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SOLAR ENERGY POWER SECTOR IN ETHIOPIA

Prathibha.E[*1], Mesfin Megra[*2]

[*1]Asst. Prof, Department Of Electrical Power And Control Engineering, Adama Science And Technology University, Adama, Ethiopia.

[*2]Sr. Lecturer, Department Of Electrical Power And Control Engineering, Adama Science And Technology University, Adama, Ethiopia.

ABSTRACT

Ethiopia is encountering expanded energy utilization and unable to meet the demand for the past few years. In such a manner, the Ethiopia government had an essential goal in the vitality division like the Transformation Plan period (GTP) and to satisfy the need for energy in the Nation by giving adequate electric power supply that satisfies international guidelines consistently. Despite all this, the country facing challenges in the present and future energy sector, especially in rural areas since the lack of grid facility. So, this leads to the development of substitute energy sources like solar, wind, geothermal could be a crucial piece of Ethiopia's energy mix and incorporated with the country's new Climate Resilient Green Economy (CRGE) Strategy. The said mix has the ambitious goal of changing Ethiopia into a Climate flexible green economy by 2025. Authors have described the thorough overview on the Ethiopian energy sector, along with previous history and present situation. The paper discussed mainly on the solar energy power sector and its major customers and demand for off-grid PV potentials and also Key factor for Solar PV actors, significant activities, Ethiopia key targets, a policy framework for future energy. It, despite everything, should be perceived how effective the large-scale projects will end up being. Nevertheless, trusts are high and with huge players intrigued by the market on its approach to taking its solar energy sector to the next higher level.

Keywords: Energy Power Sector, GDP, Key Targets, PV Potentials, Solar Energy.

I. INTRODUCTION

Ethiopia is situated in the Horn of Africa and is among one of the quickest, creating countries on the mainland. The Nation flaunts an incredibly reasonable GDP development rate somewhere in the range of 7 and 10% in recent years, making it the quickest developing economy in the area with one of the most noteworthy GDP development rates in Africa.

Despite Ethiopia's plenteous common assets and massive vitality potential, the Nation is encountering vitality deficiencies as it battles to fulfill the developing Electric power need, which is anticipated to develop by around 30% every year. The advancement of Ethiopia's capacity parts is driven by the Growth and Transformation Plan (GTP), which means to reform the Nation into an income state by 2025. The GTP I was set up in 2010 and incorporated an objective of quadrupling the Nation's Electricity generation from 2 GW to 8 GW. Even though the execution missed the mark concerning this objective, aspirations stayed high. This drove the legislature to dispatch GTP II in 2016, setting a general objective of 17.3 GW by 2020. These desires consolidated brought about the development of a few large hydro, solar, and wind power projects.

The improvement of Ethiopia's sustainable power source part has been one of the leading new drivers of financial development in the Nation. Its sufficient assets and aggressive zap targets, along with its generally elevated level of industrialization like contrasted with other African countries to make it a prime area for speculators in renewable. The administration of Ethiopia considers private interest in its sustainable power source area as necessary to the achievement of its aspiring GTP II. This has empowered particularly coordinated towards the advancement of the Nation's young solar-based photovoltaic (PV) sector [1].

II. ETHIOPIAN ENERGY GENERATION BY DIFFERENT SOURCES

The Ethiopian government is focusing on building power access from 26% (2014) to 60% by 2040. Furthermore, the upgrade in the proficiency of existing vitality sources is another objective. To satisfy these driven plans, the Ethiopian government persistently arranges new financial-related assets from China alongside the customary assets from the World Bank. The Universal Electricity Access Program (UEAP) has been created to give Electric power access to the more significant part of the country territories. By and by, Ethiopia has a

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complete power generation installation of around 4238 MW. Hydroelectric plants create about 90% (3807 MW). Also, wind, geothermal, and diesel power plants creates 324 MW (7.65%), 7.3 MW (0.17%), and 99.17 MW (2.34%) respectively [2]. The percent division of creation by various sources appears in Figure 1.

