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Pre-Feasibility Study for the Construction of a Photovoltaic Solar Power Plant with Energy Storage System Based on Lithium-Ion Batteries in Sub-Saharan Africa: Case of a 30 MWp Power Plant in Dapaong in Northern Togo

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Abstract The rate of access to electricity in Togo is estimated at 45% in 2018 despite the enormous solar potential with approximately 3203.1 hours that the country has. In order to remedy such a situation, the country plans, as part of its energy policy, to build a 30 MWp solar power plant with energy storage in Dapaong in northern Togo. In this article we propose a pre-feasibility study for the construction of the plant by addressing the technical, financial, environmental and social aspects. The construction of such a plant would require the installation of 112,320 solar panels of 275 Wp over an area of approximately 80 Hectares. We consider within the framework of this study, an energy storage duration of 2 h or 68 MWh thanks to the use of Lithium-ion batteries. The installation of this plant should require, according to our study, an investment of 82.4 million USD (50 billion XOF) with a cost of electricity produced by the plant of 0.16 USD/kWh (98.37 XOF/ kWh). This plant should make it possible to avoid an emission of around 30,749.76 tons of CO2 equivalent per year by producing clean electricity of around 42.7 GWh per year.

Keywords: *photovoltaic solar power plant, energy storage, lithium-ion battery, dapaong, togo*

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1. Introduction

A West African country with a population estimated at more than 8 million inhabitants in 2022, Togo is bound to the North by Burkina Faso, to the South by the Atlantic Ocean, to the East by Benin and to the West by Ghana. Like the majority of countries in sub-Saharan Africa, Togo has a very low electricity access rate of 45% in 2018 [1].

Moreover, in parallel with this low rate of access to electricity, the needs for electricity do not stop increasing, thus leaving the actors of the energy sector and the whole nation in a very complex situation to solve [2]. The most immediate solutions and generally seeming simpler are the installation of thermal power stations. Nevertheless, the use of such thermal power plants in a Togolese context would require enormous long-term costs due to the importation of fuels. Similarly, the emission of greenhouse gases at these power stations would have a very negative impact on the Togolese climate and the most visible of these impacts are floods and the rise in sea level causing an advance of the coasts (around 5 to 10 meters per year) [3].

Finally, it is necessary to find other types of power plants using the energy resources available on the Togolese territory and whose long-term operation is less expensive with a very low climatic impact [4].

Studies carried out to date indicate that in Togo, most of the potential energy resources are renewable energy resources, in particular hydraulics and solar energy. It therefore seems obvious to build hydroelectric and solar power plants exploiting the enormous potential of the various rivers, streams and the enormous solar field, to meet the electricity needs of the Togolese [5,6].

To achieve 100% access to electricity by 2030, the national electrification strategy obviously plans to increase the energy production base [7]. The increase in this production base is characterized by the installation of off-grid solar systems, the distribution of solar kits and the installation of large production plants. As for the share of renewable energies, it should normally accumulate a total capacity of 200 MW by 2020. As part of this energy policy, a 30 MWp photovoltaic solar power plant is planned in Dapaong in northern Togo. For the construction of this plant, the Togolese government will obtain funding under the RESPITE project (Regional Emergency Solar Power Intervention) approved by the World Bank on December 20, 2022 [8-9].

We propose through this article a prefeasibility study for the construction of this 30 MWp solar power plant with energy storage in Dapaong in northern Togo.

2. Technical Study for the Installation of the Plant

2.1. Choice of the Plant Site

Our choice of the site for the installation of the plant will essentially depend on the point of connection of the plant to the electricity transmission network, the obstacles (natural and unnatural obstacles) and the climatic data of the site.

2.1.1. The Injection Site

The power grid that will be used to transport the electricity produced by the power station must be located less than five (5) kilometers from the power station. In [10] Wu et al. identify standards that must be respected for PV integration to the grid. This measure aims to reduce power losses in transmission lines before injection into the grid. This measure is also recommended by international standards, in order to have better profitability for the plant.

Considering this fact, it seems wise to install the plant close (less than 5 km) to the Dapaong HTA/HTB transformer Power station. Thus, our plant would be installed within a maximum radius of 5 km from the Dapaong substation as shown on the CEET network map (Figure 1) [11].

Figure 1. Limit zone of electricity injection to the Dapaong HTA/HTB substation from the power station

2.1.2. The Obstacles

Uusing the Google Earth GIS software, we identified the various natural and unnatural obstacles within the radius of 5 km around the Dapaong HTA/HTB substation.

