting Private Power Investment (OPPPI)
		• Rural Electrification Master Plan (REMP)

Namibia	Efficiency / Renewables / Nuclear	• Vision 2030 • Draft renewable energy policy • Four scenarios • Huge interest in Concentrated Solar Power

South Africa	Efficiency / Renewables / Nuclear	• National Development Plan (NDP)
		  • 10 000 MWs additional electricity capacity to be established by 2025
		• New Generation Regulations under the Electricity Regulation Act (ERA)
		  • 14 725 MW RE
		  • 6 250 from coal-fired plants
		  • 1 800 MW of cogeneration under the MTRM plan
		  • 3 726 MW of Gas-fired power plants
		  • 2 609 MW of imported hydro
		• Integrated Resource Plan (IRP 2010-2030)
		  • Target: of 11.4 GW of renewables
		• South African Renewables Initiative (SARI) and the South African Renewable Energy Council (SAREC)
		• Green Economy Accord
		• Renewable Energy Independent Power Producer Procurement Programme (REIPPP)

Table 2.3: An overview of the policy in each of the focus countries.

3. ALGERIA

INTRODUCTION

Algeria is a peculiar country in terms of its current energy profile and its intended one. As of 2014, Algeria had ~4,504 billion cubic meters of proved natural gas reserves, which represented the tenth largest amount globally. Algeria also plays a key role in world energy markets as a leading producer and exporter of natural gas and liquefied natural gas. Naturally, not only does this put a huge strain on the environment but it also pushes Algeria to seek ways of more sustainable development.

Given the good natural resources, especially solar, renewable energy is a logical option for the country. Passing several legislations, Algeria has commenced diversifying its energy mix. To ensure the adequate adoption of renewable energy sources, Algeria also set out ambitious goals that will not only see the country significantly increase renewable energy but will also make Algeria a renewable energy exporter. The first signs of the country's investment into meeting its goals comes from its enormous-scale tender announcement. Besides the projects associated with the tender, there are smaller case initiatives that aim to power rural areas.

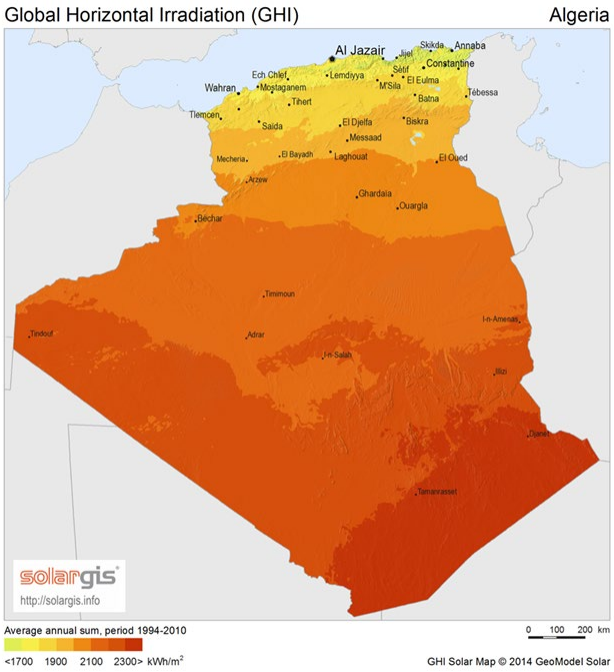


Figure 3.1: Global horizontal irradiation map of Algeria.

Table 3.1: Economical figures and key stakeholders of Algeria.

Economical figures	
GDP (2015)	164,779,470,000 USD
GDP per capita (2015, USD)	4,154.1 USD
GDP Growth ('13, '14, '15)	+2.768%, +3.789%, +3.763%
Inflation Rate - Consumer Prices (2015)	4.8%
Inflation Rate - GDP deflator (2015)	-7.3%
Population (2015)	39,666,520
Credit Rating (S&P/Moody's)	-/-
Corruption Perceptions Index (CPI 2015)	36
Ease of doing business index (2015)	156

Economical figures	
Access to electricity (2014)	100%
• Power consumption per capita in kWh	1,362
• Renewable electricity (% of total output, 2013)	0.55%
• Renewable consumption (% of total consumption, 2012)	14%

Key Stakeholders	
Energy regulator	• Algerian Electricity and Gas Regulation Commission (CREG) • New Energy Algeria (NEAL)
Utilities	• Societe Nationale de l'Electricité et du Gaz (Sonelgaz)
Top Banks	• Bank of Algeria • Banque Nationale d'Algérie • Banque Extérieure d'Algérie

Table 3.2: Noteworthy solar projects in Algeria.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Hassi R'Mel hybrid plant	150 MW	Hassi R'Mel	Commissioned	New Energy Algeria

ENERGY MIX

ALGERIA - ENERGY PRODUCTION

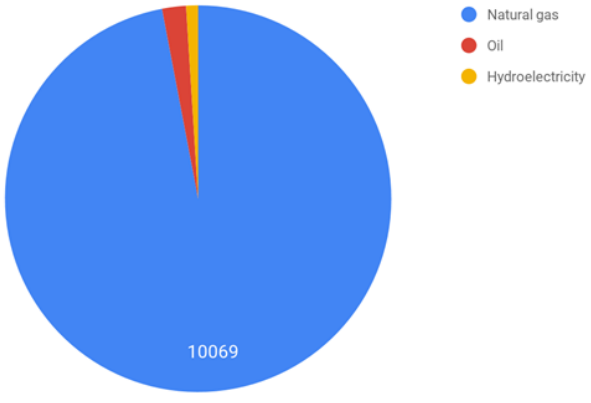


Figure 3.2: Total Algerian energy production by fuel sources in 2009 (in MWs).

Algeria, being the fossil heavyweight it is, sources the majority of its energy from nonrenewable sources. Out of the 10,380 MW worth of installed capacity that was registered in 2009, natural gas accounted for an astounding 97%, which by itself amounts to more than 10 GW. Oil constitutes the second most prominent energy source, accounting for just 2% of the installed capacity. Hydropower is the only significant renewable energy source in the country's energy mix, accounting for approximately 1% of the generated power.

REGULATORY FRAMEWORK

Despite the heavy dependence on fossil fuels, Algeria realizes the importance of diversification of its energy mix. Not only can the use of renewable energy sources decrease the harmful environmental effects of using fossil fuels, but it also provides the country with some protection against the volatility of global oil prices. Furthermore, the country has great potential for developing its share of renewables as conditions for solar and wind energy are of outstanding quality.
Thus, the government of Algeria launched the 'Renewable Energy and Energy Efficiency Program', the aim of which is to realize the renewable potential and mitigate the dependence on fossil fuels. The program is focused on developing and expanding the use of renewable resources, such as solar, wind, biomass, geothermal and hydropower, with a goal of generating 22,000 MW of power from renewable sources between 2011 and 2030. The program is divided into 3 stages:

- 2011–2013: pilot projects and testing period for various technologies with a goal to install 110 MW of RE power capacity
- 2014 – 2015: beginning of the deployment program. Installed RE power capacity to reach 650 MW by the end of this period;
- 2016 – 2020: large scale REs plants deployment. Installed power capacity to reach about 2600 MW the end of this phase.

Another mechanism that was established under the 'Renewable Energy and Energy Efficiency Program' - in an attempt to speed up the adoption of renewable energy sources - is the Renewable Energy Feed-in-Tariff (REFiT) scheme. The REFiT scheme was the first in Africa when it was launched in 2004. The scheme pertains to plants with power generation capacity exceeding 50 MW. Feed-in tariff is a premium paid per kWh above a base tariff (average annual electricity price in Algeria). REFIT is expressed as a percentage of the base electricity tariff. For CSP, where the solar is only a portion of a plant's generation, the tariff is reduced by the amounts outlined below.

Table 3.3: The current Algerian Renewable Energy Feed-in-Tariff (ReFiT) rates.

REFiT scheme	
Technology	Percentage of base electricity tariff
Hydropower	100%
Wind power	300%
Solar power	300%
CSP	200%
Solar thermal	200%
Waste to energy	200%
Hybrid plants (CSP)	>25%: 280% 20 < 25% 180% 15 < 20%: 160% 10 < 15%: 140% 5 < 10%: 100%

However, Algeria does not only want to increase its own share of renewables, but is aiming even higher and planning to supply excess renewable energy for export. The country, as part of the Desertec Industrial Initiative, takes part in the undertaking that aims to supply wind and solar power to meet 15% of Europe's electricity needs by 2050.

ON-GRID

As a kind of halfway compromise between fossil fuels and renewable energy, Algeria has been operating a 150 MW hybrid plant since 2011. The plant is located in Hassi R'Mel and sources 120 MW of energy from gas and 30 MW of energy from the sun. The power plant was developed through the joint venture between the Algerian society NEAL (New Energy Algeria) and the Spanish firm Abener, requiring an investment of $350 million.
More projects, however, are on the horizon. According to a statement in a government-owned news portal, Algeria's Ministry of Energy will launch a tender for the installation of 4,020 MW of PV capacity. The tender will be carried out in 3 phases comprising 1,350 MW each. The future projects will be located in northern Algeria, in the Hautes Plaines (High Plains) region, as well as southern Algeria. The solar plants will be owned and developed by special purpose companies of which 51% will be of domestic ownership. Financing for each project must be provided 30% with own funds and 70% with bank loans.

MINI-GRID

One example of mini-grid application of solar energy was brought about by a cooperation Korean and local groups. The mini solar power plant had a capacity of 28 KW and was installed on the rooftop of a research division in Wilaya of Adrar. The project's aim was to reduce the consumption of fuels used in the production of conventional electricity and mitigate the dependence on hydrocarbons.

OFF-GRID

With almost 100% of the country having access to electricity, the potential for off-grid solar is small. Therefore, no examples of off-grid applications in Algeria have been found.

4. MOROCCO

INTRODUCTION

Morocco is the only country in North Africathatdoesnotpossesscommercially relevant oil and gas reserves. As a result, the kingdom has long been dependent on expensive imported energy in order to satisfy domestic demand. This dependence left Morocco rather exposed to swings in market prices. This did however meant that the recent drop in oil prices have allowed the kingdom some "breathing space" and enabled it to begin the diversification of its installed energy capacity.

In recent years, Morocco has passed a series of legislations that aim to simultaneously decrease the dependence on foreign markets and increase the role of clean energy sources. As a result of the 'Renewable Energy Law', private power producers are able to sell the produced electricity on the high voltage market. Selling to smaller power consumers is a key point of improvement for the country that is yet to be addressed.

A promising sign of progress for the kingdom to meet its goals is the massive, 580 MW Concentrated Solar Power (CSP) plant that is being set up under the Noor Solar Power project. While the on-grid energy diversification is of the utmost importance, those that do not have access to the electricity grid rely on several mini-grid and off-grid initiatives that are taking place in Morocco.

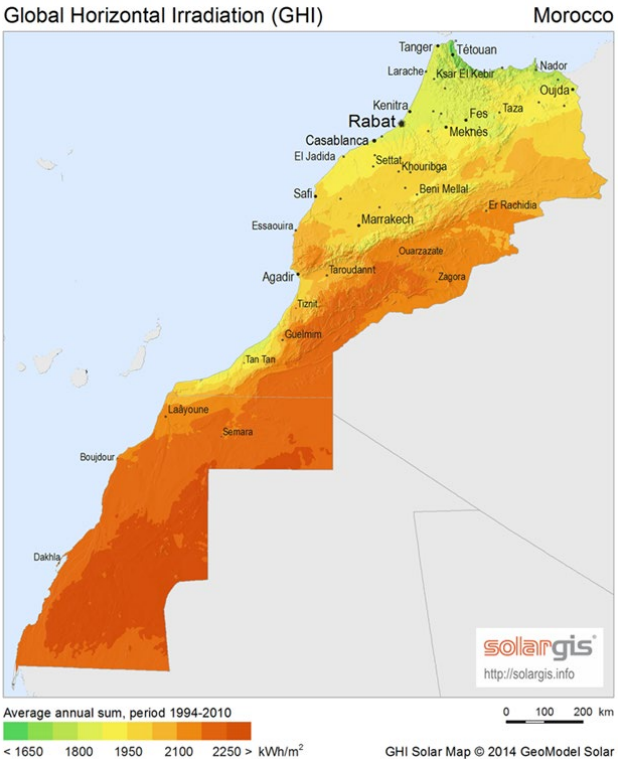


Figure 4.1: Global horizontal irradiation map of Morocco.

Table 4.1: Economical figures and key stakeholders of Morocco.

Economical figures	
GDP (2015)	100,593,280,000 USD
GDP per capita (2015, USD)	2,878.2 USD
GDP Growth ('13, '14, '15)	+4.535%, +2.551%, +4.508%
Inflation Rate - Consumer Prices (2015)	1.6%
Inflation Rate - GDP deflator (2015)	1.7%
Population (2015)	34,377,510

Economical figures	
Credit Rating (S&P/Moody's)	BBB- / Ba1
Corruption Perceptions Index (CPI 2015)	36
Ease of doing business index (2015)	68
Access to electricity (2014)	91.6%
• Power consumption per capita in kWh	912
• Renewable electricity (% of total output, 2013)	14.65%
• Renewable consumption (% of total consumption, 2012)	12.27%

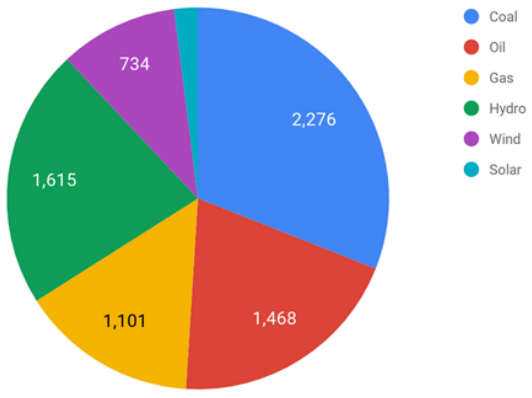
Key Stakeholders	
Energy regulator	• Office National de l'Electricité et de L'Eau Potable (ONEE)
Utilities	-
Top Banks	• Bank Al Maghrib • Attijariwafa Bank • Crédit Populaire du Maroc (Groupe Banque Populaire)

Table 4.2: Noteworthy solar projects in Morocco.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Noor Solar Power (CSP)	580 MW	Ouarzazate	Under construction	Moroccan Agency for Solar Energy

ENERGY MIX

MOROCCO - TOTAL PRODUCTION



MOROCCO - ENERGY CONSUMPTION

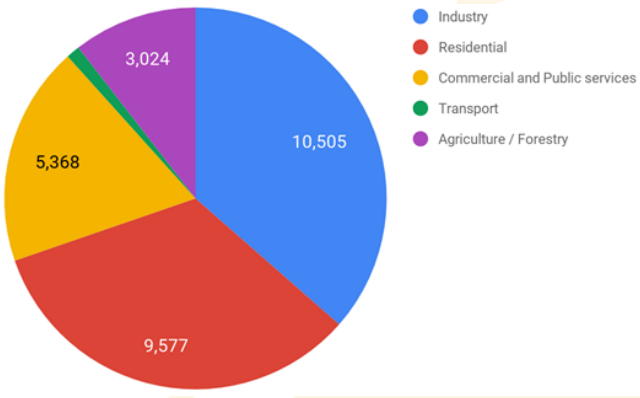


Figure 4.2: Total energy production by sources in MWs (on top) and total energy consumption overview based on sectors in GWh (on the bottom).

Morocco, despite being one of the only North-African country without substantial fossil-fuel reserves, relies on carbon-intensive sources quite heavily. Out of the 7,342 MW worth of installed energy capacity almost 5 GW is sourced from non-renewable sources such as coal, oil and gas. The remaining 2.5 GW of installed capacity is sourced from renewable energy sources. Out of this installed capacity hydroelectricity is the most prominent energy source accounting for more than 1.6 GW, whereas wind and solar energy ,have a capacity of 734 MW and 147 MW respectively.

The largest energy consumer sectors in Morocco are the industrial and residential sectors, accounting for 20,082 GWh of electricity consumption, which constitutes more than two-thirds of the total energy consumption in the country. The commercial sector and the agricultural sector are accountable for 5,368 GWh and 3,024 GWh of energy consumption whereas the transport sector only consumes 332 GWh of energy.

To bridge the gap of the deficit between its consumption and production, Morocco imports copious amounts of energy. According to some estimations, 96% of the country's energy requirements come from imports, making Morocco the largest energy importer in North Africa.

REGULATORY FRAMEWORK

The push towards adopting cleaner energy sources in the country's energy mix is two-fold. On one hand the nation realizes the importance of preserving the environment using low-carbon technologies. On the other hand adoption of renewable energy sources will also fall in line with sustainable development on the long-term satisfying the terms outlined in the kingdom's constitution.

One of the most important guidance for Morocco's energy future is outlined in the 'National Energy Strategy' (NES), which was adopted in 2009 and renewed in 2015/2016. The kingdom's goal for 2020 is reaching 42% of renewable energy in its total installed capacity whereas this number is expected to increase to 52% by 2030. This increase in renewables translates into particular goals for each source over the same period of time. Hydroelectricity, a crucial element of the kingdom's energy system for many decades, is expected to reach 2,000 MW by 2020 and up to 3,100 MW (additional 1,330 MW from 2016-2030) by 2030. Solar energy is planned to be increased to 2,000 MW installed solar power capacity (PV and CSP) by 2020 and roughly 4,800 MW by 2030 (additional 4,560 MW from 2016 to 2030). In charge of meeting this goal is the Moroccan Agency Solar Energy through the €7.7bn invested into the 'Moroccan Solar Plan'. The 'Moroccan Integrated Wind Program' aims to achieve 2,000 MW installed wind power capacity by 2020 and up to 5,000 MW by 2030 (additional 4,200 MW from 2016 to 2030).

The main driver enabling Morocco to realize its goal was the passing of the 'Renewable Energy Law' in 2010. This legislation allowed the development of private energy production through

IPPs and freed investors to establish renewable energy projects, sell electricity directly to customers on the high-voltage market and export unutilised energy. Despite the progress, the permission of renewable energy producers to sell electricity directly to lower-voltage users has yet to be seen and thus there is still room for improvement.

ON-GRID

An enormous solar project has been under construction around Ouarzazate, a city in south-central Morocco on the edge of the vast Sahara. The first phase of the Noor Solar Power station came online in February of 2016 with a generating capacity of 160 MW. The project, when fully complete, will have cost $9 billion and have a capacity of 580 MW providing electricity for over a million Moroccans. Interestingly enough, the Noor Solar Power station uses Concentrated Solar Power (CSP) in contrast to other solar projects of similar size.

Another utility-scale solar project, although much smaller and in much earlier phases might be equally as important for Morocco's solar future as the Noor Solar Power station. Delphos International, a US-based financial consultant, together with National Agency for the Development of Renewable Energy and Energy Efficiency (ADEREE) is assessing the feasibility of a 5MW PV plant. The project, if deemed attractive, could serve as a model for duplication for smaller sized cities.

MINI-GRID

An example of using mini-grids to electrify rural regions comes from the efforts of Trama TecnoAmbiental (TTA), a Spain-based mini-grid developer with a wealth of experience
in the implementation of RE mini-grid in developing countries. Set up in the village of Akkan, the system includes a 5.76 KWp PV, with an 8.2 kVA single-phase diesel generator, and a battery bank with 24 elements (48V) for 4 days of backup capacity. 95% of the electricity produced via such a system configuration came from renewable energy. The costs associated with operation, maintenance and replacement were covered by monthly flat tariffs paid by the users, which was fixed according to a pre-agreed maximum daily energy available to be consumed. In this setup, the community owned the mini-grid. However, a legal entity, a local association, was created to be responsible for the O&M, the replacement, and the fee collection.

Image: Green Technology Africa

OFF-GRID

One application of solar off-grid appliances comes in the Moroccan village of Imdjahidi, which is located out of reach of the power grid. The community of Imdjahidi relied on wood as fuel for cooking and heating water, which not only contributed to carbon emissions and deforestation, but also prevented women and girls from engaging in education and other economically productive activities, as they bore the main burden of fetching firewood. The Environmental Resources Management (ERM) foundation, in collaboration with French NGO Energie Solaire Solidaire et Dévelopement Durable provided grant funding and technical support to equip an initial 15 households (~165 people) with solar ovens, and also install a community solar bread oven in the village, replacing the need to cook on open fires or purchase expensive bottle gas.

Another off-grid solar application is offered by Zhuhai MNE Technology Co, a China-based developer of off-grid solar applications. The company offers a 5.5 kW solar pumping system or solar irrigation projects for Moroccan locals as an alternative for expensive fossil-fuel alternatives.

