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Study of Floating Solar Plant For Reducing Evaporation Of Water

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Abstract : *This paper proposes a new trends in power generation, which uses solar energy as non-conventional energy resources. The Inventor of floating power plant equipment had the privilege, after years of work on hydro dams & lakes in the North side of Australia to analyze the behavior of solar energy, with respect to the velocity and force of the air on water, in times of difference in weather. Also to acquire sufficient knowledge of and reconcile the potential energy of the solar energy, This is studied by the means of the power generation and electrical engineering. This resulted in the design of a Floating power plant with apparatus capable of producing electric energy on a large scale without prejudicing in any way the environment or the Area in which the creation may be installed. Innumerable possibilities were explored. By the application of invention as well as the benefits which would be brought to civilization on the whole. With the birth of this idea we commenced Gathering resources to place invention into practice. These inventions will REVOLUTIONIZE ON A WORLD WIDE BASIS THE METHODS UTILIZED IN THE GENERATION OF ELECTRIC ENERGY. Soon after the installation of Floating Power Plant in the lakes & on hydro dams saw daylight in order to harness the abundant energy in them through solar energy. This seminar report takes you through the history of evolution of Floating Power Plant, an introduction to how an LSA works and its future.*
Keywords : *Renewable energy sources, solar photo voltaic cell, PV technologies, efficiency, green power*

I. Introduction

I.II Liquid Solar Array (LSA)

The Liquid Solar Array (LSA) is a water-borne solar capturing system. Instead of putting the cells on the ground, occupying a lot of usable space, losing energy to cool them down, LSA (Liquid Solar Array) technology floats on calm bodies of water. The LSA combines a solar concentrator and a photovoltaic cell, with Sun-tracking and storm protection mechanisms. LSA is not bound by any specific solar technology and could potentially be applied not only to producing electricity, but other energy systems as well (such as the solar synthesis of fuels).

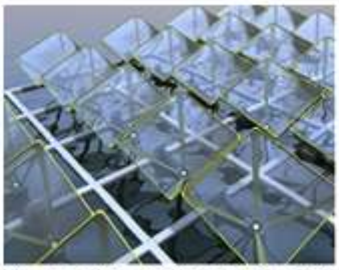

Fig. 1.1 LSA POWER PLANT

I.II CONVENTIONAL SOLAR TRACKING SYSTEM

Extracting useable power from the sun was made possible by the discovery of the photoelectric mechanism and subsequent growth of the solar cell – a semi- conductive material that converts visible light into a direct current. By using solar arrays, a series of solar cells electrically connected, a DC voltage is produced which can be physically used on a load. Solar arrays or panels are being used progressively as efficiencies reach higher levels, and are especially popular in remote areas where placement of electricity lines is not economically viable.

This alternative power source is continuously achieving larger popularity particularly since the realization of fossil fuel's shortcomings Renewable energy in the form of electricity has been in use to some degree as long as 75 or 100 years before. Sources like Solar, Wind, Hydro and Geo- thermal have all been utilized with varying levels of success. The most widely used are hydro and wind power, with solar power being moderately used worldwide. This can be attributed to the relatively high cost of solar cells and their low conversion efficiency. Solar power is being heavily investigated, and solar energy charges have now reached within a few cents per kW/h of other forms of electricity generation, and will drop further with new technologies such as titanium- oxide cells. With a peak laboratory efficiency of 32% and average efficiency of 15-20%,it is essential to recover as much energy as possible from a solar power system.

This includes dipping inverter losses, storage losses, and light gathering losses. Light gathering is dependent on the position of incidence of the light source providing power (i.e. the sun) to the solar cell's surface, and the nearer to perpendicular, the greater the power .If a flat solar panel is mounted on level ground, it is obvious that over the course of the day the sunlight will have an position of incidence close to 90°in the morning and the evening. At such an angle, the light gathering capability of the cell is essentially zero, resulting in no output. As the day advances to midday, the angle of incidence approaches 0°, affecting an steady increase in power until at the point where the light occurrence on the panel is completely perpendicular, and maximum power is achieved. As the day carry on near dusk, the reverse occurs, and the increasing angle roots the power to reduction again toward minimum again from this background, we see the need to maintain the extreme power output from the panel by keeping an angle of incidence as close to 0° as likely. By tilting the solar panel to continuously face the sun, this can be completed. This method of sensing and following the position of the sun is known as Solar Tracking. It was resolved that real-time tracking would be essential to follow the sun effectively, so that no exterior data would be required in operation.