- Non-natural obstacles: These obstacles are essentially made up of large agglomerations such as villages, large infrastructures such as roads, public buildings, etc. They are represented in red color in Figure 2 and they are places not conducive to the establishment of the power plant;
- Natural obstacles: These obstacles are essentially mountains, forests, valleys, rivers, etc. It would be abnormal and, moreover, expensive to destroy such obstacles in order to set up a power station. These different obstacles are shown in green color in Figure 2. These are therefore places where it is not recommended to install our plant;
- Favorable sites: These sites represent favorable places with the minimum possible obstacles. They are represented in blue color in Figure 2 and they are places where, apart from the climatic characteristics (temperature and solar radiation especially), are advisable to install the plant.

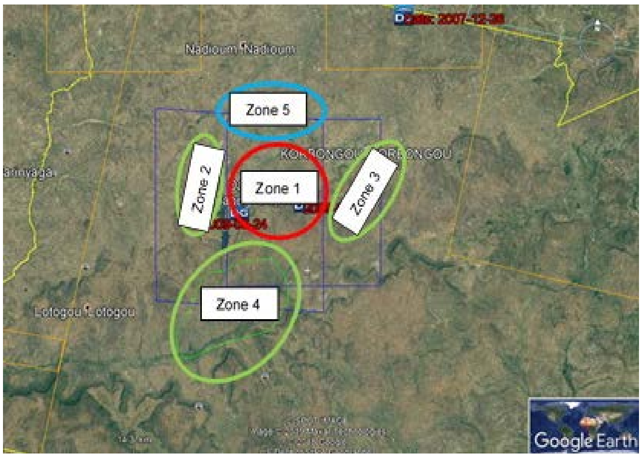

Figure 2. Location of potential sites for the establishment of our power plant

➢ Zone 1: It represents a natural obstacle. It is in reality simply the Lions' Den National Park. A closer view as in the following Figure allows us to better understand the area dominated by a large number of flora and fauna.

Figure 3. Zone 1

➢ Zone 2: It also represents a natural obstacle. It is in reality the Dapaong's Dam. A closer view allows us to better see this dam and its water resources.

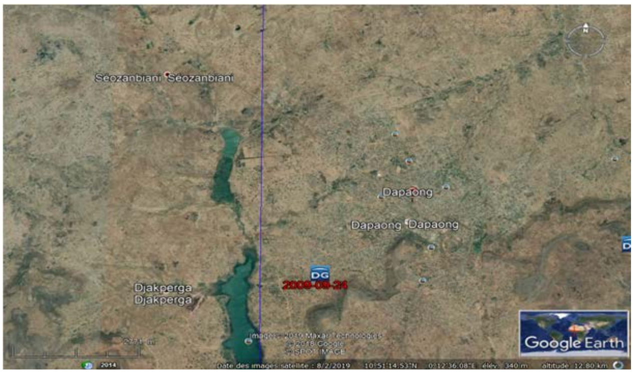

Figure 4. Zone 2

➢ Zone 3: It also represents a natural obstacle. It is a mountainous area with hills. The following Figure shows the state of this area more clearly.

Figure 5. Zone 3

➢ Zone 4: It has its level, represents an unnatural obstacle. This area simply represents the downtown area of Dapaong City. This is the area bringing together the largest urban area of the city of Dapaong. A closer view allows you to better understand buildings, roads, etc.

Figure 6. Zone 4

➢ Zone 5: Of all the selected zones, this represents the zone with the fewest natural and unnatural obstacles. A closer view shows that it is an area characterized by relocated buildings and very few, tracks for the movement of people and some trees. We consider this area ideal for the installation of our power plant. For those who are few of the populations residing in this area, the government should therefore find them other sites on which they can locate themselves without worries and which will also be able to facilitate their various activities as on the site of yesteryear.

