



Lightning as an Alternate Energy Source

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ABSTRACT

As the earth's population increases and technology advances, it has proved necessary to obtain advanced non-polluting sources of energy which has given rise to research into various renewable energy sources with sufficient amount of power. With respect to this search, this paper presents a renewable source with very high amount of energy and the viability of harnessing this renewable energy called lightning. Lightning is usually identified by its high intensity of light and high thunder sound, but it is a large scale of electrostatic discharge seen as spark which originates from a charged cloud. These charged clouds (Columbus cloud) which are 5 – 15km in height and 5-10km in width discharges an approximate 10MV and more in some cases with billions of joules and trillions of wattage power to the earth surface. For this enormous amount of energy in lightning to be harnessed, the system must be able to handle its fast-occurring nature, high energy surge and unpredictable nature. The process of harnessing this energy involves 5 basic steps leading from the ARRESTOR through highly CONDUCTING CHANNEL to the HARNESSING METHOD, then to the STORAGE and finally the UTILIZATION/MANAGEMENT unit which enables the energy to be used. When this lightning energy is successfully harnessed, it would be a substitute or supplementary power supply.

Keywords: Alternate energy source, Harness, Lightning, Electrostatic discharge, Cloud.

1. Introduction

Since the onset of time, man's quest for technology to improve its existence on earth has led to technological improvement and search for more effective less polluting (renewable) energy sources. In other words, more reliable high energy sources are being researched on. Renewable energy sources have proved to be more reliable due to their eco-friendly nature and availability at predictable periods. Some of which are already in use and others being researched on, which leads us to an old energy source but still under research; LIGHTNING.

The natural phenomenon lightning can be viewed as an alternate renewable energy source owing to lots of energy discharged during occurrence. This natural phenomenon has been seen by all and occurs during rainy or cloudy periods. It is mostly experienced or viewed as a dangerous event which gives off very bright light and high sound. But in contrast, lightning strike event is far more than the light and sound and would be fascinating when it is very well understood.

Lightning is initiated in the clouds and not just any cloud. They are usually huge, about 5 – 12 km or even more in height and 5 – 10 km in width (Dehn, 2014; Uman, 2008). These clouds become charged as a result of charge separation which occurs during particle collision under very high turbulence within the clouds. This causes oppositely charge particles to separate leading to very high potential within the cloud, ranging from 10MV to 100MV or even up to 200MV depending on the cloud. This potential is then discharge to the ground or other charged bodies which could include; to other oppositely charged region within same cloud (Intra-cloud), to oppositely charged region of another cloud (Inter-cloud) or to the air (cloud-to-air). The process of the discharge is the birth of LIGHTNING. Hence, Lightning is a large scale electrostatic discharge of charged particles between oppositely charged bodies which is initiated from charged clouds. (Afa & Kelvin, 2013; Akinyemi et al., 2014; Betz et al., 2009; Dwyer & Uman, 2014; Horváth, 2006; Lucas, 2001; Rakov & Uman, 2003; Uman, 2008)

The lightning discharge most associated with man is the cloud-to-ground discharge in which the energy during the process can be trapped and harnessed to serve as a substitute or supplementary power supply. Irrespective of lightning enormous energy, its occurrence results in loss of lives and properties yearly.

2. Harnessing Lightning Energy

Harnessing involves capturing and putting into use or extracting for use. Harnessing lightning entails capturing the energy in lightning strike for utilization. Lightning strike is known to have enormous amount of energy (billions of wattage power). This energy is discharged from the clouds to the earth or ground, which is considered waste.

