The Implementation of the Capable Solar Power Through Tackling Challenges: KwaZulu-Natal Region

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ABSTRACT

There is lack of solar power improvement and the early failing of solar panels make solar to be unsustainable in the region of KwaZulu-Natal (KZN). The article focuses on ensuring the important role solar plays as it shows capabilities for replacing fuel energy. Research analysis demonstrated the high level of unsustainability which led to an early failure of a solar system. New project implementation comes with high financial commitment for the success of the solar project. However, this article focuses on what causes early failure which reduces the trust on the solar power system to many potential

customers and the interested parties. This article adopts root cause and statistical analyses to reveal the major challenges to analyze the solar challenges in the region. An improvement and sustainability of solar power can come very handy in reducing the electricity demand in KZN. Results show that solar particles deteriorate due to high energy consumption. A necessary step will be guided by the recommendation made in the study that analyzes all the contributors. Solar Technology transformation throughout the region needs to be researched further to address less technical challenges.

Keywords:
Solar power, contributors, unsustainability, Implementation.

Introduction
Solar power is the next promising energy provider because of its response to the environment and its capability (Han, Sun, & Wu, 2020). In the current years, energy is vital for numerous activities which include household consumption. Solar power sustainability becomes the major part in transforming energy supply in the region of KZN. Virous studies found that KZN region has diversified renewable energy like solar, wind, geothermal and hydropower among others (Mutombo & Numbi, 2019).

In South Africa, majority of electricity is generated from coal and in recent years this type of energy generation showed some side effects to the environment and to the life span of human being. Renewable energy was then discovered as the reliable alternative to deal with issues of high CO_2 production from the fossil fuel energy. Based on historical information, local government emissions such as the eThekwini Municipality account to almost 6% of the total eThekwini emission which was found to be 27 067 912 tCO_2e (Municipality 2015, 2016). The research reveals that 8.5-kiloWatt peak is the most viable size per day to the grid solar system in terms of economy in one day.

The diagram presented in figure 1 clearly demonstrates the growing energy consumption in South Africa. If in 1990 there was a demand of almost 10000 TWh per year and 30 years later there is almost 25000 TWh, it is clear that soon the demand will double itself if potential renewable energy is ignored.

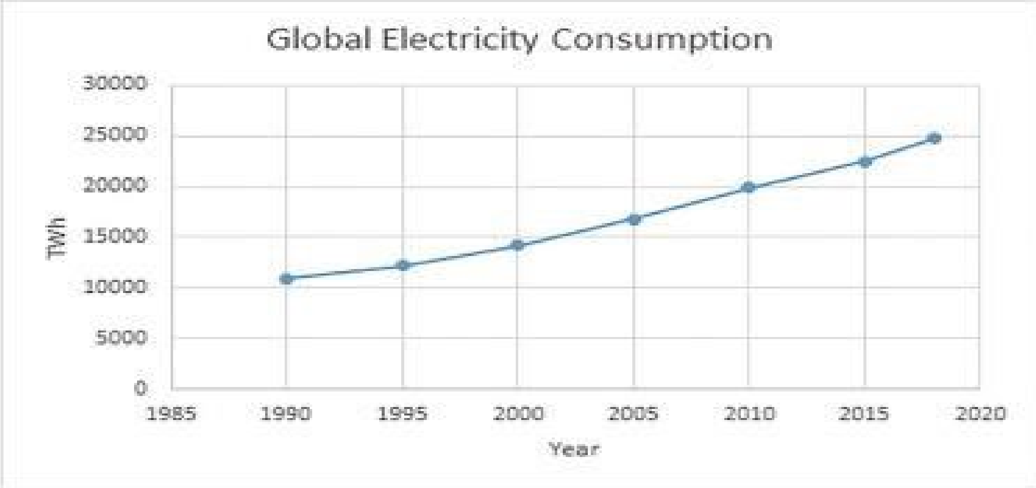

Figure 1: Schematic diagram of the increase in electricity consumption (Vivek, Ramkumar, Srividhya, & Sivasubramanian, 2021)