Figure 7. Zone 5

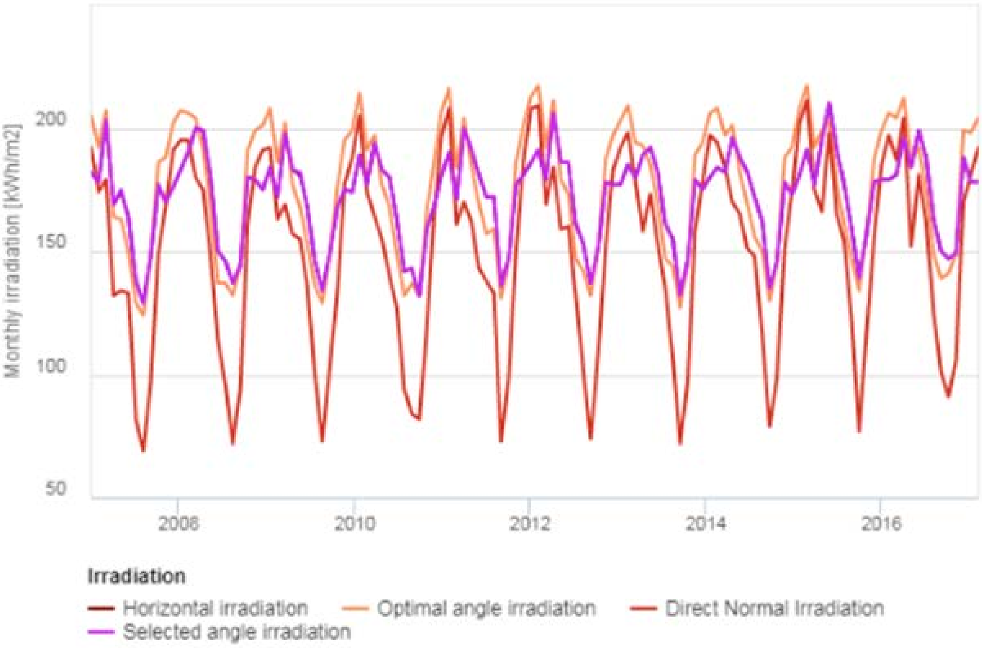

Figure 8. Variation curve of the solar irradiation of zone 5 between 2007 and 2016

Table 1. Global solar radiation on a horizontal plane of Zone 5 between 2007 and 2016

Month	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
January	182	183	184	189	190	191	185	184	191	181	186
February	178	190	172	177	171	179	180	182	177	196	180.2
March	203	200	198	194	200	206	189	196	195	184	196.5
April	169	199	183	183	191	186	192	188	210	199	190
May	174	180	181	180	181	186	182	182	191	188	182.5
June	164	150	168	163	172	161	161	172	177	163	165.1
July	138	146	146	142	172	153	155	162	159	150	152.3
August	129	137	134	143	136	137	132	135	139	147	136.9
September	148	144	149	132	147	151	146	146	157	149	146.9
October	177	180	168	159	177	178	179	178	178	188	176.2
November	170	179	175	168	181	177	175	173	179	178	175.5
December	176	175	174	181	186	177	180	181	179	178	178.7

Table 2. Temperature variation in Zone 5 between 2007 and 2016

Month	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
January	26.2	24.9	26.9	26.8	26.8	26.6	27.7	27.5	26.3	26.6	26.63
February	28.6	28	30.5	30.2	29.3	29	29	29.4	29.9	29.4	29.33
March	31	30.6	31.5	31	31.2	30.7	30.9	30.3	30.5	30.8	30.85
April	30	30.5	30.1	31.3	30.7	30.5	29.7	30.3	31.4	31	30.55
May	29.5	30.1	29.5	29.8	30.1	28.9	29.3	29.2	30.6	29.5	29.65
June	27.3	27.8	28.2	27.8	27.9	27.1	28.3	28.7	28.7	27.2	27.9
July	25.3	25.5	26.4	26	26.5	24.8	25.5	26.9	27	25.4	25.93
August	24.4	24.5	24.8	25.3	25.2	24.8	24.4	25.2	25.2	25.2	24.9
September	25.1	25.4	25.4	24.8	25.3	24.9	25	24.9	25.3	24.9	25.1
October	26.7	26.4	26.2	25.9	26.4	26.3	26.7	26.7	26.7	27.2	26.52
November	27.6	27.8	26.1	27.8	27.9	28	27.9	28.1	28.1	28.6	27.79
December	26	27.1	26.5	26.2	25.7	27.2	26.7	27.1	25.7	27.3	26.55