5. SENEGAL

INTRODUCTION

Senegal is part of the Economic Community of West African States and has been praised as one of Africa's model democracies. As a result of the democratic nature of the country, Senegal bears a relatively stable economy despite high unemployment and widespread poverty. According to World Bank, however, Senegal has been trapped in a low-growth equilibrium since 2006, experiencing lower growth rates than other Sub-Saharan countries. One of the key ways the government is aiming to solve this problem is through the improvement and diversification of the energy sector. As a result, Senegal has passed many legislations promoting the energy sector. The country is very reliant on fossil and hydro energy sources, adding up to more than 90% of the total energy production (Figure 5.2). Since the majority of the country experiences solar irradiation levels upwards of 5.5 kWh/m2/day (Figure 5.1), solar power should play a huge role in the country's electrification plan. Several utility-scale solar PV projects have been started in the recent years, as well as mini-grid initiatives aimed to electrify rural regions.

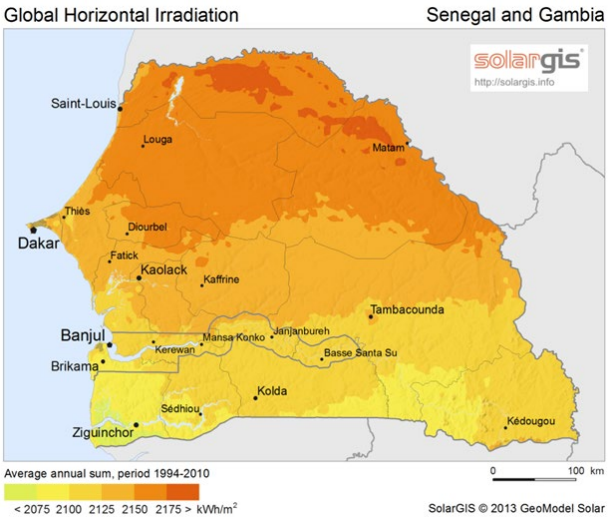


Figure 5.1: Global horizontal irradiation map of Senegal and Gambia.

Table 5.1: Economical figures and key stakeholders of Senegal.

Economical figures	
GDP (2015)	13,779,570,000 USD
GDP per capita (2015, USD)	908.7 USD
GDP Growth ('13, '14, '15)	+3.49% +4.31% +6.49%
Inflation Rate - Consumer Prices (2015)	0.1%
Inflation Rate - GDP deflator (2016)	0.0%
Population (2015)	15,129,000
Credit Rating (S&P/Moody's)	B+, Ba3
Corruption Perceptions Index (CPI 2015)	44 (0 highly corrupt - 100 very clean)
Ease of doing business index (2016)	146 (1 best - 189 worst)

Economical figures	
Access to electricity (2013)	57%
• Power consumption per capita in kWh (2013)	210
• Renewable electricity (% of total output, 2013)	10.42%
• Renewable consumption (% of total consumption, 2013)	43.59%

Key Stakeholders	
Energy regulator	• Inter-Ministerial Committee on Renewable Energy, Ministry of Energy (MoE), Ministry of Renewable Energy (MER) • Commission de Régulation du Secteur de l'Electricité (CRSE)
Utilities	• Société Nationale d'Electricité du Sénégal (SENELEC)
Top Banks	• CBAO Groupe Attijariwafa Bank • Société Générale de Banques au Sénégal • Ecobank Sénégal

Table 5.2: Noteworthy solar projects in Senegal.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Senergy	30MW	Méouane, Senega	Commissioned	Solairedirect and Schneider Electric
Senergy II	20 MW	Northern Senegal	Commissioned	GreenWish and Vinci Energies
Ten Merina solar project	30 MW	Dakar, Senegal	Financial completion	Eiffage and Solairedirect

ELECTRICITY MIX (2013)

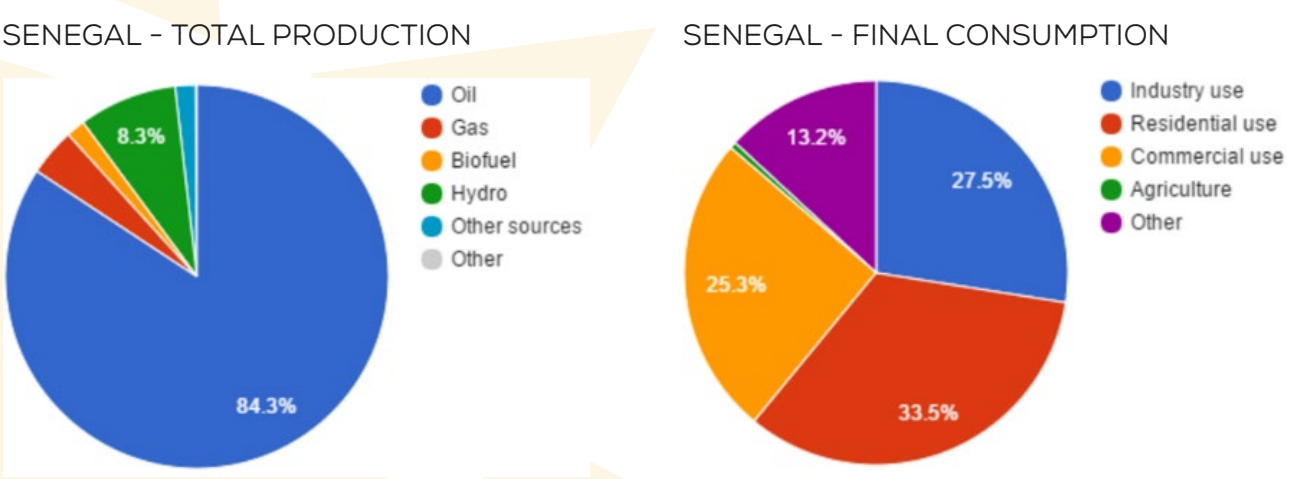


Figure 5.2: Total electricity production and final consumption of Senegal in 2013.

Senegal has a total electricity generation capacity of 660 MW out of which 444.7 MW is grid-connected. The country mainly depends on fossil fuels, consisting of heavy fuel oil and diesel accounting to 84.3% of the total production (Figure 5.2). These fossil fuel sources also have to be imported which increases electricity tariffs significantly. The other prevalent source of energy is hydroelectricity. The Senegal river, providing a perfect source for hydroelectricity, makes up approximately 10% of the total energy production. The main hydroelectricity plants are Manantali and Felou supplying the region with electricity.

REGULATORY FRAMEWORK

Senegal initiated a comprehensive energy development in 1997 through the Lettre de Développement du Secteur de l'Énergie (LPDSE). Over time this letter was revised multiple times, with the latest version published in 2012. The report serves as a point of reference for the government's task to improve the performance of the energy sector in the medium term. The main points are:

- Ensuring energy security and increasing the energy access for all;
- Developing a policy mix combining thermal generation, bio-energy, coal, gas, and renewables and seizing the opportunities of regional interconnections;
- Continuing and accelerating the liberalization of the energy sector by encouraging independent production and institutional reform of the sector;
- Improving the competitiveness of the sector in order to lower the cost of energy and reduce sector subsidies;
- Strengthening regulation of the sector.

Image: Little Sun

The 'Renewable Energy Act' 2010 consists of several decrees which are updated on an irregular basis. The two most important and recent decrees were added and updated in 2011 and mainly aim to set the conditions for the remuneration of electricity from renewable energy sources.

DECREE NO. 2011-2013

- Lays down the conditions of power purchase and remuneration for renewable energy sources and establishes the conditions of their connection to the grid;
- Provides formula for the avoided cost, serving as a reference for the calculation of the power purchase price cap;
- Elaborates on the renewable power purchase obligation and feed-in tariff for different renewable energy technologies.

DECREE NO. 2011-2014

- Provides conditions for the power purchase of surplus renewable

energy-based electricity from self-producers;
- Fixes the maximum intake from renewable energy sources (variable power);
- Demands the regulator to propose a purchase price based on several variables.

Besides the Renewable Energy Act of 2010, Senegal is also in the process of publishing an additional policy. The policy allegedly includes a target of achieving 10% of the total energy production from renewable energy by 2020. Although the specific sources of renewables are not specified, it can be assumed that country will not pursue hydroelectricity as this form of energy already accounts for about 10% of the total energy production and increasing this ratio would make the country more susceptible to droughts. Furthermore, the new policy also aims to develop flagship projects, identify sources of funding and improving the already existing legal framework.

ELECTRICITY TARIFFS

Low voltage electricity cost (CFA/kWh // USD/kWh)			
	one-phase	two-phase	three-phase
Domestic use			
Low power	106,44 // 0.180948	114,20 // 0.19414	117,34 // 0.199478
Medium power	112,96 // 0.192032	115,10 // 0.19567	116,69 // 0.198373
Commercial use			
Low power	151,59 // 0.257703	152,45 // 0.259165	153,83 // 0.261511
Medium power	152,72 // 0.259624	153,40 // 0.26078	155,46 // 0.264282

Table 5.3: Low voltage electricity costs for domestic and commercial use in Senegal

SOLAR PV

ON-GRID

The country's largest project came forth from a joint venture of Senergy, Meridiam and Fonsis SA (respectively a local energy company, a France-based global investor and asset manager and a French investment fund). The JV provided the financial means for the project, while French solar developer, Solairedirect, carried out the technical development. The 30 MW PV project was commissioned in July, 2017 and is located in Méouane, western Senegal. The plant consists of 96,000 solar panels and will cost 27 billion CFA (44.8 million USD).

A sequel project named Senergy II started construction in February 2016 and was commissioned in the last days of October. The project is part of a bigger project to create a portfolio of 600 MW of renewable energy in Sub-Saharan Africa by 2020. The projects are carried out by a partnership between an African

renewable energy company GreenWish and global private equity firm Denham Capital. The solar project will provide 20 MW to the grid and upon completion it will receive a feed-in tariff which was not revealed by the CEO GreenWish.

Besides the Senergy power plant, there is another 30 MW solar park in the pipeline to boost the nation's installed capacity. Although construction has not yet commenced, France-based investment bank Meridiam achieved financial completion for the Ten Merina solar project the end of 2016. The majority of the €43-million plant was financed by Proparco and Bio, the French and Belgian development banks, after the two banks loaned €34.5 million over 18 years for the construction and operation.

MICROGRID

An interesting initiative aiming to electrify rural regions of Africa was created by SOLAR23 provider of turnkey, grid-connected and off-grid PV systems. The solar PV system was established in 2008 for a rural village of 900 inhabitants in Ndelle, Senegal. The system consists of three PV plants, adding up to 8.4 kWp, and several high-quality industrial lead-acid batteries. In 2012, due to the success of the initiative, it was scaled up by 50%, totaling 14 kWp capacity. Based on the good experience in Ndelle, SOLAR23 and its local partner ENERGIE-R have electrified more than 100 villages in Senegal. By 2020 the companies aim to scale up to more than 10,000 mini-grids in the Sub-Sahara region.

OFF-GRID

Akon Lighting Africa is a local project to install independent off-grid solar systems that can directly benefit inhabitants of rural regions in Africa. Additional to Senegal, the initiative is present in 15 other countries throughout Africa. The initiative comprises of two types of solar PV products: Solar street lights and pre-paid home solar systems. Both products aim to increase safety of rural countries and promote commercial activities during night.

The Solar Village Project (SVP), a local non-profit organisation seeking to deploy and manage solar power projects in India and Senegal, is another participant in the Senegalese rural electrification efforts. The company is aiming to supply Solar Home Systems for 7 villages in the Sahel and Littoral regions, which are completely disconnected from the central grid system. The appliances will benefit 3,000 people and will comprise of basic electrical systems such as phone chargers and radios.

EXTRA

Senegal is very well endowed with solar irradiation with most parts of the country reaching more than 5.5 kWh/m2/day (Figure 5.1). Despite the potential, solar energy is relatively untapped besides some of the proposed solar plant projects and the recent implementations of mini-grid initiatives. There is, however, a trend of increasing solar adoption, which has resulted in less frequent outages, due to the decrease in load-shedding, as well as a 10% drop in electricity tariffs.

6. GHANA

INTRODUCTION

Despite being one of the smaller African countries, Ghana has shown immense economic progress over the past 25 years. The combination of progressive government policies and sustained efforts to alleviate poverty have fostered a strong private sector in Ghana, which is home to over 27 million people (Table 6.1). Nevertheless, Ghana remains plagued by frequent power outages and an inadequate power supply. In addition, only 52% of rural areas have access to electricity, a figure which leaves a lot of room for improvement. The government has made efforts to encourage foreign direct investment in the country, and it has recognized that the proliferation of renewable energy, particularly off-grid solutions, will be a key driver for Ghana's goal of universal electrification. The development of solar PV systems in Ghana presents a significant opportunity for investors; the country's solar irradiation rate ranges between 4.4 - 5.6 kWh/m2/day (Figure 6.1), while the government's incentives for the development of renewable energy present investors with a significant cushion against risk.

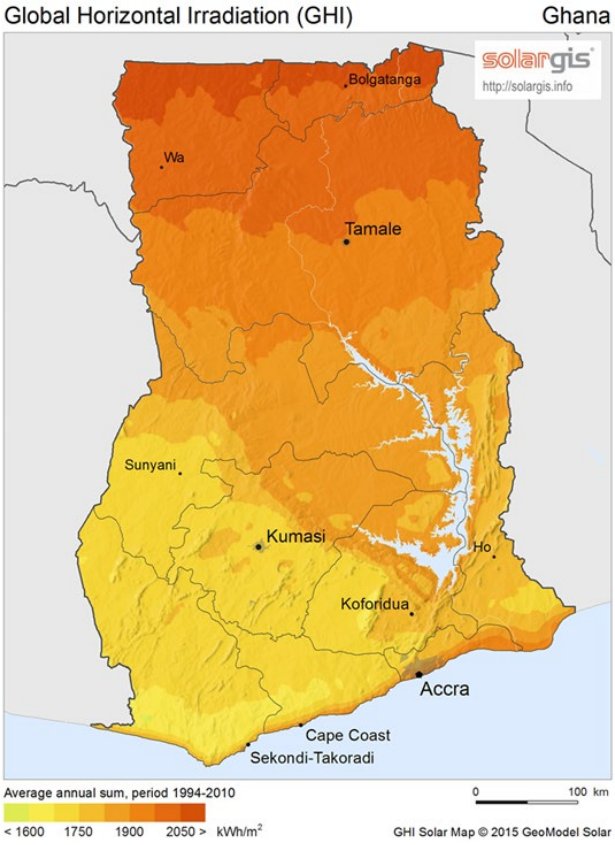


Figure 6.1: Global horizontal irradiation map of Ghana

Table 6.1: Economical figures and key stakeholders in Ghana

Economical figures	
GDP (2015)	37,864,370,000 USD
GDP per capita (2015, USD)	1,381.4 USD
GDP Growth ('13, '14, '15)	+7.3% +3.99% +3.88%
Inflation Rate - Consumer Prices (2016)	7.3%
Inflation Rate - GDP deflator (2015)	9.5%
Population (2015)	27,410,000

Economical figures	
Credit Rating (S&P/Moody's)	B, B1
Corruption Perceptions Index (CPI 2015)	33 (0 highly corrupt - 100 very clean)
Ease of doing business index (2015)	159 (1 best - 189 worst)
Access to electricity (2014)	78.3%
• Power consumption per capita in kWh (2014)	70
• Renewable electricity (% of total output, 2014)	99.9%
• Renewable consumption (% of total consumption, 2012)	92.7%

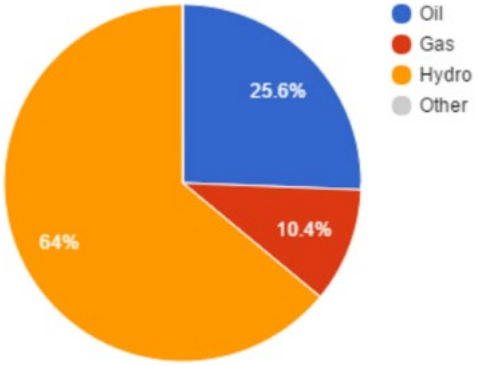
Key Stakeholders	
Energy regulator	• Ministry of Energy • Public Utility Regulatory Commission (PERC)
Utilities	• Energy Commission
Top Banks	• Barclays Bank of Ghana • Fidelity Bank • Ecobank Ghana

Table 6.2: Noteworthy solar projects in Ghana.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Unknown	20 MW (40 MW planned)	Accra, Ghana	Connected to grid	Beijing Xiaocheng Company
Unknown	100 MW	Nyimbale-Sankan, Ghana	Approaching financial closure	Home Energy Africa
Nzema Solar Park	155 MW	Aiwiaso, Ghana	Under Construction	Blue Energy

ELECTRICITY MIX (2013)

GHANA - TOTAL PRODUCTION



GHANA - TOTAL CONSUMPTION

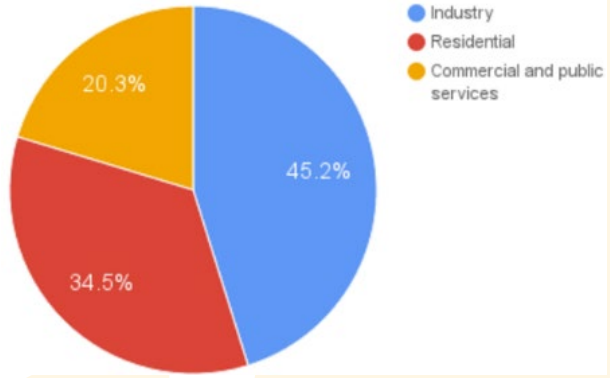


Figure 6.2: Total energy production and total energy consumption in Ghana

The majority of Ghana's electrical generation capacity comes from the country's three large hydropower plants, Akosombo, Bui, and Kpong, which collectively represent 1,598 MW or 64% of capacity. The remainder of Ghana's electrical generation capacity comes from fossil fuels, with oil and gas accounting for 25.6% and 10.4% respectively (Figure 6.2). In total, Ghana's electrical generation capacity is 2,450 MW.

REGULATORY FRAMEWORK

Ghana's currently energy policy aims to have 10% of electricity consumption stem from renewable energy by the end of 2020. The current share of renewable energy in electricity consumption is below 2%, and the government has recognized the importance of working on this issue. The Nzema Power Station is the country's first major venture into solar energy. With a capacity of 155 MW, the power plant is expected to be commissioned in late 2016.

The National Electrification Scheme (NES) has been a successful governmental program in greatly increasing the population's electricity access. Constituted in 1989, its goal is to extend the grid throughout the country by 2020. Because of the success of the program, there is little room for off-grid systems. Parts of the country that are not connected to the grid yet are convinced they will be soon, making it less attractive for these regions to invest big in micro or off-grid energy supplies.

Ghana has developed a RE policy, which is stated in the 'Renewable Energy Act' of 2011. One of the key provisions of the act is that an RE fund was to be introduced as an incentive for the promotion of RE generation. Since the establishing of the policy, progress has been made in the field of solar energy. This is also due to the feed-in-tariff that has been made for utility scale grid interconnection.

Similarly to other African countries, Ghana also suffers from heterogeneous energy distribution that impact the rural areas the worst. With more than 20% of Ghanaians lacking access to electricity, the country is in dire need for development programs. As part of the 'Renewable Energy Act', in 2015, the government launched the 'Scaling-up Renewable Energy Program' (SREP) which aimed to invest $230 million into the following project areas:

- Renewable energy mini-grids and stand-alone solar PV systems
- Solar PV-based net metering with storage
- Utility-scale solar PV/wind power generation
- Technical assistance projects

ELECTRICITY TARIFFS

Electricity tariffs effective from 1 January 2017, Gp (Ghana pesewas, Ghana Cedi (GHS); GHS 1 = Gp 100; 1 USD = 399.99 Gp)		
Charges (Gp per kWh // USD per kWh)		
Non-residential	0-300 kWh	96.79 // 0.2218
	301-600 kWh	102.99 // 0.2376
	601+ kWh	162.51 / / 0.3749
	Monthly service charge	1055.29 // 2.4344
Residential	0-50 kWh	33.56 // 0.0771
	51-300 kWh	67.33 // 0.1547
	301-600 kWh	87.38 // 0.2008
	601+ kWh	97.09 // 0.2231
	Monthly service charge	633.17 // 1.456

Table 6.3: Electricity tariff for residential and non-residential consumption in Ghana

SOLAR PV

ON-GRID

Nzema Solar Power Station, the largest (planned) solar PV plant in Africa, is now under construction in the western region of Ghana. The plant, being built by Blue Energy, will have an installed capacity of 155 MW. The plant is expected to go online in October this year.

At 20 MW, the Gomoa Onyandze plant is currently the largest operational project in Ghana. The plant was built by BXC Ghana, a subsidiary from BXC China and is located in Onyandze, Gomoa East. It required a 30 million USD investment and commenced operations earlier this year.

The Navrongo Solar Power Station was the first utility-scale PV project in Ghana. With an installed capacity of 2 MW and a required investment of 8 million USD, it was one of the first efforts towards achieving the target to have an energy mix with 10% renewables by 2020. The plant became operational in 2013.

