Solar Energy Development in Africa: Economics and Policies

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Abstract. The foreign countries have been starting to assist African counties to develop their electricity industry. The African continent is such an unopened Pandora for renewable energy, solar energy included. Africa has abundant solar resources and high availability. However, Africa accounts for a very small proportion (15MW) of the total installed capacity of 15 megawatts of solar photovoltaics worldwide. There are some solar module manufacturing plants in South Africa, but their production capacity is limited to tens of megawatts. Solar energy is known as the stainable energy resource, should have the promising problem in the African continent.This study provides a systematic study from the following perspective: describing the demand and supply situation and then the economic growth situation will be mentioned. Mainly analysing the cost with the regression model, the overall summary will be drawn.

1. Introduction

China helped Morocco to build the tallest solar tower in the world. 1.1 million people are expected to have access to electricity from this solar energy project. Most African countries are characterized by low income and economic underdevelopment due to the lack of electricity (Ikwaba Paul & Uhomoibhi, 2013). Lower-level electricity situation cannot be improved and solved in only one step by one or two departments. Collecting all the relevant perspective will be helpful to assist the African countries better and more efficient.

2. Aims, objectives and research questions

2.1 Aims

This research aims to analyse the barriers the solar power facing and supply the applicable methods for electricity promotion. As the third party of the global structure, the demand level is not supposed to be as the same as the developed countries. So is supply level. What is the exact gap between these two groups is one of the questions we need to navigate. According to the reports from the IRENA give us the clue, the data validly tell us this story. On another aspect, the report from the word bank will indicate the growth of the African economy, which is the attractive element to the global investment especially in the energy sector. While holding enough data, then the analysis model should be on the platform. We could draw the direct visual results from the tables. According to the analysis of the energy consumption and the trend of cost, the additional policy could be introduced from the past European policy.

The main action the government took was to ensure the profit the companies could get. Familiarly, some of the African countries did the same action, but the effect was below the expectation. It seems the government actions are not sufficient, the other parties still need to take some efforts on. Then introducing the projects from the foreign countries, such as the Chinese government helped to construct the solar tower in Morocco, the US government has been starting the project named power Africa since Obama government, etc.

Thus, the paper will systematically reveal the policy and economy in African solar energy

2.2 Objectives

The main objective is to analyse how solar energy shapes the African economy including the positive changes in Africa. In order to understand the main objective, having the overall idea of the current energy situation in Africa is necessary.

Aiming to systematically reveal the current and future energy situation in Africa and the potential actions the following objective this paper needs to present in this paper:

Firstly, based on the huge gap between demand and supply, introducing the economic situation is necessary. Without the basis of the economy, the African countries and the foreign countries will not be stimulated to get stick to the energy improvement. After all, doing the project for free is not possible, humanity is important though.

Secondly ,it's time to regress the model. Using the model is attached to the economic analysis. Two models will be introduced with the data from the official agencies. The energy consumption and cost price trend will be conducted. Following the trend is what the African countries and the globe should do next.

Thirdly, learning some actions from the counties that previously experience the energy shortage. As the high-level economy region, the actions the European region did seem have the significance to the highly growing continent, Africa continent.

Finally, summarizing the points that are analyzed above will be the powerful ending.

3. Methodology

3.1 Model choice

Aiming to quantify of the impact between the cost and energy, LEAP is the way to do analysis. Here is it. This system allows for up and down approaches, hence this could totally have the impact assessment (Song et al., 2017). This system is also widely used for analysing the energy policy and assessing the climate change. The accuracy has been ensured since some any professional agencies have been developing this system with the global corporation. The advantage would be the large scale of assessment, being used from country to country, city to city, and state to state. In this situation, LEAP will be used to analyze the net African consumption under the assumed different scenarios. After all, LEAP is based on different scenarios, in order to track the energy net consumption in various sectors.

LEAP is used not only to estimate the energy consumption, but also to analyse the carbon dioxide emission. Tracking the trade of the non-renewable energy is the key to support the widely solar energy installed in Africa.

3.2 Model progress and data selection

LEAP is not only a specific energy model system, but also a user-friendly tool that can be used with the different kinds of assumed scenarios. Each scenario will be more accurate with the specific database. LEAP supports a variety of different modelling methods: in terms of requirements, these methods. When it comes to supply, LEAP offers the tunnel to get though the certain situation that needs to be tested. Because of this outstanding customized feature, LEAP turned to more flexible, covering the various scenarios. All the features above are telling this system is the most suitable one to regress the result we need. The latest version of LEAP also supports optimized modelling: allowing for the construction of power system capacity minimum cost model expansion and scheduling, possibly subject to various restrictions such as carbon dioxide restrictions or local air pollution.

The data was chosen under a range of 52 African countries from period 2010 to 2014. The main data resource is from the UN Statistics Division.