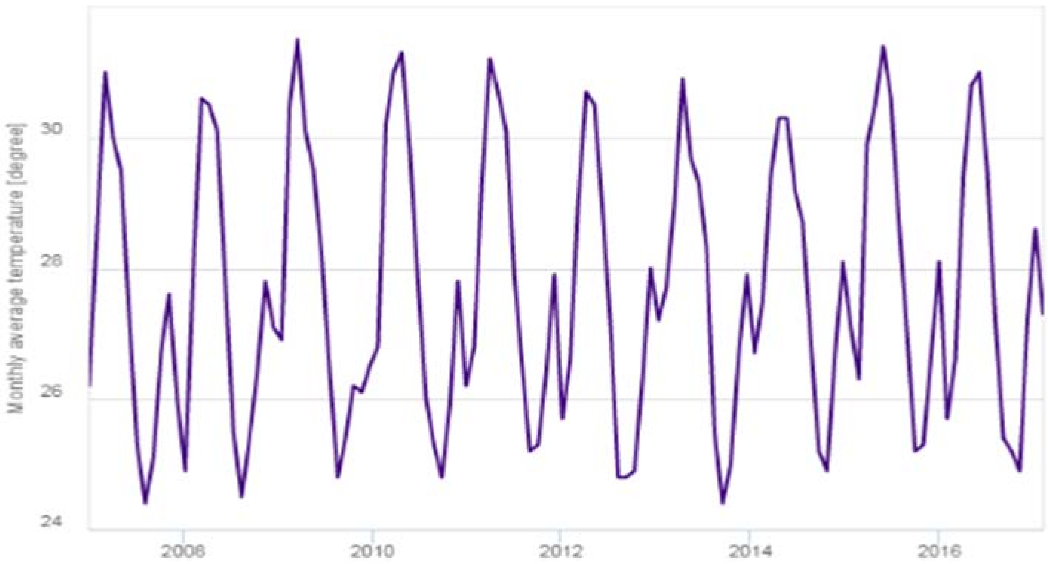

Figure 9. Curve of temperature variation in zone 5 between 2007 and 2016

2.2. Solar Resource of the Site

By locating zone 5 on PVGIS, we obtained the solar radiation and temperature data over a period of ten (10) years, i.e. from 2007 to 2016 (view Table 1 & Table 2) [12]. Thus, by taking an average over these ten years, the solar irradiation is 2066.8 kWh/m²/year and the average temperature is 27.64°C. Figure 8 & 9 and Table 1 & 2 illustrate these climate data from PVGIS.

2.3. Sizing of the Solar Power Plant

2.3.1 Choice of Solar Power Plant Inverters

Given that our plant will be made with a storage system, so in the context of this study, we will consider two (2) types of inverters: the inverter intended for the conversion of the energy of the PV panels (P_inv) and those intended for the conversion of the energy of the storage system (S_inv).

➢ The P_inv inverter: For this study the P_inv characteristics that we considered are as follows in Table 3:

Table 3. Characteristics of the P_inv type inverter

P_inv	Features
INPUT (DC)	
Voltage Range	715V to 1300V
Maximum voltage	1500V
Maximum current	1850A
Number of entries	6
OUTPUT (AC)	
Power	1169 kVA
Tension	450V
Frequency	50/60Hz
Power factor	1
Harmonic distortion rate	< 3%
Maximum yield	98.9%
Operating temperature	-20°C to +57°C

➢ S_inv inverter: For this study the S_inv characteristics that we considered are as follows in Table 4:

Table 4. Characteristics of the S_inv type inverter

S_inv	Features
Nominal voltage	771V
Minimum voltage	630V
Maximum voltage	867V
Ability	1,530 Ah
Energy	1,180 kWh
Continuous discharge power	2,500 kW
Continuous charging power	850kW
Maximum continuous discharge current	3,240 A
Maximum continuous charging current	1083A
Battery technology	Lithium ion
Operating temperature	-20°C to +55°C
Self-discharge	<5%/ month
Number of cycles	4,200
Lifetime	>25 years

2.3.2. Sizing of a Solar Panel Shed

The evaluation of the powers, currents and voltages at temperatures different from those of the STC (Standard Test Conditions) are given by the following relationships [13,14,15]:

➢ For power, we have:

$$P_T = P_{STC} \times \left(1 - K_p \left(T_{STC} - T\right)\right) \tag{1}$$

➢ For voltage, we have:

$$V_T = V_{STC} \times \left(1 - K_v \left(T_{STC} - T\right)\right) \tag{2}$$

➢ For the current, we have:

$$I_T = I_{STC} \times \left(1 - K_i \left(T_{STC} - T\right)\right) \tag{3}$$

K_p, K_v, K_i are respectively the temperature coefficients of the power, voltage and current of the PV panel. T and T_{STC} are respectively the temperature of the installation site of the plant and the temperature of STC conditions for the manufacture of the solar panels.

