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1. General context of the study

The trend in final energy consumption and its distribution reflects a country's level and development dynamics. Like the Sahelian countries, Togo is characterized by a low energy consumption estimated at 0.27 tep/capita while the African average is 0.67 tep/capita and the world average is 1.80 tep/capita (DGE, 2017; 2011).

National final energy consumption increased from 1,296 ktep in 2000, to 1,891 ktep in 2009 and 2029 ktep in 2017, an increase of 57% between 2000 and 2017 (DGE, 2018). This trend is quite close to population growth, which is up 59% over the same period. Final energy consumption is dominated by biomass energy (firewood, charcoal, and plant waste). In 2017, the national energy balance indicates that biomass-energy accounts for 75.5% of the energy balance compared to 18.9% for petroleum products and 5.6% for electricity (DGE, 2018). According to the Togo Electric Power Company's (CEET) action plan, demand for electric power increased from 1065 GWh in 2013 to 1,450 GWh in 2016 and will increase to 1,972 GWh in 2019 (CEET, 2013). This growing electricity demand is more than 70% met by imports. The use of new and renewable energies (solar, wind, biofuels, biogas, etc.) apart from hydropower is very negligible to the point of not being included in the energy balance.

Togo is not a producer of petroleum and derivatives, and all consumption of petroleum products comes from imports. Primary energy production is estimated at 2805.25 Ktep in 2017, of which 2796.40 Ktep (or 99.69%) biomass-energy and 8.86 Ktep in hydropower (or 0.31%). The development of other forms of energy, particularly renewables, is still underdeveloped but potential is huge.

Despite the Togolese government's efforts to supply the country with energy, access to electricity remains low at a rate of 40% in 2018 at the national level, of which less than 10% is in rural areas. Togo, therefore, faces enormous challenges in achieving the goal of universal access to electricity by 2030 as defined by the global initiative for "Sustainable Energy for All (SE4ALL)".

Given the national potential for renewable energy, particularly in mini-hydropower (over 200 MW), solar, wind, and biomass (biogas, biofuel, electricity), Togo could more easily achieve one of the SE4ALL targets of doubling the share of renewable energy in its energy mix for electricity. To achieve this goal by 2030, the country will necessarily need to focus on renewable energy technologies with a particular focus on electricity generation and the productive use of energy.

It is in this vision that Togo has developed its energy sector development policy plan validated in November 2017 and the main strategic directions are:

- Improve the governance framework and competitiveness of the energy sector;
- Improve the supply and access to modern, quality energy services for all;
- Renewable energy development and promotion of clean technologies, energy savings, and energy efficiency.

However, policy and implementation gaps abound in the solar market. Risk and pathways to increasing adoption of renewable energy remain undefined, especially in solar energy. These policy gaps form a key aspect that must be dealt with to increase the dissemination of solar energy technologies.

Considering the large sums of investment and development goals at stake, these programs and resources accruing to them must be deployed efficiently and with decisions informed by fact.

In this context, technical assistance (TA) has been requested by Togo's NDE based in the Ministry in charge of Environment issues from the CTCN to help the country in achieving its goal of increasing solar adoption. The TA will seek to improve the adoption of solar technologies to reduce the poor energy access in Togo and help communities mitigate and adapt to climate change. Specific emphasis is laid on the establishment of PAYG models and small-scale installations. This will be informed by benchmarks from best practices in relevant cases.

The final vision will be the access to cleaner energy which would positively impact several communities in Togo and enable healthier lifestyles and spurring economic growth for smallholder businesses. The TA will undertake analyses of markets, solar energy portfolio and also engage in capacity building of key stakeholders covering 12 months from January to December 2020.

The current study on Togo's energy policy and institutional framework is important and even essential for the intervention of the TA since, in the long run, it will allow it to have a necessary information base for the direction of its actions in the energy sector.

1.1. Objective of the study

The overall objective of this study is to analyze in detail the policy of renewable energy development in Togo.

Specifically, this study should contribute to the development of a sustainable energy system in Togo in social, ecological, and economic terms and aims to:

- Describe the evolution of energy demand in the context of climate change in Togo;
- Conduct an integrated assessment of Togo's solar energy potential;
- Conduct a diagnostic analysis of the policy of the renewable energy subsector in Togo (status, analysis of strengths, weaknesses, opportunities and threats, bottlenecks).

1.2. Methodology framework of the study

1.2.1. Localisation and administrative regions

Togo is located on the coast of the Gulf of Guinea in West Africa and covers an area of 56,600 km2. It is close to the South by the Atlantic Ocean, to the North by Burkina Faso, to the East by Benin, and to the West by Ghana. Located between 6 and 11 degrees north latitude and between 0 and 2

degrees of east longitude, the country extends from north to south for 660 km. Its width varies between 50 and 150 km. The national territory is divided into five administrative and economic regions that do not enjoy regional autonomy due to a lack of effective implementation of appropriate administrative and financial structures. The five regions are: Maritime Region (6,100 km2), Plateau Region (16,975 km2), Central Region (13317 km2), Kara Region (11,738 km2), Savannah Region (8,470 km2) (Figure 1). The country currently has 39 prefectures and 21 municipalities.

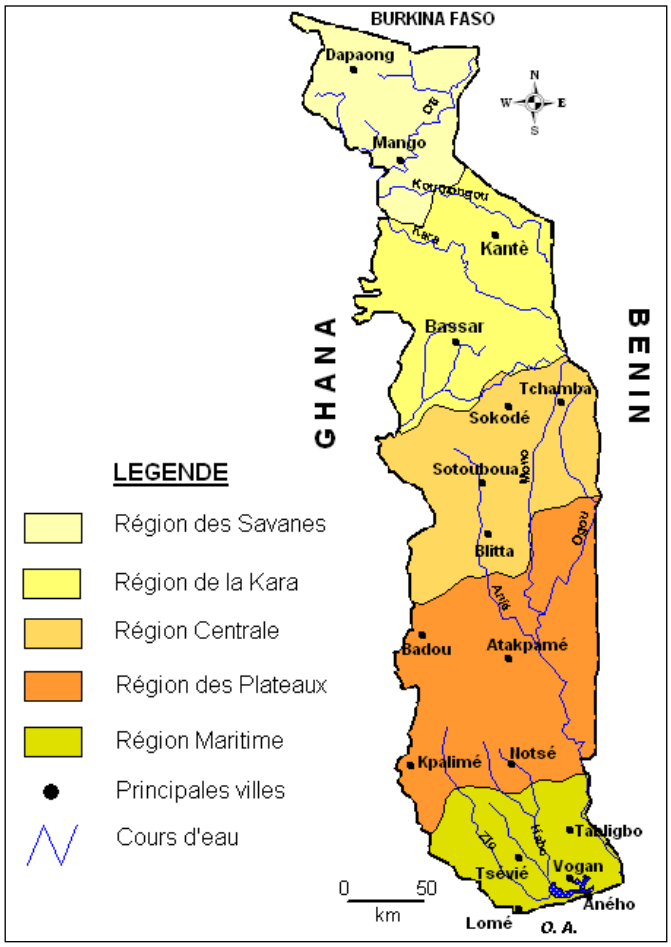

Figure 1 : *Administrative Regions (Ministry of Environment and Forestry Resources (MERF), 2011)*

1.2.2. National demography data

The fourth General Census of Population and Housing (4th RGPH) conducted in 2010 indicates that Togo's resident population was 6,191,155 (INSEED, 2011). One of the major characteristics of the Togolese population is its relatively strong growth and extreme youth. From 1981 to 2010, in 29 years, Togo's resident population more than doubled. It increased from 2,719,567 inhabitants in November 1981 to 6,191,155 in November 2010, corresponding to an average annual growth rate of 2.84%. The potentially active population (15-64 years) represents a proportion of 54%. Older people make up only 4%. Under-25s make up 60% of the population and 42% are under the age of 15.

Globally, the population is unevenly distributed throughout the territory. The Maritime region accounts for 42.0% of the total population on one-tenth of the total area. The Plateau region follows with 22% of the population, followed by the savannas (13.4%), Kara (12.4%) regions. Central (10.2%). Togo's population is made up of fewer men (3,009,095 men, or 48.6%) than women (3,182,060 women, or 51.4%). Apart from regions and gender, the population is unevenly distributed according to the area of residence. In 2010, the resident population in rural areas was 3,856,660, or 62.3% of the total population, up from 74.8% in 1981. Cities (defined as the heads of prefectures and the capital) were populated in 2010 by 2,334,495 inhabitants, or 37.7% of the population, up from 25.2% in 1981. This disparity in the distribution of the population poses challenges in terms of land use planning. The population projection carried out in 2015 by INSEED based on the 4th RGPH of 2010 indicates that Togo's total population would increase to 6.8 million in 2015, of which 40.1% would live in urban areas and 7.6 million, 43.5% of whom would live in urban areas by 2020 (INSEED, 2015).

For more than a decade, poverty and precarious living conditions have worsened overall. It is estimated that 62% of the population lives below the poverty line, 74% of whom live in rural areas. As a result of less income, these vulnerable poor groups generally have limited access to social services (health, education, drinking water). The poorest and most vulnerable categories are women, young children and abandoned children, young people, small-holder producers, the unemployed, displaced persons, the disabled, elderly or sick. The situation is exacerbated by endogenous and exogenous factors, such as soaring prices of necessities, a drastic and constant reduction in purchasing power, rising unemployment, periodic floods, etc., which result in unsustainable survival strategies, the development of prostitution, and HIV/AIDS.

1.2.3. Agriculture

Agricultural production is largely dependent on climatic conditions and characterized by subsistence rain-fed agriculture, low-strength small farms, and extensive production systems. Overall, producers, herders, and fishermen also face significant under-equipment challenges in processing, conservation, and marketing, resulting in very significant losses. The pastoral system, the agro-pastoral system, which is the predominant system throughout the territory, and the agricultural system are generally distinguished.

Food crops (corn, cassava, yam, sorghum, millet, rice, beans, peanuts, etc.) and export crops (cotton, coffee, cocoa, etc.) alone account for about 30% of GDP, with growth ranging from 0.4% to 8.1% over the last five years. Mixed cropping is widespreadly practiced, with maize being the dominant crop grown in association on about 50% of the cultivated area. Mixed cropping are very common for sorghum (63.5%), peanuts (65.5%) yam (66.8%). Yields are low and random. A small proportion of crops are grown in the shallows.

The agricultural sector has several advantages due to climatic conditions, good soil conditions, and the geographical position of the country. Overall, however, it faces significant constraints, including (i) an inadequate institutional and regulatory framework and inadequate advisory support structures; (ii) a sharp degradation of natural resources and land; (iii) farms that are too small and fragmented; (iv) land insecurity and agro-land reform, (v) the enclave nature of production areas and the

inadequacy of rural infrastructure; (vi) the inadequacy of effective microfinance institutions, (vii) the low structuring of the rural communities, (viii) Malaria and HIV/AIDS prevalence; Etc.

1.2.4. Macroeconomic framework

Efforts have been made to improve the macroeconomic framework and improve the business climate. Togo experienced an economic performance between 2008 and 2016 marked by the growth of the real GDP rate of 2.4% in 2008, 3.4% in 2009, and 4.0% in 2010. In 2011 and 2012, it rose to 4.8%. It rose from 5.2% in 2014 to 5.3% in 2015 and 5.4% in 2016. Gross domestic product (GDP) at current prices increased from 1212.822 billion CFA francs in 2007 to 2016,142 billion CFA francs in 2013. In the same year, its current price structure shows that the primary sector accounts for 51.8%, compared with 22.2% for the secondary sector and 26.0% for the tertiary sector. Real GDP growth in 2016 was favored by the primary sector, contributing 2.3% from 0.1% in 2013, and the secondary sector contributing about 1.2% from 1.1% in 2013.

The general budget execution of the State had increased from 72% in 2008 to 61% in 2010 and 66% in 2013. Capital expenditure was executed at 52% in 2008, 61% in 2010, and around 64% in 2012-2015. In the face of increasing social demand, the under-consumption of the budget poses a real problem of absorption capacity that needs to be vigorously recovered during the next economic program. Similarly, two fundamental challenges are to be met: (i) strengthening the Government's capacity to improve the quality of its spending; and (ii) work to improve budget forecasts.