MICROGRID

Despite the successful efforts of the government to expand grid connection to previously disconnected communities, some located on islands and isolated lakeside locations still do not have connection electricity. A recent study conducted by the Energy Sector Management assistance program has revealed important implications with occasional specific recommendation for several aspects of mini-grids.

Black Star Energy Limited, a Ghanaian subsidiary of Energicity Corp, is

providing a financially viable alternative to expensive fossil fuel sources in Affulkrom, Ghana. Offering energy through mini-grids, the company is able to support a wide range of customer needs — from the use of fans, TV's, refrigerators and sewing machines, to powering commercial refrigeration, restaurants and bars, health clinics, schools, grain mills and cold storage.

Another initiative was launched by the government to electrify rural areas in Accra, Ghana. The aim of the initiative is to ensure universal access to electricity, energy security and job creation. With the support of World Bank, there are currently between 5 to 7 mini-grid schemes are under development.

OFF-GRID

It is estimated that 4,000 off-grid solar systems have been distributed in Ghana. Accra-based developer Strategic Power Solutions (SPS) has launched a new PV module manufacturing plant, following a 50 million USD investment in Kpone, a commercial hub just outside the country's capital. SPS is a subsidiary of Strategic Security Systems International (3SIL), an independent Ghanaian conglomerate specialising in the procurement of solar products. According to numerous reports, SPS' motivation for the project included a desire to make Ghana more independent with its energy and provide a clean and stable solution to the national grid. Ghana's first ever PV manufacturing plant will mainly produce crystalline PV modules at a rate of 30MW a year.

Image: PRLOG

Another off-grid initiative that is based in Accra, Ghana and has a profound impact on the country's electrification rate is PEGAfrica ltd. The company provides crucial Solar Home Systems (SHS) to replace expensive polluting fuels such as kerosene. In order to make its products accessible for the lowest income household which often lack a stable income or a job, PEGAfrica provides its appliances on credit and customers reimburse it through pay-as-you-go financing.

EXTRA

The macroeconomic climate in Ghana is very favorable to foreign investors. Considering Ghana's long-lasting economic and political stability and the significant financial and bureaucratic incentives mandated by the government, Ghana presents an investment opportunity of a quality rivalling South Africa. A testament to Ghana's immense progress in the energy sector is the fact that its national electrification rate is the second highest among all sub-Saharan countries.

7. NIGERIA

INTRODUCTION

Nigeria is considered to be one of the biggest economies in Africa with more than 182 million people (Table 7.1), yet about 55% of the population has no access to grid-supplied electricity. The total energy production consists mainly of hydroelectricity and the exploitation of Nigeria's vast oil reserves, although in rural regions waste is also used as a source of energy. To keep up with the desired growth plan, Nigeria is in immediate need of electrifying its rural regions and improving its existing infrastructure. Power outages and intermittent power supply remain a challenge that roots from its weak, radial transmission system. This aspect forces Nigeria to look at alternative energy sources to power micro- and off grid solutions. Solar energy is a promising alternative as irradiation levels average 5.5-6.7kWh/m2/day with, on average, six hours of sunshine per day (Figure 7.1).

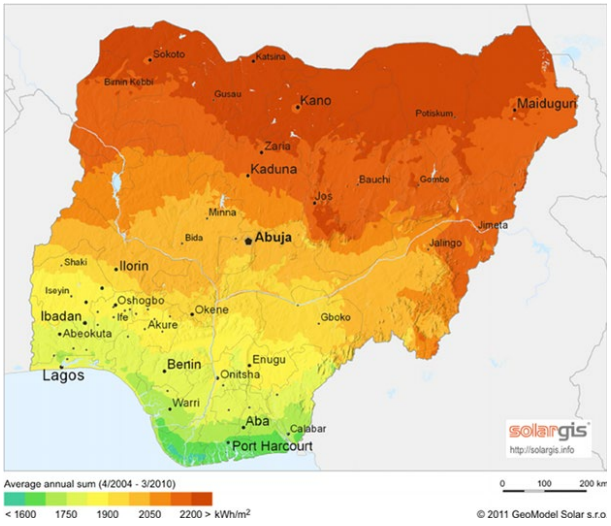


Figure 7.1: Average annual irradiation map of Nigeria

Table 7.1: Economical figures and key stakeholders of Nigeria

Economical figures	
GDP (2015)	481,066,150,000 USD
GDP per capita (2015, USD)	2,640.30 USD
GDP Growth ('13, '14, '15)	+5.39% +6.31% +2.65%
Inflation Rate - Consumer Prices (2016)	15.7%
Inflation Rate - GDP deflator (2016)	9.6%
Population (2015)	182,202,000
Credit Rating (S&P/Moody's)	B, B1
Corruption Perceptions Index (CPI 2015)	26 (0 highly corrupt - 100 very clean)
Ease of doing business index (2016)	169 (1 best - 189 worst)

Economical figures	
Access to electricity (2014)	57.7%
• Power consumption per capita in kWh	144
• Renewable electricity as % of total output (2014)	17.59%
• Renewable consumption (% of total consumption, 2012)	87.27%

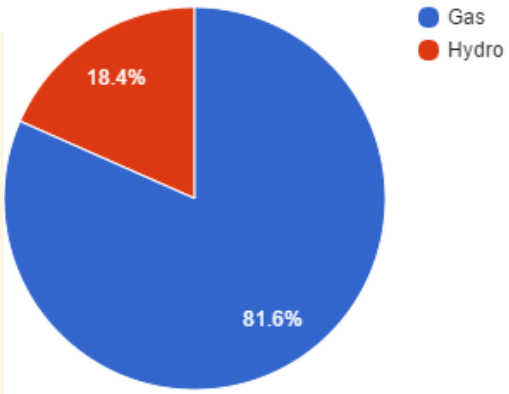
Key Stakeholders	
Energy regulator	• Federal Ministry of Power • Nigerian Electricity Regulatory Commission (NERC)
Utilities	• Nigerian Electricity Supply Industry (NESI)
Top Banks	• First Bank of Nigeria • Zenith Bank • United Bank of Africa

Table 7.2: Noteworthy solar projects of Nigeria.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Unknown	100MW	Enugu State, Nigeria	Beginning construction	Martifer Solar
Nova Scotia Power Plan	100MW	Jigawa state, Nigeria	Targeting financial closure	Scatec
JCM Solar PV plant	80MW	Katsina State, Nigeria	Beginning construction	JCM

ELECTRICITY MIX (2014)

NIGERIA - TOTAL PRODUCTION



NIGERIA - FINAL CONSUMPTION

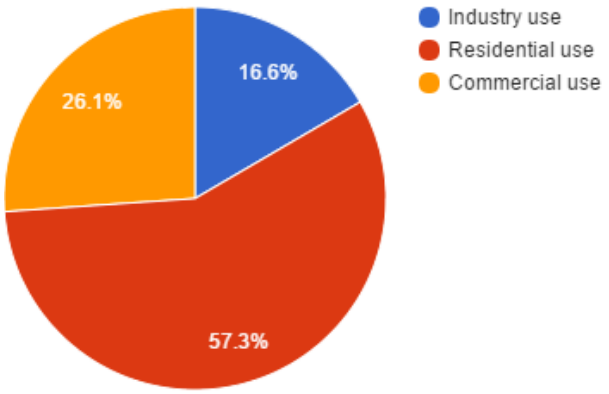


Figure 7.2: Total energy production and final energy consumption in Nigeria

The total energy production of Nigeria is estimated to be 13 GW, however, due to the poor maintenance and the outdated technology of the infrastructure the actual capacity is 6.1 GW. Of the total available energy, gas and hydro energy are most abundant, providing the majority of energy in Nigeria. Energy produced from gas accounts for 81.6% (Figure 7.2) of the total energy production as Nigeria contains one of the top ten natural gas endowments of the world and the biggest one in Africa. The other source of energy that is widely adopted in Nigeria is hydroelectricity, accounting for 18.4% of the total energy production (Figure 7.2). The popularity of hydroelectricity in the country can be linked to the numerous rivers and waterfalls that are in Nigeria.

REGULATORY FRAMEWORK

There has been an energy policy in place in Nigeria since 2006, called the Renewable Energy Master Plan (REMP). The policy was implemented to increase the share of renewables to account for 10% of Nigerian total energy consumption by 2025. The plan includes an installed capacity target of 500 MW by 2025. In a more bold statement, Nigeria's power minister has mentioned the ministry aims to boost the installed capacity of solar PV to 1 GW over the next 10 years.

More recently, the Nigerian Electricity Regulatory Commission approved regulations regarding feed-in-tariffs for renewable energy sourced electricity. Electricity distribution companies are now required to source 50% of their supplied electricity from renewable energy sources. The legislation stresses the regulatory institutions' ambitions to reach the set targets within the next couple of years.

The Energising Access to Sustainable Energy (EASE) aims to improve framework conditions for renewable energy and energy efficiency for the use of renewable energies by households and small and medium enterprises in particular. The program will be run in partnership with the World Bank (contributing €4.6 million) and the GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) (contributing €9 million). It includes the design of energy strategies to increase energy access and the development of business plans to demonstrate commercial viability of certain resources.

The government of Nigeria has laid out the National Renewable Energy and Energy Efficiency policy in 2015, aiming to provide a comprehensive framework for the development and exploitation of renewable energy sources. Solar energy is projected to grow on the medium term (2020) to 1,343.17 MW and on the long term (2030) to 6.830,97 MW.

Image: Rural Reporters

The National Renewable Energy Action Plan sets goals for the expected development and expansion of renewable energies in Nigeria in order to achieve the national target under ECOWAS Renewable Energy Policy (EREP). The plan outlines the expected percentage of homes to be connected to off-grid renewable energy supply by 2020 and 2030 as well as the means for Nigeria to achieve its ECOWAS target of 23% and 31% renewable energy in 2020 and 2030 respectively. More particularly, the target will be achieved by increasing the installed renewable energy capacity to 52% by 2020 and reaching 49% in 2030.

A promising sign with regards the electrification of Nigeria's rural areas came in 2016 when a draft regulation for mini grids was presented. The regulation sought to minimize the major risks associated with minigrid (< 1MW) investments such as: Sudden tariff changes, (tariffs would have been agreed on in advance by the relevant parties; and Stranded Mini-Grid Operator investments), that occur during the extension of main grid to cover the minigrid area. Furthermore, the legislation also aimed to reduce the administrative burden on these types of solar applications and to ensure that permits can be obtained in a timely manner.

ELECTRICITY TARIFFS

	Charge by DISCOs NGN // USD (per kWh)			
	Yola	Ibadan	Kano	Enugu
R2 (residential)	R2A: 23.25 // 0.0744 R2B: 24.75 // 0.0792	23.09 // 0.073888	R2A: 20.26 // 0.064832 R2B: 26.41 // 0.084512	27.13 // 0.086816
C2 (commercial)	43.78 // 0.140096	38.87 // 0.124384	36.25 // 0.116	42.40 // 0.13568

Table 7.3: Electricity tariff for residential and commercial consumption in Nigeria (NGN to USD exchange 09/19/2016)

Nigeria's tariff level is determined under a Multi-year Tariff Order (MYTO). The latest MYTO was put in place for the period of 1 April 2015 to December 2018. The biggest change in the new MYTO was the abolition of fixed costs for both residential and commercial consumers. Despite the abolition of fixed costs, Nigerian residents and companies cannot fully enjoy the economic ease as rates increased significantly per kWh. The raise in tariffs have enraged many Nigerian citizens, in light of the intermittent energy supply and the

outdated infrastructure. The Minister of Power explained that the increase in tariffs will boost investment in the sector and investment would drive down electricity prices on the long-term. The tariffs for both residential and commercial consumption for four Distribution companies (DISCOs) across Nigeria are shown in Table 7.3. R2A stands for single phase supply whereas R2B stands for three phase supply.

SOLAR PV

ON-GRID

No utility scale power plants are connected to the grid so far. There are however some small scale projects in the pipeline and expected to go ahead later this year. One such example is the 0.4 MW solar PV installation at the Noodle Factory in Kaduna, aimed at lowering the costs of the current diesel-powered operation. Several companies have pledged to invest significant resources towards developing 5 GW worth of solar PV projects over the coming 2-5 years (Table 7.4).

Company	Capacity	Type	Description
People's Home Association	500 MW	Utility-Scale	Consists of five 100 MW projects
Solar Force Nigeria Limited	200 MW	Microgrid	Consists of 1 MW projects in villages all across Nigeria
People's Home Association	500 MW	Utility-Scale	Consists of five 100 MW projects
GreenWish Partners	200 MW	Utility-Scale	PPA is already signed with NBET and plants are expected to start producing energy in the first quarter of 2018.
Solar Force Nigeria Limited	200 MW	Microgrid	Consists of 1 MW projects in villages all across Nigeria
Solius NGC	300 MW	Unknown	Solius has also announced it will set up a training centre for power sector professionals
SkyPower FAS Energy	3 GW	Utility-Scale	The combination of projects amount to 5 billion USD worth of investments, and will provide 30,000 green jobs
New Generation Power Chicago	1.2 GW	Utility-Scale	Signed agreements together with Motir Seaspire and the Nigerian government. The projects will amount to 2 billion USD worth of investments.
Motir Seaspire			

Table 7.4: A list of the largest solar projects pledged by private companies

In addition to these pledges, the government-owned energy purchasing company Nigerian Bulk Electricity Trading (NBET) recently signed the first ever solar power purchase agreements (PPAs) in Nigeria, totalling 975 MW of solar PV with 12 producers.
The announced PPAs of close to 1000 MW have given other companies reason to see the huge solar potential in Nigeria. Engineering and Procurement Company (EPC) Sterling and Wilson have announced that they are aiming to increase their African market presence by constructing grid-connected projects totalling 250 MW. In the meanwhile, Nigus Greenenergy and Volt Renewables have signed a memorandum of understanding (MoU) with the Nigerian government for the development of 300 MW solar PV capacity over the next 3 years.

All of this reflects a big interest from investors and developers to explore opportunities for large-scale solar PV projects, especially in the northern part of the country, where radiation is highest.

MICROGRID

The National Agency for Science and Engineering Infrastructure (NASENI) has established a solar panel manufacturing plant that produces solar panels at an annual capacity of 7.5 MW. The production plant has been in operation since September, 2011, and sells to the Nigerian market as well as the rest of the West-African solar market.

Image: Greentech Lead

One such project, initiated by Schneider Electric SE, was among five projects to be awarded grants for outstanding solar projects that help communities through their social impact. The project revolved around the electrification of 170 schools, with 190,000 students, and 11 public health centers, servicing 4.7 million patients. Furthermore, the project also saved the schools and hospitals a total of 1 million USD per year in diesel costs and benefited the community with over 3000 jobs.

As a result of the partnership of the Nigerian Community Energy Social Enterprises Limited company and American firm Renewvia Energy Corporation 10,000 local households may be electrified in the near future. The signing of the Memorandum of Understanding between the two companies marks the initial steps to establish microgrids in 25 communities totalling 10 MW. The electricity will be sold to customers through Kilowatts, a “pay as you go” microfinance company in the Nigerian states of Bayelsa, Ondo, Ogun, and Osun.

OFF-GRID

The rural electrification rate in Nigeria is at a comparably low level, as only 57% of the rural population had access to electricity as of 2017. Because grid extension on a large scale takes a long time, opportunities for utility-scale projects in rural areas are limited. This opens doors for off-grid solutions, however.

The unreliable main grid power supply and costly petrol power generators, have given birth to an interesting initiative in Nigeria's rural communities. Arnergy, a Lagos-based renewable energy company is providing pay-as-you-go services for people without any or without sufficient access to electricity. The company charges customers only for the energy that has been used on a daily or a monthly basis. Customers with internet access can purchase energy units via Arnergy's app, Rana and customers without access to the internet through distribution agents called "solar angels".

There are also other more integrated approaches for PV systems being developed in different areas. Polio has not been eradicated in Nigeria yet, as vaccines have for a long time not been available to the public. The vaccines needed for the eradication must be kept at low temperatures at all times, so they must be stored in refrigerators. However, in rural Nigeria there is often no grid to connect the refrigerators to, which posed a serious problem in removing the disease. A solution was needed to keep the vaccines, needed for the eradication program, at low temperatures during the day and night. KXN Nigeria knew that vaccine refrigerators powered by solar PV could provide 24 hour reliability. With external funding, they had installed above 750 refrigerators against the price of 11,000 USD each. This illustrates how companies can provide off-grid solutions where infrastructure is lacking in rural areas.

EXTRA: KEY CHALLENGES AND OPPORTUNITIES

One of the main challenges Nigeria faces is the foreign investors' lack of confidence in the country's currency. Nigeria, a country that is predominantly reliant on its oil exports, is heavily impacted by falling oil prices. Even though it only accounts for 10% of Nigeria's total export numbers, oil still accounts for 70% of total export revenue and 95% of the government's revenues. Nigeria's president refused to devalue the national currency (naira), however foreign investors still fear that an investment made into PV plants could diminish as the naira decreases in value when the currency is inevitably devalued.

Image: Nigeria Today

Even when investors have already committed to making an investment in the country, they're far from being in the clear. A recent study investigated why many solar power projects failed to develop. The study's leader, Eugene Ikejemba (an engineering PhD student at the university of Twente in the Netherlands) identified two main reasons for the failure of solar projects. The first reason was that governments and agencies, who were in charge of implementing the projects, often failed to provide essential expertise for the project's planning. The project planners only think of solar projects as "finding an empty plot of land and constructing a project," said Ikejemba, while the management of the projects after its completion is often neglected. The other reason for the solar projects' failure is that governments do not provide long-term regulation and support for the import and installation of solar panels.

One of the main opportunities for (non-grid-connected) solar projects in Nigeria come from the poor state of the energy infrastructure. Despite the considerable energy capacity, the country's whole energy potential cannot be exploited due to the outdated nature of the transmission lines. Furthermore, the transmission system in Nigeria is mostly radial, meaning that there is a single path for transmission from the energy source. As a result, the smallest fault in this system could translate into the collapse of the entire transmission network. Such an event occurred in on the 31st of March, 2016 when no electricity was transmitted for three whole hours throughout the country. These aspects coupled with the poor electrification of rural areas provide an excellent opportunity for solar power in off-grid and mini-grid applications.

Another aspect that could give rise to the implementation of solar power in the near future comes from the problem of liquidity in Nigeria's energy sector. The Distribution Companies (DISCOs) at the end of the supply chain were unable to collect revenues, which hurt the other members of the supply chain, such as Generation Companies (GENCOs), gas suppliers and service providers. This event led to a cash crunch and has clearly cast doubts on future investments from DISCOs. On the other hand, this presents another big opportunity for solar power in its micro-grid and off-grid applications. As some industries require uninterrupted power supply and are more reliable in terms of payment, there is potential for industrial clusters and small cottage industries to develop around completely off-grid power sources.

8. CAMEROON

INTRODUCTION

Cameroon is estimated to have around 24 million inhabitants and a GDP per capita of 1,250 USD (Table 8.1). Still, access to electricity in 2015 only amounted to 55% of the population (Table 8.1), with rural regions registering access levels as low as 20%. Cameroon has the second most abundant hydroelectricity potential on the continent and hydro already accounts for more than two-thirds of its total energy production (Figure 8.2). The grid infrastructure is in poor condition and hydroelectricity is subject to water level fluctuations, which has led officials to shift their gaze towards a more steady energy source: solar power. Besides the expansion of hydroelectricity, Cameroon is also implementing regulations that will favor the use of solar energy. Cameroon offers very favourable conditions for solar PV applications, especially in its Northern regions where irradiation levels can reach up to 5.8 kWh/day/m2 (Figure 8.1).

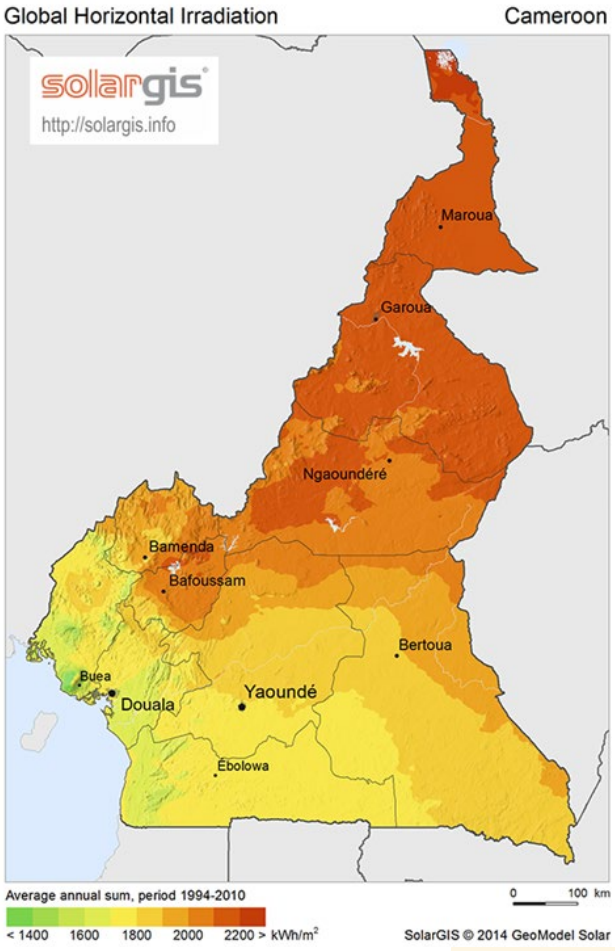


Figure 8.1: Annual solar irradiation map of Cameroon.

