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Investigation of Electric Power Distribution Lines Failure and Reliability Assessment

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ABSTRACT

Malaria is a mosquito disease of global concern with 1.5 to 2.7 million people dying each year and many more suffering from it. Malaria is most prevalent in the developing countries of the world. GIS and related spatial analysis methods provide a set of tools for describing and understanding the changing spatial organization of health care, for examining its relationship to health outcomes and access, and for exploring how the delivery of health care can be improved. This paper presents a system developed to spatially query the distribution of malaria in Nigeria. The system was developed using Hyper Text Markup Language 5 (HTML5) and Cascading Styling Sheets (CSS) for styles of the pages designed. After the design, the system was implemented and tested via the WAMP server which serves as a local server for hosting web applications without the use of internet access. Google map was used as a mapping service application to ensure that the geographical locations are displayed with the aid of the Google Map Maker. The result of the tests performed on the system showed that the system processed data adequately; the coverage of data stored showed the effectiveness of the system in data storage and retrieval. The simple interface design proved to be user-friendly for all users that handled the system. The system will also go to a long in solving the problem of poor health care system for malaria patients as access to information and statistics on malaria occurrence is made real-time. Also, the display on the map enhances easy-to-read and easy-to-understand environment for any authorized user to make decision related to malaria. In conclusion, the system has capacity to monitor malaria distribution and spatially query distribution of malaria in Nigeria. The system will go to a long in solving the problem of malaria in Nigeria so that patients can have access to information and statistics on malaria occurrence is made real-time. Also, it will be used by public health workers to monitor the distribution of Malaria in Nigeria

Keywords: Spatial Analysis, Web, Malaria, Distribution, Systems, Environment & Retrieval.

Aims Research Journal Reference Format:
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1. INTRODUCTION

Despite presence of various reasons of failure of distribution lines, installation of new methods of prevention of distribution lines can benefit a power system by improving transient stability, increasing power transfer capability, preventing huge loss of energy and eliminating the need for more parallel and uneconomical distribution methods be an important technology for increasing smart grid deployment. [5] The distribution system is a major component of the electric power supply network. Experience has shown that outages are more frequent in the distribution system than either in the generation or transmission systems Irrespective of the performance of both the generation and transmission components, the smooth operation of the entire power system may be marred by unreliable distribution network. The distribution system improvement requires assessing the performance of the system as it exists. This means quantifying the reliability of the distribution network and evaluating the effect of reinforcements and other improvements. [8]

The unreliability of power supply as a result of distribution lines failure has adversely affected both economic and social lives of citizens. One of the main stages in reliability assessment is to analyze the impact of the possible failures that may occur in a practical system on the performance of the overall system. For instance how the overloaded distributions lines influence the overall power system, is an important issue in reliability study of the bulk power systems. Network solutions can be applied to perform such system characteristics, abnormal state and the required the remedial action in form of corrective action or load curtailment to clear the abnormality. After identifying the violation in the system, remedial actions are applied to alleviate the system abnormal conditions.

Therefore the main emphasis is on clearing the abnormality of the system due to the special contingency by either removing the failed component or rescheduling the generation unit and re-supplying the load if the violation still exists, then load curtailment will be required. A high-power system model is a necessary factor in the prediction capability of the system to supply a sufficient amount of electric power required at any given time. High-power systems are very complex and require maintenance of major factors. Reliability is one of the important factors in the design, operation, and maintenance of electric power systems but failure in distribution system network are enough to inflict harm or death on living thing. The key measures of distribution system performance as it has a direct impact on system can be attributed to technical losses and non-technical losses. Technical losses refers to energy losses resulting from the heating of electrical distribution components such as cables/lines and transformer windings, whereas non-technical losses is associated with the energy unaccounted for due to consumer pilferages, faulty energy meters, incorrect billing, etc. Therefore, technical losses in distribution systems are primarily dependent on network topology, system voltages, and electrical loading. Hence, the accuracy in estimating technical losses in a distribution system would require extensive network and load data for modeling. [5]