Togo receives foreign assistance to finance much of its public investment program. The country has entered into the program with the IMF. External resources made up of grants and borrowings from concessional terms finance public investment to the tune of 80%. Following the completion point of the Heavily Indebted Poor Country (HIPC) initiative in December 2010, under the Multilateral Debt Relief Initiative (MDRI), the country has benefited from a 95% cancellation of its debt stock to Paris Club member creditors, amounting to 308.4 billion CFA francs and a cancellation of approximately 357 billion CFA francs from the World Bank and the African Development Bank Group (AfDB), thus helping to restore the solvency of the state and the sustainability of external debt. Indeed, the external public debt, which amounted to 770.1 billion CFA francs in 2009 (or 51.6% of GDP) is reduced to 260.3 billion CFA francs at the end of 2010 (or 16.6% of GDP). The public debtratio decreased from 84.5% in 2009 to 46.7% in 2010 and stood at 44.4% in 2011.

On the economic facade, Togo recorded growth rates of 4% in 2013, 5.9% in 2014,and 5.4% in 2015 due to the revival of local production (agricultural production, phosphates, cement, cotton, cocoa), and some progress in structural reforms. All these performances have been achieved thanks to the consolidation of activities at the level of all sectors, the increase in investment and revenues, the growth of the extractive industry (phosphate, clinker, marble, iron...), the cement factory, trade with the competitiveness of the Autonomous Port of Lomé (PAL), tourism and services among others.

Indeed, the EITI-Togo 2014 report indicates that the main mineral substances extracted or exported in 2012 by Togo are phosphates (1.1 million tonnes), limestone (1.9 million tonnes), iron (82,000 tonnes), gold (18,000 kg), and diamonds (456 carats). Government revenues from the extractive industries reached XOF 16 billion in 2012.

On poverty reduction, social protection, and labor, the incidence of poverty at the national level has declined from 61.7% in 2006 to 58.7% in 2011. Despite this decline, poverty remains a predominantly a rural phenomenon affecting more than 73% (Poverty Profile 2006-2011 of Togo - UNDP), especially in rural areas where almost 3 out of 4 households are poor (74.3%) 2 in 5 (36.8%) urban areas.

From a human resource development perspective, human development indicators (HDI) are growing at an annual average of 0.47 percent. Despite an HDI index (0.495) above the average for Sub-Saharan African countries (0.465), Togo has significantly lower economic and social indicators than the average in 2018. GDP per capita based on UEMOA statistical data is 282,716 CFA francs per year (430 EUR)[1].

Moreover, the country's energy situation remains mixed with national electiricity access at 36% in 2016 compared to a rate of only 7% in rural areas. Yet, the rural environment is home to more than 57% of the national population and remains poorer than the urban environment. To better meet the pressing needs of rural populations, the CIZO project, an initiative of the President of Togo, has been launched to equip two million Togolese in rural areas (approximately 300,000 households) with individual solar kits paid in a convenient manner via mobile wallets (PAYGO). This innovation would increase the rural electrification rate from 7% in 2016 to more than 40% by 2022. Besides, the country's new national electrification strategy launched in 2018 aims to provide universal access to energy by 2030 for the entire Togolese population; strategy based specifically on the development of renewable energies with specific focus on solar energy.

1.2.5. Methodological approach

The study is carried out in a participatory and inclusive approach to meet the country's real and concrete needs for renewable energy systems. It is conducted in three phases: A research phase, a data collection phase, and a phase of data processing and results in analysis.

1.2.5.1. Documentary research and analysis

The documentary research phase collected and analyzed information from policy and planning documents such as the National Sustainable Energy Action Programme for All (SE4ALL, 2012), the Framework for an Autonomous Soft Energy Pathway in Togo (2014), Togo's Energy Policy Letter (November 2017), Togo's Energy Information System (SIE - Togo, 2017), the National Renewable Energy Action Plan (PANER), the Law on the Promotion of Electricity Production from Renewable Energy Sources in Togo (August 2018), Togo's Electrification Strategy Document (May 2018). Information is also collected from study reports such as the Study Report on Information Processing for Energy Policies for Ecodevelopment (TIPEE) (HELIO International, 2011), the Study 2017 Report on the Dynamics of Wood-Energy Use in Togo, QUIBB Survey Reports, National Communications Thematic Reports, Scientific Publications, etc. All the data collected was used to describe the energy subsector (electricity, hydrocarbon, and renewable energy) in Togo.

[1]Commission de l'UEMOA, juillet 2012

1.2.5.2. Data collection from public, private and civil society institutions

Interviews were held with public institutions, as well as civil society organizations and private companies involved in the renewable energy sector. These interviews were carried out in Lomé using surveys that were developed for this purpose. They collected data on the various initiatives carried out and underway in the field of renewable energy at the institutional, legal, and operational levels. We also collected data on the challenges stakeholders face on the ground.

The main structures involved in the survey are:

- **At the level of technical public services**
  - The services in charge of the energy sector (DGE, AT2ER, CEET, ARSE) ;
  - The Ministries in charge of Water and Environment;
  - Statistics Directorate of the Ministry of Agriculture (DSID).

- **At the level of civil society and private society organizations**
  - 2 NGOs/ Local associations working in renewable energy ;
  - 12 private companies involved in renewable energy.

1.2.5.3. Preparation of the study report

Survey data was collected, compiled, and processed manually based on the synthesis of the information sought. The results of surveys with the above target groups and the exploitation of available documentation are presented in an appropriate and understandable form for all. They were used to write the study report, the analyses of which identified the specific indicators mentioned in the terms of reference for the institutional data collection mission.

1.2.6. Study limit

The completion of this study is not without difficulties. The major challenge has been the reluctance of some actors to provide reliable, above all statistical information on their activities and the absence of recent data. It is also necessary to note the time allocated to the study was too short because of the delay in starting, provoked by the current COVID 19 pandemic. Despite these difficulties, the study was conducted successfully and with conclusive results.

2. Analysis of renewable energy sub-sector

2.1. Solar (PAYG) Market Analysis

Pay-as-you-go (PAYG) is one of the fastest-growing business models within the off-grid lighting and electricity services sectors in Africa. It rose from contributing less than 1% of sales in 2014 to contributing 12% in 2016 while reaching as high as 25% of sales in Kenya. Other sources estimate a total of 285,000 home units of PAYG systems sold in Africa in 2018 [1]. The total global market for off-grid PAYG systems is expected to reach $6 billion by 2022[1]. Considering the glaring issues of energy finance that often plague the African energy sector, PAYG's growth is a welcome development [2].

This is being driven by consumer demand and manufacturers including value-added services and products in their standard offers. The adoption of PAYG has enabled otherwise low-income households to access energy in several locations and even promoting their ability to earn better and improve their school grades. This is in stark contrast with the popular generalization that low-income individuals are often unable to afford energy.

Nonetheless, there is a recognized market concentration taking place in East Africa. An estimated 85% of all PAYG sales in Africa are domiciled in Kenya and Tanzania and new entrants often target the east African market. This is largely driven by the region's massive adoption of mobile payments, availability of market research, and a fair disposition towards the business environment there. On the other hand, lack of planning data and low adoption for flexible payment systems constitutes a hindrance of PAYG adoption in other climes.

2.1.1. PAYG in Togo (Demand and supply)

In Togo, the pursuit of subsidies by the government is driving the adoption of PAYG solar faster than previously expected. The entrance of foreign businesses into the market space is also a key driver of adoption as well as the expansion of mobile money platforms. According to data in the International Finance Corporation (IFC) attractiveness index, Togo accumulated a total of just over 17,000 units of PAYG energy systems between 2014 and 2017 [2]. The market size for PAYG in Togo is unknown at the moment, but reports of sales over 10,000 units in 2018 with plans to reach 550,000 units by 2030 depicts growth [1]. Currently ranked by IFC as 21 out of 24 countries in market attractiveness (Figure 2), Togo presents investors with gaps that if filled represent massive opportunities as well as risks. Yet, according to the World Bank’s ease of doing business rankings, Togo is the 97th in the world and 7th in sub-Saharan Africa. However, it ranks 1st and 3rd in starting a business and registering property respectively [3]. Ease of doing business plays a key role in promoting PAYG business models.

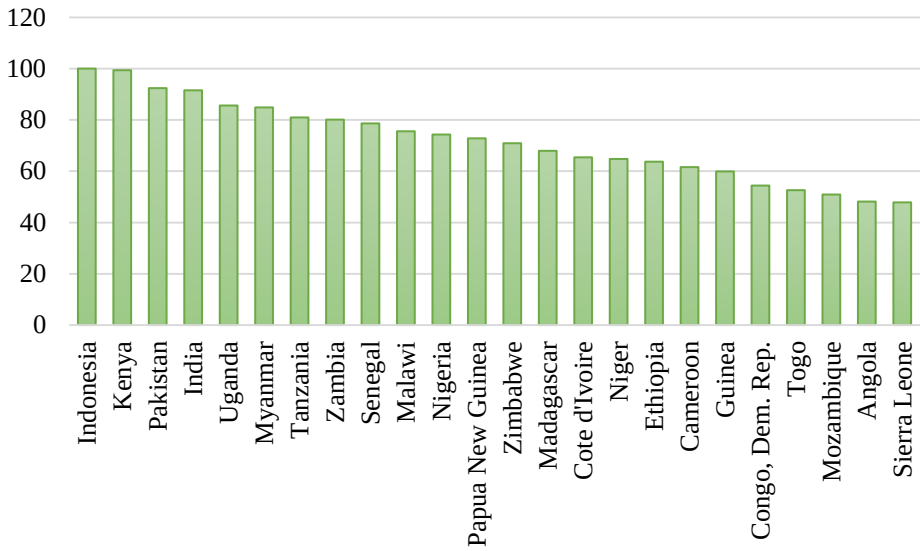

***Figure 2**. Countries ranked based on 2019 scores on the market attractiveness scale developed by the International Finance Corporation*

2.1.2. PAYG attractiveness index to Togo

The PAYG attractiveness index developed by the International Finance Corporation is a tool for developers, policymakers, and planning entities to make informed decisions on the best approaches to adopting PAYG in various industries and locations. It queries vital aspects of PAYG and the location it is meant for. The index is populated by pillars, sub-pillars, and indicators as can be seen in figure 3 below.

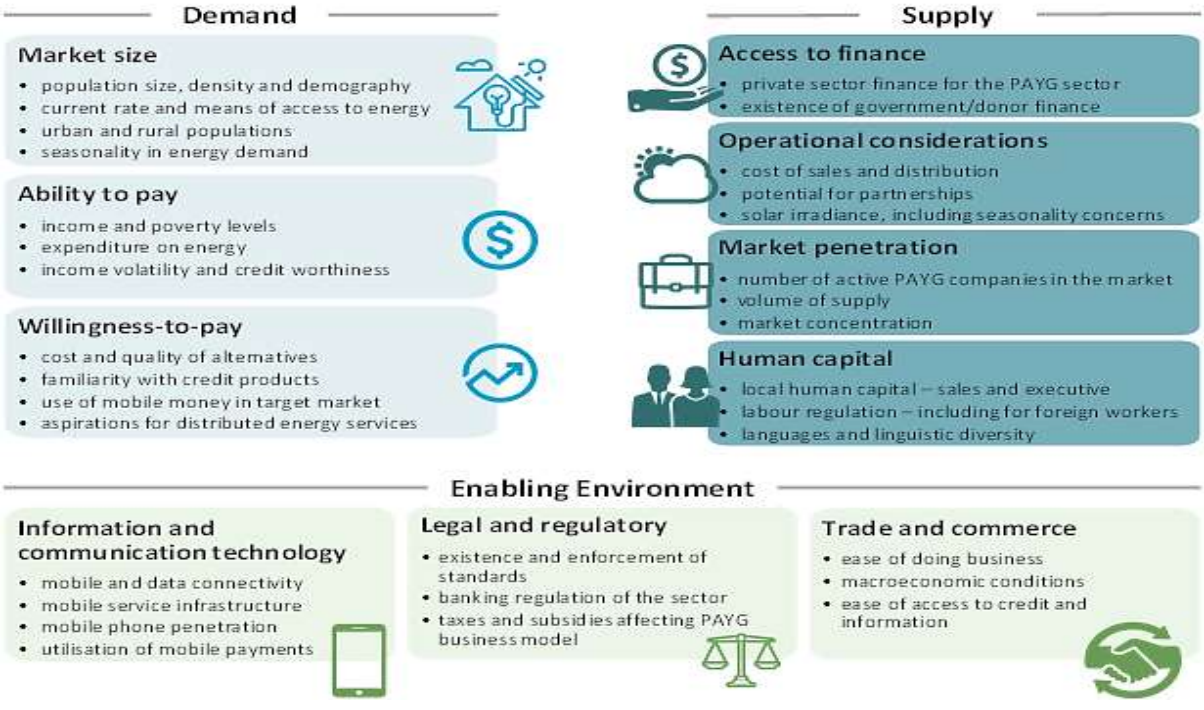

***Figure* 3**. *PAYGo Market Attractiveness Index [2]*

A detailed analysis of Togo's PAYG attractiveness is depicted in Figures 4 – 6 below. Each criterion is individually accounted for and scored based on the IFC's 2017 MAI toolkit. This analysis informs the final inference of the report.