Table 8.1: Economical figures and key stakeholders of Cameroon.

Economical figures	
GDP (2015)	29,198,370,000 USD
GDP per capita (2015, USD)	1,250.8 USD
GDP Growth ('13, '14, '15)	5.56% +5.93% +6.24%
Inflation Rate - Consumer Prices (2015)	2.7%
Inflation Rate - GDP deflator (2016)	-18.3%
Population (2015)	23,344,000
Credit Rating (S&P/Moody's)	B, B2
Corruption Perceptions Index (CPI 2015)	27 (0 highly corrupt - 100 very clean)

Economical figures	
Ease of doing business index (2016)	166 (1 best - 189 worst)
Access to electricity (2015)	55%
• Power consumption per capita in kWh	281
• Renewable electricity (% of total output, 2014)	74.3%
• Renewable consumption (% of total consumption, 2014)	77.4%

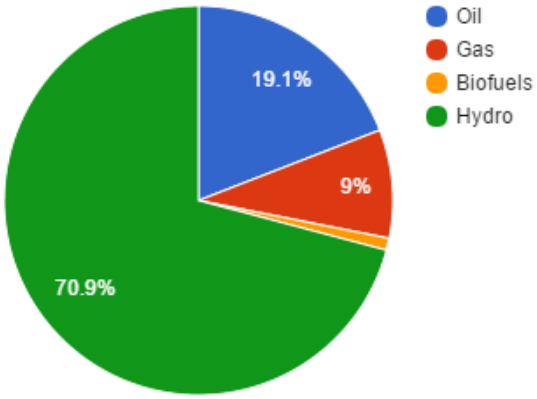
Key Stakeholders	
Energy regulator	• Ministère de l'Energie et de l"Eau (MINEE) • Electricity Sector Regulatory Agency (ARSEL) • Rural Electrification Agency (AER)
Utilities	• ENEO Cameroun (56% held by Actis)
Top Banks	• AfriLand First Bank • ACEP Cameroun • Alios Finance Cameroun

Table 8.2: Noteworthy solar projects in Cameroon.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
JCM Greenquest	72MW	Mbalmayo, Cameroon	Approved grant to finance	JCM Greenquest Solar Corporation
-	10 MW	Ngaoundérén, North Cameroon	Under planning	Eneo
-	15 MW	Maroua, Far North region	Under planning	Eneo
-	10 MW	Guider, Northern region	Under planning	Eneo

ELECTRICITY MIX (2013)

CAMEROON - TOTAL PRODUCTION



CAMEROON - FINAL CONSUMPTION

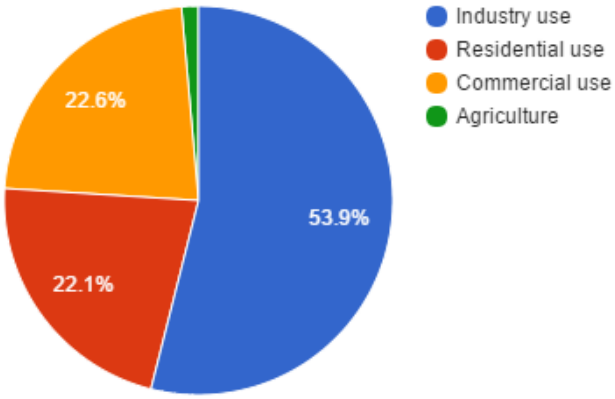


Figure 8.2: Total electricity production and final consumption of Cameroon

The country of Cameroon annually produces approximately 1475 MW of electricity. Out of the total energy produced, hydroelectricity is the most common source, amounting to more than 70% of the total production. The two main hydro stations of the country are both located on the Sananga river. Due to Cameroon's high dependence on hydro energy and the hydro stations dependency on the same river, the country is heavily affected by droughts and water level fluctuations. The other prevalent source of energy is fossil fuel powered: approximately 30 aging diesel power stations serve as a backup solution.

REGULATORY FRAMEWORK

Under the long-term energy sector development plan (PDSE 2030) and the poverty reduction strategy paper (PRSP) the country is seeking to leave its under-developed status behind.

Image: Sandel Environment

To achieve this, investment in energy sector is inevitable. Cameroon is also heavily expanding towards renewable energy sources to diversify its energy portfolio. These ambitions are aided by the objectives laid down under the Vision 2035. The policy aims to increase production and deliver electricity with an emphasis on renewable energy. Besides this policy Cameroon is creating a new legal framework for the promotion of

renewable energy. The framework will cover promotional, legal and financial operation matters of the implementation of renewable energy sources. Even though the setting up of such framework is in its initial phases, David Payang of the Ministry of Environment has confirmed that a committee is now in place to write a draft law.

In 2011, the Ministry of Finance exempted solar panels from value-added tax. This exemption will ease solar power consumers of 19.25% of their tax and has contributed significantly to the expansion of solar systems in the Cameroonian residential area. According to the Ministry of Mines, Water and Energy, over 12 per cent of Cameroon homes run on solar energy predominantly in the urban areas.

Cameroon also puts a big emphasis on the electrification of its rural areas in its Rural Electrification Master Plan. The aim of this initiative is to provide 660 localities through the extension of interconnected grids and rehabilitation of already existing energy sources. By 2020, the government aspires to reach electrification rates of 48% countrywide, with 75% electrification in urban areas and 20% in rural ones.

ELECTRICITY TARIFFS

Category		Range	USD/kWh
LV		<110 kWh	0.0896
		>801 kWh	0.168
Public Lighting		Independently of range	0.112
MV	Normal hours	0-200 hours	0.1232
		>401 hours	0.1008
	Peak hours	Independently of range	0.1456
HV		Negotiate on case by case base	

Table 8.3: Electricity tariffs for different voltage levels in Cameroon

SOLAR PV

ON-GRID

There are currently no utility scale PV projects in Cameroon. For the past decades, the main source of energy production has been hydro. Besides hydroelectricity, Cameroon also relies on energy produced from fossil fuels, however, due to the expensive nature of this solution it is only used in emergencies. Solar solutions are quickly gaining attention though and many large announcements have recently been made by a number of companies.

A French company, Generale du Solaire, together with an investment fund, Arborescence Capital, have signed a memorandum of understanding (MOU) to build a number of solar PV plants, adding up to an envisioned capacity of 300MW. The plants, when ready, are expected to produce 32 GWh of energy per year and will peak when energy from hydroelectric is at the lowest. The first part of the plan should be built in the Adamaoua region in northern Cameroon, where irradiation levels are the highest in the country reaching to 5.8 kWh/m2/day.

Joule Africa signed a MOU to build 100MW solar power plant in the northern regions of Cameroon. The project is aimed to boost Cameroon's energy production capacity by 15%.

JCM Greenquest Solar Corporation, the Cameroonian offshoot of Canadian JCM Capital together with African Development Bank (AfDB) got approval of a 770,000 USD preparation grant to pave the way for the country's first independent power producer (IPP). The grant will facilitate the construction of a 72 MW solar plant in Cameroon.

South African company, GSC Ltd. started a project aimed at developing a solar power plant portfolio ranging up towards 500MW of capacity, after performing several feasibility studies. The project was estimated to require 18 months and a total of 2.2 billion USD in investments to complete. The project has allegedly secured 80% of the necessary funding through South Korean business

Image: Now How Africa

conglomerate Hanwha group, and Irish solar developer Investricity. PV systems, as part of the project, have already been installed southern cities of Sangmelima, Meyomessala, Mengong Benbgis, the northern city of Maroua and the coastal city of Yingui.

Cameroon's power utility Eneo, owned by British investment fund Actis, is also planning to significantly increase the country's solar installed capacity in the years to come. According to their initial announcement, three PV plants will be installed with a combined capacity of 35 MW. These solar parks, a 10 MW, a 15 MW and another 10 MW project, will be located in Ngaoundéré, Maroua and Guider respectively.

MICROGRID

Singyes Solar, a China-based solar power technology firm, completed and passed inspection of its first smart microgrid project. The project entailed the construction of a system that provides electricity for the lighting project of the presidential palace with a total capacity of 50kVA.

One of the most prominent companies in Cameroon's rural electrification efforts is Chinese company, Huawei. With its 'Microgrid Solar Solution', the company provides solar PV installations ranging from 30 kW to 300 kW, and can expand to a MW-level installed capacity by 2018. The solar solution contains an energy storage system and supports diesel generator access to ensure reliable energy supply for households that do not have access to grid electricity. Since phase 1 of the project has been finished, Huawei Microgrid Solar Solution helps a 166 villages and over 120,000 people to gian access to electricity.

OFF-GRID

A recent study conducted by the university of Dschang, Cameroon investigated the feasibility of off-grid solar, hydro and biogas electricity supply systems. PV systems were concluded to be among the most economical options for villages located in the Northern regions of the country, with the ability of providing at least 6.21kWh/m²/day. The solutions investigated were shown to outperform grid extensions for distances greater than 33.5km and 9km, with energy costs of 0.527 €/kWh and 0.215€/kWh respectively.

PowerOak, a Dutch company specializing in off-grid power supply solutions, is expanding operations to provide locals with 10KW three-phase distributed off-grid solar power generators. This initiative can help the spread of commercial solar power generators, electrifying remote areas.

Yandalux, a Hamburg-based solar PV plant developer, installed a 10kW off-grid PV system at the Foyer du Marin in the port city in Douala, Cameroon. The system consists PV generators, batteries and a diesel generator and is expected to cover a quarter of the cities energy demand.

A significant increase in the country's rural electrification rate can possibly be expected as a result of the country's collaboration with the Bank of China. With the signing of decree N° 2017/287, the Bank of China will loan CFA 73.95 billion ($123.2 million) to the Ministry of Economy, Planning and Regional Development to boost rural development. The funds will be used to finance phase II of the government's solar rural electrification program and will provide 350 communities with off-grid PV capacity of 32 kW.

EXTRA

One of the main challenges Cameroon is facing lies in the discontinuity of its national grid infrastructure. This issue prevents the transfer of power among the three separate grids: the Northern Interconnected Grid (NIG), the Eastern Isolated Grid (EIG) and the Southern Interconnected Grid (SIG) (Figure 8.3). As a result, solar micro-grid and off-grid solutions can be huge factors in Cameroon's electrification ambitions.

Figure 8.3: Main transport grids in Cameroon.

The unreliability of hydroelectricity in the wake of climate change and the general tendency to increase the promotion solar energy in Cameroon has pushed to government to seek sustainable, domestic solutions for the development of new renewable solutions. One of the initiatives running with that aim, is to increase the amount of locally trained technicians. The university of Yaounde is offering courses to train engineers who can expand the adoption of sustainable energy throughout the country.

9. ETHIOPIA

INTRODUCTION

Ethiopia is among Africa's fastest growing nations, boasting an impressive average GDP growth rate of 10.5% over the past 10 years (Table 9.1). The country is home to over 99 million people (Table 9.1), which makes it the second most populous country in Africa (behind Nigeria). Despite its recent progress, however, Ethiopia remains one of the poorest African states, with a GDP per capita of barely 619.10 USD (Table 9.1). The development of Ethiopia's renewable energy sector has been one of the leading new drivers of economic growth in the country. The bulk of the country's 2.26 GW energy generation capacity comes from hydroelectricity, which accounts for 86% of the country's total capacity (Figure 9.2). The government of Ethiopia considers private investment in its renewable energy sector as critical for the success of its ambitious Growth and Transformation Plan (GTP), which aims to reshape the country into a middle-income state by 2025. Considering the high amount of solar irradiation Ethiopia receives, averaging at 5.2 kWh/m^2/day (Figure 9.1), the development of solar PV projects in Ethiopia is an extremely lucrative opportunity for investors.

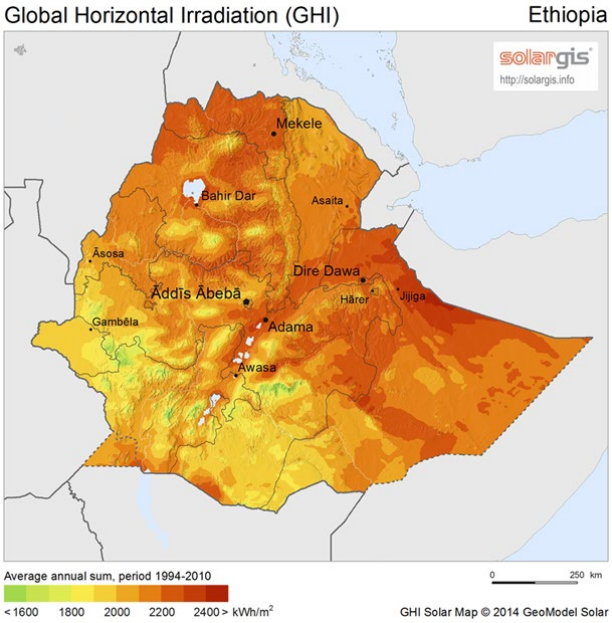


Figure 9.1:Global horizontal irradiation of Ethiopia

Table 9.1: Economical figures and key stakeholders in Ethiopia

Economical figures	
GDP (2015)	61,537,140,000 USD
GDP per capita (2015, USD)	645.5 USD
GDP Growth ('13, '14, '15)	+10.6% +10.3% +9.61%
Inflation Rate - Consumer Prices (2016)	7.3%
Inflation Rate - GDP deflator (2015)	9.5%
Population (2015)	99,391,000
Credit Rating (S&P/Moody's)	B, B1
Corruption Perceptions Index (CPI 2015)	33 (0 highly corrupt - 100 very clean)

Economical figures	
Ease of doing business index (2016)	159 (1 best - 189 worst)
Access to electricity (2014)	27.2%
• Power consumption per capita in kWh (2014)	70
• Renewable electricity (% of total output, 2014)	99.9%
• Renewable consumption (% of total consumption, 2014)	92.72%

Key Stakeholders	
Energy regulator	• Ministry of Water and Energy (MWE) • Ethiopia Energy Agency (EEA)
Utilities	• Ethiopian Electric Power Corporation (EEPCO)
Top Banks	• Dashen Bank • Cooperative Bank of Oromia • Bank of Abyssinia

Table 9.2: Noteworthy solar projects in Ethiopia.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Unknown	20MW	Addis Ababa, Ethiopia	Commissioned	Sky Energy International and Metals and Engineering Corporation (METEC)

ELECTRICITY MIX (2013)

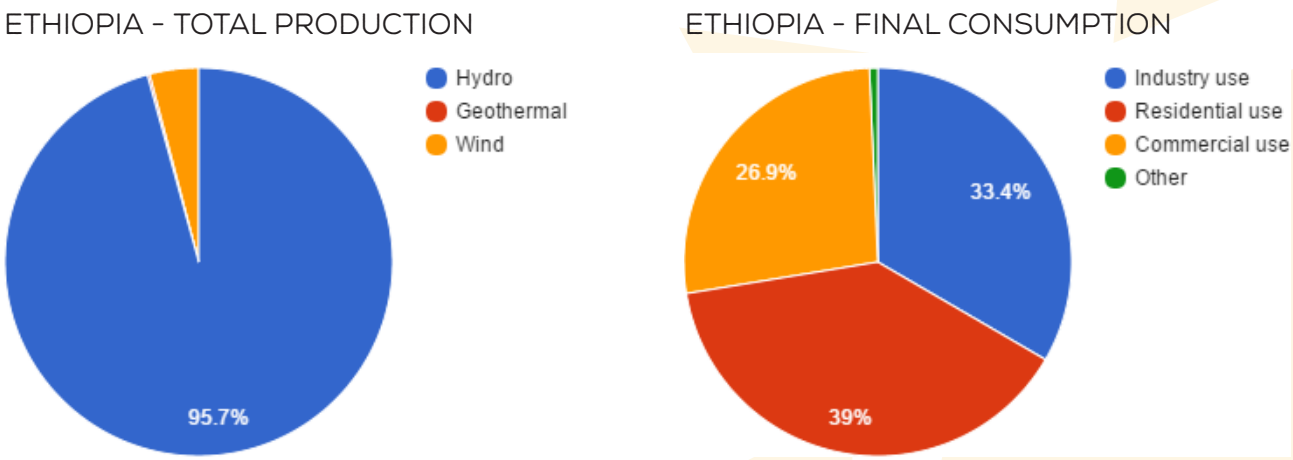


Figure 9.2: Total electricity production and final consumption of Ethiopia

Ethiopia's total energy production amounts to 2.26 GW. An overwhelming amount of the country's energy generation capacity, 86%, comes from its hydropower plants (Figure 9.2), which harness Ethiopia's extensive river system. Currently in development are several ambitious hydropower plants, the most notable ones being Gibe III, Adama II, and the Grand Ethiopian Renaissance Dam, which would collectively provide 8,060 MW of capacity. Wind power accounts for 8% of Ethiopia's energy generation capacity (Figure 9.2), with the Adama wind farm providing 153 MW of capacity. Fossil fuels account for less than 4% of Ethiopia's energy generation capacity (Figure 9.2), mainly in the form of gas turbines.

REGULATORY FRAMEWORK

The Ethiopian government's 'Growth and Transformation Plan' includes very ambitious targets for 2020, including increasing energy generation capacity from 2.26 GW to 17,34 GW and increasing the country's electricity service coverage from 60% to 90%. The government acknowledges that private investment will be pivotal in the achievement of these goals, and they've made significant progress to encourage foreign direct investment in Ethiopia's renewable energy sector. In 2012 the government amended its investment proclamation to include provisions for the establishment of development zones with tax, investment, and infrastructure incentives. In 2014 the government passed Proclamation 810/2013, a law focusing extensively on the proliferation of independent Power Purchase Agreements, the development of off-grid systems, and the enactment of more efficient on-grid management policies.

One of the most influential legislations in the Ethiopian regulatory framework is the 'Climate Resilient Green Economy' (CRGE) initiative. This initiative is aimed to transform Ethiopia into a middle-income country before 2025, while building an economy that is sustainable and environment friendly. The CRGE foresees a development of up to 25GW in generation potential mainly through the increase in hydro, geothermal and wind energy.

Ethiopia is also part of the Scaling Solar initiative, which aims to further develop renewable energy sources especially solar energy. Not only does this program diversify the country's energy mix but the local water resources can be better managed to minimize the harm caused by the recurring droughts.

The most significant foreign energy partner in Ethiopia is the Power Africa initiative. It was launched by the United States in 2013 with the goal of establishing 30,000 MW of energy generation capacity across Africa. Another significant international initiative is the 'Eastern Africa Power Pool' (EAPP). Based in Ethiopia, the EAPP facilitates cross-border grid connections and mandates the establishment of common codes and standards.

ELECTRICITY TARIFFS

1 USD = 22.19 BR (10/10/2016)

No.	Tariff Category	Monthly (Consumption kWh)	Rate (BR per kWh // USD per kwH)
1.1.1	Domestic		
	Equivalent Flat Rate		0.4735 // 0.021338441
	First Block	01-50 kWh	0.2730 // 0.012302839
	Second Block	51-100 kWh	0.3564 // 0.016061289
	Third Block	101-200 kWh	0.4993 // 0.022501127
	Fourth Block	201-300 kWh	0.5500 // 0.02478594
	Fifth Block	301-400 kWh	0.5666 // 0.025534024
	Sixth Block	401-500 kWh	0.5880 // 0.026498423
	Seventh Block	above 500 kWh	0.6943 // 0.031288869
1.1.2	General (Commercial)		
	Equivalent Flat Rate		0.6723 // 0.030297431
	First Block	First 50 kWh	0.6088 // 0.027435782
	Second Block	Above 50 kWh	0.6943 // 0.031288869
1.1.3	Low Voltage (380 V) Industrial Tariff		
	Equivalent Flat Rate		0.5578 // 0.025137449
	Peak		0.7426 // 0.033465525
	Off-Peak		0.5435 // 0.024493015
1.1.4	Medium Voltage (15 or 33 kV) Industrial Tariff		
	Equivalent Flat Rate		0.4086 // 0.0184137
	Peak		0.5085 // 0.022915728
	Off-Peak		0.3933 // 0.0177242
1.1.5	Medium Voltage (15 or 33 kV) Industrial Tariff		
	Equivalent Flat Rate		0.3805 // 0.01714736
	Peak		0.4736 // 0.021342947
	Off-Peak		0.3664 // 0.016511942
1.1.6	Street Light Tariff		
	Equivalent Flat Rate		0.4843 // 0.021825146

Table 9.3: Electricity tariff for domestic and commercial consumption in Ethiopia

SOLAR PV

ON-GRID

Currently there are no utility-scale solar PV projects in Ethiopia. Since an overwhelming part of the country's power is generated through hydropower plants, the solar energy sector in Ethiopia is still in its earliest stages of development.