Solar power in the region lasts the maximum of three years and later, the entire system deteriorates. As promising as it is, Solar power has shown some slow development due to numerous factors that need urgently attention. In approaching these factors that might affect the growth of solar power in the region, one has to focus on the contributing factors when building solar power. Jaber et al. (2017) believed that environmental degradation was becoming a reality due to heightened contamination by GHG emissions produced by the energy sector. This article will utilize root cause analysis to address the solar power challenges and statistical approach to understand the findings of solar power installed in the past.

The aim of this article is to address the unsustainability of solar power in the region of KwaZulu Natal and improve the status moving forward. To ensure the aim was achieved, the research questions below were developed:

- What are the root causes of the unsustainability of solar power in the KZN region?
- What are the implementation processes regarding implementing solar power in the region and are these processes effective?

Solar power unsustainability can be the huge loophole to the newly recommended energy provider if not dealt with on time. Energy demand has been seen not to merge the energy supply. Excluding challenges surrounding the development of solar panel, this paper focusses on challenges that face this energy type (solar Power). A recommendation of relevant improvement will be outlined to ensure continuity of the solar power implementation to protect affected structures such as environment.

This article is managed in the following custom: Literature review deals with historical information around energy solar power and energy as whole. The Methodology address the way this study was carried out. Result section deals with data analysis, discussion and relevant recommendation whereas conclusion is the last section of the study which wraps up everything.

Literature Review

This section reviews appropriate past renewable energy (mostly solar power) research and concentrates on articles written between 2010 and 2018 to acknowledge the latest studies regarding renewable energy.

a) Education around renewable energy

In supplying information about all sorts of renewable energy, education could play a significant role. South Africa has initiated the Renewable Energy Independent Power Producers Procurement Program (REI4P megawatts) for continuous assessment and public discussion in respect of delivery versus main purposes (Walwyn and Brent, 2015). There is still a lot to be done in educating people when it comes to renewable energy implementing policies. Renewable energy implementing policies are not being followed as expected (Energy, 2015).

Science and technology are developing at a rapid pace and the education system (vocational-technical education mostly) seems to lag, which affects developing countries the most (Kacan, 2015). That is why it has been found to be extremely important to conduct research and studies toward analyzing and evaluating the existing energy and renewable energy education programs (Jaber et al. 2017). Assali, et al. (2019) believe that it is vital to measure the awareness of the youth when it comes to RE in conservatories such as state or private universities. The main reason for this is the fact that renewable energy implementation failure globally has to do with a lack of community awareness, policy failures and market classification (Assali, et al. 2019).

Finally, Jennings, (2010) insisted that education and training be delivered on every level from customers to managers to guarantee that renewable energy systems encounter the maximum values of dependability and efficiency.

b) Government policy regarding the renewable energy

Matters relating to renewable energy developments are precisely political program from administration harbor (Dostál and Ladányi, 2018). Government policies are developed by the politicians in parliament. Activities such as renewable energy policy developments end up getting mixed up with politics. According to Damari and Kissinger, (2018) critical developments such as renewable energy ends up being awarded to contemptible organizations because of political connections. Policies are more important in the new development of renewable energy and its sustainability.

Developing policies is another way a government can provide support to renewable energy development. Ling-zhi et al., (2018) believed that the CSP industry needs urgent intervention in terms of government support with policies, particularly the policy rate. Comparable to other renewable energy power technologies, a good example has been set by the Chinese government when they embraced price subsidy policies to support the CSP progress (Ling-zhi et al., 2018). Pfenninger and Keirstead, (2015) believed that a strategic energy policy can recommend technology over another policy for reasons to do with lasting energy security or other governmental benefits.

