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Thunderstorm Energy: An alternative energy resource in the humid tropical region of West Africa

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ABSTRACT

Energy crisis is the talk of the world today. There are several evidences on the utilization of some renewable energy resources but facts and technological innovations on the use of thunder storm energy are yet to be fully documented. This paper aims at investigating the technological innovations, potentials and utilization of thunderstorm energy in the humid tropical region of West Africa.

Keywords: lightening, energy crisis, electrical energy

1. INTRODUCTION

Total dependence on only one source of energy is the major cause of instability in the flow and use of energy in the world. The present world is in thirsty need of a large amount of green and environmental friendly source of renewable energy. Since the late 1980s, there have been several attempts to investigate the possibility of harvesting energy from lightning. Thunderstorm which is

also known as an electrical storm, lightning storm, or thundershower, is a storm characterized by the presence of lightning and its acoustic effects on earth atmosphere. Each lightning strike has an average of 5 billion joules of energy which is equivalent to about 1,400 kWh at zero loss in transfer and storage (Akinnubi and Komolafe 2016). The onset and magnitude of electrical activity can be objectively assessed, which otherwise can only be estimated from indirect parameters such as certain thresholds in radar reflectivity. In most previous studies, lightning events are considered only within a pre-identified cell volume defined by other data sources (Soul, 2002). Individuals that has made attempt to harvest thunderstorm energy include; Steve LeRoy; He was able to power a 60-watt light bulb for 20 minutes using the energy captured from a small flash of artificial lightning made by an alternative energy company called Alternate Energy Holdings, Inc. (AEHI), but could not store the energy for future use. Martin A. Uman, co-director of the Lightning Research Laboratory at the University of Florida tested and stated that the energy in a thunderstorm is comparable to that of an atomic bomb, but trying to harvest the energy of lightning from the ground is "hopeless" (Glassie, John, 2007).

It has been proposed that the energy contained in lightning can be used to generate hydrogen from water, or to harness the energy from rapid heating of water due to lightning, or to use inductors spaced far enough away so that a safe fraction of the energy might be captured. If the quantity of water that is condensed in and subsequently precipitated from a cloud is known, then the total energy of thunderstorm can be calculated. Hot and humid zones are prone to more thunderstorms. Humid regions are the climate region where mean monthly temperature are consistently high and exceeds 18^{o}C throughout the year and where rainfall exceeds evapotranspiration for at least 270 days in a year (Salati, 1983). Humid is a zone of climate characterized by hot, usually humid summers and mild to cool winters. It normally lies on the southeast side of all continents, generally between latitudes 25° and 40°. It tends to be located at coastal or near coastal locations. However, in some cases it extends well inland, most notably in China and the United States. In Africa, the humid climates are found in two separate areas on the southern hemisphere of the continent. The *Cwa* climate is found over a large portion of the interior of the Middle and Eastern African regions. This area includes; central Angola, northeastern Zimbabwe, the Niassa, Manica and Tete provinces of Mozambique, the southern Congo provinces, southwest Tanzania, and the majority of Malawi, and Zambia. Some lower portions of the Ethiopian Highlands also have this climate. The climate is also found in the narrow coastal sections of southern and eastern South Africa, primarily in KwaZulu-Natal and the Eastern Cape provinces. South Africa's version of this climate features heavy oceanic influences resulting in generally milder temperatures. This is particularly evident in its winters when temperatures do not drop as low as in many other regions within the humid subtropical category. Our focus is to look into harnessing the thunderstorm power more in the newest future for Energy in this region of West Africa and have same effect as that of solar energy by harnessing clean electricity from it.