This status, however, may not last long thanks to Ethiopia's participation in the Scaling Solar initiative. A tender for the 100 MW Metahara project that initially attracted 60 bids is reportedly being narrowed down to 5 bids and the winner should be announced in the near future. Another, similar 100MW solar power tender that is part of the 'Growth and Transformation' plan has narrowed potential developers down to 18. Among these prequalified bidders are Enel Green Power, Sky Power, Biotherm, Acciona, Mitsubishi and TBEA Xinjiang Sunoasis.

Recently, the Ethiopian government signed a memorandum of understanding with the US-based Green Technology Africa for the development of utility-scale grid-connected solar PV plants with a total capacity of 300 MW.

MICROGRID

Realizing the importance of micro- and minigrids and following the guidelines of CRGE, the Ministry of Water, Irrigation and Electricity (MoWIE) has put a huge focus on these applications. Thanks to investment of the 'Rural Electrification Plan', the feasibility of micro- and mini grids has extensively been studied and thus the uncertainty surrounding their development is greatly reduced. As the foundation has already been laid down, the MoWIE is planning to commission 350 decentralized grid systems in the upcoming 4-5 years. Simultaneously, Ethiopian Electric Power (EEP) aims to contribute to the electrification of rural Ethiopia by adding another 200 micro-grids.

German-based SMA Solar Technology has invested in the creation and installation of small PV systems to power hospitals across Ethiopia. The system consists of 100 solar panels with an individual capacity of 1.5 kW.

OFF-GRID

Off-grid solar applications are instrumental for the development of rural areas in Ethiopia, however, the relatively large upfront costs associated with it constitute a hurdle hindering progress. In an attempt to overcome this, the Development Bank of Ethiopia (DBE) in partnership with the International Development Association (IDA), is providing working capital loans to private sector household solar providers, as well as micro-financing to households for the purchase of solar lanterns and Solar Home Systems (SHS). The funding for this initiative includes a $20 million credit line under the 'Electricity Network Reinforcement and Expansion Project' (ENREP), and another $20 million l by the World Bank Board of Directors in May 2016 as part of $200 million in additional financing to ENREP.

The upfront costs are not the only aspects that make the scaling of off-grid applications troublesome. Maintenance and battery replacement costs also manifest significant financial burden for low-income rural households. Fortunately, the DBE's recent agreement with the Carbon Initiative for Development (Ci-Dev) might just be able to solve this issue. The 'Emissions Reduction Purchase Agreement' (ERPA) that was signed between the two entities will bring a $125 million in funding to address concerns over insufficient warranties and battery replacement for SHS, thus helping to ensure the sustainability of off-grid solutions and to protect the market from counterfeit products.

Small photovoltaic home systems, offered by the Solar Energy Foundation, with rechargeable batteries could provide regular lighting and even power radios and televisions. The Ethiopian initiative installed the first batch of systems free of charge, but additional units are funded through a loan with affordable monthly payments.

Estimates from Ethio Resource Group put the sum of off-grid solar PV capacity in Ethiopia at 5.3 MW. More than 87% of this capacity is used to power telecom systems, both landline and mobile network stations. This percentage is expected to increase further due to the Ethiopian government's pursuit of universal mobile phone access throughout the country.

EXTRA: CHALLENGES AND OPPORTUNITIES

Ethiopia's potential for solar PV projects is immense. Considering the country's high levels of solar irradiation, which averages around 5.2 kWh/m2/day, utility-scale PV power plants would benefit greatly from a dramatically increased level of output. This is especially valid for the eastern and northern parts of the country, where irradiation levels can reach as high as 6.25 kWh/m2/day.

Due to Ethiopia's lack of operational utility-scale solar PV plants, there is ample opportunity for entrepreneurial firms to enter this new market in its earliest stages of development. The government of Ethiopia is actively encouraging foreign direct investment, especially directed towards the development of the country's young solar energy sector.

Of course, despite Ethiopia's enormous energy potential, the country continues to be plagued by challenges to its development. Although huge progress has been made in the national electrification rate, which has more than doubled over the past ten years, it still remains at a low 26%. The national electricity grid uses outdated loss-prone technology. In addition, the majority of Ethiopia's population lives in rural areas without a functional grid connection. Although this is a great opportunity for the development of off-grid or microgrid solar solutions, Ethiopia's decentralized population and insufficient power grid present serious developmental challenges for utility-scale solar.

10. KENYA

INTRODUCTION

Kenya, one of the strongest and most advanced economies in Central and East Africa, has set out ambitious goals to meet its growing energy demand. Kenya has been heavily investing in renewable energy sources in order to meet the energy demand that is projected to grow at a rate of more than 18% annually. Although the country has focused on the construction of hydroelectric and geothermal plants, the electrification of rural and remote areas remain a challenge. These areas can have an electrification rate that's as low as 6.7%. Solar energy, however, seems like the perfect solution for the problem. With the country's insolation levels of 4-6kWh/m2/day (Figure 10.1) and peak insolation hours lasting up to 5-7 hours, Solar energy development is certainly going to be a main focus for Kenya.

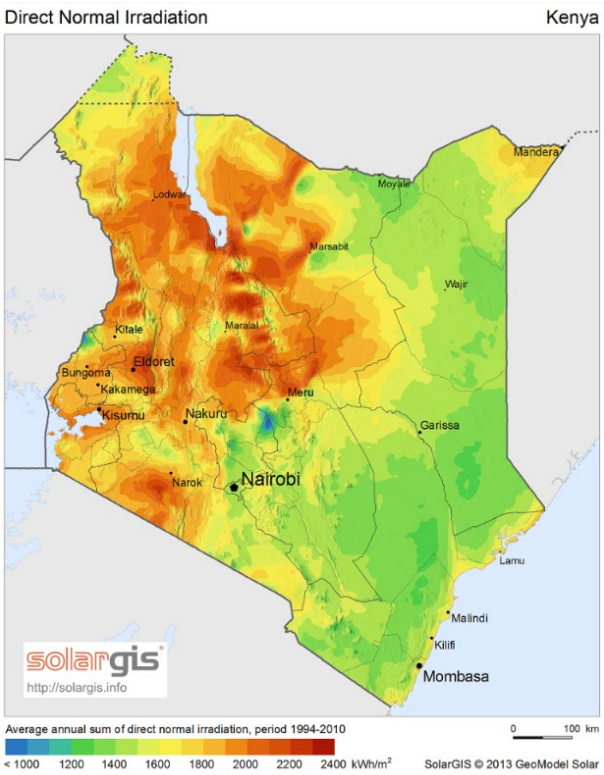


Figure 10.1: Solar irradiation of Kenya.

Table 10.1: Economical figures and Key Stakeholders of Kenya.

Economical figures	
GDP (2015)	63,398,040,000 USD
GDP per capita (2015, USD)	1,376.7 USD
GDP Growth ('13, '14, '15)	+5.69% +5.33% +5.65%
Inflation Rate - Consumer Prices (2015)	6.6%
Inflation Rate - GDP deflator (2015)	9.1%
Population (2015)	46,050,000
Credit Rating (S&P/Moody's)	B+, B1
Corruption Perceptions Index (CPI 2015)	25 (0 highly corrupt - 100 very clean)
Ease of doing business index (2015)	108 (1 best - 189 worst)

Economical figures	
Access to electricity (2016)	56%
• Power consumption per capita in kWh	168
• Renewable electricity as % of total output (2012)	75%
• Renewable consumption (% of total consumption, 2012)	78.5%

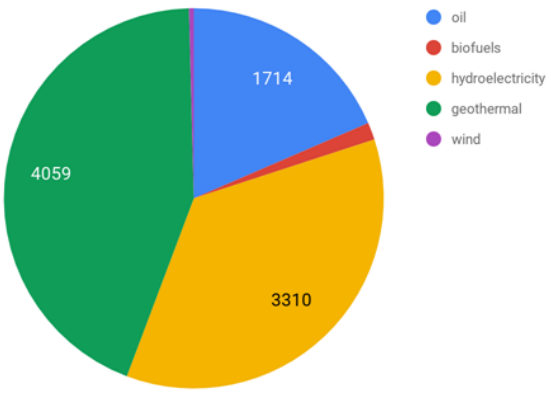
Key Stakeholders	
Energy regulator	• Ministry of Energy (MOE) • Energy Regulatory Commission (ERC)
Utilities	• Kenya Electricity Generating Company (KenGen) • Kenya Power and Lightning Company (KPLC)
Top Banks	• Equity Bank • Standard Chartered Bank • KCB

Table 10.2: Noteworthy solar projects of Kenya.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Garissa Solar PV Plant	50 MWp	Garissa, Kenya	Under construction	Rural Electrification Authority
Lamu Solar PV	40MW	Lamu, Kenya	Under construction	Kenya Solar Energy
Changoi Tea Farm	1MW	Changoi, Kenya	Operational	SolarCentury

ELECTRICITY MIX (2014)

KENYA - TOTAL PRODUCTION



KENYA - FINAL CONSUMPTION

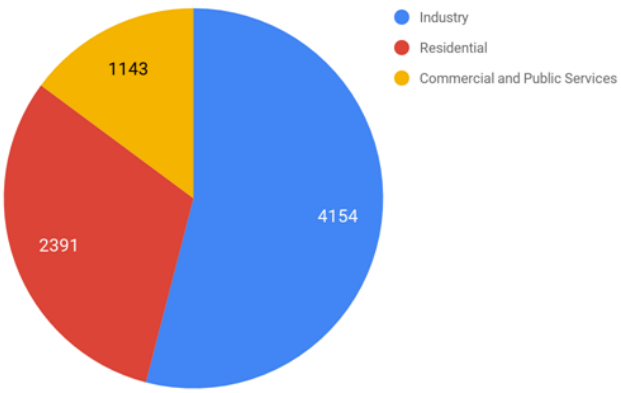


Figure 10.2: Total energy production and final energy consumption in Kenya.

Kenya´s openness to renewable energy sources is reflected clearly in its total energy production. Over two-thirds of the total energy production in Kenya comes from renewable energy sources, with the main focus being hydroelectricity and geothermal energy (Figure 10.2). These sources of energy, however, mainly power the entities that are located close to the grid. The rate of electrification is very low in rural and remote places, which is evident from the relatively low residential energy consumption number found in Figure 10.2. The electrification of this segment will be crucial in the upcoming years if Kenya wants to sustain its socio-economic development.

REGULATORY FRAMEWORK

Kenya's current energy policy was articulated in 2004 and implemented through The Energy Act of 2006. The act states clear policies on the mitigation of climate change with the promotion of renewable energy sources. Hence, a feed-in-tariff was put in place for renewable energy. In 2011, the Least Cost Power Development Plan (LCPDP) was updated, which stated long-term goals with regards to electricity generation until the year 2030. The electricity demand was projected to grow towards 19,220 MW by 2030, with geothermal and hydropower projected to be the main power sources by that time. The government has also put in place specific solar energy targets in its National Energy Plan (2012), when they mapped out that installed solar capacity should reach 100 MW by 2016, 200 MW by 2022 and 500 MW by 2030.

The enactment of the Public Private Partnerships Act (PPPA) has also changed the energy landscape of Kenya greatly. The PPPA has created a framework for PPP's in Kenya and has provided operational details on how PPP projects should be tendered, approved and implemented. Partnerships of this kind can prove to be an opportunity for private companies affiliated with solar PV.

When compared to the rest of Sub-Saharan Africa, Kenya has a relatively strong regulatory framework, which offers an enabling environment for investors. There are many examples of successful PPP projects, although the majority are wind and geothermal projects. In addition to the robust regulatory framework there are many Green-Minigrid and ReFit Programmes in place that stimulate development on micro and off-grid level.

More recently, in January of 2015, the Ministry of Energy and Petroleum released an updated National Energy and Petroleum Policy that has had profound effects on the framework of both renewable and non-renewable energy sources. The legislation included the creation of a sovereign wealth fund as well as the upward adjustment of the currently existing feed-in-tariff policy to enable sustainable returns from various projects and emerging technologies. Simultaneously, the Energy Bill 2015 and the Petroleum (Exploration Development and Production) Bill 2015 were published. The former intends to unbundle electricity transmission and distribution while liberalizing licensing of electricity generation, transmission and distribution. To achieve this, the Energy Bill 2015 recognises different sources of renewable energy and creates the corresponding licensing and regulatory agencies. The Petroleum Bill 2015, apart from introducing several provisions for investors, also introduces guidelines for Capital Gain Tax (CGT), which may deter investments in the oil and gas sector. The new CGT rate for resident firms is 30%, while the rate for non-resident companies is 37.5% (effective 1 January 2015).

ELECTRICITY TARIFFS

1 KES = .0099EUR	Charges (KES // USD)		
	Fixed charge	Energy charge (per kWh)	Demand charge (per kVA)
DC (Domestic, 240V)	150 // 1.485	2.5 // 0.02475 (<50kWh) 12.75 // (50-1500 kWh) 20.57 // (>1500 kWh)	n/a
SC (Small Commercial, 240V)	150 // 1.485	13.50 // 0.1302	n/a
CI1 (Commercial, 415V)	2 500 // 24.11	9.20 // 0.0887	800 // 7.92
CI2 (Commercial, 11kV)	4 500 // 44.55	8.00 // 0.0771	520 // 5.148
CI3 (Commercial, 33kV)	5 500 // 54.45	7.50 // 0.0723	270 // 2.673
CI4 (Commercial, 66kV)	6 500 // 64.35	7.30 // 0.0704	220 // 2.178
CI5 (Commercial, 132kV)	17 000 // 168.3	7.10 // 0.0685	220 // 2.178
IT (Domestic water heating)	150 // 1.485	13.50 // 0.1302	

Table 10.3: Electricity tariffs for domestic and commercial use in Kenya (Exchange rate: 14 September 2016.)

SOLAR PV

ON-GRID

The largest operational PV project in Kenya is situated in Changoi, Kenya. The project was developed for the Williamson Tea company, as its management was looking for cost effective and reliable ways to secure its energy requirements. The 1 MW plant supplies 30% of the daily energy requirements, and when the factory is not running it supplies the surplus to the national grid. Several proposals for large scale utility projects have been approved by the Kenyan government recently. These are a few of the largest projects announced or under construction:

- A 55 MW solar PV plant in the East Kenyan county of Garissa. The 128 million USD investment will be financed through concessional funding of the Chinese government.
- A 40 MW solar PV plant in the Northern Kenyan county of Isiolo. The plant will be the first of its kind to qualify for the Kenya feed-in tariff.
- A 40 MW solar farm along the Nakuru-Marigat road. The project, named Migotiyo Solar Park will be developed by a special purpose vehicle and requires a total investment of 65 million USD.

Although most large projects are currently often undertaken by companies from outside Kenya, local companies are also emerging as

important players in the market. E.g. Kenya Solar Energy Ltd. has proposed to construct a 40 MW PV plant in Lamu County and has recently received a green light to commence construction.

MICROGRIDS AND MINI-GRIDS

The installation of mini-grids has recently taken a leap in Kenya. Through the Rural Electrification Master Plan of 2008, the government encourages current diesel generators to install PV systems to reduce diesel reliance. This market is growing rapidly and has received international support. A good example of this is the World Bank which, through its "Scaling Up Renewable Energy" program, funded the hybridisation of 12 existing (brown) mini-grids to solar-diesel hybrids.

Microgrid systems can be especially useful for villages that are too far away from the main power lines to access the grid. Corporations like Powerhive and small institutions like Generalia are on their way to power over 100 villages and 200,000 residents in Kenya with microgrid PV systems, decreasing the reliance on dangerous fuels. SteamaCo and Powerhive have introduced a new payment method for microgrid energy that is attractive to both consumers and investors. The new smart microgrid platform enable the capturing of consumer payments by a mobile money platform. Through this method, investors like Enel Green power are partnering up with Powerhive to power at least 90,000 residents with PV electricity in the near future.

An example that illustrates the potential of microgrid opportunities is the solar project at Strathmore University. In September 2015, the university signed a power purchase agreement with the Government for 20 years. It was the first time the government had agreed to purchase solar power. According to the director at the University Research Centre, Izael Pereira Da Silva, the university has seen its buildings save 160,000 USD on energy costs. When comparing this to the 1.3 million USD costs involved, the institution has shown that there is certainly a case to be made for microgrid systems in Kenya.

Image: African Solar Designs

In order to increase the prevalence of mini-grid PV systems in Kenya, Vulcan Inc. and steama.co carried out research based on data collected from ten local mini-grids ranging from 1.5kW to 6 kW. The result of the research put forward some valuable insights into the local market dynamics and provided a wealth of information about the behavior of the rural consumers in the country. One of the main lessons was that rural consumers are willing to pay up to $4 per / kWh without subsidy. The established systems recorded an Average Revenue Per User (ARPU) ranging from USD $0.38 to USD $15.38 averaging USD $5.34 across the ten sites. It was also found that the minigrid users completely moved away from using fossil fuels, thereby significantly reducing the emission of greenhouse gases.

OFF-GRID

One of the most interesting business models that is being used in Kenya to enable energy access and tackle the problem of high upfront costs, is the pay-as-you-go interface. This system allows users to pay for their electricity as they use it. Companies such as UK startup Azuri Technologies also provide solutions that allow households to pay for solar power as they use it with scratch cards, making them a lot more affordable. Once users have paid for their startup system, they will have the opportunity to upgrade, which for example can enable them to develop and grow stores.

Off-grid solar initiatives have also experienced a rise due to companies like BBOXX, which promote the use of renewables energy sources in rural areas of Africa. BBOXX matches the prices of existing energy sources and spreads the expenses of the solar system over time to widen its customer base and make solar energy affordable for a larger audience. Moreover, the integration of their PV systems with mobile payment platforms provides a convenient solution

Another initiative that has helped thousands in rural Kenya comes from M-KOPA. The company provides a 8W battery powered-system that comes with three lights, mobile phone-charging and a solar powered radio. Customers now also have the opportunity to choose a 20W system with digital TV. Besides the electrification of rural households, the company is also helping customers reduce their energy bill by providing an alternative to expensive kerosene sources.

EXTRA: SOLAR POTENTIAL - CHALLENGES AND OPPORTUNITIES

The potential for solar projects in Kenya is quite big, as the country experiences solar irradiation levels of 4-6kwh/m2/day, and six hours of strong sunlight each day on average. Especially in the West of the country (Figure 10.1), irradiation reaches levels high above average when compared to the rest of the world. These conditions imply a great potential for utility-scale projects that can be connected to the grid. As stated in an Elsevier-paper on PV grid connection in Kenya: " Kenya has the potential to generate orders of magnitude more electricity from solar PV than is consumed each year from its national grid".

A big hurdle for the country to overcome is the low electrification rate of 56% of the population. Utility scale projects can offer to be a sizable part of the solution, but because so many villages are too far away from the power lines, it will definitely not offer a solution for these areas. Therefore the growth in the microgrid and off-grid markets is a logical and absolutely necessary development to secure Kenya's energy supply. The new generation of microgrids is beginning to win funding from investors, as it solves previous problems with maintenance and bill collections.

Another challenge is dealing with the insecurity concerning grid extension plans. The lack of clarity that the government gives regarding these plans can make consumers and investors uncertain about whether to invest in mini-grids in general. Separate from all of this, is the question of how much room and incentive there will be for further (centralized) power generation through PV, when there is now more than 1GW of coal power generation scheduled to be added to the grid.

11. UGANDA

INTRODUCTION

With hard work, Uganda has impressively recovered from an atrocious civil war and major economic catastrophe to become a relatively peaceful, stable and prosperous country. However, despite its stability, the economy continues to be limited by weak exports and a lack of external investments. In 2014, Uganda experienced significantly weaker GDP growth due to the under-execution of externally financed public investments (Table 11.1). The level of electrification is very low; only about 20% of the population has access to the electricity grid. To tackle this issue the government has put in place policies that provide incentive for external investors to invest in Uganda's energy sector. The country is especially focused on the development of renewable energy sources with its specified feed-in-tariff system. The country's development is very skewed towards the Central and Western regions while the other parts of the country suffer from very high levels of underdevelopment and poverty. The adoption of solar PV technology can especially benefit the poorer regions as annual irradiation levels reach 6.6 kWh/m2/day (Figure 11.1).