For the sizing of Sheds, the following conditions must be respected [16,17].

$$0,5 \le \frac{Pss(50°C)}{Pmaxent} \le 1,2 \tag{4}$$

$$0,5 \le \frac{Pss(10°C)}{Pmaxent} \le 1,2 \tag{5}$$

$$Vcoss(50°C) > Vmin\ fct \tag{6}$$

$$Vmpss(50°C) > Vmin\ fct \tag{7}$$

$$Vcoss(10°C) < Vmax\ fct \tag{8}$$

$$Vmpss(10°C) < Vmax\ fct \tag{9}$$

$$Iccss(50°C) < Imaxent \tag{10}$$

$$Iccss(10°C) < Imaxent \tag{11}$$

$$Impss(50°C) < Imaxent \tag{12}$$

$$Impss(10°C) < Imaxent \tag{13}$$

With Vcoss the short-circuit voltage of the sub-shed, Vmpss the voltage at the maximum power point of the sub-shed, Pss the total peak power of the sub-shed, Iccss the short-circuit current of the sub-shed, Impss the current at the maximum power point of the sub-shed, Nps the number of panels per string of the sub-shed, Npss the number of panels per sub-shed and Nsss the number of strings per sub-shed.

Table 5. Configuration of a Shed of PV panels

Setting	STC value	NOCT value
Number of entries	15	15
Vcoss	924 V	854.4 V
Vmpss	753.6 V	691.2 V
Iccs	1688.4 A	113.7 A
Imps	105.12 A	1705.5 A
Nps	24	24
Nss	180	225
Npsh	4,320	5,400
PS	1.188 MW	1.1 MW

2.3.3. Overall Configuration of the PV Panels of the Plant

By associating several sheds and taking into account that the plant we want to install is 30 MWp, we can make the overall Configuration of the plant, thus allowing us to know for our plant, the number of inverters to be installed, the total number solar panels to be installed.

In summary, the global Configuration data of the plant are as follows in Table 6:

Table 6. Global plant Configuration data

Setting	STC value	NOCT value
Number of shed (inverter) to install (Nshed)	26	28
Total number of panels to install (Ntp)	112,320	151,200
Power actually installed (P_Y)	30.888 MWp	30.743496 MWp

2.3.4. Plant storage System Configuration

To have continuous production on the electrical network even in periods of low sunshine, a storage time (Ts) of 2 hours is planned for our plant. The system chosen for our plant is electrochemical storage with lithium-ion technology.

Since the field of photovoltaic panels is subdivided into a shed, the storage system to store the surplus energy produced by its solar panels would also be configured in a shed.

2.3.4.1. Configuration a Shed Storage System

The sizing of the shed storage system is based on the characteristics of the PV shed and the characteristics of the battery. For this sizing, we will consider [18,19,20]:

➢ Ems the minimum energy storage system needed. With:

$$\text{Ems} = \frac{P_s \times T_s}{\eta_b \times 0{,}99} \tag{14}$$

➢ Nmse the maximum number of batteries in series per input. With:

$$\text{Nmse} = \frac{Vmaxfct}{V_{bmax} \wedge 1{,}25} \tag{15}$$

➢ Vmie the nominal voltage of the battery pack per input. With:

$$\text{Vmie} = \text{Nse} \times \text{Vbmin} \tag{16}$$

➢ Vmae the maximum battery pack voltage per input. With:

$$\text{Vmae} = \text{Nse} \times \text{Vbmax} \tag{17}$$

➢ Eps the battery pack energy per input. With:

$$\text{Eps} = \text{Nse} \times \text{Eb} \times \text{Pdb} \tag{18}$$

➢ Ne the entry number. With:

$$\text{Ne} = \frac{Ems}{Eps} \tag{19}$$

➢ Es the energy stored by inverter. With:

$$\text{Es} = \text{Ne} \times \text{Eps} \tag{20}$$

➢ Cts the capacity of the storage system per inverter. With:

$$\text{Cts} = \text{Cb} \times \text{Ne} \tag{21}$$

➢ Nts the total number of batteries per shed. With:

$$\text{Nts} = \text{Nse} \times \text{Ne} \tag{22}$$

Nevertheless, in order to ensure optimal operation of the storage system, the inverter input voltage range must be compatible with the end-of-charge (Vmae) and end-of-discharge (Vmie) voltages of the storage system. Which means:

$$\text{Vmin fct} \geq \text{Vmie} \tag{23}$$

$$\text{Vmax fct} \leq \text{Vmae} \tag{24}$$

Table 7. Shed storage system Configuration data

Setting	STC value	NOCT value
Storage time	2 hours	2 hours
Nse	1	1
Born	3	3
Nts	3	3
Vne	771 V	771 V
Vmie	630 V	630 V
Vmae	867 V	867 V
Is	2.616 MWh	2.616 MWh
CTs	4242 Ah	4242 Ah