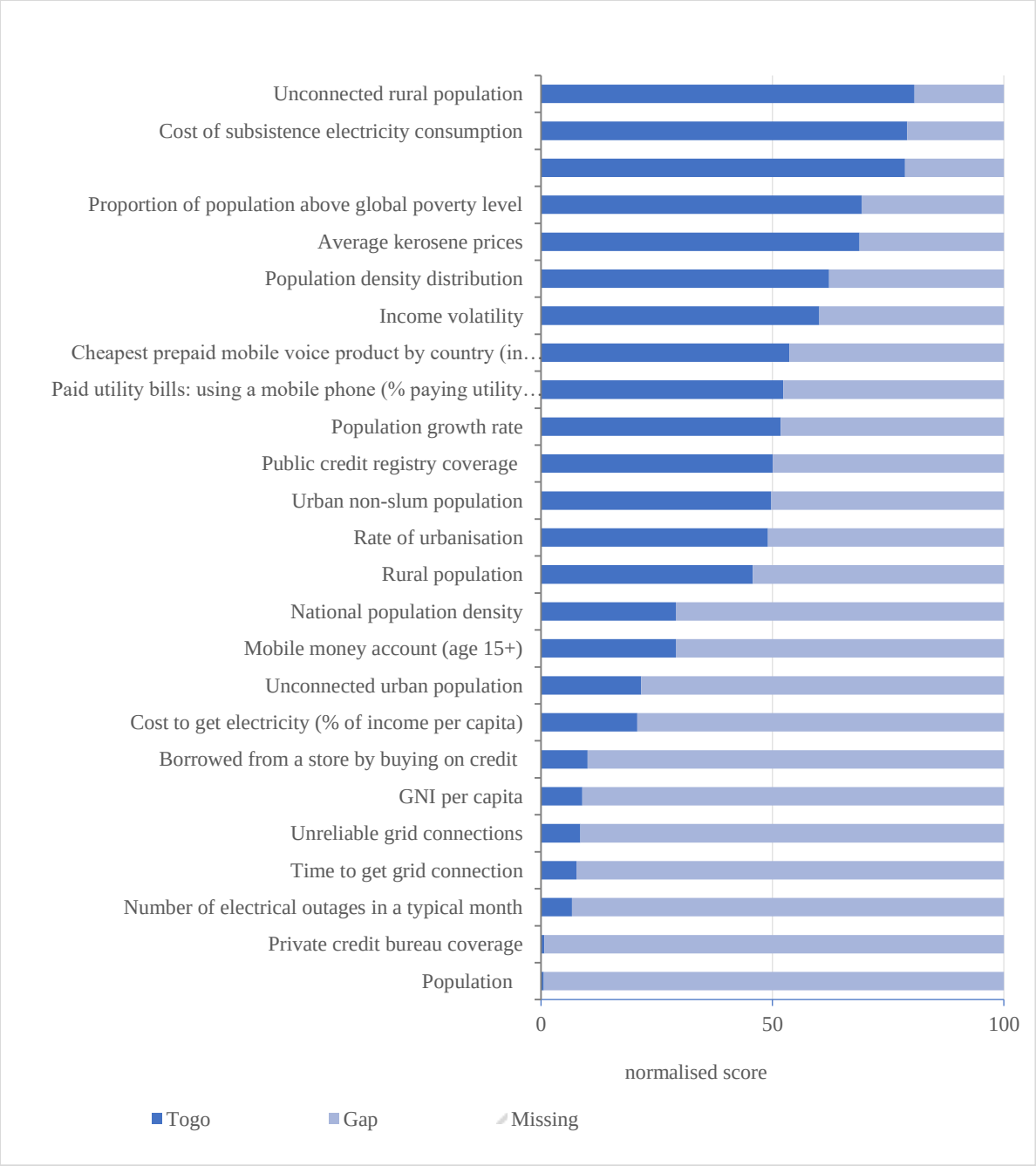

***Figure 4**. Togo's PAYG attractiveness index (Demand)*

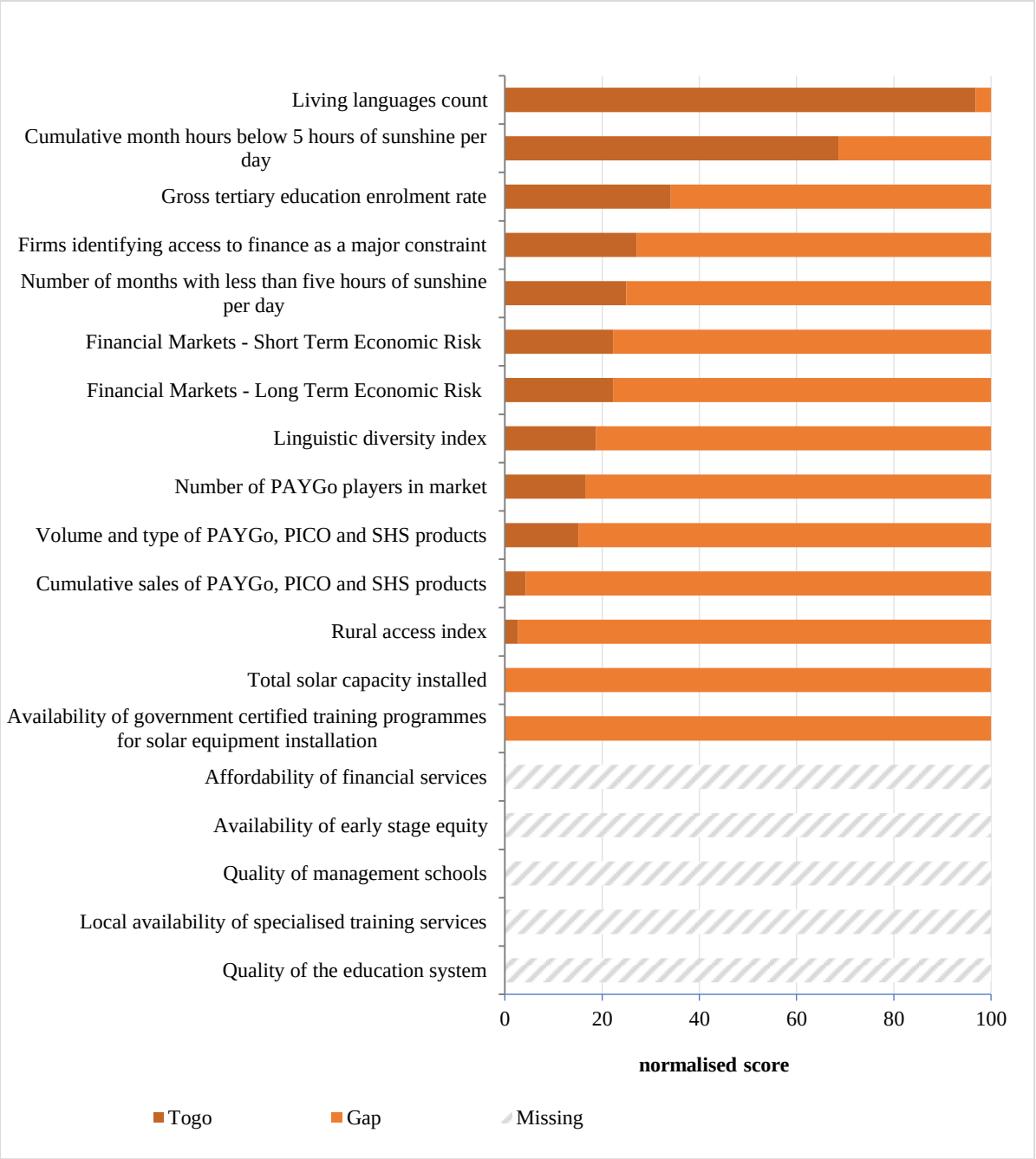

***Figure 5**. Togo's PAYG attractiveness index (Supply)*

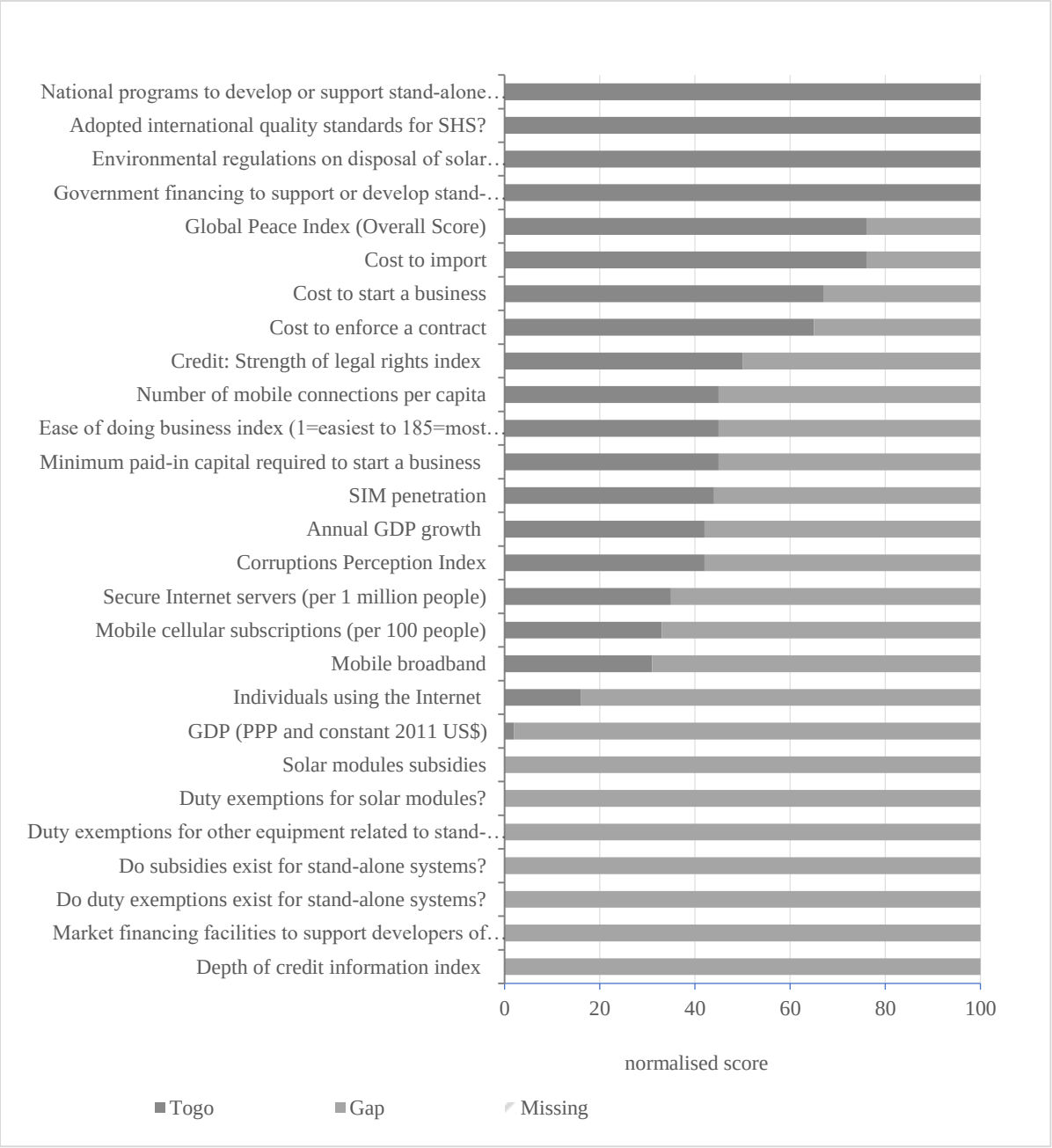

***Figure* 6**. *Togo's PAYG attractiveness index (Enabling environment)*

Although Togo's attractiveness in 2017 was depicted as low, the growth observed between 2018 and now is impressive and points to an upward trend in the adoption of PAYG energy systems. It also presents new entrants with opportunities in terms of gaps requiring solutions. Also, its adoption of mobile money is an indicator of readiness. Mobile money and already existing flexible payment platforms are identified as key components needed to deploy PAYG[4].