In order to provide a quantitative evaluation of the reliability of an electrical system, it is necessary to have indices which can express system failure events on a frequency and probability basis. The following three basic reliability indices: Expected failure average outage rate duration (λ), rand Average outage time (U), are evaluated for each load point of any meshed or parallel system. These indices help to assess the measure of reliability at each load point and allow subsidiary indices such as the customer interruption indices to be determined. The limitations of this technique according to include:

(i) Not able to differentiate between the interruption of large and small loads. (ii) Inability to recognize the effect of load growth by existing customers or additional new loads and (iii) It could not be used to compare the cost –benefit ratios of alternative reinforcement schemes nor indicate the most suitable timing of such reinforcements. These deficiencies could be accounted for through evaluation of the following two additional indices

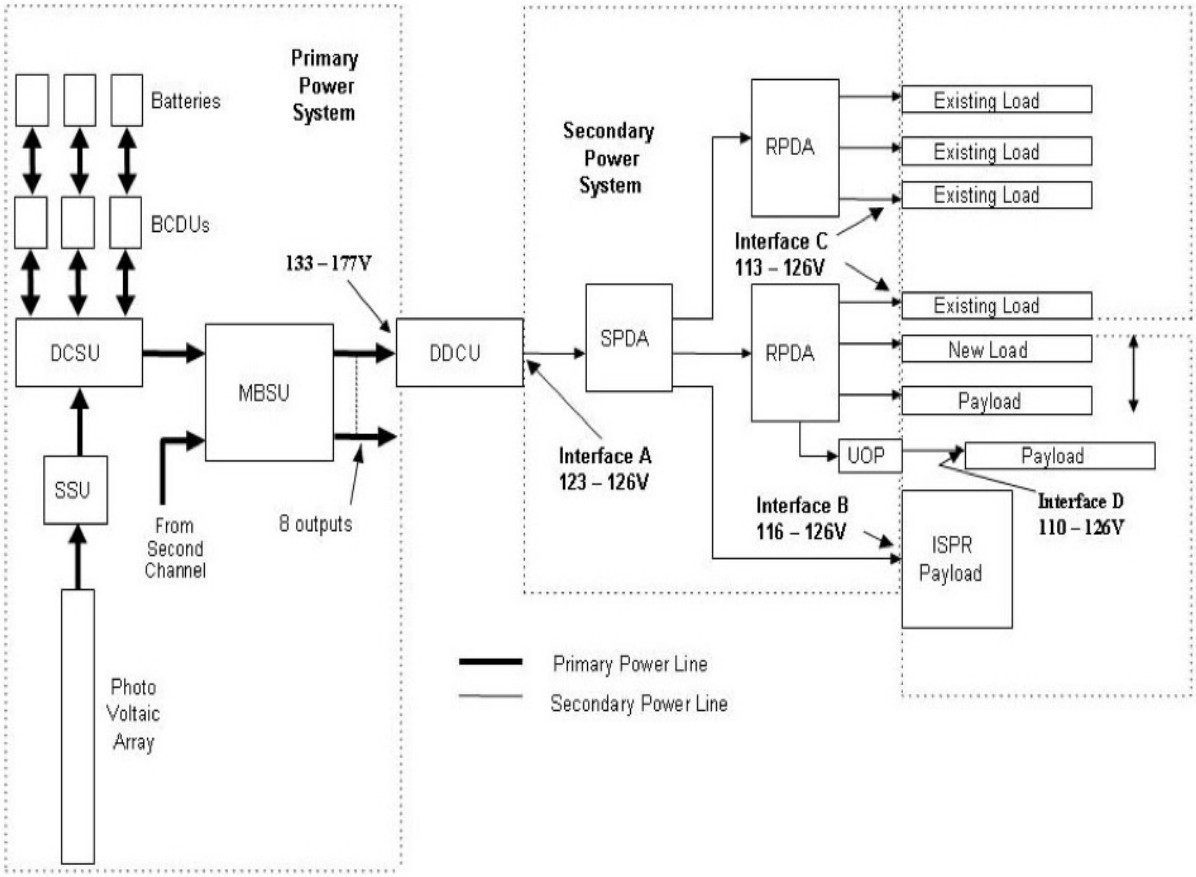
(ii) The average load disconnected due to a system failure, measured in KW or MW. (ii) The average energy not supplied due to a system failure, kWh or MWh. Two sets of reliability indices, customer load point indices and system indices have been established to assess the reliability performance of distribution systems. Load point indices measure the expected number of outages and their duration for individual customers. System indices such as SAIDI and SAIFI measure the overall reliability of the system. The third popular index most utilities have been benchmarking is CAIDI. These indices can be used to compare the effects of various design and maintenance strategies on system reliability. SAIFI can be improved upon by reducing the frequency of outages (tree trimming and maintaining equipment), and by reducing the customers' through interruptions provision of reclose and fuses) in his Mahmud and Saeed [5], that presented the results of a preventive maintenance application-based study and modeling of failure rates in breakers of electrical distribution systems and examined the impacts of preventive maintenance on failure rate of selected network connectives. We cannot ignore the fact that in some parts of the world, natural disasters do happen which may lead to serious destructions to power systems. Natural phenomena could be earthquake, flooding, drought, thunder storm (lightning strokes) etc. If adequate measures are not taken to restore the system on time, it could lead to severe economic problems to the power distribution lines and consumers