2.3.4.2. Overall Configuration of the Plant Storage System

Based on the per-shed Configuration of the storage system, we can perform the overall Configuration of the storage system. We will consider [21,22,23]:

➢ Egs the overall energy of the storage system. With:

$$\text{Egs} = \text{Es} \times \text{Nshed} \tag{25}$$

➢ Ct the overall capacity of the storage system. With:

$$\text{Ct} = \text{Cts} \times \text{Nshed} \tag{26}$$

➢ Nt is the total number of batteries in the storage system. With:

$$\text{Nt} = \text{Nts} \times \text{Nshed} \tag{27}$$

➢ Nshed the total number of shed.

Table 8. Storage system global Configuration data

Setting	STC value	NOCT value
Storage time	2 hours	2 hours
Nshed	26	28
Nt	78	84
Egs	68.016 MWh	73.248 MWh
CT	110,292 Ah	118,876 Ah

Table 9. Plant installation area

Setting	Value
Active area (S_A)	166 114.54 m² (16.6 Hectares)
Total area to be fenced (S_T)	794,351.056 m² (79.5 Hectares)

2.4. Installation Area of the Plant

Taking into account the dimensions of the PV panels, the storage system and the respect of the shade between the different rows of PV panels, we determined the active surface (i.e. the surface which produces electricity) and the total area (i.e. the total area to be fenced) of the plant.