2.2. Analysis of the legal, policy, and institutional framework of the renewable energy sub-sector

2.2.1. International legal framework for renewable energies

Togo is involved in international, regional, and sub-regional agreements whose implementation is expected to channel the development of renewable energies.

- International level: Togo ratified the Paris Agreement in 2015 to contribute to international efforts to limit the temperature increase to 2°C by taking mitigation measures. By ratifying this agreement, Togo has resolutely embarked on a low-carbon development path focused on focus on renewable energy. Also, Togo is part of the agreement to create the International Solar Alliance (ASI) adopted on 15 November 2016 in Marrakech. It is an initiative that aims to facilitate and significantly increase solar power generation, reduce the cost of solar technology technologies and mobilize, by 2030, more than US$1 trillion in investment to deploy solar energy in all member countries.

- Regional level: it is the African Energy Commission Convention of 11 July 2001 ratified by Togo by Law No. 2007-004 of 10 January. It expresses the willingness of member states to implement the necessary efforts to promote the energy sector. The Convention created a specific body known to the African Union called the African Energy Commission is known by the acronym AFREC.

- Sub-regional level:

    - ECOWAS Energy Protocol A/P4/1/03 of 28 May 2003 ratified in Togo by Law No. 2006-012 of 23 December 2006, which aims to develop an open and competitive energy market in the community area by promoting access to international markets for energy materials and products, and energy-related equipment. This protocol is reinforced by The Additional Act A/SA.2/01/08 of 18 January 2008 establishing the ECOWAS Regional Electricity Regulatory Authority (ARREC). ARREC is responsible for regulating cross-border electricity trade between ECOWAS member states to enable the development of a regional electricity market;

    - Regional Committee of Energy Regulators of UEMOA Member States (CRRE) was created on 27 March 2009 by the decision of the UEMOA Council of Ministers under 02/2009/CM/UEMOA. This committee has an advisory role within the Commission of this institution;

    - The bilateral agreement under the Benino-Togolese Electricity Code of 27 July 1968 between the Togolese Republic and the Republic of Benin ratified by government of Togo by Ordinance 43 of 15 October 1968 and Law No. 2006-005 of 13 July 2006. This code is amended by the signing of a new convention on 23 December 2003 in Cotonou, Benin and covers in both countries the areas of production, transportation, distribution, import and export of electricity and all related activities. A recent

amendment was made on 27 November 2018 and confiscates the mandate of the importer to the CEB.

The existence of financing mechanisms associated with the implementation of multilateral agreements, the launch by several donors of renewable energy initiatives, and the competitiveness of renewable energy technologies and price accessibility are opportunities for governments to raise more funds for renewable energy development. However, the conditions for access to such funding are not always easy. This requires training national stakeholders on the mechanisms of operation of these funds.

2.2.2. National legal framework for renewable energies

Togo has well defined laws that have been enacted to promote renewable energy generation and sustainable development as outlined below.

2.2.2.1. Text and legal documents in favor of the development of renewable energies

Several legal documents support the development of renewable energy. It's all about:

- Law No. 2018-010 of August 8, 2018, on the promotion of electricity generation from renewable energy sources in Togo. This law sets out the general legal framework for the implementation of electric power projects based on renewable energy sources, either for self-consumption or for commercialization. It also provides incentives for projects. Four (4) enforcement legislation are currently being developed. These are (i) draft decree setting the power thresholds for the various schemes for electricity generation projects based on renewable energy sources; (ii) draft decree setting out the conditions for granting and withdrawing the right of access to the national electricity distribution network; (iii) draft decree setting out the conditions and terms for issuing and withdrawing the license for the production, distribution, and marketing of electricity from renewable energy sources; (iv) draft decree setting out the terms and conditions for concluding and terminating a concession agreement for the production, distribution, and marketing of electricity from renewable energy sources;

- The Framework Law 2008-005 on the Environment Act of May 30, 2008. This law aims to create the conditions for the rational and sustainable management of natural resources to guarantee the availability of biomass-energy to the present and future generations.

One of the weaknesses of the legal framework is the lack of duties and tax relief measures on imports of renewable energy equipment. It will therefore be necessary to provide for implementing texts in this direction. It should be noted that there is no incentive from the private sector to move towards the development of hydropower.

2.1.2.2. Main policy orientations and strategy in favor of renewable energies

In terms of policy and strategic orientation, Togo has a policy document for the development of the energy sector and an electrification strategy.

- **Energy sector development policy**: it places particular emphasis on renewable energy and energy efficiency in its 3rd strategic axis entitled "Developing Renewable Energy and Promoting Clean Technologies, Energy Savings and Energy Efficiency." Through this strategic direction, Togo affirms its commitment to increase the share of renewable energies in the energy mix and to enhance their potential in respect and preservation of the environment, with a strong commitment to energy savings and energy efficiency. To achieve this commitment, the targets include increasing the share of renewable energy to 20% in national electricity production in 2022 to achieve a national electrification rate of 60%, of which 20% is in rural areas. To achieve this, the policy document plans to increase renewable energy generation capacity by 115 MW through the construction of 50 MW solar power plants and three 64.1 MW micro-hydro plants by 2022. Implementation of this policy should reduce the country's dependence on the outside world by 35% by 2022. This policy letter should be translated into an energy sector policy document. This is not yet the case.
- **Electrification Strategy:** elaborated in 2018, the strategy aims to support the government's vision to achieve universal access to energy by 2030. It is based on the combination of several technologies, namely (i) network extension; (ii) the deployment of solar kits; and (iii) the construction of mini-grids. In the long term, it aims to increase the rate of access to electricity from 37% in 2017 to 49% in 2020, 74% in 2025, and 100% in 2030, i.e. electrification of 113,000 households per year. To achieve this, particular emphasis is placed on renewable energy. This strategy aims to (i) deploy more than 300 mini-grids by 2030, or about 9 MW of installed capacity; (ii) electrify 555,000 households by Solar Kits by 2030 or up to 85 MW of solar generation capacity installed by 2030; and (iii) to expand and densify the grid to approximately 670,000 connections by 2030, or install about 108 MW of additional capacity to install, with a focus on renewable energy including solar and hydropower.
- **Nationally Determined Contribution (NDC) :** The nationally determined contribution of Togo was submitted in September 2015 at the Paris Conference of the Parties in which compared to 2010, Togo opted for the reduction of 31.14% of national greenhouse gases emissions by the year 2030. This NDC aims to promote a regional vision of development for the people concerned in a spirit of solidarity while participating in the international effort to combat climate change. Several measures are taken in this document to strengthen actions in favor of energy efficiency and low-carbon technologies. This is, in the field of energy, (i) Development of renewable energy by promoting biofuels and upgrading degraded land, training and supporting research for the production of new and renewable energy, and import-free solar and wind energy equipment, (ii) Sustainable management of traditional energy (firewood and charcoal), (iii) Implementation of energy-saving strategies, (iv) Development of mini hybrid networks for rural electrification, (v) Promotion of low-carbon modes of transport and (vi) Promoting new clean technologies in the building sector.

Renewable energy, therefore, plays a prominent role in national policies. In addition to these national policy guidelines, Togo has developed its own policy in line with the ECOWAS Renewable Energy Policy (PERC) and its Energy Efficiency Policy (PEEC), which includes the development of Renewable Energy Action Plans (PANER) and Energy Efficiency (PANEE) in each member state.

Togo developed its PANER in October 2015 which takes into account the laws, incentives, and measures that will be implemented by the country to achieve the objectives set.

But it should be noted that the current policy framework has weaknesses to be overcomed to achieve the objectives. These include:

- The negative perception of firewood: Firewood is a resource perceived in Togo as traditional energy that destroys natural resources. This explains its failure to be taken into account in the current energy policy strategy. However, if managed sustainably, it is the most accessible and available energy for people. The main problem of this resource remains emission of greenhouses from burining wood;
- The absence of a robust national technology transfer program: the production at reasonable costs of renewable energies (green charcoal, biogas, briquettes, solar, wind, micro-hydro, etc.) requires the need for appropriate technologies. The transfer of technologies through North-South strategic partnerships would be one of the conditions for the sustainable development of renewable energy. Also, the appropriation of knowledge in the field of renewable energy production technologies remains a challenge. This requires sufficient qualified human resources (technicians, engineers, researchers).
- The lack of a mechanism to finance the development of renewable energy at the national level ;
- Lack of funding for renewable energy research.

It will therefore be necessary to seize the opportunity to integrate biomass-energy in future energy policy as a renewable energy source and provide guidance for the transfer of technologies. This policy should also guide the creation of a renewable energy fund and make a good case for research.

2.2.3. Institutional framework

The existence of public and private institutions is conducive to the development of renewable energies. As far as public institutions are concerned, there is :

- At the sectoral level, the Ministry of Mines and Energy (MME) and its central services such as :
    - Directorate General of Energy (DGE): for essential responsibilities to propose the country's energy policy elements, develop and implement defined energy investment programs, encourage public and private initiatives aimed at promoting the energy sector in Togo, develop and propose energy legislation, regulations and standards, to initiate and develop, in conjunction with the relevant structures, the national energy plan ;
    - The Electricity Sector Regulation Authority (ARSE) which is responsible for (i) participating in the evaluation of projects and the supervision of national and international tenders for the conclusion of concession agreements, the construction of

new electrical installations and the modification of existing electrical installations; (ii) propose to the Minister responsible for energy draft standards and formulas to regulate activities, or any other issues relating to the electricity sector and in particular in the area of tariffs charged by dealers and operators, the quality of the electricity supplied, specifications and safety standards; iii) conduct the necessary checks and investigations, and implement all the powers it has to certify the compliance of electrical installations with applicable safety and technical standards, as well as compliance with the provisions of the law by dealers and operators; (iv) to form a Board of Arbitration for conciliation or arbitration of dispute for dispute between stakeholders.

There are other services related to the MME such as :

- Togolese Agency for Rural Electrification and Renewable Energy (AT2ER): Established by Decree No. 2016-064/PR of 11 May 2016, the AT2ER is a public institution of an administrative nature, endowed with legal personality and financial autonomy. It is under the technical tutelage of the Ministry of Energy and the financial supervision of the Ministry of Finance;

- Togo Electric Energy Company (CEET): Created by Ordinance 63-12 of 20 March 1963, it was transformed into a state-owned company by Decree 91-028/PMRT of 02 October 1991 and subject to the rules of common law applicable to all commercial companies;

- The Benin Electrical Community (CEB): An international public body, it is co-held by Togo and Benin. It operates by the Benino-Togolese Electricity Code adopted in 1968 and revised in 2003, which gives it "the exclusivity to carry out the activities of transport, import and sole purchaser for the needs of both states". But in November 2018, the two States of Benin and Togolese decided to change the purpose of the CEB. From now on, the CEB, which manages the energy transmission network, with the related activity being the continued operation of the production facilities of the Nangbéto dam and the two gas turbines installed in both countries. As a result, each state will ensure direct import for its complementary energy needs. Delegated management has been put in place for the restructuring of the company. This decision was expected to take effect from 1 January 2019.

- At the general level, several other departments are involved in energy management. It's all about:

  - Ministry of Trade, Industry and Private Sector Promotion, which oversees oil import and distribution companies;

  - Ministry of Environment and Forestry Resources responsible for the sustainable exploitation of natural resources and the protection of the environment;

  - Ministry of Agriculture, Livestock and Hydraulics responsible for implementing agricultural policy with strict respect for the environment and ensuring food security;

- Ministry of Higher Education and Research is responsible for developing the extension of solar energy through the solar energy laboratory of the University of Lomé.

This institutional framework suffers from some weaknesses. This include:

- The lack of cooperation between universities and ministries, especially the Ministry in charge of energy, is intended to strengthen the technical and human capacity of the energy sector and in particular the renewable sector. This lack of cooperation also means that research is disconnected from the needs of ministries, and the results of some research that should help solve some development problems are not often exploited by governments;
- The lack of collaboration between departments and local authorities in the renewable energy subsector.