The following equation demonstrates the consumption of net energy (Ouedraogo, 2017):

$$ET_P = ETP_{\sec,tec} \,\&\, [\frac{1}{f_{p,\sec,tec}} - 1]$$

ET is net consumption, *EPT* is product from transaction, *f* is the function of energy transformation efficiency, *tec* is abbreviation of technology, *p* is the type of primary energy, and *sec* displays the type of secondary energy.

Table 1. Net consumption of each region in different scenarios.

Regions(Africa)	2015	2020	2025	2030	2035	2040
Reference scenario						
Western	134.91	140.60	147.51	155.93	166.18	178.69
Eastern	136.68	154.42	178.64	211.76	257.17	319.52
Middle	78.83	92.17	109.07	130.49	157.63	192.02
Southern	19.99	20.26	20.65	21.20	21.99	23.11
Energy Efficiency Scenario						
Western	130.09	134.12	138.38	142.90	147.69	152.78
Eastern	133.98	145.41	159.30	176.18	196.76	221.90
Middle	86.87	94.96	104.04	114.24	125.69	138.57
Southern	17.82	17.63	17.49	17.42	17.42	17.52

According to different scenarios, it is clear to notice that the largest increase in energy comes from Western Africa. Coincidentally, Western Africa has abundant solar energy resources.

3.3 Additional method

Using LEAP is mainly to test the net energy consumption. In order to get closer to the influence that the cost price brings to the energy, Levelized cost electricity (LOCE) is the way to be implied. The main idea of LOCE is based on the power generation cost per kWh of the power generation project during the operation cycle. It is a widely recognized and transparent method for calculating the cost of power generation.

LCOE is the cost of generating electricity when the net present value (NPV) is zero. The economic meaning is that under the cost of leveling power generation, the project can reach the lowest expected rate of return, and the project does not have economic profit, that is, when the net present value is zero. The net present value of income is equal to the net present value of expenditure.
The following equation is based on this defination (Ouyang&Lin, 2014) :

$$LCOE = P_c = \sum_{t=0}^{T} (It + Ot + Dt)(1+r) - t / \left(\sum_{t=0}^{T} (E(1+r) - t)\right)$$

P,I,O,D and *r* each indicates to price, investment, operation and interest rate.

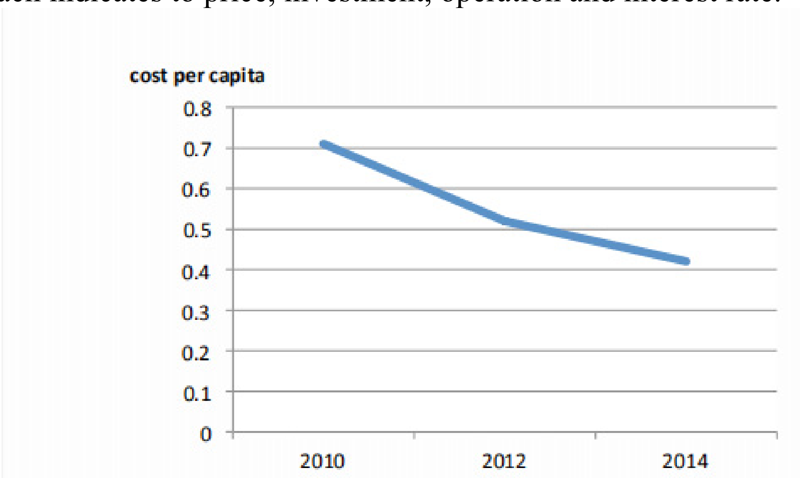

Fig. 1.The dropping cost the trend for the solar energy.

4. Significance

Studying electricity providing in Africa has great significance. Not only will African countries be beneficial from these projects, but also the investors can gain the profit. Solar energy expansion could realize if profitable and creditworthy electricity utilities are installed and then the private sectors will gain the confidence to invest in the relevant projects (Fritsch, 2011).

African has the cherished renewable recourses, especially the solar energy. It will be such a pity to waste this treasure. Ironically, the current energy situation is at the bottom of the globe. After describing the situation from demand and supply these two aspects, analyzing the cost trend where is gradually decreasing, the brilliant future for African countries to get rid of the darkness is getting close. In the near decade, some countries have developed the project helping to build the electrical installation. Firstly, what the US project called Power Africa was intended to add 10,000 megawatts of electricity to sub-Saharan African countries (Usaid, 2018). In addition, the European Commission injected 300 million euros for the African Union-led African Renewable Energy Initiative (AREI) to fund sustainable energy projects in March 2017.

The construction of soft power played an important role in the planning of non-electric power cooperation. The resource survey and planning work laid a solid foundation for the follow-up project. In terms of talent cultivation, we attach importance to capacity building and training. The think tank is rooted in Africa and effectively promotes the export of national technical standards and concepts. Not only that, the diversified financial support provides a strong guarantee for non-electricity cooperation. The construction of the cooperation mechanism provides a good platform for non-electricity cooperation. Perfect top-level design and clear division of labor between government and enterprises are essential. At the same time, the daily liaison mechanism is also the key to the continued development of non-electricity cooperation. Through these experiences worth learning.

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