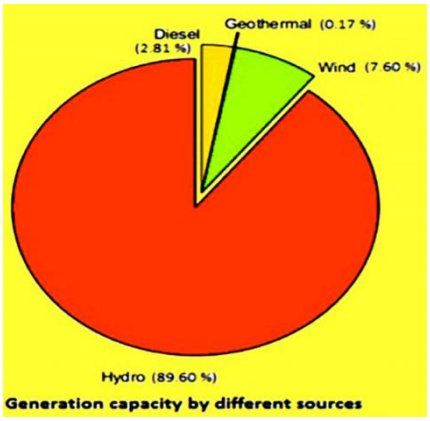

Figure 1: Ethiopian energy generation capacity by various sources (%)

Ethiopia is honoured with a lot of sustainable power sources, for example, hydroelectric potential, wind, solar-powered, and geothermal just as diesel. Even though there is an extraordinary chance of sustainable power generation, just a modest quantity of reestablishment vitality is created because of less financial related issues and other significant variables. Still, Ethiopia is very nearly a sustainable power source insurgency; it requires extensive help in the fields of wind, geothermal, solar-based, and biomass. These sources can be utilized as long haul vitality possibilities international energy exchange. For that reason, the Ethiopian Electric Power Corporation has created different designs to accomplish 75% vitality access. Like other sub-Saharan nations, Ethiopia needs satisfactory power creation and equivalent vitality to get-up. Urban populaces have significant access to power, while the enormous populaces dwelling in the rural zones have less access to power. Figure 2 presents the jolt access in Ethiopia.

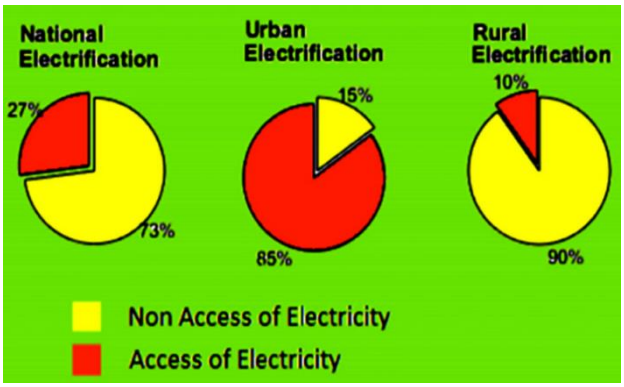

Figure 2: Electricity access in Ethiopia

The energy production expected in the financial year 2015-16 is approximately 10311807 MWh [4]. The production of the plants in the year twenty fifteen twenty sixteen (Table1)

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Table 1: Ethiopian energy production in 2015-16

		Energy Production (MWh)				
No.	**Power Plant**	**Hydro**	**Diesel**	**Geothermal**	**Wind**	**Total**
1	**Adama I**				174375	174375
2	**Adama II**				378194	378194
3	**Amerti Neshie**	128360				128360
4	**Ashegoda**				226585	226585
5	**Awash II**	66185				66185
6	**Awash III**	65493				65493
7	**Dire Dawa (Mu)**		1110			1110
8	**Finchaa**	819188				819188
9	**Gilgel Gibe I**	891941				891941
10	**Gilgel Gibe II**	1955551				1955551
11	**Gilgel Gibe III**	1709491				1709491
12	**Tana Beles**	2925792				2925792
13	**Koka**	45267				45267
14	**Meleka Wakena**	273383				273383
15	**Tekeze**	619542				619542
16	**Tis Aby II**	27036				27036
ICS Sub-total		**9527229**	**1110**		**779154**	**10307493**
SCS Sub-total			**4314**			**4314**
Grand-total		**9527229**	**5424**		**779154**	**10311807**

In 2018, the majority of Ethiopia's 4.5 GW of generation from 14 hydropower plants, which represent 85% (3.8 GW) of the Nation's absolute limit making it the principal vitality source. Other than hydro power, the Nation additionally has 324 MW generation from three wind power plant, and a couple of diesel plants are around 143 MW capacity, with the rest being generated by solar power plant (14 MW), geothermal force (7.5 MW). Its hydropower plants will remain the primary wellspring of base burden power. Anyhow, they should be bolstered by unreliable sources, for example, wind and solar-based, to have the option to manage peak load. Different power generation capacities by 2018 are as shown in Figure 3[1].