2.3. Renewable energy development prospects: Vision of the government

Togo aims to ensure universal access to electricity at a rate of 100% by 2030 (Table 1) thanks to renewable energy in particular. This goal will be achieved :

- ✓ A clever combination of network extension and off-grid technologies (mini-grids and solar standalone);
- ✓ Support for the most cost-effective approach to identifying technologies to be deployed in the national territory, including renewable energy technologies. To achieve universal access to electricity, Togo relies on the mobilization of private sector investment, including Public-Private Partners (PPPs) as well as targeted support mechanisms enabling the most vulnerable populations to access electricity. Approximately 883 billion FCFA will need to be mobilized: 438 billion FCFA investments by private operators and 445 billion in public investment.

Table 1. Togo's electrification trajectory (Strategy document for electrification of Togo, May 2018)

2010 - 2016	2017	2018 - 2020	2021 - 2025	2026 - 2030
Business as usual	**Paradigm shift**	**Demonstration**	**Acceleration**	**Consolidation**
▪ Network-based ▪ Manage by the public sector	▪ Creation of AT2ER ▪ Introducing off-grid solutions ▪ Private sector involvement in electrification	▪ New electrification strategy ▪ Review of the regulatory framework ▪ Implementation of flagship programs ▪ Proof of regional leadership	▪ Mobilizing the additional funding required for scaling ▪ More tenders and project launches	▪ Continuous deployment of electrification strategy to universal access

Taux d'électrification **23 – 37%**	Taux d'électrification **~40%**	Taux d'électrification **~40 – 50%**	Taux d'électrification **50 – 75%**	Taux d'électrification **75 – 100%**

2.3.1 Analysis of PAYGO market in Togo

The Togolese Government aims to ensure universal access to electricity at a rate of 100% by 2030 thanks to mainly solar energy. To achieve this, the national electrification strategy calls for the deployment of nearly 555,000 solar kits in approximately 1,970 locations. Indeed, the configuration of these localities does not justify their connection to the network. The strategy is also based on private sector involvement, as the public sector alone cannot mobilize the volume of investment needed to achieve the objectives. To date, the only project underway in Togo to commercialize solar systems using the PAYG model is the CIZO project.

Launched on 02 December 2017, the CIZO project aims to electrify 100,000 Togolese rural households in three years and 300,000 in 5 years via digitally funded domestic solar kits, financed in Pay-As-You-Go model by mobile money. This provision is part of the government's direction and the electrification strategy of combating the energy deficit in households, mainly in rural areas, as well as the digitalization of the energy sector.

The operators currently on the market in Togo are those who are recruited under the CIZO project. These are BBOXX and SOLEVA. These operators offer payment for up to 3 years and at the end of the payment, the kit becomes the property of the customer who has access to the activation code. Other companies and NGOs, including SOLERGIE, ENERGA AFRIQUE, ARESS, KYA Energy, etc. as well as NGOs such as JVE, Mivo Energy, have also opted for this PAYG payment strategy.

In line with the achievement of the various points of this path, and to promote the development of renewable energies, the law on the promotion of electricity generation from renewable energy sources in Togo was adopted in July 2018. This law aims to promote all forms of renewable energy, including the conversion of solar radiation and wind into electricity (art.2). It stipulates that the production of electricity from those sources, the activity of the public service, is regulated by the State and can be entrusted to a natural or legal person, private or public (art.4).

In line with Togo's electrification strategy presented in April 2018, the government has initiated, launched, and programmed several projects, the details of which are presented in Table 2 below.

Table 2. Public projects running and planned soon

Field of activities	Projects	Component	Funder	Objective of project	Duration of realization	Project area	Comment	Power (MW) 2018	Power (MW) Horizon 2030
A. Electrification rurale décentralisée (AT2ER)									
A.1	Rural electrification by individual solar kits (Solar Home Systems)								
A.1.1	Off-grid rural electrification project by domestic solar kits in PAYGO mode « CIZO »		Government/Private / Financial & technical partners	- Increase rural electrification rate from 7% to 40% by 2022, - Providing electricity to 300,000 households within 5 years or 2 million people - Providing electricity to 300,000 households within 5 years or 2 million people	2017 - 2022	5 regions of Togo	- Phase underway, - Nearly 6000 kits distributed to 30/11/18 by BBOXX. A second company SOLEVA is not yet active	Installed : 0,3 MW (2018)	Forecast power 2030 for solar kit projects: 85 MW

		Component A: Implementation of the platform of a national Pay-as-you-Go (PayGo) solar kit management	EU/GIZ	- Collecting data for national electrification statistics, - Making it easier for private distributors of solar kits to access the market, - Provide a reusable solution for mobile phone payment.	2018-2019	5 regions of Togo	Starting at 2019		
		Component B: Deployment of a national granular distribution network	SEFA/AFDB	- Providing mobile money services to rural populations using individual solar kits as sources of electricity, - Recruit and train 3,000 bank agents.	2018-2019	5 regions of Togo	Recruitment process underway		
		Component C: Regional solar academies creation in Togo (one solar academy per region)	SEFA/AFDB	- Creation of 5 solar training centers in the 5 regions of Togo, - Recruit and train 50 trainers and 3,000 solar photovoltaic installation technicians.	2018-2019	5 regions of Togo	5 solar academy created and training of 3,000 solar technicians in 2019		

		Component D: Social component	EU	- Introducing subsidies for disadvantaged rural households (25% of households), - Equip 3,000 small farms with solar pumps and electrify 1,000 health centers.	2018-2019	5 régions of Togo	Starting in 2019		
		Component E: Establishing a public fund to support distribution companies	-	- To give private operators installation subsidies to test and adapt their business model to the Togolese market.	2018 - 2022	5 régions of Togo	In studies		
A.1.2	Off-grid rural electrification project in 9 localities through the supply and installation of photovoltaic solar kits (phase 3)		CONSEIL DE L'ENTENTE	- Installation de 350 kits ménages, 1 health center, 2 community infrastructures, 3 solar lamps - Construction and equipment of a management structure	2018	9 localities	Realized	0,0191	
A.1.3	Electrification of 350 villages using photovoltaic		ISA (BIDC)	- Installing 70,672 solar kits for households, - Installing 10	2019	5 regions of Togo	Starting in 2019	2,695464	

	solar systems			solar street lights per locality - Installing 350 photovoltaic systems for schools and 150 for health centers; 357 drinking water supply (AEP)					
A.1.4	Off-grid rural electrification project in 300 localities through the supply and installation of photovoltaic solar kits		Seeking for funding	- Installing 16,760 solar kits for households, - Installing 6000 solar street lights - Installing 400 photovoltaic systems for community centers	2020-2021	Togo regions except maritime			
A.2 Electrification par mini-grid (AT2ER)									
A.2.1	Strategic technical, economic, and environmental feasibility studies for decentralized rural electrification by mini photovoltaic solar power plants in Togo		EU	- Collect detailed data on the demand and potential of the 317 pre-identified sites for mini-grids - Confirm the technical, economic, environmental,	September - Décember 2018	317 sites pre-identified in the electrification strategy			9 MW

				and social feasibility of the projects and their prioritization; have a well-developed tendering file for the selection of private partners					
A.2.2	Studies on public-private partnership for the development of mini-networks in Togo		GIZ/PROENERGIE	- Get an overview of PPP models that can be applied to mini-networks in general; -identifier adapted model in the context of Togo ; - have recommendations on how to structure the Togolese PPP model for mini-network			process underway		
A.2.3	Studies on the regulatory framework and the licensing process for		GIZ/PROENERGIE	- Have standardized licensing documents and			process underway		

	mini-network			procedures; - Getting a roadmap					
A.2.4	Analysis of applications of the productive use of solar energy in agriculture		GIZ/PROENERGIE		2018		process underway		
A.2.5	Decentralized rural electrification project of 62 localities in the 5 regions using photovoltaic solar systems in the Republic of Togo		BOARD	- Electrification of 62 localities by mini solar networks - Supplying and laying BT networks and connecting households	2019-2020	62 localities among the 317 sites identified in the strategy	Etudies underway		
A.2.6	The pilot project to install 3 mini-solar power plants		GIZ/PROENERGIE	- Construction of 3 mini-pilot grids geared towards productive use	2018-2020		Etudies underway		
B. Production (AT2ER)									
B.1	Scaling solar								

B.1.1	study		IFC	- Identifying geographical areas conducive to the development of PV power plants	2018	Togo	Study of the absorption capacity of the realized network (more than 100 MW can be connected to the grid); Study of potential realized; A study of the CEB's dispatching capacity carried out; carrying out the site identification study		100
B.1.2	Dapaong Solar Power Station		Research	- Help reduce the energy deficit, - Improve the share of renewables in Togo's energy mix.	2019-2022	Dapaong	Seeking for funding	30	

B.1.3	Blitta Solar Power Plant		Research	- Help reduce the energy deficit, - Improve the share of renewables in the mix énergétique du Togo.	3 years	Blitta	Etudies underway		
B.1.4	Kara Solar Power Plant		Research	- Help reduce the energy deficit, - Improve the share of renewables in the mix énergétique du Togo.	3 ans	Kara	Etudies underway		
B.1.5	Momé-Hagou Solar Power Plant		Research	- Help reduce the energy deficit, - Improve the share of renewables in the mix énergétique du Togo.	3 ans	Momé-Hagou	Etudies underway		
C.	**Ministry of Grassroots Development, Crafts, Youth, and Youth Employment National** Program for the Development of the Multifunctional Platform (PN-PTFM)								
	Solar Multifunctional Platforms Project		**Funding**: With funding from the Emergency Programme for Community Development (PUDC)-UNDP, the ministry			**Status**: The project is undergoing a pilot phase with the installation of four 10 kWc pilot platforms: a			

		launched a tender in 2017 for the supply and installation of forty (40) new 10 kWc solar multifunctional platforms to supply electrical energy to socio-community infrastructure (public primary schools and health centers) in rural areas.	(01) new all-solar multifunctional platform in the village of Toule 1 (Tchaloude Township, Blitta Prefecture, Central Region) and the hybridization of three (03) former standard multifunctional platforms by photovoltaic solar in the villages of Betoe (Canton of Ountivou, Ogou Prefecture, Plateau Region); Atchintsé (Atchintsé Township, Blitta Prefecture, Central Region) and Koumdé (Massedena Township, Doufelgou Prefecture, Kara Region).
D	**Pilot projects to produce electricity from renewable energy sources:** Construction and technical and commercial operation of a 5 MWc photovoltaic (PV) solar power plant by EIFFAGE & GREENWISH group		

2.4. Potential of solar energy in Togo

In terms of solar potential, Togo has considerable solar potential, the country being in an area of strong sunshine and where the solar radiation is fairly well distributed. The various measurements on real sites carried out using neural networks at different latitudes of the country by the Laboratory on Solar Energy of the University of Lomé and the Directorate of National Meteorology make it possible to estimate the global sunshine. The average sunstroke measured horizontally is estimated at 4.4 kWh/m2/d for Lomé, 4.5 kWh/m2/d for Tabligbo and Kouma Konda, 4.8 kWh/m2/d for Atakpamé, 5.1 kWh/m2/d for Sokodé, 5.2 kWh/m2/d for Kara, and 5.4 kWh/m2/d for Mango and Dapaong (Table 3). Power can exceed 700 Wc/m2, especially in the dry season when the sky is clear and the air humidity is low (SIE-Togo, 2007). The results show that the northern regions of the country are therefore the most suitable to host large-capacity photovoltaic solar power plants (Figure 7).

Furthermore, work carried out in 2013 by LAND RESOURCE on behalf of the CEB indicates that Togo has a good solar deposit with a minimum in the south-west Sake (potential 1300 hours of production per year) and a maximum in the north in the Sokode Parakou line (potential - 1450 hours of production per year), (LAND Resource / CEB, 2013).