Governments across the globe use different stimulatory procedures and tools such as Feed-in Tariffs (FIT) to achieve installation targets, point of sale repayments, such as Renewable Energy Certificates (REC) as well as tax benefits (Chapman et al., 2018). Among others, demand-pull procedures (e.g. feed-in-tariffs) have demonstrated they are extremely resourceful in fostering renewable growth and many countries have implemented them to duplicate the pioneers' successes (Kuik et al., 2019). Kuik et al., (2019) said that the feed-in tariff policies end up as a set of distinguished tariffs through sites and vary in terms of the agreement period. They added that accessing grid and approval procedures might be as important as the feed-in-tariff (Kuik et al., 2019).

Renewable Electricity support is the first policy targeting the solar sector that uses the PV Roofs Program which is classified as a regulatory instrument and endorsed by the installation of solar PV (Polzin et al., 2014). There are many other decent policies that provide policy support mechanisms such as strategic planning which prove to be more operative (Polzin et al., 2014). South Africa is classified as an upper-middle income country where policies are divided into two categories which are a Regulatory policy and Fiscal incentives and public financing. REN21, (2017) at the 22nd Conference of the Parties (COP22) in November 2016 grouped all policies that need to be considered by upper-middle income countries to promote RE and deal with climate change.
Fiscal incentives and public financing:

1. Investment or production of tax credits
2. Reductions in sales, energy, VAT, or other taxes
3. Energy production payment
4. Public investment, loans, grants, capital subsidies or rebates.

On top of all these policies, South Africa has had its own energy policies that regulate energy in the country. National Energy Regulator of South Africa (NERSA) has put in place policies that assist in promoting renewable energy in South Africa. These policies also measure the success of implementing the RE goal in South Africa such as job creation.

Methodology

a) Research design

To answer the initial research questions, it is necessary to analyze the research design. This research consists of numerical phases or stages for it to be successful. All these phases or stages are interconnected; however, each phase or stage can be developed independently. It begins with problem discovering as an initial vital stage of the research. To proceed with the research, the next phase was necessary, which was data gathering. In this stage relevant data was collected on renewable energy focusing on solar energy. The utilization of collected data followed. Here, data is analyzed using various techniques such as cost benefit analyses, statistical approach and cause and effects diagram.

Then in the next phase, data was checked for validity. Results and recommendations are addressed in the next stage where the presentation and interpretation of data are discussed. Lastly, the research conclusion is presented; this is a summary of everything discussed in this study.

To attain the objectives of this research, the study was conducted using the quantitative method. The Root cause analysis: the analysis of the major problems facing the KZN region, and its contributors revealed problems such as the environment (dramatically changing environment), manpower (lack of skill), and method (inadequate method), etc.

b) Root cause analysis overview

The research objective was to investigate the root causes of solar unsustainability in the region of KwaZulu Natal. It was thus necessary to properly analyze the root causes. The cause and effects diagram are useful in analyzing the challenges contributing to the unsustainability of solar in the region. Kastner et al., (2017) recommended that implementation of renewable energy sources should be systematic to obtain successful models of renewable energy in Germany. The analysis of root causes has been found to be the best method now. Understanding the factors contributing to or the causes of a system failure can help develop actions that sustain the correction.
As all factors contributing to the unsustainability of solar energy are analyzed, they are also rated in terms of the contribution of each on a 1-5 scale before inserted to the Root Cause Analysis (RCA) graph, where 1 represents the minimum contribution and 5 represents the maximum contribution to the unsustainability of solar energy in the region. The statistical presentation is developed and presented in the form of graphs to present the failure rate.

Results and Discussion

1. Root cause analysis application on solar energy unsustainability

The results are presented in the form of a diagram (fishbone diagram) to simplify the findings and for better understanding of results. Dobrusskin, (2016) noted that cause and effect analysis is prevalent for many reasons; some of the reasons are:

- it consists of easy learnable and usable principles.
- its application can be addressed to a different kind of problem due to its flexibility. - it gives in-depth details of a problem.