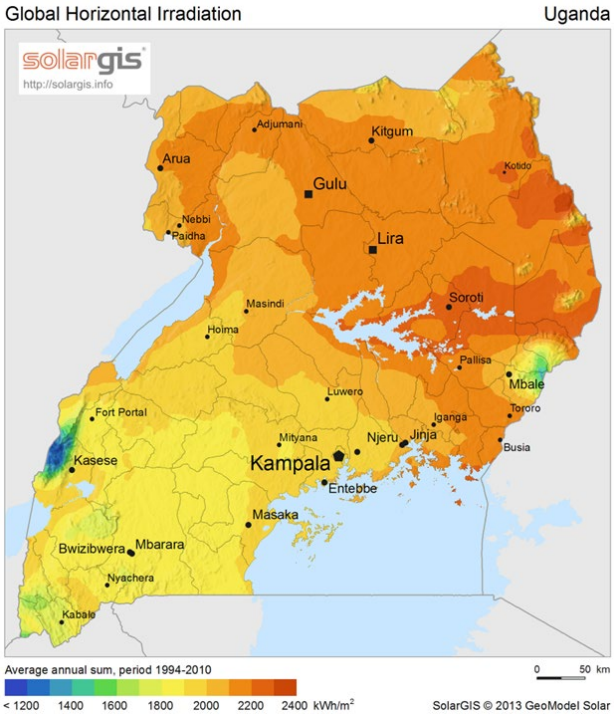


Figure 11.1: Global horizontal irradiation map of Uganda.

Table 11.1: Economical figures and key stakeholders of Uganda.

Economical figures	
GDP (2015)	26,369,240,000 USD
GDP per capita (2015, USD)	675.6 USD
GDP Growth ('13, '14, '15)	+3.27% +4.82% +5.04%
Inflation Rate - Consumer Prices (2015)	5.2%
Inflation Rate - GDP deflator (2016)	6.6%
Population (2015)	39,032,000
Credit Rating (S&P/Moody's)	B / B2
Corruption Perceptions Index (CPI 2015)	25 (0 highly corrupt - 100 very clean)
Ease of doing business index (2015)	115 (1 best - 189 worst)

Economical figures	
Access to electricity (2014)	20.4%
• Power consumption per capita in kWh	-
• Renewable electricity (% of total output, 2014)	78.6%
• Renewable consumption (% of total consumption, 2014)	89.22%

Key Stakeholders	
Energy regulator	• Ministry of Energy and Mineral Development • The Electricity Regulatory Authority
Utilities	• UEGCL (Generation) • UETCL (Transmission) • UEDCL (Distribution)
Top Banks	• STANBIC BANK UGANDA • STANDARD CHARTERED BANK UGANDA • CENTENARY BANK

Table 11.2: Noteworthy solar projects in Uganda.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
-	10MW	Soroti, Uganda	Commissioned	Access and Eren Renewable Energy

ENERGY MIX (2015)

UGANDA - TOTAL PRODUCTION

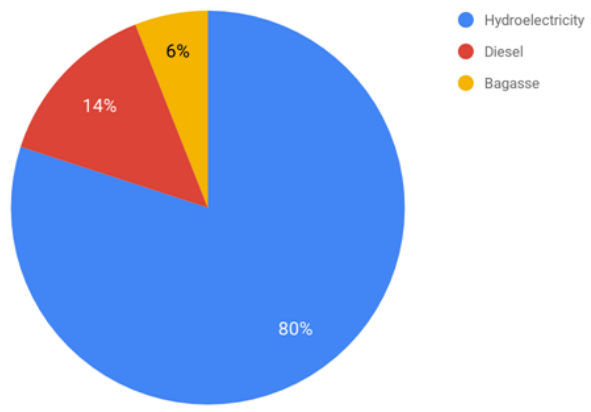


Figure 11. 2: Total energy production of Uganda in 2015.

Uganda has one of the lowest electrification per capita rates in the entire world at around 20%. The country's electricity generation capacity amounts to 810 MW for almost 40 million people (Table 11.1). The use of hydroelectricity is the most abundant in the country, accounting for 80% of total energy production (Figure 11.2). The largest hydroelectricity plant located in Bujagali produces 250MW of the total energy supply. The country's huge dependence on hydroelectricity makes it very vulnerable for erratic rainfalls and droughts. The second most

important energy production method is the production of electricity through the burning of diesel fuel, accounting for 14% of the total production (Figure 11.2). Uganda has recently increased heavy fuel capacity by the addition of 50 MW worth of fossil fuel plants. Bioenergy, more specifically Bagasse (sugar cane fibre), provides the remaining 6% of Ugandan electricity production (Figure 11.2). This method is especially effective in rural regions where biomass is abundant and other electricity sources are scarce. The two most important bioenergy companies are Kakira Sugar Works (1985) Limited and Kinyara Sugar Limited and both are licensed to generate electricity for the main grid of Uganda.

REGULATORY FRAMEWORK

Uganda implemented the Renewable Energy Policy 2007, of which the overarching objective is "to increase the use of modern renewable energy from the current 4% to 61% of the total energy consumption by the year 2017." The country has established a Standardized Power Purchase Agreement and Feed-in Tariffs (FiTs) for renewable energy projects, although these are not yet applicable to the Kiziizi mini-grid. Uganda also made solar and hydro renewable energy technologies VAT exempt to incentivize the use of such energy sources.

Uganda recently launched the Global Energy Transfer Feed-in Tariff program (GET FiT). The program has been effective since 2013 and aims to address

Image: Comboni

the key barriers private investors are facing in the renewable energy sector. The tariff rate that is currently in effect was introduced a year after launching the program.The program not only brought premium payment mechanisms (a results-based top-up on the existing REFiT), but also provided guaranteed facilities to secure against off-takers and political risks. Finally, through the program, investors have the opportunity to use private financing mechanisms from Deutsche Bank that will offer debt and equity at competitive rates. The program has approved a total of of 17 projects amounting to 128 MW including Small Hydro, Biomass, Solar PV and Bagasse. As a result of the success of these projects, combined with the global cost reduction of solar PV prices, the European Union offered Uganda €20 million through the Special EU Sustainable Energy for All Investment fund for the solar facility. Since then ERA has initiated 20 MW of grid-connected solar PV plants that had come online in 2015.

ELECTRICITY TARIFFS

Uganda's Electricity Tariff (UGX to USD) 1 USD = 3,596.95 UGX		
	2017 Base Tariffs	2nd Quarter 2017
Domestic consumers	696.9 // 0.194	687.1 // 0.191
	629 // 0.175	620.9 // 0.173
Commercial consumers	577.8 // 0.161	569.7 // 0.158
	376.3 // 0.105	370.2 // 0.103
Medium industrial consumers	372.8 // 0.104	366.9 // 0.102
	679.7 // 0.189	671.2 // 0.187
	376.3 // 0.105	370.2 // 0.103
Extra large industries	372.8 // 0.104	366.9 // 0.103
Street lighting	679.7 // 0.189	671.2 // 0.187

Table 11.3: Electricity tariff for commercial and domestic consumption in Uganda from July 2017 to September 2017.

SOLAR PV

ON-GRID

East-Africa's largest privately funded PV plant has been recently commissioned in Uganda. The project was developed by French clean energy firm Eren RE and Access Clean Energy. The funding is provided by a truly international effort including London's Emerging Africa Infrastructure Fund, Dutch development bank FMO and Germany's KfW Development Bank. The project is located in the region of Soroti in the northeastern corner of Uganda and will power 40,000 households. The project is a direct result of Uganda's renewable energy policy, as the first project to be approved through the GET FIT Solar Facility. The tariff of the project for the upcoming 20 years will be 0.16 USD / kWh, however, end users will only pay 0.11 USD / kWh as a result of the subsidy provided by the GET FIT program.

MINIGRID

The Energy for Rural Transformation (ERT) programme (part of the Rural Electrification Strategy and Plan), started back in 2002, now specifically focuses on increasing rural energy access from 1% to 10% through a combination of grid extension, mini-grids, and solar home system programmes.

Progress can already be observed in the example of the micro grid installation that will power the local school, Pope John Paul II College in Laliya Parish, Bungatira Sub County, Gulu District.

The 30 kW solar system was funded by Accenture Foundation, South Africa and the University of Notre Dame, USA under BOSCO Uganda's Project intervention Connectivity, Electricity and Education for Entrepreneurship (CE3) initiative. The technical development of the project was carried out by Power Gen a Nairobi-Kenya based Company.

OFF-GRID

One prolific off-grid player in Uganda is Foundation Rural Energy Services (FRES), a non-profit, small multinational that supports companies in rural areas in Africa by supplying them with solar PV systems. The company installs Solar Home Systems mainly for commercial use and charges a fixed monthly fee and as well as an amount based on the kWh consumption. The maintenance and replacement as well as the initial capital costs are incurred by FRES' own capital.

Another organization, Rural Energy Foundation (renamed as Solar Now) initially mainly focussed on training local networks of entrepreneurs to stimulate innovation and bring solar to the people. The company has shifted that focus to providing energy systems to a variety of homes and have provided electricity for over 300,000 people in 9 countries.

Another off-grid solar power provider company that seems to have been successful in their swim against the current has recently reached an important milestone in its activities. Fenix International, a venture-backed technology company providing a next

Image: VOA news

generation energy solution, has adopted Pay-to-own business model instead of the pay-as-you-go one, which is more widely adapted on the continent. With a daily payment of $0.15, rural households are able to afford entry level, $160 solar off-grid appliances in the matter of 3 years. Considering the average salary amounts to $2/day in such rural areas, Fenix offers a significant springboard opportunity for rural Ugandans to switch to clean energy sources.

EXTRA

Uganda experiences average irradiation levels of 5-6 kWh/m2/day. The highest irradiation levels are in the Northern and Eastern parts of the country and exceed 6 kWh/m2/day(Figure 11.1). Despite the huge solar potential and the beneficial regulatory framework, solar energy is primarily used in rural communities in simple applications like solar cooking and water heating, and for providing power to public buildings such as hospitals. The adoption of solar systems in rural areas could provide a great solution towards increasing the country's electrification rate and phasing out the use of expensive diesel generators.

12. RWANDA

INTRODUCTION

Rwanda is a country endowed with plentiful natural resources. Despite its large reserves of methane gas, large river systems and high levels of solar irradiation, Rwanda's electric generation capacity amounts to barely 186 MW, spread out among its 10.5 million residents (Table 12.1). The majority of Rwanda's electric generation capacity come from hydroelectric power plants. Rwanda's 26,338 km2 land area makes it one of the smallest nations in mainland Africa. Consequently its population density is among the continent's highest, with the majority of its population living in rural areas and surviving on subsistence agriculture. While only 24.5% of Rwanda's population has access to electricity (Table 12.1), the country's location just a few degrees south of the Equator makes it a prime candidate for the development of solar PV plants.

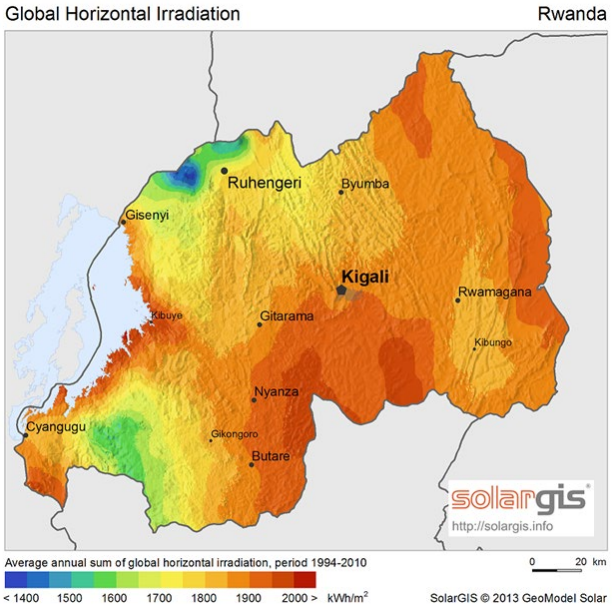


Figure 12.1: Global horizontal irradiation map of Rwanda.

Table 12.1: Economical figures and key stakeholders of Rwanda.

Economical figures	
GDP (2015)	8,095,980,000 USD
GDP per capita (2015, USD)	710.3 USD
GDP Growth ('13, '14, '15)	+4.68% +7.01% +6.9%
Inflation Rate - Consumer Prices (2015)	2.5%
Inflation Rate - GDP deflator (2015)	0.1%
Population (2015)	11,610,000
Credit Rating (S&P/Moody's)	B, B2
Corruption Perceptions Index (CPI 2015)	54 (0 highly corrupt - 100 very clean)
Ease of doing business index (2016)	56 (1 best - 189 worst)

Economical figures	
Access to electricity (2016)	24.5%
• Power consumption per capita in kWh	-
• Renewable electricity (% of total output, 2014)	39.03%
• Renewable consumption (% of total consumption, 2014)	88.45%

Key Stakeholders	
Energy regulator	• Ministry of Infrastructure • Rwanda Utilities Regulatory Agency (RURA)
Utilities	• Energy, Water and Sanitation Authority
Top Banks	• Access Bank Rwanda • Bank of Kigali • Commercial Bank of Rwanda

Table 12.2: Noteworthy solar projects in Rwanda.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Rwamagana Solar Power Station	8.5MW	Kigali, Rwanda	Commissioned	Gigawatt Global

ENERGY MIX (2012,2013)

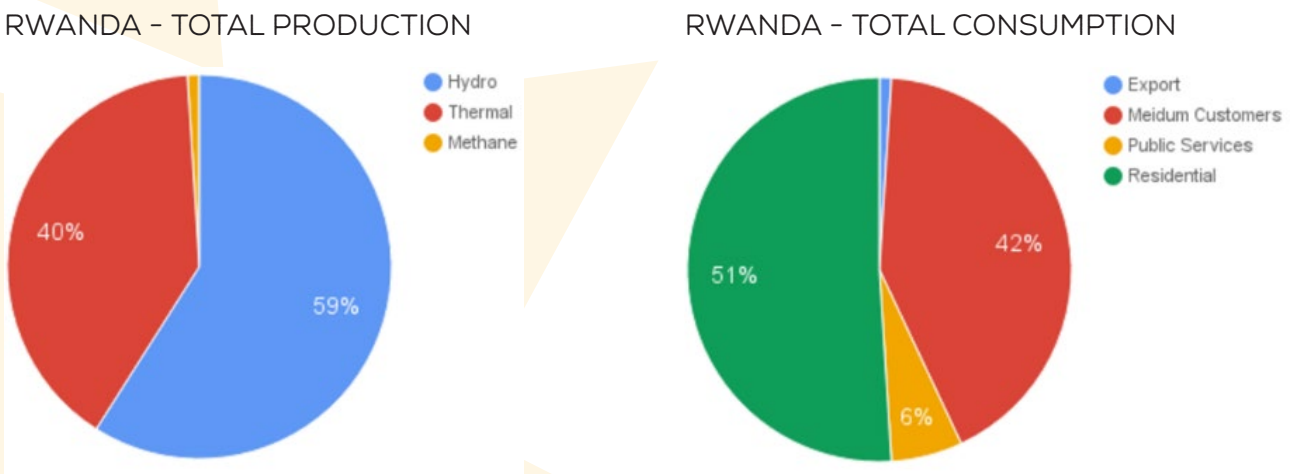


Figure 12.2: Total energy production (2013) and total energy consumption (2012) in Rwanda.

Rwanda's total electrical generation capacity amounts to 186 MW, 59% of which comes from the country's 7 largest hydroelectric power plants (Figure 12.2). Thermal power generation, mostly from diesel and heavy oil fuel, account for the remaining 40% of electrical generation capacity, with methane gas representing barely 1% of total capacity (Figure 12.2). Rwanda's national electrification rate sits at 24.5%, which 23% coming from on-grid systems and only 1.5% coming from off-grid-systems. This leaves over several million of the country's residents without access to electricity and ranks Rwanda among the countries with the least annual electricity consumption per capita.

REGULATORY FRAMEWORK

The government of Rwanda has ambitious goals for the development of its energy sector. Notably, it intends to expand the country's electrical generation capacity to 563 MW and to increase the national electrification rate to 70% by 2018. In order to achieve these targets the government has enacted various incentives to encourage private sector investment, like exemption from VAT on imported power equipment, free repatriation of profits, and investment allowance of up to 50%. In an effort to remove regulatory hurdles for investors, in 2014 the government of Rwanda disbanded the previous electric utility and reincorporated it as the Rwanda Energy Group Limited. In 2016 the Rwandan Cabinet approved the 'Rural Electrification Strategy', in which the Ministry of Infrastructure emphasizes the importance of private sector investment and sets forth clear guidelines for the achievement of the government's electrification goals.

The main law that governs Rwanda's electric power production, transmission, distribution and trading within or outside the national territory is the 'Electricity Law' which was passed in 2011. The legislation prevents tariffs to be discriminatory to any entities and pronounces the regulatory authority to be the determinant of the tariff rates. Moreover, the law has the following objectives:

- Liberalization and regulation of the electricity sector;
- Development of electric power distribution for all categories;
- Establishment of a framework to facilitate electric power investments;
- Ensuring respect for the conditions of fair competition and for the rights of users and operators.

ELECTRICITY TARIFFS

Electricity tariff rate in Rwanda (RWF // USD) effective starting 1st January 2017 (Exchange rate: 1 USD = 805.06 RWF)		
Customer type	Consumption (kWh) block/month	FRW/kWh (VAT exclusive)
Residential	[0-15]	89 // 0.1065
	[>15 – 50]	182 // 0.2181
	>50	189 // 0.2265
Non-residential	[0 -100]	189 // 0.2265
	>100	192
Industrial	Flat rate	126

SOLAR PV

ON-GRID

On February 5th, 2015 Rwanda's first utility-scale solar PV plant was inaugurated. Developed by GigaWatt Rwanda Limited, the solar plant boasts 28,600 panels with a total capacity of 8.58 MW.

Goldsol II is developing a 10 MW solar PV plant in the Kayonza Eastern Province. The plant is estimated to cost 20 million USD.

A 2.4 MW solar PV plant in south-eastern Rwanda is used to power eight secondary schools. Funded partially by the European Union, the power plant is part of a larger program that aims to electrify schools in 27 districts across Rwanda.

MICROGRID

The government of Rwanda has pledged to set up 100 solar PV mini-grids in rural areas as part of an effort to mitigate the effects of climate change. Since Rwanda is a country that is very heavily affected by climate change, the country is taking extensive measures to become a developed, climate resilient and low carbon economy by 2050.

Image: Gigawatt Global

The world's largest off-grid battery system is coming to Rwanda by German commercial system manufacturer Tesvolt. The 2.86 MWh storage system

will be connected to a 3.3 MW PV plant that's being developed by IdeemaSun Energy, as part of an agricultural project. The mini-grid project aims to supply energy during power cuts, which are very common in the region.

Other notable companies working towards Rwanda's rural electrification are Energy 4 Impact and MeshPower. The former has supplied 77,000 rural citizens with power solutions, while creating 7,000 jobs as part of the 'Scaling up Off-Grid Energy in Rwanda' (SOGER) initiative, and the latter realizes solar microgrids for rural communities and is funded by the national environment and climate change fund, FONERWA.

OFF-GRID

According to the Ministry of Infrastructure, off-grid solar solutions are increasingly materializing in Rwanda. The Climate Investment Funds have allocated 50 million USD through the 'Scaling up Renewable Energy Program' to fund the development of off-grid systems in Rwanda.

The private sector is the leading developer of off-grid solar solutions in Rwanda, one of the biggest company present in the market being Off Grid Electric. The government of Rwanda mandates strong and explicit support for such private sector initiatives.
The largest effort for the electrification of the rural areas comes from Ignite Power Ltd. The 70% electrification goal that is outlined in the Rural Electrification Strategy, is visioned to be met partially via off-grid solutions. More precisely, 22% of the electrified households will own smaller off-grid systems consisting of 4 light bulbs, a phone charging point and a radio. The Ignite project is currently East Africa's largest undertaking of its kind and will provide appliances for 250,000 households in rural areas. After only seven month into the project, the company managed to supply a 100,000 Rwandans with safe solar solutions. The mode of financing for the solar appliances is done by the popular pay-as-you-go model. The company, however, does not only stick out due to its remarkable rural electrification efforts but it also made headlines by employing women for 70% of its workforce.

EXTRA

Despite its ambitious goals and the incentives it has enacted, Rwanda faces significant challenges in attracting foreign investors. The most prominent hurdle to such endeavors is currency risk: over the past four years the Rwandan Franc has depreciated by more than 25%, which has cut into the already tight margins of existing energy projects. Nevertheless, Rwanda's abundant natural resources and growing demand for electricity make the development of renewable energy in the country an investment with large upside potential.

13. TANZANIA

INTRODUCTION

Tanzania is the largest country in East Africa and is among the few nations that have not experienced civil war since independence. Due to its political stability it is considered one of the safest African countries for investment. Home to over 55 million people (Table 13.1), Tanzania's economic landscape is dominated by agriculture, which accounts for 70% of the country's gross exports and employs 75% of the workforce. Only 30% of the population resides in urban areas, and the national electrification rate is only 24% (Table 13.1). Tanzania's energy sector makes use of the country's plentiful rivers, with hydroelectric power plants representing 35% of total energy generation capacity (Figure 13.2). Although the majority of Tanzania's energy generation comes from fossil fuels, there has been strong support for the development of renewable energy in the country.