Table 3. Average solar deposit of some Cities in Togo between 2002 to 2009 (kWh/m²/day)

Cities	Lomé	Tabligbo	Kouma Konda	Atakpamé	Sokodé	Kara	Niamtougou	Mango	Dapaong
Janvier	3,7	3,9	4,2	4,3	4,9	5,3	5,4	5,5	5,7
Février	4,4	4,6	4,7	5,0	5,5	5,8	5,9	6,0	6,1
Mars	4,8	5,0	5,1	5,5	5,8	6,1	6,1	6,2	6,3
Avril	5,0	5,1	5,1	5,4	5,7	5,9	5,8	6,0	6,1
Mai	4,7	4,9	5,0	5,3	5,5	5,6	5,6	5,7	5,7
Juin	3,8	4,2	4,7	4,8	5,1	5,2	5,2	5,2	5,3
Juillet	3,9	4,0	4,0	4,1	4,3	4,4	4,4	4,5	4,5
Août	3,8	3,9	2,9	3,6	3,8	4,0	3,8	4,3	4,1
Septembre	4,5	4,4	4,5	4,5	4,7	4,6	4,7	4,9	4,8
Octobre	4,9	5,0	4,8	5,2	5,4	5,6	5,6	5,7	5,8
Novembre	4,9	5,0	5,0	5,2	5,3	5,4	5,4	5,5	5,5
Décembre	4,2	4,3	4,4	4,6	4,9	5,1	5,1	5,2	5,2
Moyenne	**4,4**	**4,5**	**4,5**	**4,8**	**5,1**	**5,2**	**5,3**	**5,4**	**5,4**

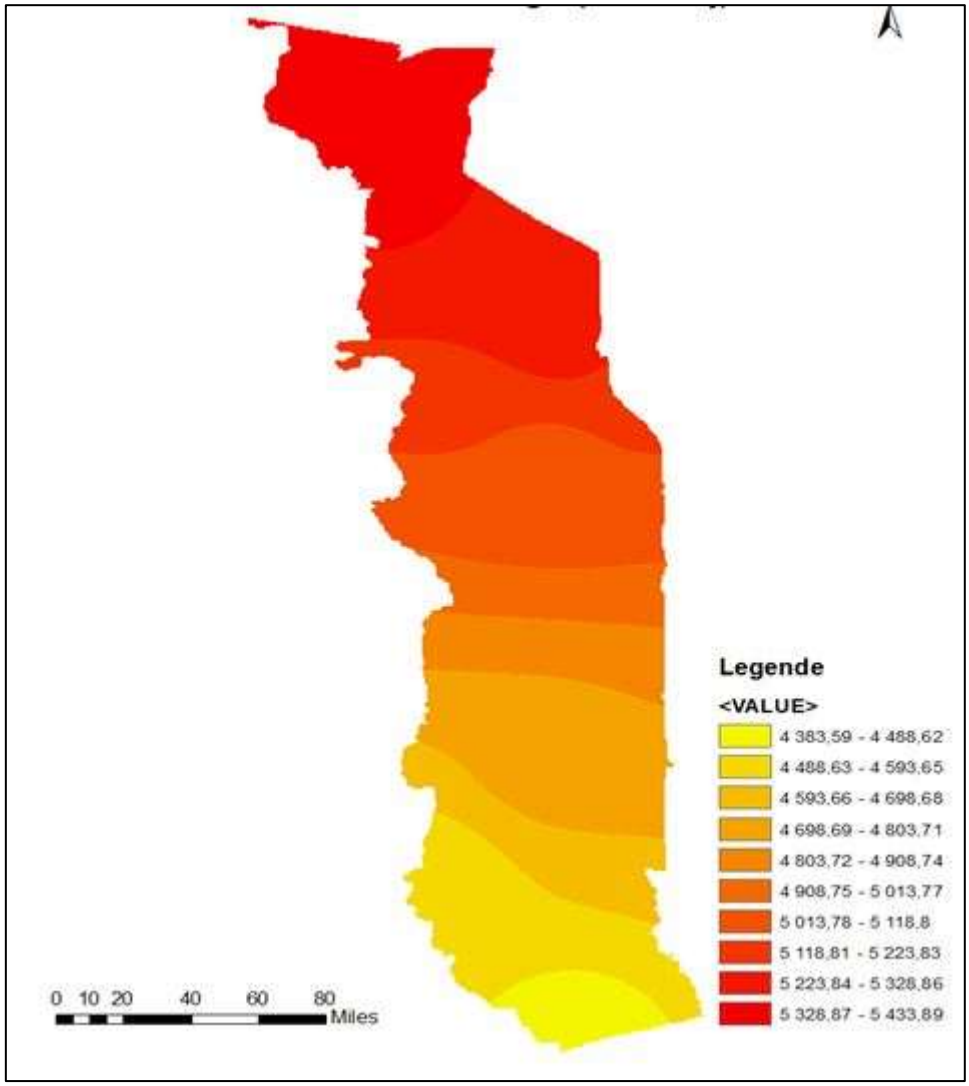

Figure 7. *Geographical distribution of the solar potential in Togo*

Concerning sunshine, the maximum and minimum ambient temperatures (in degrees Celsius) at the various weather stations are relatively high. Overall, average maximum temperatures are above 30 degrees Celsius for all weather stations except Kouma Konda, where its value is around 29 degrees Celsius. Minimum temperatures, on the other hand, range from 20 to 25 degrees Celsius throughout the year. The ambient temperature of a place depends, among other things, on the solar energy received by that place.

As a result, the highest temperatures are also found in northern regions correlated with sunlight. These regions would therefore also be suitable for solar thermal installations. However, it should be noted that these ambient temperature values provided by the weather services are indicative since the performance of solar modules is highly dependent on their temperature. There is not yet data on the temperatures of solar modules in real installation conditions in Togo. Work is underway at the Solar Energy Laboratory at the University of Lomé to study the behavior of solar modules in real-world locations in the country's various cities. The technical analysis by this technical assistance aims to provide more light on this.

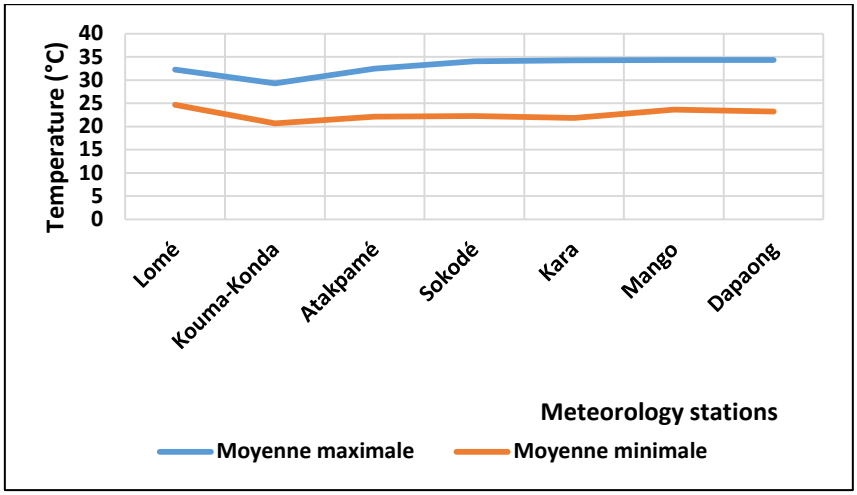

Figure 8. *Average temperatures of the various weather stations in 2002 à 2009*

Based on this potential of the solar deposit, its geographical distribution, and taking into account the existing electricity grid and the localities of Togo, the national electrification strategy has identified a mix of technological solutions most adapted to existing and projected demand for lower cost electrification (Figure 8). Thus, off-grid solutions are needed to connect 47% of households (including 4% by mini-grids and 43% by solar kits) not yet electrified if the energy for all target is to be achieved by 2030 (AT2ER, 2008).

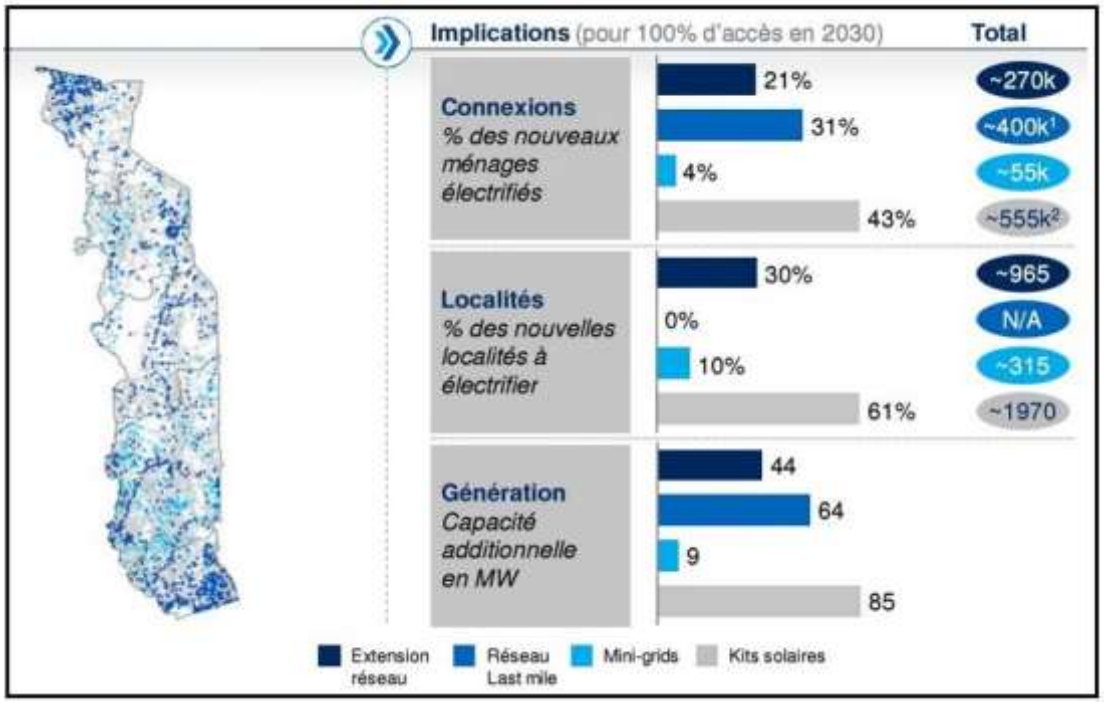

Figure 9. *Illustration of electrification technology choices by locality*

Source: AT2ER, 2018.

2.5. Current situation for the exploitation of Renewable Energy in Togo

2.5.1. Solar energy

The actual situation of solar installations indicates that modern solar energy use in Togo is still quite low to date. It is limited to a few projects to install streetlights, mini-grids, individual household solar kits, and drinking water systems. Precisely, there are 13,000 solar streetlights installed in the city capital of urban areasa, sub-urban areas and non-electrified cantons; 4 solar mini-grids (600 kWc), approximately 8,045 individual solar kits installed in more than 50 rural communities (6000 kits installed as of this date as part of the CIZO project, 1,745 PRODERE kits and 300 kits funded by the cartel council) and 19 solar-powered drinking water systems (AEP). Thus, the contribution of solar in electrification in Togo is still quite small, currently about 3%.

2.5.2. Wind energy

Wind energy is lagging further behind in Togo compared to solar. The only use that has been made so far is the pumping of groundwater by private individuals. In terms of projects, the only major project envisaged, not yet completed, was that of Delta Wind, a private developer who planned to install a 24MW wind power plant.

2.5.3. Hydropower

Hydropower is the energy produced by the fall or movement of water and harnessed through dams. Togo has only two operational hydroelectric dams, the Nangbeto dam, which is twice 35 MW, and the Kpimé dam, which has been two times 0.8MW and has been installed since 1963. However, several potential hydroelectric sites have been studied. According to the Study conducted by Tractionnel8, 39 sites have been identified, 23 have an individual potential greater than 2 MW, the bulk of which is on the Mono and Oti rivers. The potential capacity of all these sites is 224 MW, with an estimated potential production of around 850 GWh per year. In 2016 under the funding of the European Union a pre-feasibility study was carried out on all these sites and 8 sites with a capacity of 118 MW were identified including TITIRA AVAL and AMONT, SARAKAWA, DJAMDE, BAGHAN, SEREGBENE Kolocope, KPESSI, Wawa .

2.5.4. Bio-energy

In general, biomass aggregates all energies from the degradation of organic matter. Traditional biomass-energy (firewood, charcoal, wood briquette) can therefore be distinguished from biomass transformed into Biogas or Biofuel. Traditional energy biomass in Togo mainly includes firewood and charcoal taken from the forest and plant waste. It accounts for 76% of final energy consumption compared to 20% for petroleum products and only 4% for electricity (DCN, 2010). (SIE 2017).