Table 1 introduces the contributors posing a challenge to solar power sustainability. It also emphasises their importance and explains why they warrant an in-depth analysis. These are the major resources that contribute to the unsustainability of solar in the region.

Table 1: An overview of the contributors to the challenge to solar power (Dobrusskin, 2016).

Contributor	Description
Environment	Investigated impact of environment on solar power technology and it cause to understand problem even better. The objective of analysing the environment is to see how solar power installation can reduce environmental climate change.
Man	How people that are responsible for solar power contribute to its unsustainability. These are the major stakeholders in solar power since planning relies on the manpower available.
Method	To further understand the importance of the installation method in the solar unsustainability. The objective of analysing the method is to ascertain the most effective method that could be used in the region.

Material	Solar power uses unique material to absorb sunlight, therefore it is very important to analyse its contribution to the unsustainability of solar power in the region.

Solar power analysis through RCA is presented in the diagram below (figure 2). The numerous contributors are discovered and presented in the graph below and demonstrate a significant factor that impacts badly in the growth of the solar power in the region of KwaZulu Natal.

The figure below demonstrates the contributors in their categories as grouped according to the best four major found. The men represent employees and expectation of the solar panel installation and it also include the challenges faced with concerns to the implantation and monitoring the solar power system. Some employees lack skills and experience which is the most important part needed from them. This has led to major challenges of them being unable to discover that they are utilizing cheap material for solar panel. Therefore, the lack of one of the contributors led to project failure.