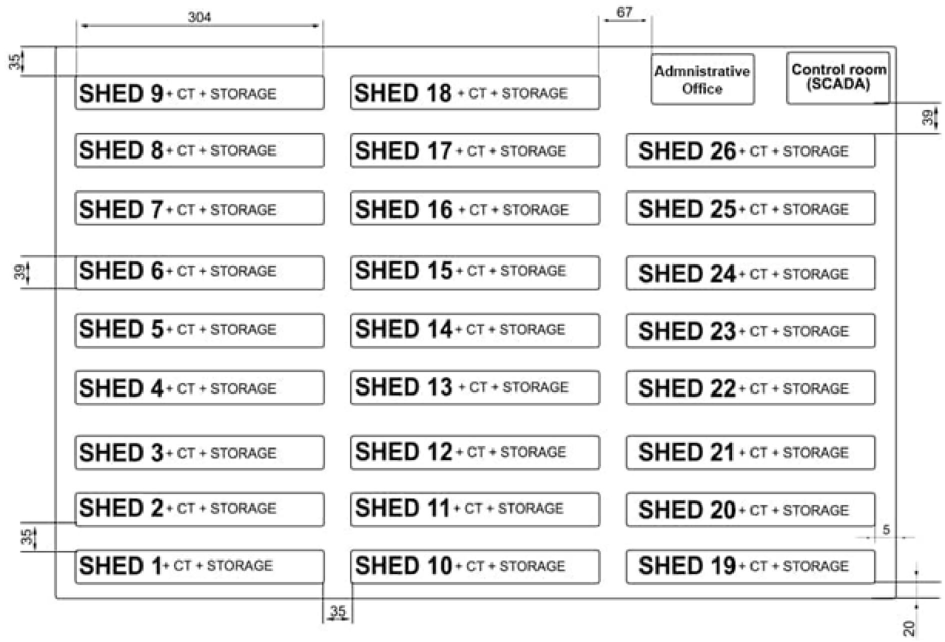

Figure 10. Overall presentation of the PV plant

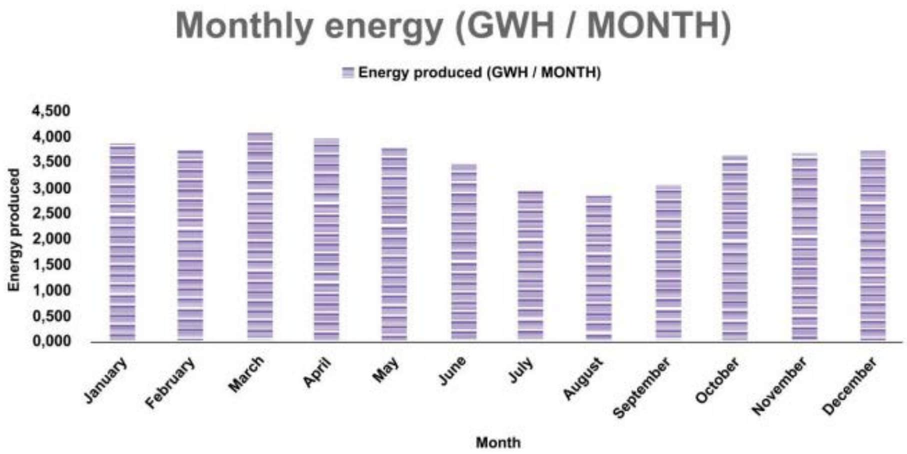

Figure 11. Variation in the energy produced by the plant during the year

2.5. Electrical Cables and Protections of the Plant

In this part we will evaluate the section of the electrical conductors which connect the different components of the power plant.

This evaluation of conductor cross-section depends on the length of the conductor, the maximum current to flow in the conductor, the resistivity of the conductor and the maximum acceptable voltage drop over the entire length of the conductor [24]. This minimum section is expressed by the following relation (28):

$$S_{\min} = \frac{2 \times \rho \times I \times L}{\Delta U} \tag{28}$$

For the protection of people and property, fuse holders, thermal magnetic circuit breakers, differential circuit breakers and lightning arresters must be installed between the various components of the plant. One or more lightning rods must also be installed to protect the plant equipment against thunder.

Table 10. Conductor section between plant components

Conductor section	Value
Between two junction boxes	4mm²
Between connection box and P_inv inverter	35mm²
Between Battery and Inverter S_inv	150mm²
Between busbar and transformation center	25mm²

2.6. Plant Performance and Productivity

The power plant suffers energy losses at all levels, that is to say from the solar panels to the output of electricity for the distribution of energy. We have evaluated and summarized these losses in the following Table (Table 11):

Table 11. Different losses between plant components

Element	Losses (%)	Yield (%)
Inverter	1.5	98.5
NOCT	12.3	87.7
DC wiring	1	99
AC wiring	0.1	99.9
hot spots	2	98
Light Induced Degradation (LID)	2	98
Mismatch	1	99
Dirt and dust	0.5	99.5
Angle of incidence	2	98
Irradiation intensity	3	97
Performance index	76.83%	
PV module yield	16.9%	
Storage Battery Performance	96%	
Overall return	12.5%	

Table 12. Electricity production during the year by the plant

Month	Sunshine (E_n) (kWh/m²/month)	Active area (S_A) (m²)	Overall return (η_G)	Energy produced (Ep) (GWh /month)
January	186	166114.54	0.125	3,862
February	180.2	166114.54	0.125	3,742
March	196.5	166114.54	0.125	4,080
April	190	166114.54	0.125	3,945
May	182.5	166114.54	0.125	3,789
June	165.1	166114.54	0.125	3,428
July	142.3	166114.54	0.125	2.955
August	136.9	166114.54	0.125	2,843
September	146.9	166114.54	0.125	3,050
October	176.2	166114.54	0.125	3,659
November	175.5	166114.54	0.125	3,644
December	178.7	166114.54	0.125	3,711

Taking into account the solar irradiation of the site (E_n), the active surface of the solar panels (S_A) and the overall efficiency of the installation (η_G), the energy produced by the plant can be evaluated by the relationship (29):

$$Ep = S_A \times E_n \times \eta_G \qquad (29)$$

In Figure 11, it appears that the most productive month is March with a monthly production of 4.08 GWh/month and the least productive month is August with a monthly production of 2.843 GWh/month.

The annual energy produced by the plant is the sum of the monthly energy produced by the plant. It can be evaluated as follows:

$$Ep = \sum_{January}^{December} Epm \qquad (30)$$

Ep = 42.708 GWh /year

Also called Yield, the productivity of the plant makes it possible to estimate the annual operating time of the plant taking into account the nominal operating conditions of the components of the plant. It is expressed in peak hours per year (hc/year) and is assessed by calculating the ratio between the annual energy produced by the plant and the total peak power installed. In the case of our plant, it is evaluated as follows in relationship (31):

$$Pd = \frac{Ep}{P_T} \qquad (31)$$

Pd = 1382.67 hc/year

Thus, we can consider that our plant will operate under its nominal power of 30.888 MWp for 1382.67 hours per year.