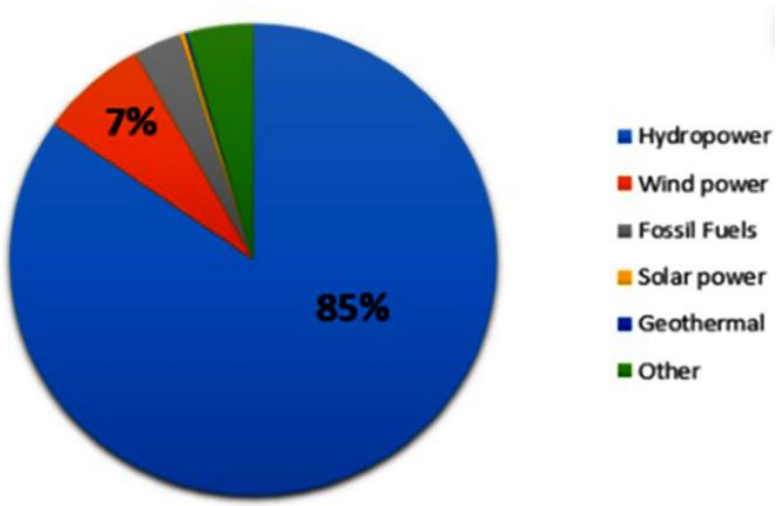

Figure 3: Ethiopia's Power generation mix of 2018

III. SOLAR PV POTENTIAL IN ETHIOPIA

Ethiopia has substantial renewable and non-renewable energy resources like Hydropower, Solar, Wind, Geothermal, and others. The graphical representation of the availability of different energy sources in entire Africa and Ethiopia is as shown in Figure 4[5].

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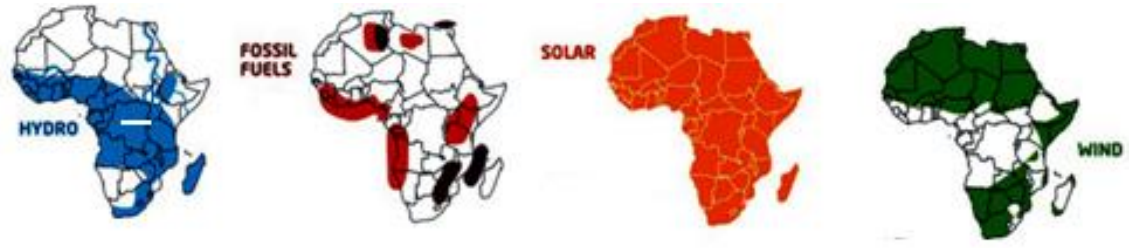

Figure 4: Graphical representation of energy potential in Africa and Ethiopia.

In considering the severe extent of solar PV potential in Ethiopia, The Nation's irradiation levels around 5.2 kWh/m2/day, which give the ideal conditions to the improvement of utility-scale PV plants. Since the Ethiopian government needs to have in any event 500 MW of introduced solar limit by 2020, it should increase the solar power generation to meet its yearning objective. This opens up incredible open doors for mini-grids and stand-alone solar systems to help make this eager objective a reality. Ethiopia is about 5 MW power from off-grid solar. Majority of solar power is utilized for Ethio telecom. Remaining little percentage power will be used for health care, village well pumps, and school lighting, which are shown in Figure 5.

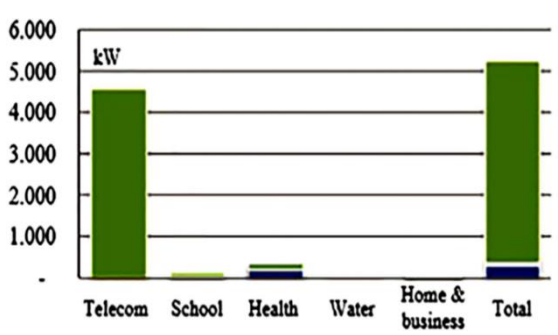

Figure 5: Major Distribution of solar power

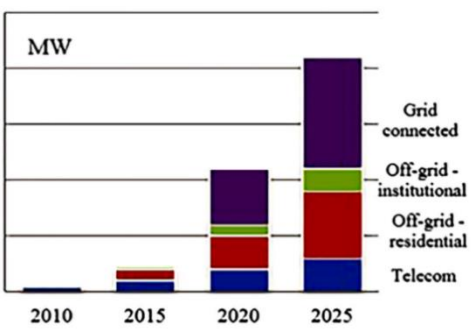

Figure 6: Solar demands from 2010 to 2025

Solar based power division in country like Ethiopia is for rapid development in off-grid and grid- applications. Grid-connected solar is expected to be a important market in Ethiopia and PV is likely to become grid competitive. The demand for PV in concerning off-grid and grid-connected are shown in Figure 6 [7].