1.1. Failure Functions

According to Stevenson, 1982 said all electricity industries worldwide experience power-delivery problems. Faults can be very destructive to power system. [4] A great deal of study and development of devices and design of protection schemes have resulted in continual improvement in the prevention of damage to distribution lines. We assume that is a continuous random variable with values in a positive real line. Many methods are available to specify the properties of a random variable. The best four methods specifying the properties of are probability density function (PDF), cumulative distribution function (CDF), reliability function, and hazard or failure function. The reliability function is one of the mathematical and engineering indicators that describe the role of the equipment in the system using the probability function. Reliability is defined by the North American Reliability Council Glossary of Terms as "The degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards, and in the amount desired". Reliability can be calculated from the frequency, duration, and magnitude of the adverse effects by the equipment on the electric supply. Electric system reliability can be addressed by considering two basic and functional aspects of the electrical system: adequacy and security. Competition arises among manufacturing companies, especially within the warranty period, by increasing this period based on product quality. Reliability is an important element to measure product specifications. Furthermore, ensuring reliability reduces the cost of corrective actions on items that fail within the period of time.

1.2. Conductor type

Aluminum conductors reinforced with steel (ACSR) were used in the distribution lines but they can be replaced by the modern conductor that offers reduced thermal sag is known as ACCC ("Aluminum Conductor Composite Core"). In lieu of steel core strands that are often used to increase overall conductor strength, the ACCC conductor uses a carbon and glass fiber core that offers a coefficient of thermal expansion about 1/10 of that of steel. While the composite core is nonconductive, it is substantially lighter and stronger than steel. Its lighter weight allows the incorporation of 28% more aluminum (using compact trapezoidal shaped strands) without any diameter or weight penalty. The added aluminum content helps reduce line losses by 25 to 40% compared to other conductors of the same diameter and weight, depending upon electrical current. The ACCC conductor's reduced thermal sag allows it to carry up to twice the current compared to AAC ("All Aluminum Conductor") or ACSR ("Aluminum Conductor Steel Reinforced").[2]



Electrical Power Distribution Overview

Figure 1 : Typical Distribution Overview

2. POWER FLOW STUDY

In his (Roy, 2011; Ahmad et al, 2011). That the Power flow analysis is performed to investigate the magnitude and phase angle of the voltage at each bus and the real and reactive power flows in the system failure. The load flow results are very valuable for setting the proper protection devices to ensure the security of the system. The objective of any power flow program is to produce the following information. [9]

- Voltage magnitude at each bus.
- Real and reactive power flowing in each li
- Phase angle of voltage at each bus.

In numerical analysis for power flow, the Newton-Raphson method, is the best known method for finding successively better approximations to the zeroes (or roots) of a real-valued function. (Gupta, 2011; Roy, 2011) [9]
If,

$$I_i = \sum_{j=1}^{n} Y_{ij} V_j \tag{1}$$

Also

$$I_i = \frac{P_i - jQ_i}{V_i^*} \tag{2}$$

Expressing in polar form

$$I_i = \sum_{j=1}^{n} |V_{ij}||V_j| \angle \theta_{ij} + \delta_j \tag{3}$$

Substituting for Ii from Eqn.3 in Eqn. 2

$$P_i - jQ_i = |V_i| \angle - \delta_i \sum_{j=1}^{n} |V_{ij}||V_j| \angle \theta_{ij} + \delta_j \tag{4}$$

$$P_i = \sum_{j=1}^{n} |V_i||V_j||V_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \tag{5}$$