Even with its enormous and disastrous effects, research has proved the viability of harnessing this natural renewable energy. Research has also alighted limitations or challenge in harnessing this energy. These include;

- Fast occurring nature:** This involves the duration of lightning occurrence. The actual lightning strike occurs within milliseconds and involves an average of 4 return strokes. The extended witnessed effects are by products due to lightning occurrence, which is the light (due to electron recombination and collision) and sound (due to electronic collision). Since light travels faster than sound, the light is always seen first. In order to harness this energy, a device is needed which could handle its fast nature.
- High energy:** This involves the high amount of energy in lightning (approx. 1 billion watt). A device to harness lightning energy should be able to withstand or handle such enormous energy.
- Unpredictability:** Lightning occurrence with its ability to strike a particular location is known to be very unpredictable, which is due to certain factor associated with its phenomenon. But some level of probability can be obtained to a degree based on previously observed patterns of occurrence called lightning frequency for a particular location or region. There are areas with higher lightning frequency than others, hence a higher probability of lightning occurrence. This can help facilitate location analysis for lightning harvesting farm.

In summary, a lightning harnessing facility must be able to handle its fast occurring nature, enormous energy and unpredictability nature.

(Lux, 2010)

3. Lightning Harvest Process

Lightning harnessing has been researched by various authors and these 5 step procedure are the generalized process for harnessing the enormous energy from lightning. This is also presented as a block diagram in figure 1.

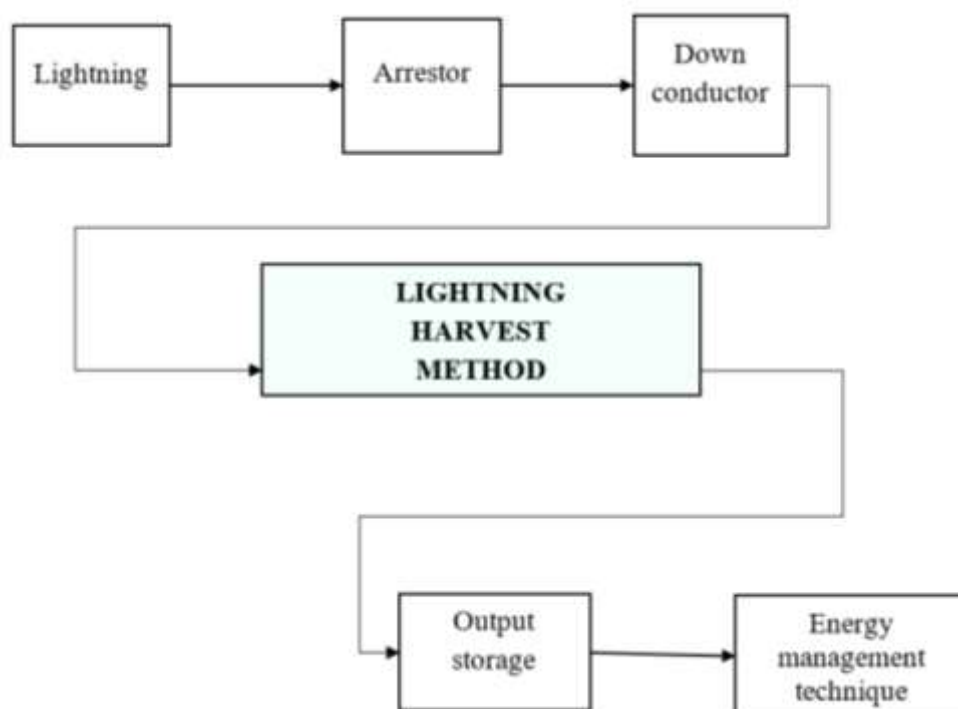


Figure 1 : Block diagram showing a generalized lightning energy harnessing process

Capturing: The CG lightning discharges energy from the cloud to earth through a point of contact on ground surface. This contact point can be determined by the highest conducting point within a region covered by the down streamer, or it could strike directly to ground in open fields. This can be better understood with knowledge of upward streamer (concentrated amount of charged particles which creates the lightning discharge path). With the knowledge of highest conducting point as illustrated by Benjamin franklin in 1752, custom points are being created using arrestors. Arrestors are the v-shaped devices at the top of building or structures which capture and channeling lightning to ground with the aim of protecting the structure. This arrestors have a region of coverage dependent on the height of the arrestor from the ground (Coverage Radius, $R = 2 \times \text{height of arrestor from ground}$). (Dwyer & Uman, 2014)

