Atmospheric Electricity Research

In the Nineteenth and early Twentieth Centuries, a large number of researchers investigated ways to extract electrical power from the Earth's ambient electric field.

The leader in this field was Dr Hermann Plauson who in the 1920s succeeded in generating significant quantities of electrical power comparable with modern solar photovoltaic systems of a similar scale.

Background

It is well known that large quantities of electrical energy are present in the atmosphere and in lightning. Lightning was one of the first forms of electricity harnessed in the modern age by Benjamin Franklin in his famous kite experiment. Franklin developed a number of electrostatic motors as well as the lightning conductor for protection of buildings.

A lightning discharge contains in the order of 10^{10} Joules of energy. Several ideas and concepts have been proposed for collection of lightning as a source of power. It has been estimated that the total electrical power of lightning across the Earth is of the order of 10^{12} watts.

Lightning is but a small part of the total electrical activity of the atmosphere. When a local build up of charge above the Earth exceeds the local breakdown potential of the atmosphere a lightning discharge occurs. However, there is a continual invisible flow of charge from Ionosphere to Earth occurring day and night over the entire surface of the globe, which exceeds the global lightning power output by many times. It is this flow that can be tapped and directed to provide useable electrical power.

Technical Approach

The essence of capturing Atmospheric Electricity is to utilize the natural electrostatic potential gradient of the Earth to electrically charge a bank of capacitors or operate an electrostatic motor/parametric conversion machine.

Electricity is then withdrawn from the capacitors (or condensers to use the older term) by the load as required. Alternatively, the parametric conversion device converts the static atmospheric electricity into conventional Alternating Current.

The electrostatic potential gradient between the Earth and the Ionosphere is about $100Vm^{-1}$ near the surface in summer, rising to $300Vm^{-1}$ in winter. It is well known that electrostatic motors can be driven by the atmospheric electric field indefinitely from an appropriate antenna and earth connection.

To convert this "static" potential field into useable electricity, an antenna or collector is raised to a suitable altitude. The static charge collected is then used to charge a condenser bank or drive an electrostatic parametric generator that converts the static charge into alternating current.

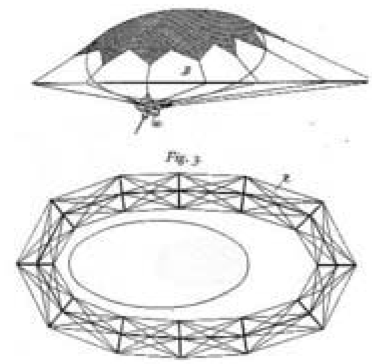
Optimum antenna or collector design is essential. The antenna can be considered to operate on the same principle as the Van de Graaff generator. Instead of the charge being transported continuously from a generator by a belt to the terminal, charge is transported from the earth to the terminal by a physical connection. The terminal then charges up in the same way as a VDG generator.

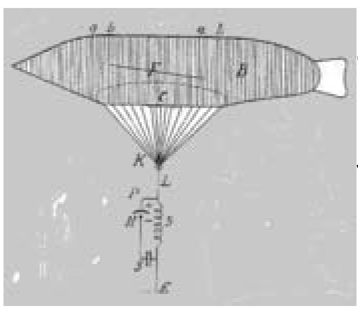
Historical Research

The leader in this field before the Second World War appears to have been Dr Hermann Plauson. Dr Plauson was an Estonian citizen who lived in Hamburg and Switzerland. He carried out experiments in Finland with aerostats manufactured from magnesium-aluminum alloy, covered with electrolytically deposited needles. The needles were further doped with a radium compound to increase local ionization of the air. (This was the era in which the hands of watches were hand painted with radium to make them luminous in the dark). Zinc amalgam patches were also painted onto the aerostats. Plauson obtained a power output of between 0.72kW and 3.4kW from one and two aerostats 300m above ground level. Dr Plauson filed patents in the USA, Great Britain and Germany in the 1920s. His book "Gewinnung und Verwertung der Atmosphärischen Elektrizität" is the most detailed known account of the technology.