Firewood is used more by rural households (75% or 347 kg/year/hab.), while charcoal is used largely by urban households (72% or 62 kg/year/hab.). The biomass sector in Togo is a large informal trading network for many women. Charcoal is the second-largest source of domestic energy and accounts for about 80% of the biomass-energy used. It is traditionally produced

using earth stones with very low yields (15-20%). The main sources of biomass energy production are semi-deciduous forests, dry dense forests, forest records, wooded and tree savannahs, shrub, and herbaceous savannahs.

Biogas is the gaseous effluent, mainly methane, derived from the fermentation of organic materials contained in landfills, sewage treatment plants, etc. Methane is a potent greenhouse gas and its capture is highly desirable anyway. It can be considered an energy resource, often through its combustion to produce steam and electricity. Biofuels (also called agrofuels) is composed of several sectors: biodiesel, ethanol. They come from the processing of different crops: sugar cane, corn, rapeseed, sunflower, oil palms, sorghum, cassava. They are mainly used for transport but may have other uses.

Besides, the Togolese government, aware of the stakes of the ENR, has an institutional framework and a policy on renewable energy following the renewable energy policy of ECOWAS (PERC).

2.6. Private sector and civil society organization

In Togo, there is a strong involvement of the private sector and civil society organizations in the development of renewable energy. There are about 98 of these structures, including 57 private companies in the whole country.

The main difficulties mentioned by the actors on the field (Technicians, engineers, consultants, etc.) are, in order decreasing in proportion as seen in Figure 10: the unavailability of funding (92.31%), the unavailability of quality equipment (54%), the lack or lack of training (42%).

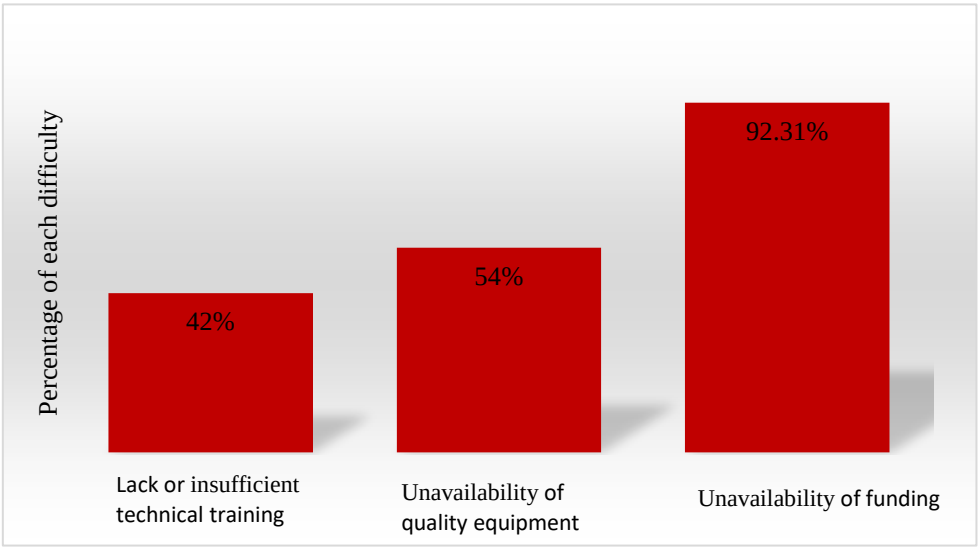

Figure10. *Difficulties encountered by the actors*

The main needs expressed by private actors are divided in descending order of importance as follows: the reduction or cancellation of taxes on equipment 100%, as mentioned by all actors the establishment of financing to help actors and companies (96.15%), the assurance of the availability of quality equipment (88.5%) and the establishment of programs and training centers (40%).

2.7. Analysis of the biophysical framework

On the biophysical framework, Togo has important solar, hydro, and biomass deposits for the development of renewable energy. There is a fairly detailed knowledge of the potential of this deposit. But the weaknesses of the biophysical framework lie in the low wind potential that is not favorable to large-capacity wind installations. Added to this is the lack of complete hydrological and meteorological data; this hinders a better understanding of potential risks and the sensitivity of sub-basins to climate change. Climate change is becoming increasingly evident as both an opportunity and a threat to the development of renewable energy. Thus, desertification, especially in the northern part of the country, could influence the distribution of precipitation in the sub-basins and therefore affect reserved flows (ecological flow).

2.8. Synthesis of strengths, weaknesses, opportunity, and threat (SWOT) of the renewable energy subsectors policy in Togo

Togo has many assets to boost the development of renewable energy as bin legally, institutionally, in the private sector and civil society as on the biophysical level. But there are also huge challenges to achieve this goal (Table 4).

Table 4. SWOT analysis of the renewable energy subsector

LEGAL AND POLICY FRAMEWORK	
Strengths	Weaknesses
- Commitment and real vision of the government - Existence of an energy policy letter - Existence of a strategy for electrification - Existence of law on renewable energies promotion - A favorable regulatory framework for renewable energy development - Existing incentives for public-private projects - Liberalization of electricity generation	- Not including biomass energy in the law on Renewable Energy - Application Text of the law on Renewable Energy is not Yet Available - The non-existence of a technology transfer program - Lack of national funds for renewable energy development - Non-existing funding for research in the renewable energy subsector - Lack of subsidies measures on imports of renewable energy equipment out of the public project - A regulatory framework that is not advantageous to smallholders
Opportunity	Threat
- Ratification of international and	- Difficult conditions for access to finance

regional agreements on renewable energy and energy efficiency - Availability and stated willingness of technical and financial partners for the development of renewable energy - There are funding mechanisms in connection with multilateral agreements; - Several donor initiatives for the renewable energy sector exist; - Competitiveness of renewable energy technologies and price accessibility; - Ease of benchmarking in the field of renewable energy.	- Poor equipment quality from China
INSTITUTIONAL FRAMEWORK	
Strengths	Weaknesses
- The existence of a ministry in charge of energy - AT2ER operationalization - Availability of human expertise and expertise in the field of solar - There is a center of excellence in energy	- Lack of cooperation between universities and energy ministries - Lack of collaboration between ministries and local authorities in the renewable energy subsector - Inadequate development of public-private partnership in the renewable energy subsector - Lack of high-level renewable energy training framework - The non-existence of decentralized services in the energy sector
Opportunity	Threat
- There is a favorable business creation environment	
PRIVATE SECTOR AND CIVIL SOCIETY	
Strengths	Weaknesses
- People's enthusiasm for renewable energy - The strong involvement of CSOs and the private sector in the development of renewable energy - Availability of Local expertise - Growth in electricity demand, especially in rural areas	- Insufficient local expertise - Lack of private sector support funding - Difficulty accessing bank guarantees - Tax too high on solar equipment - The inadequate organization of actors

Opportunity	Threat
BIOPHYSICAL FRAMEWORK	
Strengths	Weaknesses
- There is a solar field favorable to the development of solar energy in all regions - There is a water system that supports the development of micro and macro hydroelectric dams - Biomass deposits for the development of modern bioenergy - The results of many renewable energy pilot projects	- Weakness in wind potential - Lack of hydrological and complete weather data
Opportunity	Threat
- Climate diversity conducive to the development of biomass-energy and solar power	- The increasingly evident manifestation of the negative effects of climate change posing a danger to renewable energy installations - Desert advance especially in the north of the country

2.9. PAYG Lessons and Key Considerations from Around the World

2.9.1 Consultative Group to Assist the Poor (CGAP) Recommendations

The Consultative Group to Assist the Poor, an independent think tank that aims to promote development in the developing world outlines some key components of making PAYG systems work in sub-Saharan Africa[5]. These are obtained as part of the Financial Inclusion on Business Runways (FIBR) research to increase the affordability of PAYG solar systems. These considerations are as follows:

2.9.1.1. Longer Loans:

Extending loan tenors is a common and effective way of improving affordability. An elongated loan tenor greatly reduces the cost of energy per unit time and increases the demographic to which it is appealing. However, this strategy has its drawbacks affecting the consumers and energy or finance provider. Consumers face interest rates that are sometimes higher than typical and often ambiguous. The devices they own also wear out after a few years which seems to be a characteristic of the majority of the relatively affordable systems. For the provider, the challenge of repayment risks becomes more eminent.

2.9.1.2. Smaller Deposits:

Initial costs are a huge barrier to energy access for the poor. Numerous households cannot afford the steep cost of initial deposits but can often comfortably pay in small sums over time. The risk with this approach as a solution is that majority of users in these situations do not have credit histories backed by formal financial institutions. As such it could lead to nonperforming loans. Albeit this might be the case in our recent study at the Institute for Global Climate Change and Energy, Kyungpook National University, we argue that credit histories of individuals in organized savings groups – which often recover over 90% of member loans – can be used to expand the reach of these systems.

2.9.1.3. Flexible Loan terms:

Flexibility is seen as one of the core drivers of PAYG adoption. Since numerous individuals have erratic sources of income with no fixed payment dates, flexible repayment plans that do away with fears of repossession and shame attract more users. However, this also has its drawbacks and one is that paying on time subsidizes late payment and as such becomes unsustainable in the long term.

2.9.1.4. Push Volumes Not Margins:

The tendency to focus on products with a larger profit margin by the providers of PAYG solar systems by promoting incentives to their resellers and marketers on those products is a huge barrier to the adoption of smaller margin products. To push the sale of products with a smaller margin, the providers would need economies of scale which is capital intensive, and therein lies the challenge.

2.9.2 United Nations Framework Convention on Climate Change Report on Kenya and Peru

In Kenya, the focus was firmly placed on small businesses and entrepreneurs. In peri-urban locations in Nairobi, over 1,500 small-scale enterprises keyed in to purchase high-quality PAYG solar products at different price points[6]. The variation in pricing is a key promoter of acceptance as it caters to multiple income levels and behaviors. This is echoed in the Harvard Business Review magazine article on pricing[7] which explains how pricing helps drive purchases.

Peru’s approach was to support and build distribution infrastructure. Approximately 50 PAYG solar system distributors, distributed over 4,000 solar-powered products reaching almost 20,000 homes[6]. This used the bus network to reach more consumers. The reliance on existing structures like bus systems depicted the innovative ways by which PAYG models are applying already existing structures to the issue of energy access.

In both approaches, the decision to develop different segments of the market helps connect funding from the private and public sectors to small-scale businesses and consumers. The model has proven to be scalable and applicable in places with carrying socio-economic realities.

3. PAYG business model

The business model proposed in this report is targeted at places with existing mobile money platforms and mobile telecommunications penetration while considering their lack of energy access in such rural settings.

The model aims to improve energy access including its attendant co-benefits and minimize the cost of the initial energy investment.

Two models are proposed. One mostly carters to business clusters, housing apartments or estates, and medium to small-scale commercial consumers. The second is targeted at providing energy for individual consumers. Both models are delineated below (Figure 11):

3.1 PAYG model A:

This model leverages complex financial systems and sources of credit to provide the initial capital needed for solar PAYG systems. It considers the enormous risk manufacturers and suppliers of the system would face otherwise and recommends a best-case scenario that offers wins for both suppliers and consumers. It requires the presence of willing capital in form of government support, development bank, or multilateral financial institution grants.

In this model, energy suppliers and energy consumers after reaching an agreement on how much energy is required, agree on the exact system that would provide adequate energy. The energy system is costed and a timeline for completion and delivery is designated. Details of funding and need are presented to a development bank or government agency that guarantees the consumer in the event of a default. The PAYG system is delivered and the consumer makes payment to the supplier as agreed. Typically, these systems are prepaid and metered by units of the local currency per KWh. This model is adopted by farming clusters, business colleagues, or strings of community-based organizations is very effective.

It is possible to improve this model by including aspects that are outside of the traditional PAYG model. However, if these changes are made, it greatly improves the model and increases the opportunity for communities to gain access to energy. One such recommendation is that a loan facility is included in the PAYG model, this capital injection goes to the project developer, paid on behalf of the consumer by a development bank or government agency. This could be for part ownership of the system, to cover the cost of metering systems or an upfront payment of guarantee, or for initial construction costs in cases of larger systems. An advantage of this is that it removes the limit of PAYG applying to only small-scale systems.