- **Channeling:** This involves the pathway of the captured lightning from arrester to ground. This is essential, as the captured energy would choose an alternate path if not provided. And this must be a highly conducting path in-order to reduce the amount of heat generated along this path due to resistance. A copper strip is usually used.
- **Harvesting method:** This involves rectification and/or conversion of lightning energy to storable or usable form. Lightning energy is an impulse or static energy and this is to be converted to conventional energy form for use. Various methods have been proposed to effectively harness lightning enormous energy, with some being direct and others indirect.
- **Storage:** This step involves storage of the converted captured energy. The converted energy is stored with appropriate mechanism for utilization.
- **Utilization mechanism:** The stored energy is then converted to usable energy for homes or cities depending on the amount or capacity of storage.

4. Summary / Discussion

The summary of the methods proffered for harvesting lightning energy are;

- Electrolysis, which involves harnessing or extracting hydrogen gas from water electrolyte for chemical process of energy conversion or by extracting the energy from recombination of hydrogen and oxygen molecules after splitting (recombination energy is higher than splitting energy). (Srinivasan & Gu, 2006)
- Inductive-capacitive method of harvesting lightning (Bhattacharjee, 2010)
- Rectification process (Bhattacharjee, 2010)
- Heat extraction from filament coil or wire like tungsten wire (Srinivasan & Gu, 2006)
- Suspended superconductor coil system (Mims, 1994)

With the above varying methods, no real system has been built but only a small scale prototype of the capacitive harvesting method. These all have common capturing or trapping step and similar capacitive storage due to lightning's static/impulse nature.

The limitations to the implementation of the above listed methods are due to lack of research work sponsorship or financial constraints. But some research has concluded that the limitation to implementation of the lightning farm is due to the small output from lightning strike as comparable to the large enormous peak voltage and current of lightning. According to a renowned researcher in the field of lightning (U. A. UMAN), stating that lightning could be comparable to an atomic bomb effect but only a little output can be obtained from the ground (John, 2007; Stepanchenko, 2014). Following research work carried out, there has really been significant amount of work done to harness lightning's enormous energy. Among these are opposing views to the extraction and utilization of this energy source with appropriate reasons.

Some research presented the worthlessness in harnessing lightning energy, giving reasons as its unpredictable nature and a small fraction of energy that could be obtained, while others are of the opinion that a reasonably high amount of energy can be obtained and stored for use.

A conclusion can be assumed due to the contrary views presented by various research work. As backed by U. A. UMAN, viewing lightning as an atomic bomb with disastrous effects could sink these opposing views (Malavika & Vishal, 2013). This can be achieved by using lightning which occurs for a very short time to impact a better lasting process (like being converted to heat) and then slowly extracted for energy as suggested by (Srinivasan & Gu, 2006).

5. Conclusion

This paper has presented on the possibility of harnessing lightning's enormous energy as an alternate renewable energy source. Lightning energy is characterized by its static/impulse nature, very high peak amplitude, very short occurring duration (milliseconds) and its unpredictability which has limited the implementation of a lightning harvest farm. Even with small scale laboratory prototype experiments, a large-scale harnessing system has not yet been actualized.

As more research are being carried out, the possibility of harnessing lightning enormous energy increases whether directly or indirectly with its harvesting processing involving 5 basic steps; capturing, channeling, conversion, storage and utilization. Irrespective of the various views by the different research work showing different methods, using lightning to impact a better lasting processing of harnessing could prove to be more result oriented for a large-scale harvest actualization.

Lightning when successfully harnessed and lightning farm established, it would indeed serve as a contributing renewable energy source for some regions.

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