IV. SOLAR PV ACTORS AND ACTIVITIES

PV actors are extensively classified into 3 division (i) Telecommunication, (ii) government and NGOs, and (iii) private driven sector. The Telecom sector is biggest and mainly administrations are given for the foreign telecom temporary workers. Solar PV systems mainly for NGO and government ventures are given by outside and local solar organizations; neighborhood privately owned business activities have been constrained to an establishment in the more prominent activities. Around fifteen privately owned businesses disseminate solar system in Ethiopia. Five of these organizations represent over 80% of the frameworks provided or introduced (barring Telecom frameworks). The job of privately owned businesses had been constrained to items gracefully and service to government and NGO ventures preceding 2000. Even though legislature and NGO contracts are as yet imperative to their business, privately owned businesses are presently increasingly dynamic in advancing PV in provincial territories, especially for home use. The major PV sector actor and activities by 2011 (Table 2) [6]

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Table 2: Major PV sector actors and activities during 2011[6]

Project	Size (kWp)	Description	Application
Ethio Telecom	4,600	Up to 15kW per mobile station	Increased rural connectivity, access to information,
Rural Electrification Fund (REF) – Solar Home Systems	40	1,111 Solar Home Systems installed	Provide lighting service for 1,111 off-grid rural households, better lighting improved education, access to communication through radio/TV, reduced indoor air pollution due to kerosene lamps
REF – Institutional PV-1	124	345 Institutional solar PV systems installed	345 off-grid rural health posts electrified with solar PV system, improved health services
REF – Institutional PV-1	92	300 Institutional solar PV systems installed	200 rural health posts and 100 rural schools in off-grid areas electrified with solar PV system, improved health and education services
REF – Institutional PV-2	55	270 Institutions solar PV systems installed	270 rural schools in off-grid areas got access to electricity using solar PV systems
REF Solar Home Systems - 2	1,250	25,000 Solar Home Systems; size ranges 20Wp to 130Wp	
GIZ Energy Coordinating Office (ECO)-1	155	100 Institutional systems installed; 1.4kWp to 1.7kWp	100 rural health clinics in off-grid area are electrified with solar PV system. Provide better health service for 24 hours a day.
GIZ-ECO-2	8	5 community battery charging systems; 1.53kWp each	Increased access to electricity through solar PV systems. Replaced kerosene lamps, improved education, reduced indoor air pollution
Solar Energy Foundation (SEF)		Solar home, community and institutional systems	11,012 Solar lanterns; SHS 8,872 for households, small enterprises, schools, clinics, churches, mosques, community houses etc. 5.5kWp water pump for Rema community 6kWp water disinfection system in Rema 7 x 80Wp solar street light systems in Rema 2kWp for Solar Training School in Rema 9kWp Solar system for Solar Valley Addis (Int. Solar Energy Institute)
Plan International Ethiopia - EU grant for energy access	85	Institutional PV and Community system	15 rural schools, 12 health posts and 13 solar pumps in off-grid rural areas were installed. Improved education, evening classes, improved access to potable water, improved health services to rural communities.
Menschen für Menschen (MfM)		Solar home and institutional systems	1,314 x 10Wp Solar systems and 144 x 20Wp systems for rural schools 29 health posts with 260Wp solar system for medicine cooling and light

Source: ERG.

V. THE SOLAR PV MARKET POTENTIALS

Interest for PV has been developing in Ethiopia in the course of the most recent ten years. A portion of the real economic situations that have prompted current PV showcase development incorporate the accompanying. Authoritatively, access to power is assessed at 22 % with a genuine association pace of just around 6 % across the Nation. This leaves large areas of off-grid networks unelectrified by the matrix. Given the disseminated idea of solar, a decent segment of this market could be served to utilize PV innovation. The general Ethiopian economy has been developing by more than 10 % for as far back as quite a while in succession. So also, send out re-direction of the administration arrangements have brought about a consistent ascending of pastoral livelihoods during a similar period [7].