Other atmospheric electricity researchers contemporary to Dr Plauson included Walter Pennock and MW Dewey in the USA, Andor Palencsar in Hungary and Dr Heinrich Rudolph in Germany. Hippolyte Charles Vion in Paris predated them all, putting forward proposals in the 1850s and 1860s.

Heinrich Rudolph made an interesting contribution to the design of the aerostat collectors. In 1898 he designed an elliptical aerostat made up of faceted surfaces to minimize the effect of wind. The design bears a strong resemblance to Northrop's 2003 UCARS unmanned helicopter UAV project. The design uses the Coanda Effect to help keep the aerostat on station and minimize wind effects.





One of Hermann Plauson's schematics is also shown here.

In recent times, the only person who seems to have been active in this field is Dr Oleg Jefimenko. Dr Jefimenko carried out experiments on driving electrostatic motors from the Earth's electric field in the 1970s and has recently called for research into the neglected field of electrostatic motors to be renewed.

MIR's Research Program

Since 1997 we have been carrying out theoretical research into conversion of atmospheric electricity into useable electrical power.

From a low level (5m high) simple zinc antenna we are able to obtain sufficient charge to light a number of white power LEDs. Further experimental investigations with metallic aerostat collectors and cavity resonant slow wave antennae concepts are ongoing.

A number of programs are underway in developing countries to provide remote communities with LED lighting instead of conventional incandescent lighting. LEDs are a very efficient way to provide lighting for minimal electrical power requirements. Atmospheric electricity would be ideally suited to powering domestic LED lighting or low energy neon lighting.

There is every reason to believe from our experimental tests and earlier research by Plauson, Jefimenko and others that Atmospheric Electricity will be able to provide practically useful levels of electrical power particularly suited for off-grid applications in the developing world.

Advantages of Atmospheric Electricity

- Simple and robust technology
- Low Cost technology - much cheaper than photovoltaics or wind turbines
- Available day and night in all weather conditions - in fact, more power is produced at night than during the day
- Available at any point on the Earth's surface

Theoretical Basis

The ultimate source of obtaining useable electrical power from the Atmosphere is the Sun.

The Sun emits continuously a solar wind of positively charged particles; these are captured by the Earth's magnetic field and create the Ionosphere, a highly charged region above the atmosphere.

This positively charged region in turn induces (by electrostatic induction) a negative charge on the surface of the Earth. The Earth becomes in effect an enormous spherical capacitor. A potential gradient or electric field is thus established between the two "plates" of this capacitor, the Ionosphere (or electrosphere) and the surface. While the upper strata of the atmosphere conduct electricity reasonably well, the lower levels act as an insulator or dielectric.

Near the surface of the Earth, this potential gradient is in the order of 100 Vm^{-1} in summer, rising to 300 Vm^{-1} in winter.

In fine weather, currents in the order of 1000 amperes are flowing continuously from the atmosphere to ground. During unsettled weather, the currents can be much higher. As the charge flows down to Earth, the electrosphere is replenished by the solar wind.

If we interpose a collector to intercept and collect some of this flow, nothing will be lost since after use in a load or circuit, the charge will be sent on its way to earth. By careful design, we can use a slow wave structure type of antenna that acts as if it is much larger than its real physical dimensions (i.e. it is electrically small) to capture greater quantities of charge and amplify the input. We can effectively apply a suction pressure on the electrosphere in this way to speed up and amplify the local natural flow of charge, since we are effectively "punching a hole with a conductor" through the dielectric of the atmosphere to join the two "plates" of the capacitor together. As charge is drawn down, the electrosphere will be simply replenished by the vast quantity of charge carried by the solar wind.

Ultimately, even if by some future stupendous need for electrical power we were to strip part of the ionosphere bare by shorting it to earth through an enormous conductor, this would simply create a potential hole that would immediately attract more solar wind to fill it. Engineering on such scales is of course well beyond our capabilities, so there should be no concern about "depleting" the ionosphere.

References