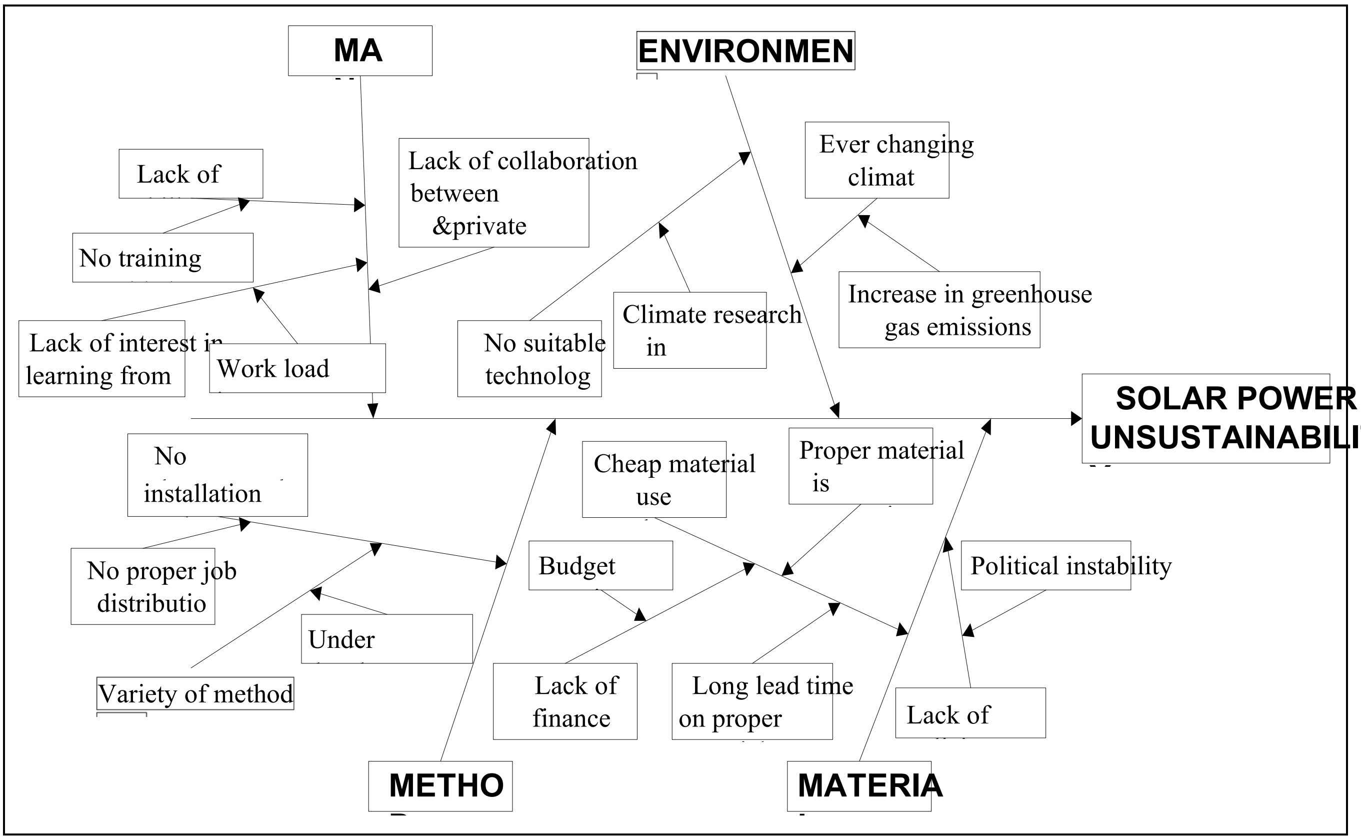

Figure 2: RCA for solar power analysis

The below diagram in figure 3 illustrates very clear the major contributor and minimum contributor to the problem of solar power unsustainability. The highest contributor has been discovered to be meterial with a 35% contributing rate of failing. If material used is not in good quality, there will be less life span of the solar power system. However, this is because of the information of men (employees), which also has 25% contributing rate as the second highest.

Environment and method contributor are found to be the least contributor to the equation as they both contribute 20% to the failure rate of solar power unsustainability. However, the method still has to be carried close the assessment of men capabilities. The figure 3 below shows clear all the contributors in percentages. In addition, an emerging line for linear presentation has ben added to the diagram to merge the accepted difference between each of the contributors. In the below figure we discover that material is extremley above the accepted merger.

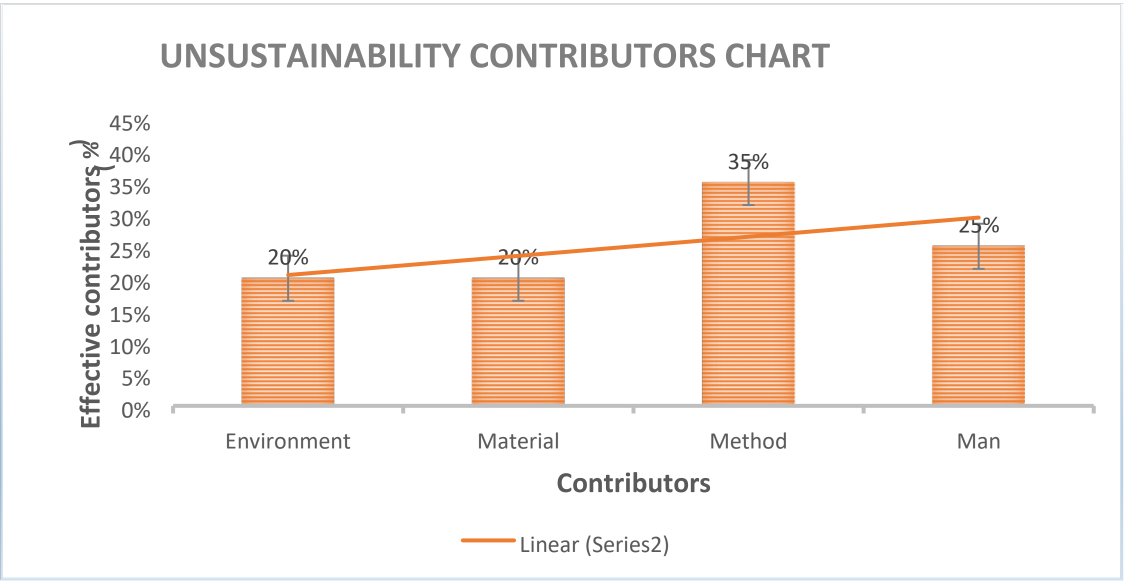

Figure 3: Unsustainability contributor's chart

RECOMMENDATION

What are the root causes of the unsustainability of solar power in the KZN region?