Endeavors made mutually by the Ethiopian government, and universal givers to construct showcase framework for solar-based PV commercialization have prompted developing mindfulness, some specific limit, and production of linkages between different players in the business. For example, somewhere in the range of ten years back, mindfulness about solar PV innovation among country networks in Ethiopia was none existent. Because of endeavors made and local Legislatures of Oromia and Southern Ethiopia, at present, more than 33% of the rustic networks have utilized solar PV system. Analytical matrix of the prospective market for solar off-grid systems in Ethiopia (Table 3)

Table 3: Solar PV off-Grid Market Potential in Ethiopia

Market segment	Basic Potential market size	Estimated financial volume (million €)
Solar home systems	38 MW	400
Small Scale commercial	1 MW	>10

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Off-grid schools	3.6 MW	40
Health institution	4.6 MW	50
Community water supply	2 MW	20
NGO power	0.1 MW	1
Isolated grid and rural grid	1.5 MW	15
Telecom	>2 MW	>20
Tourism	0.5 MW	5
Total	**52.3 MW**	**500**

In order to summarize, the total possible market for solar PV in Ethiopia is evaluated to be around 52 MW. Right now, the assessed advertising infiltration rate is around 8 % of the potential. More than seventy-five percent of the undivided interest originates from the household segment remotely followed by the health sector, rural schools, and the telecom business. As per And so forth's short to medium term provincial availability plan, the assessed PV showcase in the telecom part is probably going to immerse over the coming five years or somewhere in the vicinity. In any case, this does not imply that the showcase for the provincial telecom availability is completely depleted. With quickly developing urbanization and improving provincial wages, interest for solar PV to rural telecommunication in off-grid areas is relied upon to keep developing. At present, water supply and institutional PV markets are financed for the most part by givers. Out of an expected likely market of around 10 MW in the network and institutional PV showcase, just a little division (around 1 %) is at present served. Since the central part of the market is yet to be tapped and financing is well on the way to originate from benefactors, request in these segments will keep on giving genuinely intrinsic motivators to the business PV market development [8].

Lighting Africa program structured the Market Improvement for Sustainable power source and Vitality Effective Item Credit Line, which is a rotating, store giving advances to private area undertakings and microfinance establishments to extend the neighbourhood sustainable power source market. In a joint effort by the Advancement Bank of Ethiopia, the World Bank Electricity Network Rehabilitation and Enhancement Project (ENREP) built up in 2013 with US$20 million and multiplied the credit line to US$40 million [9]

VI. ETHIOPIA KEY TARGET AND POLICY INITIATIVES FOR FUTURE ENERGY

2019 Africa Energy generally exhaustive and complete vitality over the African landmass, it incorporates energy profiles of eleven nations that speak to seventy-five percent of the district's GDP and vitality request. Some of the policy and key targets (Table 4) [10]

Table 4: Ethiopia Policy and critical targets

POLICY	KEY TARGETS AND MEASURES
PERCENTAGE TARGET	National Electrification program(2017), 100 % Electrification in 2025, with 35% off grid and 65% grid, while extending grid to reach 96% grid connection by 2030.
INDUSTRIAL DEVELOPMENT TARGETS	Achievean annual average real GDP Growth rate of 11% within a stable environment and become a lower-middle-income country by 2025
	Focus on ensuring rapid, sustainable growth by enhancing the productivity of the agriculture and manufacturing sectors and stimulating completion in the country

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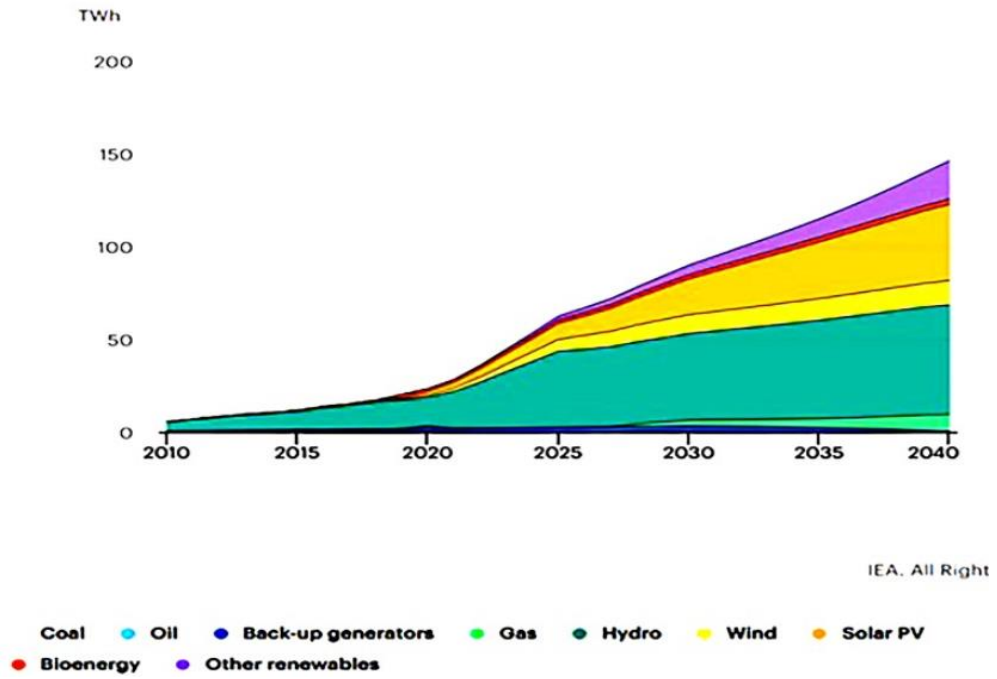