3. Economic Studies

The investment cost of the plant is assessed taking into account the cost of equipment and its installation and the cost of connection to the electricity network.

Thus, the total investment cost of the plant is evaluated as:

CI = 82,432,511 USD = 49,892,277,299 XOF

The operating cost of the plant includes the cost of annual maintenance (which in the standards must not exceed 1% of the cost of installation) and the cost of paying staff. Thus, the operating cost of the plant is evaluated at:

CE = 1,002,764 USD = 606,922,773 XOF

Still called Levelized Cost of Energy, the cost of the electricity produced by our plant is determined by dividing the overall cost of the investment and operation of the plant by the total energy produced by the plant [25]. It is therefore evaluated by the following relationship (32):

$$LCE = \frac{A \times (CI + CE)}{E_P} \quad (32)$$

With A, the annuity factor calculated as follows:

$$A = \frac{K_d \times (1 + K_d)^n}{(1 + K_d)^n - 1} + K_a \quad (33)$$

With:

- n the lifespan of our plant, which we take at 25 years;
- K_d the interest rate which would be taken at 6%;
- K_a the insurance rate that would be taken at 0.5%.

A = 0.0832

Thus, the cost of electricity from our plant is:

LCE = 0.16 USD/kWh = 98.37 XOF/kWh

4. Environmental Impact Study of the Plant

It is no longer a secret nowadays that solar panels help protect the environment by avoiding the emission of greenhouse gases responsible for global warming. Therefore, our plant will not be an exception since its major components are solar panels.

Thus, taking into account the Greenhouse Gas Emission Factor (GEF) in Togo [26] which is 0.72 eqkgCO_2 /kWh, the annual energy produced by the plant (Ep) and the lifetime of the plant (n i.e. 25 years), we will evaluate the quantity of greenhouse gases (QCO_{2ev}) avoided by our plant as follows:

$$QCO_{2ev} = FEG \times Ep \times n \quad (34)$$

QCO2ev = 768,744 eqCO2 avoided
QCO2ev = 30,749.76 eqCO2 avoided per year

Using the RETScreen software, we will evaluate the equivalent of this quantity of greenhouse gases from our plant and which is:

Qbaril = 71,512 barrels of oil not consumed per year
Qplant = 2,828 Hectares of forest absorbing carbon per year

From the design of their various components to their construction on a given site, photovoltaic solar power plants have an impact on the environment. In the case of our project, we can cite some impacts:

- The industries producing the components of a solar power plant produce enormous quantities of Greenhouse Gases during the production of these components. In addition, these component production industries not being on the installation site of the power plant, then it will be necessary to ensure the transport of these components to the installation sites of the power plant and which also constitutes a significant source of environmental pollution. Generally known as the carbon debt for the case of solar panels, it is estimated that the pollution mentioned above would be reimbursed by the panels after two (2) or three (3) years of operation of the installation [27];
- The installation of the plant in zone 5 constitutes in a way, a small source of deforestation. In the sense that before the establishment of the plant, there were some trees on the site (visible on the image of Google Earth) and these trees would be cut down to be able to set up the plant;
- Before the establishment of the power plant, there existed on the site a certain fauna quite at ease in its biocenosis, but the establishment of the power plant risks modifying or even eliminating this biocenosis;
- In a Togolese context, the recycling of components (especially solar panels and batteries) of the plant at the end of its lifespan is not yet possible. So the question remains to know what would become this waste if we know the chemicals that compose it and especially the impact of these products on the environment (soil, air, water etc.)

5. Social Impact Study of the Plant

The establishment of this plant has many positive impacts on the social level, among which we can cite:

- The creation of temporary jobs during construction periods and permanent jobs during plant operation periods. Even if these jobs may seem insignificant, they could have a significant effect on the unemployment rate which remains high in Togo;
- Access to electricity has many advantages for populations. And this would also be the case for the populations who will benefit from the electrical energy produced by our plant;
- For local populations, many income-generating activities could arise from the establishment of the plant in their area;
- The establishment of such a large-scale infrastructure would require the creation of other infrastructures such as roads, a hospital, etc., which would contribute to a significant improvement in the standard of living of the local populations.

6. Conclusion

This study aims to propose a pre-feasibility study of the installation of a 30 MWp solar power plant with Lithium-ion battery-based energy storage (with a total capacity of 68 MWh). This study addresses the technical, economic, social and environmental aspects related to the construction of such a plant. But this study remains nevertheless, a brushed study and more in-depth studies could be carried out in order to be able to carry out the power plant.

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