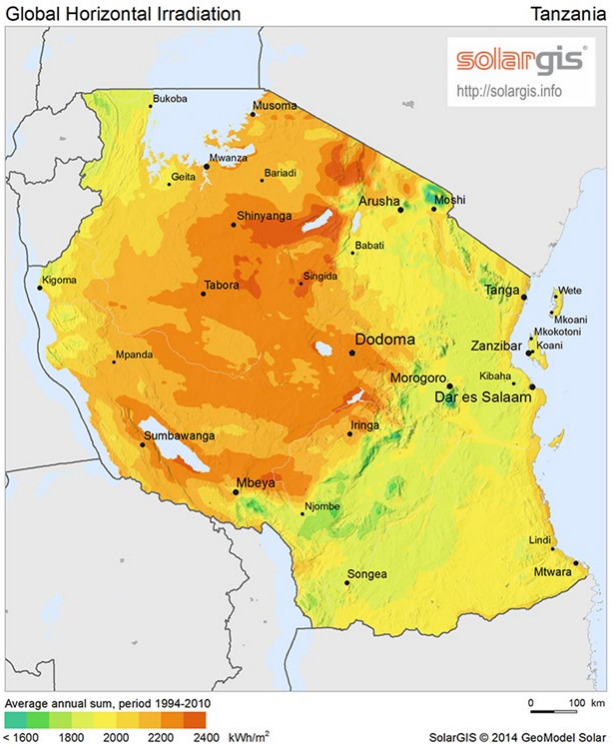


Figure 13.1: Global horizontal irradiation map of Tanzania

Table 13.1: Economical Figures and key stakeholders of Tanzania

Economical figures	
GDP (2015)	44,895,390,000 USD
GDP per capita (2015, USD)	872.3 USD
GDP Growth ('13, '14, '15)	+7.26% +6.97% +6.97%
Inflation Rate - Consumer Prices (2015)	5.6%
Inflation Rate - GDP deflator (2015)	6.6%
Population (2015)	53,470,000
Credit Rating (S&P/Moody's)	*not rated*
Corruption Perceptions Index (CPI 2015)	30 (0 highly corrupt - 100 very clean)
Ease of doing business index (2015)	132 (1 best - 189 worst)

Economical figures	
Access to electricity (2014)	15.5%
• Power consumption per capita in kWh (2014)	99
• Renewable electricity (% of total output, 2014)	42.29%
• Renewable consumption (% of total consumption, 2014)	86.67%

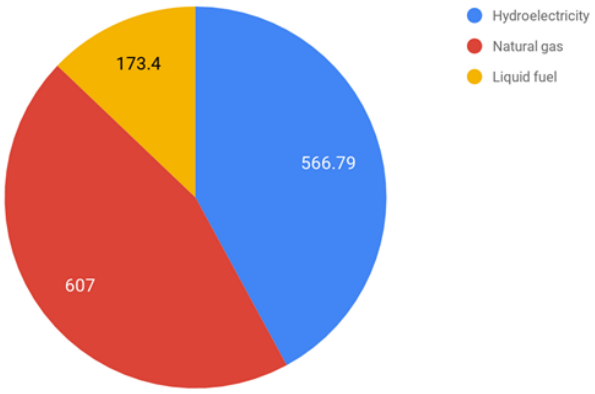
Key Stakeholders	
Energy regulator	• Ministry of Energy and Minerals • Energy and Water Utilities Regulatory Authority (EWURA)
Utilities	• TANESCO and private companies
Top Banks	• CRDB BANK • NMB – NATIONAL MICROFINANCE BANK • NBC – NATIONAL BANK OF COMMERCE

Table 13.2: Noteworthy solar projects in Tanzania

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
Unknown	60MW	Kigoma Region, northwest Tanzania	Feasibility study	Camco International Limited and Rex Investment Ltd

ELECTRICITY MIX

TANZANIA - TOTAL PRODUCTION (2016)



TANZANIA - FINAL CONSUMPTION

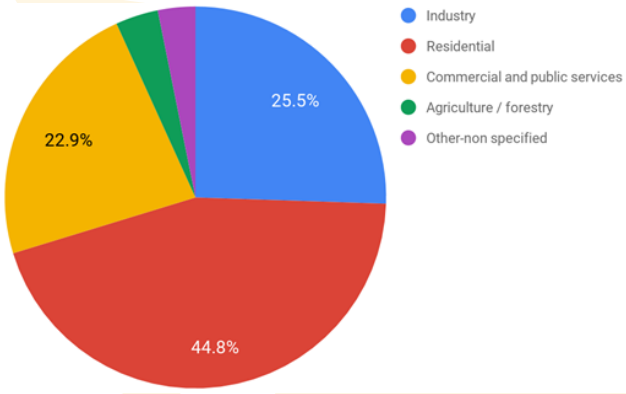


Figure 13.2: Total energy production (2016) and final consumption (2014) of Tanzania.

Tanzania's indigenous natural resources are extremely abundant, with an estimated 4.7 GW of hydroelectric capacity, 53.3 trillion cubic feet (TCF) of proven natural gas reserves, and 1,200 million tons of coal. Tanzania also features very favorable conditions for the development of renewable energy: its average wind speed is 10 m/s, and its average solar irradiation is 4.6 kWh/m2/day (Figure 13.1). Despite its huge potential, Tanzania's electric generation capacity is a mere 1,357.69 MW. The majority of its capacity comes from fossil fuels, 45% from natural gas and 13% from liquid fuels (Figure 13.2). Although Tanzania currently has 6 operational hydroelectric power plants, which collectively represent 42% of the country's electrical generation capacity, their actual output has significantly diminished due to the droughts that have gripped Tanzania since 2011. There is currently a single wind power station under construction in Tanzania with a capacity of 100 MW. Despite the minimal development of solar and wind energy in Tanzania, the government is continuously seeking to encourage private sector development.

REGULATORY FRAMEWORK

Tanzania's political stability is one of its greatest advantages. The investment climate in Tanzania has been overwhelmingly favorable since 1997, when the government passed the Tanzania Investment Act, which established a governmental organization specifically dedicated to the facilitation of foreign direct investment. The Energy and Water Utilities Regulatory Authority, established in April 2001, handles policy making and regulation of the electricity industry, and in 2005, the Rural Energy Agency and Rural Energy Fund were established to promote rural electrification. The government of Tanzania laid out comprehensive goals in its National Energy Policy from 2003, the most significant targets are:

- a reduction in the dependence of the energy sector on fossil fuels;
- the proliferation of renewable energy, particularly non-hydro alternatives, due to Tanzania's frequent droughts;
- achieving 100% national electrification rate by 2030;
- adding 8,990 MW of electrical generation capacity by 2035.

To achieve these goals, Tanzania's state-owned electric utility company TANESCO has initiated the Tanzania Energy Development and Access Project with funding from the World Bank and the Global Environment Facility. Under this project, the government hopes to attract private sector investment in the development of rural microgrid and off-grid solutions. Since passing the Electricity Act of 2008, Tanzania provides Standardized Power Purchase Agreements to private investors interested in developing small-scale renewable energy projects (between 0.1 MW and 10 MW).

Image: World Bank

ELECTRICITY TARIFFS

1 USD = 2237.67 TZS

Tariff	Net tariffs effective from 1 January 2016, TZS // USD		
	Service charge/ month	Energy charge (per kWh)	Maximum demand charge (kVA/month)
D-1 (low usage tariff, average < 75 kWh/month)	–	100 // 0.447 At 75+ kWh: 350 // 0.156	–
T-1a (general usage tariff)	-	392 // 0.175	–
T-2 (general consumption tariff, > 7,500 kWh/metering period)	14233 // 6.369	195 // 0.087	15004 // 6.696
T-3 (medium voltage)	16769 // 7.493	157 // 0.070	13200 // 5.899
T-4 (high voltage)	–	152 // 0.068	16550 // 7.396

Table 13.3: Electricity tariffs for different voltage levels in Tanzania.

SOLAR PV

ON-GRID

There are currently no utility-scale solar PV projects in Tanzania. There are several large-scale projects in the planning stages (150MW), but a lack of confidence by investors in long term payment from the utility have hampered progress. Although the government has dropped VAT and import duties on solar energy generation equipment, the combination of low tariffs and high currency inflation has continued to push major investors away from utility-scale solar PV development in Tanzania.

The largest solar PV undertaking in Tanzania is undertaken by NextGen Solawazi for its 60 MW PV plant in Shinyanga, in northwestern Tanzania. The US Trade and Development Agency (USTDA) awarded a grant to project to carry out a feasibility study concerning the project's economic viability. The feasibility study will be undertaken by U.S. engineering and technical consulting company Clean Energy Consulting & Education, LCC.

One of the prospective PV projects that has won Access Power's US$7 million Access Co-Development Facility (ACF) award, is the Kondoa PV project. The 30MW solar park will receive funding jointly from emerging market developer, owner and operator Access Power and global independent power producer (IPP) EREN Renewable Energy. After sharing US$7 million with the other winners, the Kondoa PV project will now enter into Joint Development Agreements (JDA) with Access Power, who will take an

equity stake in the undertaking.

MICROGRID

In northwestern Tanzania the Jumeme Rural Power Supply company is constructing a 5 MW microgrid that will power 16 villages. The €17 million project is being financed by the European Commission and the Sustainable Energy Fund for Africa.

Another company that is busy in the Tanzanian microgrid sector is Netherlands-based PV microgrid developer, Developing Energy (Devergy). The company has received funding from Acumen, a nonprofit organization investing in East Africa in sectors as water, agriculture, sanitation, low cost housing and energy, OPES Impact Fund, an Italian fund dedicated to support enterprises in emerging countries in the early stages, and HERi Africa, a non-profit organization that promotes solar energy in Madagascar and other African countries. The company has commenced its operations in 2012 and has since connected 800 households in 6 villages throughout the years.

OFF-GRID

More than 500 kW of solar PV capacity have been installed in Tanzania over the past three years. About 30% of this capacity is in the form of solar home systems (10 - 200W).

Tanzania's government announced in 2015 the launch of its One Million Solar Homes initiative, which plans to provide solar power to a million Tanzanian homes by the end of 2017. The program's main financiers are the International Finance Corporation, the Overseas Private Investment Corporation, and USAID's Development Innovation Ventures Program.

EXTRA

Despite the country's huge potential, Tanzania's solar PV industry is still in its earliest phases of development. The government has passed laws to incentivise private investment, but these efforts have still not borne fruit. The biggest challenges for Tanzania are its significantly high inflation, which has devalued the Tanzanian shilling by over 20% over the past year and has made foreign direct investment unprofitable. The country's increasing reliance on fossil fuel emergency generators during extended drought periods has been depleting Tanzania's currency reserves, which contributes to its overall low energy tariffs. With these challenges in mind, the development of solar PV projects in Tanzania can be extremely lucrative for an investor with the right risk appetite, especially considering the favorable regulatory framework and Tanzania's overall political stability.

14. ZAMBIA

INTRODUCTION

Zambia is located in the center of the South African Development Community (SADC) and has experienced strong economic growth in recent years. Despite the good economic performance, Zambia's socio-economic development is heavily hindered by the inadequate electrification rates across the nation. Due to Zambia's abundant natural resources and a pushing need for rural electrification, renewable energy sources are at the focus of the country's energy development.

The use of renewable energy is by no means a new concept to Zambia, as the vast majority of its produced energy originates from hydro power stations. Rural areas, however, still rely largely on wood fuel and other expensive, non-renewable energy sources for energy production.

Solar power, including both central and rural applications, could come as a saviour for Zambia's electrification deficiency. In recent months, the Zambian government has organized two rounds of large-scale solar power auctions under the Scaling Solar initiative, powered by the IFC. The auctions witnessed tariffs that were rather competitive with other forms of energy generation methods used in the country. Mini-grid and off-grid solar applications are heavily incentivised by several developmental programs, kickstarting the electrification in areas for which the national grid is out of reach.

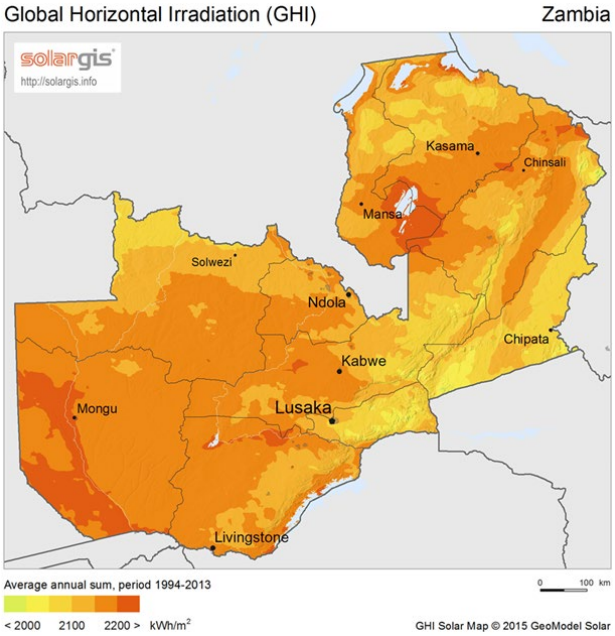


Figure 14.1: Global horizontal irradiation map of Zambia.

Table 14.1: Economical figures and key stakeholders of Zambia.

Economical figures	
GDP (2015)	21,154,390,000 USD
GDP per capita (2015, USD)	1,304.9 USD
GDP Growth ('13, '14, '15)	+5.59%, +4.69%, +2.92%
Inflation Rate - Consumer Prices (2015)	10.5%
Inflation Rate - GDP deflator (2015)	6.7%
Population (2015)	16,211,770
Credit Rating (S&P/Moody's)	B / B3
Corruption Perceptions Index (CPI 2015)	38

Economical figures	
Ease of doing business index (2015)	98
Access to electricity (2014)	27.9%
• Power consumption per capita in kWh	703
• Renewable electricity (% of total output, 2012)	99.86%
• Renewable consumption (% of total consumption, 2012)	88.51%

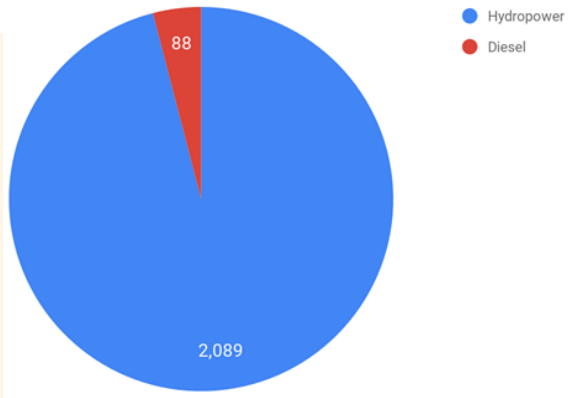
Key Stakeholders	
Energy regulator	• Industrial Development Corporation (IDC) • Energy Regulation Board (ERB)
Utilities	• ZESCO • Copperbelt Energy Corporation (CEC) • North-Western Energy Corporation (NWEC) • Lusemfwa Electricity Company (LEC) • Maamba Collieries Ltd
Top Banks	• Indo-Zambia Bank • First Alliance Bank • Cavmont Bank

Table 14.2: Noteworthy solar projects in Zambia.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
-	50 MW	Lusaka-South multi-facility economic zone	Under development	Neoen First Solar
-	50 MW	Lusaka-South multi-facility economic zone	Under development	Enel Green Power Limited

ENERGY MIX

ZAMBIA - TOTAL PRODUCTION



ZAMBIA - TOTAL CONSUMPTION

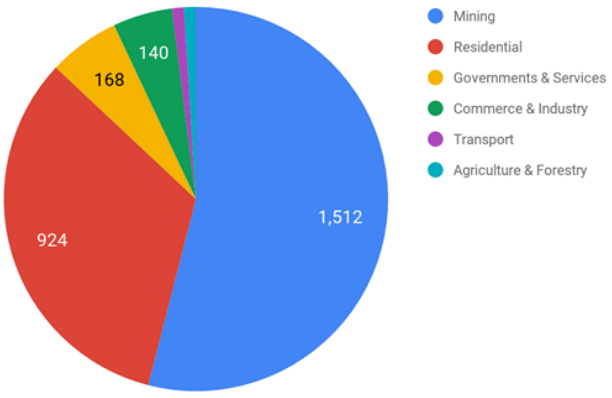


Figure 14.2: Total energy production by fuel sources in MWs as of 2014 (on top) and total energy production by sectors in Zambia (on the bottom).

In 2014, Zambia's installed power capacity amounted to 2,177 MW. Of the total installed capacity, the country relied 96% on hydro energy, amounting to more than 2 GW. Besides hydroelectricity, Zambia also relies on diesel-generated power, however, this capacity is mainly on stand-by and only used when there is a fluctuation in the supplied hydroelectricity.

The country's economic expansion lead to an increase in energy demand from 1,100 MW in 2001 to 1,600 MW in 2009 and is estimated to continue increasing between 150 MW and 200 MW per annum. The main contributors to the nation's energy demand are the mining and residential sectors which together comprise more than ¾ of all energy demand.

REGULATORY FRAMEWORK

Zambia's current energy policy was outlined in 1994 under the 'National Energy Policy' (NEP94) and was aimed at at promoting optimal supply and utilization of energy, especially indigenous energy forms, for socio-economic development in a safe and healthy environment. Realizing the key role renewable energy sources could play in this development, the 'Poverty Reduction Strategy Paper' (PRSP) was published in 2002 which caused a significant increase in renewable energy utilization, predominantly hydropower, in order to meet the country's energy needs.

Further guidelines for the Zambian energy development are provided in the the 'National Development Plans' (NDPs) which span a period of 5 years. The NDPs have provided for the introduction of a cost-reflective electricity tariff regime, establishing an open and non-discriminatory transmission access regime in the electricity sector, and introducing an appropriate cost-effective renewable energy feed-in tariff (FiT).

Other key pieces of legislation in the nation's history were the ' Electricity Act' and 'Energy Regulation Act' that opened the electricity sector to private operators and established two key institutions to ensure the country's development. The Energy Regulation Board (ERB) was tasked with regulating the operations and pricing of the electricity sector while the Office for Promoting Private Power Investment (OPPPI), as the name would suggest, was meant to attract new players to the electricity market.

Rural electrification remains to be a huge issue in Zambia as, according to some estimations, the level may be as low as 4%. Since the electrification of rural areas is essential to the country's economic development, the Zambian government has put in place a 'Rural Electrification Master Plan' (REMP) to gradually change the status quo. The plan aims to improve rural access to electricity by 15% in 2015 and 51% in 2030. The body to carry out this task is the Rural Energy Agency (REA), through financing off-grid and mini-grid solutions in the area. The finances are sourced from the Rural Electrification Fund (REF) which is replenished predominantly from a 3% levy on every unit of electricity consumed, as well as grants and loans from development partners.

ON-GRID

The main driver of grid-connected solar power in Zambia, is the IFC's Scaling Solar initiative, under which projects can go through the IPP agreement obtaining process in an accelerated manner. The first round of Scaling Solar took part in May of 2016 and saw the distribution of permits for two 50-megawatt solar plants. The two lowest bidders, Neoen First Solar and Enel Green Power Limited, won the IPP for the solar farms in the Lusaka-South multi-facility economic zone after bidding 6.02 US cents and 7.84 US cents per kilowatt hour respectively.The tariffs offered by these two projects were reportedly better than that of the hydro-power sub sector.

As a result of the success of the first round of Scaling Solar, Zambia was quick to organize the second round. In this round the IFC planned a preliminary procurement round of up to 200 MW with ensuing rounds to follow with a target of developing 500 MW of solar power.

MINI-GRID

Since the electrification rate of rural areas are estimated to be 4%, there is a significant demand for power that does not originate from the main grid. Solar mini-grids provide a perfect solution for this challenge. In March of 2017, Zambia established its first independently owned power system, the Muhanya Solar Mini-grid. The project was developed within the Off-Grid Energy Challenge program which was led by the collaboration between the United States African Development Fund (USDAF) and US-based company General Electric. Through the Off-Grid Energy Challenge, Zambia's Muhanya Solar Limited was awarded a $100,000 grant in 2016 to develop a 30-kilowatt mini-grid in Sinda, an off-grid community in Eastern Zambia.

OFF-GRID

For the quick and efficient electrification of rural areas, off-grid initiatives provide the best solution. Inspired by such, a new undertaking aims to bring clean energy to over a million of Zambians and accelerate private-sector growth in energy generation and distribution in the country. The 'Power Africa: Beyond the Grid Fund for Zambia' program will be in place from 2016-2018, with a maximum funding level of €20m. The program will not only reduce the dependence on expensive fossil-fuel power generators that are widely adopted in the rural areas but will also increase confidence and capacity of banks to extend credits to off-grid business ventures.