Figure 7: Electricity generation by Technology in Ethiopia from 2010 to 2040

Giving power access to all and zapping gainful utilizations will prompt a fivefold increment in the generation, and a much higher increment in solar and also geothermal record for practically forty-five percentage of the force blend by Twenty forty are shown in the Figure 7.

One of the most persuasive enactments in the Ethiopian system is the 'Climate Resilient Green Economy' (CRGE) activity. This activity is praised for the GTP II and is planned for changing Ethiopia into a middle-income nation by 2025 while building an economy that is feasible and naturally inviting. The CRGE anticipates an advancement of up to 25 GW in generation potential through the expansion in hydro, geothermal, wind, and solar energy. The most critical remote vitality accomplice in Ethiopia is the Africa power activity. It was propelled by the United States Agency for International Development (USAID) in 2013 to set up 30,000 MW of vitality generation limits across Africa. The activity expects to include 2,880 MW by 2020, and 4,640 MW by 2030.

As indicated by Teshome Tafesse, State Minister of Finance, the delicate will concentrate on the development of 6 vast scope PV activities in the districts of Afar, Somali, Oromia and Tigray, and will draw in around $795 million of ventures. The scaling solar-powered program has brought about a broad pipeline of large-scale solar projects in Ethiopia (Table 5).

Table 5: Solar PV projects announced in Ethiopia

Sl.No	Project Name	Capacity(MW)	Estimated cost (USD million)	Region	Status
1	Metehara solar	100	120	Oromia	Scaling Solar
2	Gad Solar Scale(Phase I)	125	150	Somali	Scaling Solar
3	Dicheto Solar Scale(PhaseI)	125	150	Afar	Scaling Solar
4	Mekele Solar	100	120	Tigray	Pending
5	Humera Solar	100	120	Tigray	Pending

6	Welenchiti Solar	150	165	Oromia	Pending
7	Weranso Solar PV	150	165	Afar	Pending
8	Metema Solar PV	125	150	Amhara	Awaiting Approval
9	Hurso Solar PV	125	150	Dire Dawa	Awaiting Approval

VII. CONCLUSION

This paper presents a brief description of Ethiopian electricity power generation and present demand on solar power off-grid and on-grid. Concerning renewable, Ethiopia is well in front of its territorial neighbors. It is right now one of the most encouraging forthcoming solar markets in Africa, with clean vitality sources. In any case, the Nation's reliance on hydropower could represent challenges later on, due to massive droughts. The Ethiopian government has predicted this issue and has begun to concentrate their assets on different renewable, for example, solar. As solar as of now just takes up a little part of Ethiopia's power mix, the government of Ethiopia needed to set up a regulatory frame that would be valuable for the two financial specialists and project engineers. The Ethiopian government is likewise striving to give power to every one of its occupants, even in remote territories without access to the power matrix. Through its national development plan (GTP II) and national electrification program (NEP), the Nation's administration intends to arrive at complete access of power by 2025, expecting to arrive at 35% of the populace with off-grid network arrangements. This opens up incredible open doors for mini-grids and stand-alone solar home frameworks to help make this ambitious objective a reality. This paper gives a review of the history of the Ethiopian energy sector and the importance of renewable sources like solar energy and its activities; the market sector also discussed vital policies and plans.

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