Lightning in humid regions could be harvested for energy just as the energy from the sun is been harvested. Just as solar energy could free some households from paying electric bills, this promising new energy source could have a similar effect. Energy continually has been a major problem which necessary attention needed to place on it in other to utilize the renewable source to have a better means for energy use. If we can find some way to store the energy, we may be able to solve the problem of power generation, crisis of fuels, etc. Additionally, lightning is sporadic, and therefore energy would have to be collected and stored so that it can be used afterwards. Contrary to the original believe by scientists that water droplets in the atmosphere were electrically neutral, and remained that way even after brushing up against charges on dust particles and other liquids (Knowledge, 2007). Water droplet pick up charges and can become increasingly charged as the amount of water vapor in air increases which shows that water in the atmosphere can accumulate electrical charges and also transfer them to other materials it comes into contact with,". From various contents we looked in thunderstorm; it is shown that thunderstorm and thunder with lightning goes together and it is better utilized in it the humid tropical region.

A severe thunderstorm is measured in terms of intensity based on the strength of the wind speeds or significant winds associated with the thunderstorm event. Thunderstorms occur throughout the world, even in the Polar Regions, with the greatest frequency in tropical rainforest areas, where they may occur nearly daily. At any given time approximately 2,000 thunderstorms are occurring on Earth. Kampala and Tororo in Uganda have each been mentioned as the most thunderous places on Earth, a claim also made for Bogor on Java, Indonesia and Singapore. Other cities known for frequent storm activity include Darwin, Caracas, Manila and Mumbai.

2. HARVESTING LIGHTNING ENERGY FROM HUMID REGIONS

A technology capable of harvesting lightning energy would need to be able to rapidly capture the high power involved in a lightning bolt in the humid region. Several schemes have been proposed, but the over-changing energy involved in each lightning bolt render lightning power harvesting from ground based rods impractical (too high), which may damage the storage, too low and it may not work. To facilitate the harvesting of lightning, a Laser-Induced Plasma Channel (LIPC) could theoretically be

used to allow lightning to strike in a predictable location. A high power laser could be used to form an ionized column of gas, which would act as an atmospheric conduit for electrical discharges of lightning, which would direct the lightning to a ground station for harvesting (Discovery News Lighting Control).

Additionally, lightning is sporadic, and therefore energy would have to be collected and stored; it is difficult to convert high-voltage electrical power to the lower-voltage power that can be stored. The energy contained in a lightning bolt disperses as it travels down to Earth, so a tower would only capture a small fraction of the bolt's potential. To ease thunderstorm harvest, there is need to build a lightning harnessing power plant that is. The lightening arrester power plant is an array of lightning rods which will be far enough to collect a large percentage of the lightning. This concept is perhaps not as impractical as it once was. The main limiting factor of implementing a lightning capturing scheme such as this was the inability to be able to store large amounts of electricity for later use. However, new Utility Scale Battery technology or other energy storage technologies such as Flywheels or Capacitors could be used to store the electricity captured from lightning in massive quantities, for later grid use (APS, 2007). Obviously, a lightning capturing power plant would only be practical in regions with frequent thunderstorms. The biggest hurdle would really be creating power plant infrastructure that could survive the harsh surges created by lightning strikes, but even that seems possible with current technology and materials. Electrical and building design engineers could come up with an innovative way to make it work. Specially designed buffer/insulation and transformer materials could be used to safely capture and harness the massive amounts of electricity generated during a lighting strike, and transfer it to large storage device for later use. The oppositely charged regions create an electric field within the air between them. This electric field varies in relation to the strength of the surface charge on the base of the thundercloud – the greater the accumulated charge, the higher the electrical field. Thunderstorm monitoring as accurate as possible and a better understanding of the driving processes, together with a well-set monitoring of crucial storm parameters, can contribute to improve the prediction of extreme non-linear developments of the thunderstorm. Thunderstorm tracking be objectively assessed, which otherwise can only be estimated from indirect parameters such as certain thresholds in radar reflectivity.

Lightning can start in regions of thunderstorms that have relatively low electric fields and, so, should create no sparks. Because lightning obviously is made by thunderstorms.