(6)

$$Q_i = -\sum_{j=1}^{n} |V_i||V_j||V_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j) \tag{6}$$

$$\begin{bmatrix} \Delta P_2^{(k)} \\ \vdots \\ \Delta P_n^{(k)} \\ \Delta Q_2^{(k)} \\ \vdots \\ \Delta Q_n^{(k)} \end{bmatrix} = \begin{bmatrix} \begin{pmatrix} \frac{\partial P_2^{(k)}}{\partial \delta_2^{(k)}} & \cdots & \frac{\partial P_2^{(k)}}{\partial \delta_n^{(k)}} \\ \vdots & \ddots & \vdots \\ \frac{\partial P_n^{(k)}}{\partial \delta_2^{(k)}} & \cdots & \frac{\partial P_n^{(k)}}{\partial \delta_n^{(k)}} \end{pmatrix} & \begin{pmatrix} \frac{\partial P_2^{(k)}}{\partial |V_2|} & \cdots & \frac{\partial P_2^{(k)}}{\partial |V_n|} \\ \vdots & \ddots & \vdots \\ \frac{\partial P_n^{(k)}}{\partial |V_2|} & \cdots & \frac{\partial P_n^{(k)}}{\partial |V_n|} \end{pmatrix} \\ \begin{pmatrix} \frac{\partial Q_2^{(k)}}{\partial \delta_2^{(k)}} & \cdots & \frac{\partial Q_n^{(k)}}{\partial \delta_2^{(k)}} \\ \vdots & \ddots & \vdots \\ \frac{\partial Q_n^{(k)}}{\partial \delta_2^{(k)}} & \cdots & \frac{\partial Q_n^{(k)}}{\partial \delta_n^{(k)}} \end{pmatrix} & \begin{pmatrix} \frac{\partial Q_2^{(k)}}{\partial |V_2|} & \cdots & \frac{\partial Q_2^{(k)}}{\partial |V_n|} \\ \vdots & \ddots & \vdots \\ \frac{\partial Q_n^{(k)}}{\partial |V_2|} & \cdots & \frac{\partial Q_n^{(k)}}{\partial |V_n|} \end{pmatrix} \end{bmatrix} \begin{bmatrix} \Delta \delta_2^{(k)} \\ \vdots \\ \Delta \delta_n^{(k)} \\ \Delta |V_2^{(k)}| \\ \vdots \\ \Delta |V_n^{(k)}| \end{bmatrix} \tag{7}$$

It can be written as

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} J_1 & J_2 \\ J_3 & J_4 \end{bmatrix} \begin{bmatrix} \Delta \delta \\ \Delta |V| \end{bmatrix} \tag{8}$$

3. FINDINGS AND DICUSSION

The main task of the electrical power distribution system is to supply continuous electric energy to customers (consumers). Distribution system reliability indices are also defined by the approach of better provision of load. [12]

A method relies on a proper processing procedure of the starting instants of the voltage transient originated by the fault, measured in the monitored nodes of the network by using a distributed system. Its architecture is of master-slave type: a given number of slave units are located in all the nodes of the network. Each slave unit acquires both the starting instant and the waveform of the voltage transient. The former information is sent to the master unit, which locates the transient voltage source by relating the starting instants at all the slaves units to the stored characteristics of the network. Figure 1 shows the schematic block diagram of a slave unit: the dashed box contains the blocks performing the measurement of the transient starting instant. [6] The voltage u (t) at the monitored node is conditioned by a Voltage-to-Voltage Transducer (VVT), whose output uVVT feeds an Event Detection Block