Fig. 1.2 shows conventional solar tracking system

I.III PREVIOUS GENERATION

AQUASUN system

AQUASUN system places floating solar panels on bodies of water. One of the potentially limiting features of solar power is the fact that it takes up a lot of space. Solar panels clearly aren't going to be of far use if they're stacked one on top of the other, so instead must be spread out side-by-side, so each one can soak up the sun's rays. Although they're normally not in the way when mounted on top of buildings, large arrays of solar panels *could* start to become a hindrance when placed on the ground. Tech companies from Israel and France, however, are rising what could be a way of escaping that situation – floating solar panels that are installed on the surface of current bodies of water Called AQUASUN, the system is the effect of collaboration between Israel's Solaris Synergy and the French EDF Group. The panels themselves consume silicon cells, which are less costly than other types, but also prone to inefficiency caused by overheating. Due to a chilling system that incorporates the water on which they're floating, however, overheating is said not to be a problem in this case. A system of mirrors that concentrates the sun's rays onto the panels reportedly boosts their efficiency additional, dropping the number of panels wanted and thus helping to lesser costs even more. The floating panels, which would produce 200kw of clean energy, would also be flexible to a region's energy necessities with panels being added and removed when needed.

The system would not be set up on the open ocean or in ecologically-sensitive zones, but instead on reservoirs already in use for industrial or agriculture purposes. Even then, the panels are designed to tolerate oxygen to permeate through them, so that the water underneath won't become stagnant. In some cases, the panels could even help reduce vaporization and excess algae growth.

Fig. 1.3 floating solar pannel

A prototype has already been built, and showcased at the 4th International Eilat-Eilot Renewable Energy Conference in Israel. The designers had planned on installing it for a nine-month test period on a basin at a hydro-electric facility in southeast France, on September 07, after observing the performance of the prototype through different seasons and water levels, they have gathered sufficient data to make the system ready for the commercial market. But, major problem arises that effect of solar panels on the ecosystems within lakes and other bodies of water , they literally cast a shadow on local wildlife. Due to this problem AquaSun would not be installed in "ecologically-sensitive areas or in open seas." Instead they would be installed on reservoirs that are used for agriculture and industrial purposes.

II. Lsa Technology

The LSA utilizes well established solar and structural component technologies that have current and proven market reliability i.e. all technologies used are not revolutionary but evolutionary. It is LSA's application of these technologies in water that is sole and patented. LSA is a new PV concentrator using fairly lightweight plastic concentrators that float on water, mounted on anchored rafts. A skinny plastic focused concentrator lens rotates gently to track the sun both daily and seasonally. A minimal quantity of silicon (or other types of) photovoltaic cells are housed in a PV container that sits in the water where the cells are kept cool and capable, through convective heat flow to the surrounding water. In bad weather the lens is protected by rotating it under the water to avoid damage in high winds, so the water becomes the vital structural component, cooler and protector. It is these applications of the water that are the source for IP security (patented so far in 10 countries including USA). The key feature of the LSA is its very little usage of materials and the easiness of the materials used. Any further developments in solar energy converter technology can be leveraged to decrease the LSA's cost per watt. LSA is not assured by any certain solar technology and could potentially be applied not only to producing electricity, but other energy systems as well (such as the solar synthesis of fuels).

Core process

The solar energy from straight sunlight is focused by a thin acrylic lens downcast through a glass lid, into a sealed, partially submerged metal well, containing photovoltaic cells. Collectors rotate tracking the activities of the sun by both a light sensor and dead reckoning software. A wind sensor is linked to the sun tracking software to submerge each unit into the water should winds rise above a prearranged force and return the lens to its tracking position once the winds have abated. The lens is water-sealed and is cleaned automatically. An inverter converts LSA power from direct current to alternating current, which is then connected to the power supply system (Grid).

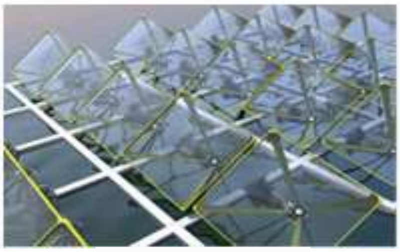

Fig. 2.1 LSA model

As the name array implies, the LSA is designed to be modular and is rafted as the diagram (right) depicts. Every array is anchored to permits for changes in the water level and to keep them in position.