Image: Wagner Solar

15. NAMIBIA

INTRODUCTION

Namibia, similarly to many African countries, is lacking the electrification rate necessary to drive its economic development. The country predominantly relies on fossil fuel sources and large hydropower for energy generation. The Kudu gas field, which is located approximately 170km from the Namibian shore, has a huge influence in the country and thus it is considered in the future energy plan. Despite this aspect, there is consensus within the the country's governance that renewable energy have great potential to solve local issues and boost the economy. Given the outstanding solar resources Namibia bears, solar energy is one of the main candidates to drive the country's electrification forward.

As a result, there has been an increase in solar projects of larger-scales, in addition to off-grid applications. The development of the Omaruru and Otjozondjupa Solar Parks are early indicators of the potential Namibian solar energy boom.

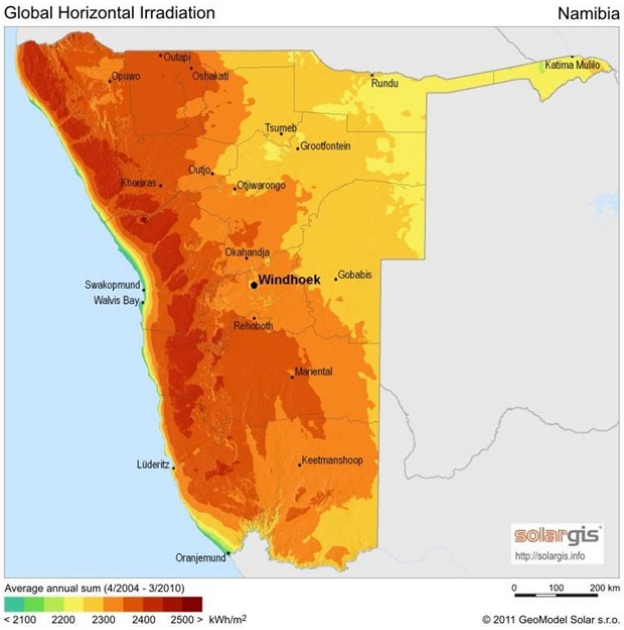


Figure 15.1: Global horizontal irradiation map of Namibia.

Table 15.1: Economical figures and key stakeholders of Namibia.

Economical figures	
GDP (2015)	11,490,000,000 USD
GDP per capita (2015, USD)	4,737.7 USD
GDP Growth ('13, '14, '15)	+5.65% +6.46% +5.3%
Inflation Rate - Consumer Prices (2015)	6.3%
Inflation Rate - GDP deflator (2015)	0.18%
Population (2015)	2,458,830
Credit Rating (S&P/Moody's)	-/Baa3
Corruption Perceptions Index (CPI 2015)	52
Ease of doing business index (2016)	108

Economical figures	
Access to electricity (2014)	49.6%
• Power consumption per capita in kWh	1,564
• Renewable electricity (% of total output, 2012)	95.57%
• Renewable consumption (% of total consumption, 2012)	28.27%

Key Stakeholders	
Energy regulator	• Electricity Control Board (ECB)
Utilities	• NamPower
Top Banks	• Bank Windhoek Limited • EBank Limited • First National Bank Namibia Limited

Table 15.2: Noteworthy solar projects in Namibia

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
-	4.5 MW	Omaruru, Erongo region	Commissioned	InnoSun Energy Holding
Otjozondjupa Solar Park	5 MW	Grootfontein, Otjozondjupa Region	Commissioned	HopSol AG

ENERGY MIX

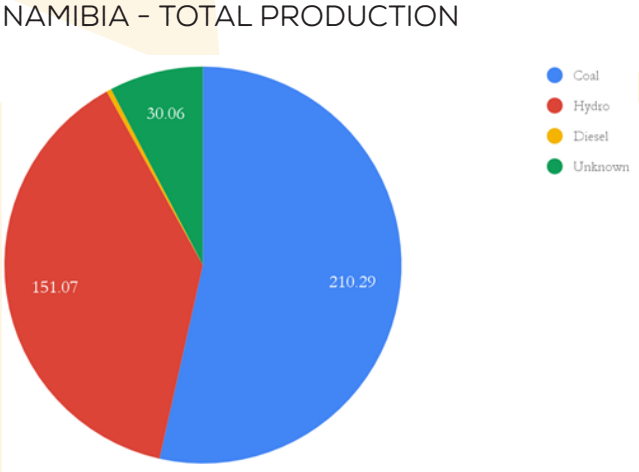


Figure 15. 2: Namibia's total energy production based on energy sources in MWs.

Namibia has long faced difficulties supplying enough electricity to meet the faced demand. Since precise data of the country's energy supply is scarce, the total Namibian power generation capacity can only be estimated. The closest estimate puts the Namibian installed capacity at 393 MW. Most of this power capacity is made up by generation through fossil fuel sources such as coal and diesel, accounting for 210.29 MW and 1.57 MW respectively. Hydroelectricity provides another

big chunk of the nation's electricity, generating 151.07 MW. The unknown component of the Namibian installed capacity consists of local, small-scale renewable energy sources and other unidentified energy sources.

Besides the installed capacity, Namibia heavily relies on imported energy from surrounding countries to meet its growing energy demand that already stood at 533 MW in 2008. The energy deficit is met through the South African Power Pool (SAPP).

Solar energy, similarly to other countries in the region, shows promising signs to solve Namibia's issues. At the moment, however, solar energy is confined to a few, megawatt-scale solar plants and some off-grid application.

REGULATORY FRAMEWORK

Under the Vision 2030 act passed in 2004, Namibia is aiming to be an industrialised nation with a viable natural resources - based export sector, and increased size of skills - based industrial and service sectors, and market oriented production. To achieve this, however, the energy sector must keep the pace with the economic development. One of the ways in which this goal is planned to be met is through the integration of renewable energy sources into the country's energy mix.

In charge of realizing the outlined plan, is the Namibian Electricity Control Board which has recently announced that the country's renewable energy policy is close to completion. In final draft presented in August, 2016, the board outlined four main scenarios based on the level of installed renewable energy capacity in the future. These scenarios include the Reference Scenario; a Pro-Wind/Solar Scenario with Kudu; a Pro-Hydro scenario without Kudu; and a 70% Renewable Energy (RE) in 2030 Scenario.

Although there are a number of scenarios outlined in the nation's renewable energy policy revolves around a couple main aspects. Firstly, Namibia must address the problem of inadequate access to electricity (especially in rural areas), the challenge of extending affordable energy services to underserved populations and the need for self-sufficiency and energy independence. Furthermore, the country must also ensure that the energy sector development is climate-resilient and able to secure energy access even in a non-stationary natural environment. Lastly, renewable energy has to be developed strategically and with foresight to provide a solution for the country's issues

Although Namibia acknowledges the potential of solar power, it has shown interest towards Concentrated Solar Power (CSP) as a method to harvest the energy of the sun. In order to kickstart this Namibian ambition, the United Nations Development Program (UNDP) allocated $1.7 million to increase the share of renewable energy resources in the Namibian energy mix by developing the necessary technological framework and conditions for the successful transfer and deployment of CSP technology for on-grid power generation, thereby reducing greenhouse gas emissions.

ON-GRID

Despite the underdevelopment of the local on-grid solar market, there are some projects in the country that are worth menntioning. The largest solar park in the country, at time of development, was commissioned in mid-2015 and has a total capacity of 4.5 MW. The solar plant was developed by InnoSun Energy Holding, part of French wind power developer InnoVent, and it is located near the town Omaruru, Namibia's Erongo region, northwest of the city of Windhoek. The project is also an important milestone in the country's history because it marks the first PPA agreement between the developer and NamPower, the national power utility.
InnoSun's prominent PV plant, however, is not the largest one anymore in the region. The 5 MW Otjozondjupa Solar Park, located in Grootfontein in Otjozondjupa Region, Namibia claimed the top position with a small margin. The Otjozondjupa Solar Park was carried out by HopSol AG, a Swiss solar energy developer, in only three months and reached operations by June of 2016.

OFF-GRID

Since local irradiation is abundant, and diesel generators are expensive for locals to sustain, off-grid solar has great potential in the country. Stand-alone applications such as the one provided by Atlantic Solar Namibia provide scalable PV solutions for both household and business consumption. The company's appliances, can reach 102 kW and may also supply the generated electricity back into the grid in regions where with FiT schemes lowering the electricity bills.

Image: Ecopreneurist

16. SOUTH AFRICA

INTRODUCTION

South Africa is one of the largest and most developed countries on the African continent. Even so, the adequate supply of energy is met by large obstacles to overcome, which remain quite similar to those of other African countries. Coal and gas are the most prominent means of electricity generation and renewable energy sources are scarce in the country's energy mix. Realizing the harmful effects of using fossil-fuel sources, and looking for sustainable ways for job creation, South Africa has put forth an extensive regulatory framework to drive the adoption of renewable sources.

Programs such as the 'Renewable Energy Independent Power Producer Procurement Programme' (REIPPP), through its several procurement rounds, have managed to kickstart the country's renewable energy markets and paved the path to reaching the established goals.

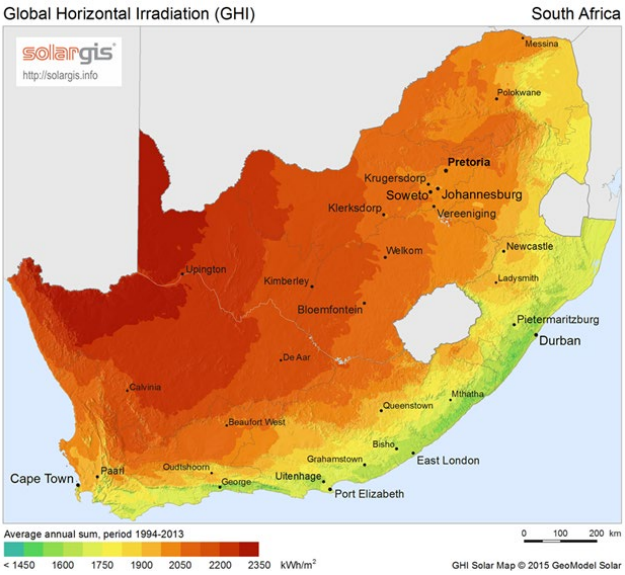


Figure 16.1: Global horizontal irradiation map of South Africa.

Given the country's size and its dire need for energy, the largest progress in terms of added generation capacity can be observed in the utility-scale solar plant segment, which include some of Africa's largest installations. However, 14% of the country does not have direct access to grid electricity, thus mini-grid and off-grid applications have also popped up on the map.

Table 16.1: Economical figures and key stakeholders of South Africa.

Economical figures	
GDP (2015)	314,571,950,000 USD
GDP per capita (2015, USD)	5,718.2
GDP Growth ('13, '14, '15)	+2.3%, +1.5%, +1.3%
Inflation Rate - Consumer Prices (2016)	6.3%
Inflation Rate - GDP deflator (2015)	4%
Population (2015)	55,098,110

Economical figures	
Credit Rating (S&P/Moody's)	BB+ / Baa3
Corruption Perceptions Index (CPI 2015)	44
Ease of doing business index (2015)	74
Access to electricity (2014)	86%
• Power consumption per capita in kWh	4,229 kWh
• Renewable electricity (% of total output, 2014)	1.39%
• Renewable consumption (% of total consumption, 2014)	16.29%

Key Stakeholders	
Energy regulator	• Department of Energy
Utilities	• ESKOM
Top Banks	• Standard Bank • Absa Bank • Capitec

Table 16.2: Noteworthy solar projects in South Africa.

Noteworthy solar projects				
Name	**Capacity**	**Location**	**Status**	**Developer**
-	75 MW	Northern Cape Province, South Africa	Commissioned	SolarReserve, Kensani and Intikon Energy
-	96 MW	Northern Cape Province, South Africa	Commissioned	SolarReserve, Kensani and Intikon Energy

ENERGY MIX

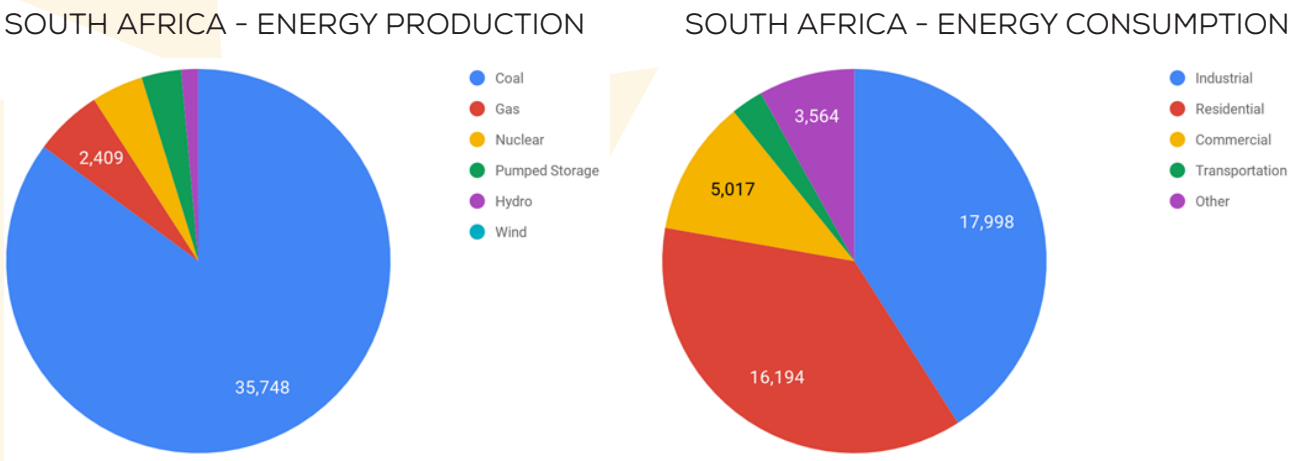


Figure 16.2: The total South African energy production overview based on sources in 2009 (in MWs) and the total South African energy consumption by sector in 2012 (in MWs)

In 2013, South Africa's power generation capacity was considered to be 41,990 MW. The most prominent mode of energy generation was thermal energy, fired by coal and gas. These two sources together represented more than 90% of the entire country's energy generation. Nuclear and pumped storage accounted for 1,830 MW and 1,400MW respectively. Hydroelectricity and wind energy were the least prominent but still significant modes of generation accounting for 600 MW and 3 MW of the total installed capacity respectively.

The largest power consumer sector in South Africa is the industrial sector, which consumes nearly 18 GW of energy on its own. The residential sector constitutes a demand of more than 16 GW. Together, these sectors makes up almost 80% of energy demand in South Africa. The commercial and transportation sectors are more modest in terms of their energy use, accounting for approximately 8.5 GW together.

REGULATORY FRAMEWORK

The 'National Development Plan' (NDP) that governs South Africa, identifies the need for South Africa to invest in a strong network of economic infrastructure. Since the economic development of the country is closely related to its energy generation development, the NDP requires the addition of 10,000 MWs of additional electricity capacity to be established by 2025 against the 2013 baseline.

The 'New Generation Regulations', under the 'Electricity Regulation Act' (ERA), specified the targets based on sources as the following:

- 14 725 MW RE
- 6 250 from coal-fired plants
- 1 800 MW of cogeneration under the MTRM plan
- 3 726 MW of Gas-fired power plants
- 2 609 MW of imported hydro

The main governing plan driving the country's renewable energy adoption is outlined in the 'Integrated Resource Plan' (IRP), which was passed in 2010. The plan was set up in order to help minimize greenhouse gas emissions related to South Africa's excessive dependence on fossil fuels and to provide a boost in sustainable job creation. The Department of Energy released the IRP 2010-2030, a 20-year capacity addition plan for the electricity sector, which set a target of 11.4 GW of renewables. After a round of public participation was conducted near the end of 2010, several changes were proposed and a second Policy Adjusted IRP was recommended and adopted by Cabinet in March 2011. As part of the South African Energy Plan, the new IRP set a target capacity of 17.8 GW of renewable energy and 42% of all new generation capacity developed up to 2030. More specifically, the IRP mandates 8,400 MW of wind and solar photovoltaic each, and 1,000 MW of concentrated solar thermal to be added throughout the plan's period.

In an attempt to meet its targets, South Africa has set up several initiatives that will enable the country's development. These initiatives include the 'South African Renewables Initiative' (SARI) and the 'South African Renewable

Energy Council' (SAREC), the creation of the 'Green Economy Accord', the 'South Africa's Green Economy Accord', the incorporation of green growth goals in the 'Industrial Action Plan' (IPAP2), the introduction and revision of the 'Integrated Resources Plan' in 2009 and 2010, and finally the 'Renewable Energy Independent Power Producer Procurement Programme' (REIPPP).

ON-GRID

South Africa is one of the most prominent regions in Africa when it comes to utility-scale solar. The largest PV plant in the continent, the Solar Capital De Aar 3, is located in the country. The 175 MW facility is located on mostly arid land of De Aar in Northern Cape and cost 4.8 billion rand ($315 million) for its developer, Solar Capital to bring online.
Another on-grid solar PV plant is located in Northern Cape Province, near the town of Kimberly. The project was built by California-based solar developer SolarReserve, along with its consortium partners Kensani and Australian company Intikon Energy. The plant will be operated and maintained by Gransolar until 2019. The 75 MW installation reached commercial operation stage in 2014, producing enough electricity to power 65,000 homes. The same consortium connected an even larger PV plant in the same location just a couple months later. This 96 MW solar plant was the largest of its kind in Africa at the time of its commission in October 2014. Both projects were established as part of the 'Renewable Energy Independent Power Producer Procurement Programme' (REIPPPP) that has been at the cradle of most of South Africa's renewable energy capacity.

MINI-GRID

There are two mini-grid systems in the Eastern Cape. One of the mini-grids is located in the Hluleka nature reserve and consists of a hybrid of different power generators. The hybrid system consists of two wind generators (total of 2.5 kW), three solar PV module arrays (total of 10.6 kW), and a diesel generator for backup power supply. The other mini-grid is located in Lucingweni and comprises solar PV panels (50 kW) and wind generators (36 kW) to provide electricity to 220 residences. Through the utilization of mini-grids, the residences are provided with lights, radio, television, cell phone charging, street lighting, telecommunications, and water pumping.

OFF-GRID

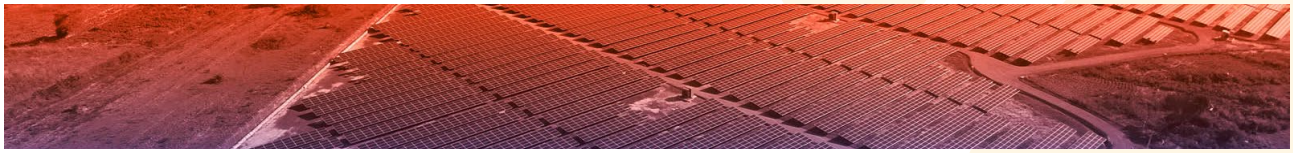
Grundfos, a Danish company which is allegedly the world's leading pump manufacturer, offers solar-powered, off-grid water systems in South Africa. The company offers systems ranging from crop irrigation for farmers and livestock watering for ranchers, to water supply solutions for both household use and community use. Through its innovative design, the company offers solutions that can become a viable alternative to expensive fossil-fuel generators that are being used in rural areas.

17. GENERAL SUMMARY

Africa is home to over a billion people and consistently ranks among the poorest regions in the world. Despite making huge progress over the past two decades, many African countries are still struggling in many aspects. Generating electricity is one of the biggest challenges the countries face, as only about half of their citizens have consistent access to electricity. This challenge, however, also presents an opportunity. Right now, banks and foreign investors are racing to secure contracts for the development of renewable energy projects throughout Africa. Considering the immense demand that are bound to arise as these developing countries mature into middle-income economies, various private and governmental parties are currently laying the groundwork for large-scale renewable energy solutions that will eventually become the bedrock of African growth.

The African continent presents significant opportunities for the development of solar PV energy. Its average solar irradiation rate is the highest among all continents, with some countries boasting an impressive 4,300 hours of annual sunshine. In the face of its immense potential, solar PV remains one of the least developed renewable energy industries. The total capacity of commissioned solar PV power plants remains well under 1 GW, and although recently there have been numerous signed MoUs and sealed investment deals, the majority of projects in development will not come online until 2020. To further encourage foreign investment, local governments have gone to great lengths mandating financial incentives and lifting bureaucratic hurdles. The challenge of providing energy for Africa is rapidly becoming a forefront of investment in the developing world and it will be a defining point in the region's economic future.

Solar PV, however, does not only provide a viable solution for meeting the continent's (growing) power hunger through utility-scale solar power plants. Off-grid and microgrid applications electrify communities and households that otherwise would have to rely on expensive and carbon-rich fossil fuels. Since economic development goes hand in hand with energy access, the application of solar power is, slowly but surely, contributing to the continent's economic development.



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SOLARPLAZA

FACTS & FIGURES 2017
SOLAR ENERGY

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