Process of Lightning:

In order for an electrostatic discharge to occur:

- a sufficiently high electric potential between two regions of space must exist
- a high-resistance medium must obstruct the free, unimpeded equalization of the opposite charges.

Establishing Electric Field

As a thundercloud moves over the surface of the Earth, an equal electric charge, but of opposite polarity, is induced on the Earth's surface underneath the cloud. The induced positive surface charge, when measured against a fixed point, will be small as the thundercloud approaches, increasing as the center of the storm arrives and dropping as the thundercloud passes. The referential value of the induced surface charge could be roughly represented as a bell curve (Gaussian!!!! once we get to Gaussian, we can apply a lot of signal processing techniques to quantify).

Thunderstorm Hazards

Thunderstorm poses risk from lightning, flooding or tornadoes. Thunderstorms have a life cycle of three stages; the developing stage, the mature stage and the dissipating stage. Hazardous impacts of thunderstorm-related phenomena like heavy rain, hail, and lightning strikes render short-term prediction (now casting) of thunderstorm propagation and evolution an important issue for weather-related dangers (Kohn et al., 2010). Thunderstorm at the dissipating stage is capable of destroying electric appliances and machines if they are not properly protected by earthling. Lightning information is needed to be used primarily as an additional data source to obtain a more comprehensive picture about the development stage of a storm in order to prepare for its hazardous effects. Electrical gadgets if not fused or on earth can be exposed to thunder hazards. Some forms of thunderstorm hazards include; Dissipating Stage hazard, Cumulus Stage hazard, Mature Stage hazard, Action of Hail, Tornadoes, Downburst, Flash flood. Due to the evolution of more efficient and more accurate lightning detection systems, general use of lightning data increases steadily. The data are especially interesting for monitoring of severe storms in regions where no or insufficient other high-resolution data are available for observation of deep convection, for example over the Mediterranean Sea (Price et al., 2011) in data-sparse areas of the Alps (Bertram & Mayr, 2004), and for tropical clones over oceans (Demetriades and Holle, 2006). Active lightning accompanied by gusty winds and rain brings potential hazards. There are two types lightning strikes: Cloud-to-Cloud (CC) and Cloud-to-Ground (CG). The

latter is more threatening to our safety. To avoid lightning strike, the most important thing is to stay away from highly conductive objects to avoid various risks such as:

1. Direct strike : a cloud-to-ground lightning strike directly hits you or something you are holding, such as a golf club or fishing rod, which is the most dangerous way of lightning encounter;
2. Side flash : lightning strikes something (e.g. lamp post, mast) close to where you are and a portion of that current jumps from that object to you;
3. Touch potential: you come in touch with an ungrounded object which has been charged by a lightning strike causing part of the lightning current to pass through your body.
4. Step potential: lightning strikes in close proximity to you and its electrical current dissipate into the ground. Due to the proximity of the strike, there could be a voltage difference between your feet resulting in current travelling through your body. You could be at risk of injury during a CG strike simply by being too close to it!

Precautions

Thunderstorms come and go fairly uneventfully; however, any thunderstorm can become severe, and all thunderstorms, by definition, present large energy alongside with the danger of lightning. Thunderstorm preparedness and safety refers to taking steps before, during, and after a thunderstorm to minimize injury and damage.

The following are precautions to be taken if a storm is imminent or in progress:

- Ensure all electrical gadgets are fussed.
- Take action immediately upon hearing thunder. Anyone close enough to the storm to hear thunder can be struck by lightning.
- Avoid electrical appliances, including corded telephones. Cordless and wireless telephones are safe to use during a thunderstorm.
- Thunderstorm at the dissipating stage is capable of destroying electric appliances and machines if they are not properly protected by earthling. Therefore, it is advised that all electrical gadget is fused earthed
- Close and stay away from windows and doors, as glass can become a serious hazard in high wind.
- Do not bath or shower, as plumbing conducts electricity.
- If driving, safely exit the roadway, turn on hazard lights, and park. Remain in the vehicle and avoid touching metal.

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