3.2. PAYG model B:

Model B relies on mobile technology and where possible fintech solutions leveraging blockchain technology. In this model, energy systems and meters are supplied to end-users who pay using mobile money through prepaid or in the case of employed individuals; automatically deductible accounts. Low-cost meters are recommended as these systems are usually used by low-income individuals. Systems deployed in this model will be of two types,

mobile systems strictly for lighting and in cases of higher wattage, fixed systems. Fixed systems require agreements of fair usage, maintenance, and ownership rights between the user and supplier. In the case of fixed systems, a path to ownership can also be included as an incentive. Again, if a multifaceted finance structure is applied instead of a strict PAYG business model, it is possible to obtain better results.

In this case, we recommend a model that utilizes mobile service providers or banking institutions as the supplier instead of the main energy company. Funds from international development institutions can be applied to this to provide no-interest loans for individuals with proven capacity and willingness to repay. This loan once replenished can be reused by others.

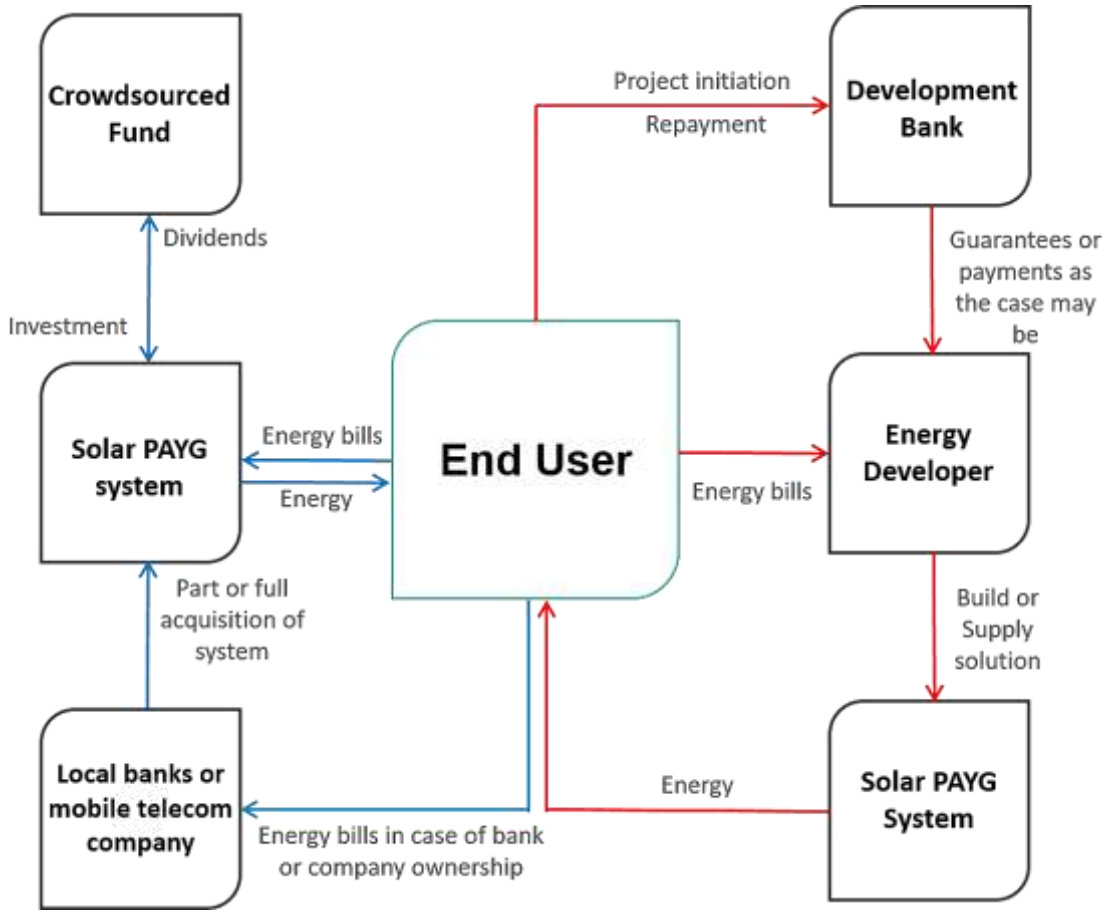

***Figure 11**. Business model structure for Model A (red) and Model B (blue)*

Models: Summary

Predicting a near future of stifled global funds, it is pertinent to consider new avenues for financing for the proposed business models above. Crowdfunding is one way of dealing with the shortage of capital, because of its robustness and ability to aggregate considerable amounts of funds from all over the world[8]. Typically, not much is raised from crowdsourced funds but the similar application of crowdfunding in Nigeria[9] and other parts of East Africa have shown great promise and have been exemplary. In addition, strategically

including Africans in the diaspora in raising crowdsourced funding is guaranteed to increase the chances of success. This is informed by the willingness of this demographic to invest in Africa and their record remittance figures to the continent, estimated at $40 billion annually since 2010[10].

The benefit of both models is that they cater to the needs of both commercial and domestic energy users. They provide an arguably better application of ODA funds and grants while also relying on the PAYG models to enable low-income individuals and businesses to afford clean and renewable energy.

Critical Success Factors

These models are not to be taken as silver bullets that solve every problem. They represent the possible outcome in an ideal implementation. For these goals to be achieved, there are key factors that must be considered and accounted for as outlined below.

- Availability of government or development finance to energy development.
- Institutional and legal support from relevant organizations and government agencies e.g. legislation or a defined national PAYG solar policy
- Commitment to implementation and ratification of policies and agreements.
- Improvements in data collection, knowledge sharing, and synergies between institutions and stakeholders
- Standardization and approaches to guarantee ROI. e.g. metering and adopting monitoring systems to prove against vandalism and tampering.
- Compulsory monitoring, reporting, and performance requirements

4. Recommendation

Based on the results of the diagnostic analysis of tossing the renewable energy subsector in Togo, some recommendations deserve to be formulated to boost the development of this subsector for universal access to energy by 2030. These include:

- Ensuring shared energy governance: Providing an environment conducive to investment, decentralized energy solutions, and innovation.

- Completely exempt taxes on the importation of solar equipment: despite the government's efforts to exempt VAT from the import and sale of solar equipment, their prices remain unsuitable for the Togolese population (according to the actors surveyed). To encourage a transition to clean REs in rural areas, a total tax exemption will be needed, which will make the price very affordable for the population;

- Combating energy insecurity in Togo by subsidizing rural household facilities: it is in rural areas that there are more poverty and precarious access to electricity;

- Establish a national plan that brings together development finance institutions, the private sector, and national stakeholders to align energy sector budget allocations to support investments in energy access;

- Enact coherent and predictable regulatory reforms that Technical and Financial Partners and the private sector must adhere to accelerate the transition to sustainable energy by developing the sector, strengthening investor confidence, and freeing upflows (such as the National Energy Policy, which has yet to be finalized, the Energy Efficiency Act to be drafted and adopted);

- Adopt an inclusive gender strategy to unlock investments in the country's energy sector that include the talents of men and women. Donors, investors, and development agencies will turn to governments to provide the necessary conditions for gender and social inclusion throughout the energy value chain;

- Adapt business and investment models related to the country's context to build on the experience and lessons learned from freeing up investment in the sector.

- Making AT2ER, the champion of the promotion of EnRs in Togo: Equipping and strengthening the AT2ER to fully play its role as File Leader, Focal Point, Mobilizing Agent, Catalyst for Investment and Guarantee of Quality Control in the Sector.

- Building on the Potential of the GENRE approach: Togo's lack of sustainable energy infrastructure offers a new opportunity to build the sector in a gender-based way that leverages the talents of the entire population and avoids certain male-dominated structures already replicated in the energy sector in more developed countries.

- Focus on job creation through training and research.

- Decentralise the effort to promote distributed renewable energy by supporting energy planning at the local and sectoral level: The electrification strategy would only succeed within the framework of a citizen-inclusive and shared scheme;

Current policy initiatives in these sectors are not enough to stimulate the transition from fossil fuels to renewable energy. This involves training executives and technicians, upgrading or modernizing infrastructure; raising awareness of renewable alternatives to combat reluctance to change and lack of consumer confidence. These barriers, which are not exhaustive, can and should be removed through programs and political support, including awareness campaigns, training projects, and renewable incentive strategies.

5. Conclusion

This study provided diagnostic analysis of Togo's energy sector with a particular focus on renewable energy. This analysis shows that the energy sector is dominated by biomass-energy, which accounts for 75.5% of the national energy balance in 2017. Hydrocarbons account for 18.9% and electricity 5.6%. The total energy is consumed at 73.5% by households.

Access to electricity remains low, with a rate of 40% in 2018 at the national level, of which less than 10% is in rural areas. Total electricity supply increased from 1,390 GWh in 2013 to 1,651 GWh in 2017. Global electricity demand is projected at 1,543 GWh in 2018, 1,867 GWh in 2020, and 2,260 GWh in 2022. The primary production of electricity is based on fuel and hydraulics, although Togo is not a producer of hydrocarbons. In 2017, electricity generation was at 804,898 MWh, of which 74% is fuel-based (593,808 MW) and only 26% hydropower-plant (211,090 MW). National electricity production, therefore, accounts for 48.8% of total supply in 2017. The rest of the supply is supplemented by hydroelectric imports to the tune of 51.2%, reflecting Togo's dependence on the outside world in terms of electricity, while the country has a high potential for hydroelectricity. Apart from the Nangbéto and Kpimé sites (currently operated), as well as the Adjarala site (planned for exploitation from 2020), Togo has more than a dozen potential sites whose hydrological characteristics in the context of climate change allow the installation of macro/micro-hydroelectric dams. These are the sites of Titira, Sarakawa, Tetétou, Baghan, Kolo-Kopé, etc., for macro dams and those of Landa-Pozanda, Sika, Fazao, Koutougou, Malfakassa, etc., for micro dams. Exploiting the country's hydroelectric potential will reduce its dependence on energy importation.

The contribution of solar in electrification in Togo is currently about 3%. But several projects are planned and some are already underway to rapidly increase the share of solar in the national energy mix. Throughout the country, the most popularised solar equipment or products are the SHS (32%), followed by torches and recharable lamps (26%), streetlights (21%), and solar kits. The potential of the solar deposit is very high and follows an increasing gradient from south to north ranging from 4.4 kWh/m2/d for Lomé to 5.4 kWh/m2/d for Mango and Dapaong through 5.1 kWh/m2/d for Sokodé and 5.2 kWh/m2/d for Kara. This solar potential is conducive to large solar installations, but projects for high-capacity photovoltaic and thermal solar power plants should focus primarily on the northern regions. About 27% of the players working in the field as solar technicians have not received any training on solar technology and 29% of the solar installations encountered in the field do not meet the required standards. This poses a need to build the capacity of the actors in the field of solar.

This solar potential is conducive to large solar installations, but projects for high-capacity photovoltaic and thermal solar power plants should focus primarily on the northern regions. About 27% of the actors working in the field as solar technicians have not received any training in solar and 29% of the solar installations encountered in the field do not meet the required standards. This poses a need to build the capacity of the actors in the field of solar. Finally, Togo has enormous potenatial for the development of renewable energy. These energies are one of the best ways to develop sustainable and low-carbon products. But this requires technology transfer, training, and capacity building of actors (technical; private, public and NGOs, etc.) with a focus on innovation.

Following the surge of PAYG energy systems, it is expected that interests will be piqued. This analysis of best practices and consequently a business model recommendation is made in

consideration of Togo's economic landscape and the best practices of PAYG implementation following analyses and recommendations from foremost organizations in the sector.

While we found that Togo scores relatively high for ease of doing business, critical factors need to be addressed to successfully implement a solar PAYG solution. This will require policy changes from the national government and other tiers of government. A systemic approach is also recommended as this ensures better decision making. Without systemization, there are bound to be waste and poor information exchange as concerns implementation.

Key considerations depict that long term loans, reduced deposits, flexible loan repayments, a shift in focus from margins to volume as well as developing market segments are all vital to the adoption of PAYG business models.

Generally, the adoption of mobile money, willingness to pay and gaps in energy supply tend to be the biggest pointers for PAYG success. For Togo, an improvement in data collection to answer these questions will also play a critical role.

It is worth noting that the coronavirus pandemic will also affect the ability of governments around the world to respond to issues, including Togo. Attracting international development finance will be harder as funds have been diverted to deal with the pandemic, leaving little for countries relying on this finance mechanism.

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