The study analyses the root causes of solar power sustainability in the KZN region, using the causeand-effect diagram. The prime solar power contributors were also discussed in relation to solar power. The following contributors were found to play a major role in solar power sustainability:

- Man is one the main contributor to solar power unsustainability since he lacks the very necessary skills to develop and understand the relevant technology recommended for the KZN region. This introduces the major challenge of time delay as more time has been requested to study solar power energy systems. Providing a regular training will ensure proper solar system maintenance and improved knowledge on the system.

- Environment was given a brief overview to demonstrate the aspects of the challenges of the solar power system during the implementation phase. All delays are briefly discussed for technological aspiration in the region. As this study gave an overview of the KZN region where a solar PV system had been installed, an environmental analysis was used to provide a better understanding of the technology. A study of the local environment was also used to calculate the cost effectiveness of technology in the KZN region. Recycling and maintaining the solar system will reduce environmental challenge. Therefore, all solar power components must be kept in a good storage for re-use to prevent environmental damage.

- Method is key when it comes to solar power implementation. A brief analysis of method is also given under the cause-and-effect overview. Solar power implementation methods were benchmarked to compare the region of KwaZulu-Natal with, for example, Germany. Benchmarking to these developed countries will yield positive impact regardless of economic muscle that will be needed. Method has the major impact, and the region should divert from implementing and regulating solar power in the same way coal is done. If responsible individuals are trained on a better solid solar system implementation, the system will last longer than it does now.

- Material to create a solar power system that will be sustainable due to the structure and quality of the material used was reviewed. The material used for solar power will determine the duration of the solar power system's existence under different weather conditions. However, weather conditions prevalent in KZN were not analyzed in the study. Technology is the major aspect that can improve the implementation of solar and reduce the early failure rate, it is recommended to search for the best technology, and this can be achieved by collaborating with the developed countries such as China that are currently leading when it comes to solar power implementation.

• What are the implementation processes regarding implementing solar power in the region and are these processes effective?

During the root cause analysis of solar power in the KZN region, the process of implementation was also discussed in detail. A financial analysis was also used to indicate the cost effectiveness of all the processes. However, a process flow did not form part of the study analysis.

A conclusive analysis is that interjoining of all contributors should be created with equal approach as they interlink to each other failure rate. Solar power failure is due because of numerous contributors mentioned in the study. Therefore, the authors fully support the technological analysis and implementation. This will ensure a different mechanism from the coal energy.

CONCLUSION

The importance of solar power sustainability in the region of KwaZulu-Natal, is the major contributor in dealing with renewable energy in the region. The growth of solar power depends on its sustainability. The outcome of this solar power unsustainability investigation was highlighted, among other things, a lack of education on solar power. The root causes of solar power unsustainability were discovered in the region of KZN using the special tool for determining the root causes. There are indulgences (such as the solar power policy gap) that are hindering implementation of solar power in the region that eThekwini municipality needs to deal with. According to the root cause outcome, solar power sustainability relies on solar power (SP) policing, SP financing, SP technology controlling and understanding. Monyei et al., (2018) agreed that some solar power problems exist because of policy fall-out.

The solar power root causes concluded that solar power installation was not growing as in other provinces such as the Western Cape. Financial support appeared to be the main obstacle to solar power installation as was outlined in the study. If solar power continues to be unsustainable in eThekwini municipality, the well-known impact will be increased energy demand and lack of sponsors to give financial support. The solar power financing will continue to depend on governmental support. As solar power implementation is not trusted by many citizens of eThekwini region, marketing of this commodity needs to be vastly improved. Strategic marketing will lead to improved solar power education.

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Biographies

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