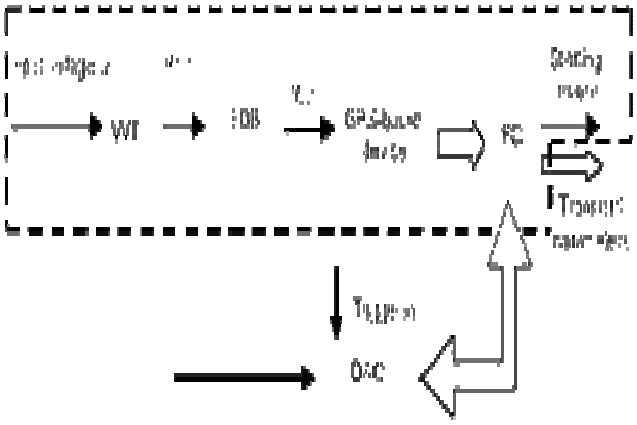


Fig. 2. Block diagram of a remote unit

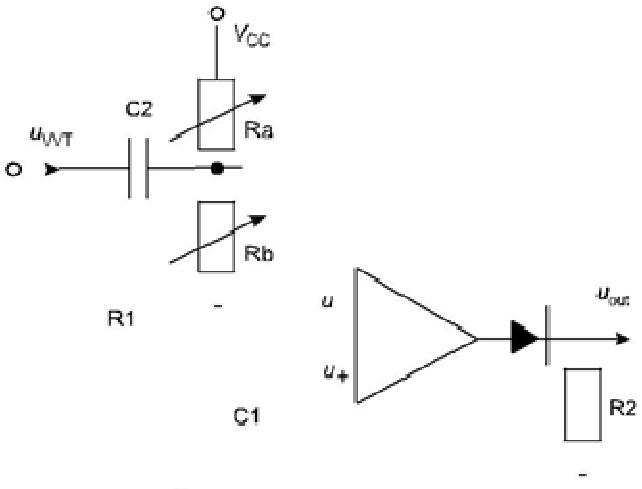


Fig. 3. Circuit implementing the event detection block (EDB)

Figure 4 illustrates six paths covered by travelling waves originated by a fault in the line L3. The travelling waves are reflected at the line terminations and at the fault location. Paths with partial reflections at the point where more lines converged are here disregarded. Only three paths (namely paths 3, 1 and 2) reach the observation point. The interactions between birds and power lines differ according to the voltage of the line . Faults due to the electrocution of birds bridging the conductors-to-tower air gap by the wings and body occur primarily at voltages of and below 132kV where clearances are smaller than on higher voltage lines.[11]

As mentioned in section above it is possible to correlate each path to characteristic frequencies of the fault transient recorded at the observation point by the following considerations: path 3 is associated to a period given by a travelling time equal to 4 times L1+0.7*L3 divided by the propagation speed of the considered propagation mode , as the travelling wave experiencereflections of opposite sign at the fault location and at the sending end of the main feeder. For paths 1 and 2, the associated periods are given by the travelling time relevant to the double path lengths (L1+L2+L4 and L1+L2+L5, respectively), as the travelling wave is reflected at the line terminations.[11]

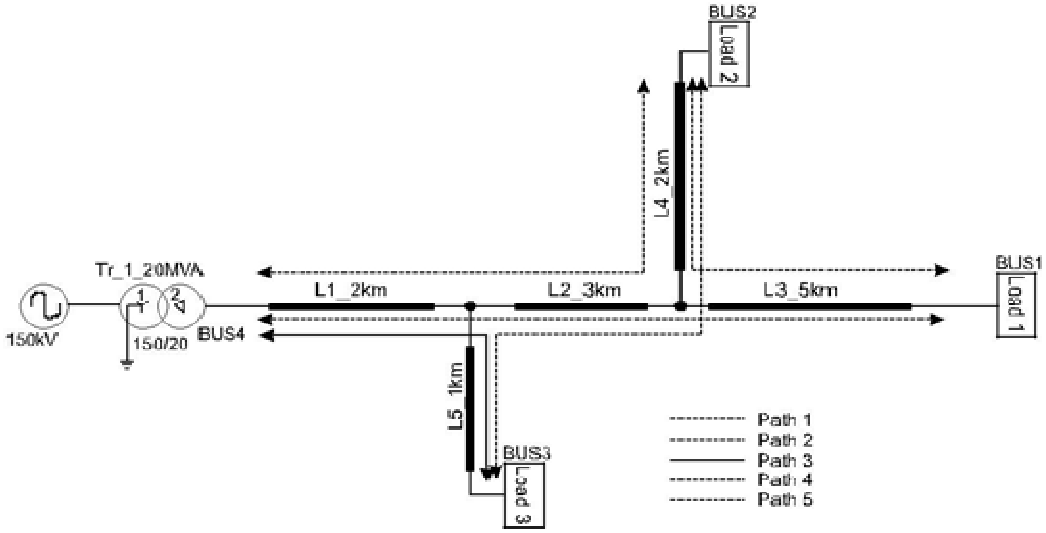


Fig. 4. Paths covered by travelling waves caused by a fault at line 3

The Exposure of electricity lines and unauthorized construction of residential houses in areas where there were medium- and low-voltage lines were responsible for 37% of the injuries and death. The findings showed that the highest rate of accidents occurred in recent year.

Fig 5. High- tension line fell on the roof in Calabar, Nigeria

Fig.6.Damage high tension pole

There is need to Improve the quality of the electrical design will maximize the security. The design of various electrical equipment is according to the operation without considering the surrounding of installation. The design of distribution lines such as towers, conductors, insulators, and auxiliary fittings remains same throughout the distribution of the power system without considering the surrounding conditions. The calculation and selection of Ray devices is very important to the designers who just only mechanically copy, copy the typical design and design specifications. As mentioned above, lightning factor after the accident of the lightning cause the fault, which can be protected by adopting specific design, the designer according with local surrounding take the appropriate lightning protection measures, copying the design specification, resulting in protection from the lightning factor. Later in the installation of surge arresters on towers, the accident was rarely the same time, the power lines must also be reasonable design in order to better exercise its duties. In the design work of the distribution line there is great need of careful calculations, site survey and line path selection of the topography and line the path.

Initially it should be quickly and carefully investigated the climatic conditions and terrain, try to avoid erecting tower in adverse terrain and geographical location, and should strengthen the mechanical strength of the tower, try to use a steel bar or strengthen the type of concrete pole cross arm can be thicker. Selecting a different structure for the cross arm installed on the pole in the ice prone areas. Structure of the insulator should be with the hydrophobic properties of the coating. Pollution Flashover cause number of accidents and the impact leads to the creation of fault. The prevention of lines with pollution flashover is to improve the power system for the safe use of electricity distribution, continuing the important work of the electricity by increasing the creep age distance and the use of synthetic insulators can effectively prevent the pollution flashover occurred, or the use of anti-pollution flashover, coating thereby limiting occurrence of leakage current accident.

External damage to the transmission line, the strong winds make the trees fall overwhelming line. Furthermore, it is increasingly rampant theft and frequent traffic accidents. So it should be to optimize the electrical design and power transmission lines so as not to too close and woods, to take full account of brought to the tree growth rate "hazard" and the road to keep the proper distance, and in accordance with the specific location of the tower, additional protection pier, and finally painted with eye-catching protective signs. For external damage to the transmission line fault analysis, may take the following steps to protect the transmission lines. Increase the protection of power facilities and efforts to do the publicity and education work of the electricity users and the establishment of a strict line inspection system. To constantly improve the electricity regulations to strengthen the power of law enforcement efforts.

4. RECOMMENDATION AND CONLUSION

Upgrading of the power transmission and distribution infrastructures. More emphasis should be on distribution infrastructure now and then after ensuring that the equipment on ground and it performing optimally. [15] In this paper we examine the distribution system reliability and open circuit detection of power line system at the last mile pole is very useful to avoid transmission line breakage mishaps compared to short circuit fuse blowing mechanism which is now used in practice. Also Wireless communication RTU technology can be used over years without any maintenance. Breaking mechanism technology now is so much advanced with microprocessor based and compact, also they can be controlled remotely by using a shunt trip mechanism signal. This integration of breaking mechanism + Wireless link + open circuit detection will give an excellent result and avoid any electrical accidents due to open hanging wires. [7]

By analyzing the prevention methods of distribution line. It can be concluded that the need of protective system is an important part of power system. Distribution line protection method from fault mentioned in the paper can be achieved by adopting the methods mentioned. Electrical power plays a very important role in the country's economy and hence the need for prevention of distribution line increases many more times than that of any other type of energy. Implementation of immediate measures for emergency cases in which modifications are required. [1]

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