Fig. 2.2 Operating position

Fig. 2.3 Protected position

Limitations of conventional solar technology:
High structural rate per watt of traditional solar power systems and accessible supply of silicon for the photovoltaic cells has limited its widespread acceptance.

III. Superiority Over Other Solar Technologies

LSA is a solar concentrator with medium to high efficiency; reduced structural cost through the use of water; lower silicon cost by using concentrators and eliminating overheating through the dual use of water. Experiment results (as reflected in the graph right) comparing flat plate photovoltaic system (pink line) and a LSA system that tracks the sun (blue line).There is significant difference in power produced and longer peak power output. Daily/seasonally tracking increases the efficiency and offers more peak hours of solar energy generation equated to flat plate PV cells

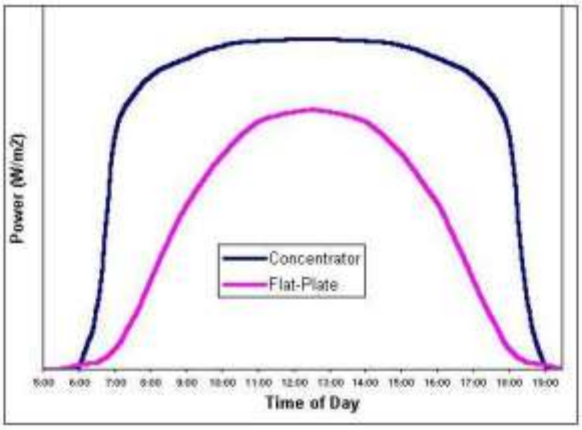

Fig. 3.1 Power vs Time of delay

IV. Structural Advantage

The structure can be made from very light-weight, durable and inexpensive components that are widely available. One can expect lesser maintenance as the unit is secure from extreme weather forces. Minimal land & structure cost and minimal mass, 12-14 kg per sq. M of collector. The process gives better efficiency and near constant output all day. Being modular, LSA is scalable from 1kW to Giga-watts. The use of minor quantities of silicon implies rapid deployment of large capacity at minor cost.

V. Installation Locations

LSA units can be hired on protected waterways from large-scale hydropower dams or mine pits to small-scale village dams or ponds (as illustrated below). The water can be fresh, salt or slightly caustic; LSA installations reduce vaporization and there is no toxicity in materials used.

Fig. 5.1 Virtual Storage via Hydropower Dams

The group also worked on the ecological impact of the technology. It works in fact as a breathing surface by which oxygen can penetrate to the water. This feature confirms that sufficient oxygen will maintain the underwater life of plants and animals.

VI. LIQUID SOLAR ARRAY WITH HYDROPOWER

A. Virtual Storage via Hydropower Dams

There are certain interesting opportunities that arise when a large scale solar power generator such as the LSA is combined with a hydropower plant. It is possible to achieve 'virtual storage' of the solar produced electricity without changing the basic hydropower installation at all. Any solar power produced can allow a corresponding reduction in the water flow through the hydropower turbines. This saves that water for use at a later, and potentially more valuable time (such as the early evening peak load time that is typical in many locations).Typically a hydro facility that growths its energy output by 3-5% is considered leading edge, whilst Sun energy' LSA technology is expected to potentially double the output once implemented at scale. In most hydro installations it is not possible to generate power at full capacity 24 hours per day because there is not sufficient annual flow through the dam catchment to maintain the average flow rate that is required at full power. Therefore the turbines and their grid transmission line are used intermittently. The grid connection is therefore considerably under-utilized. This capacity utilization factor for hydro seems to be commonly under 50% worldwide and even lower in dry periods when water (the fuel) is scarce. See http://en.wikipedia.org/wiki/Hydroelectric for statistics on capacity factors for whole countries' hydropower systems, showing a range from 0.2 to 0.6, mostly around 40%. The capacity factor is normally chosen by the designers to suit the site and load limitations. So, since the annual water flow availability through a hydro system is the principal limit to the hydropower energy source in that location, a co-located solar component of generation can allow increased dispatch-able energy production, making more full usage of the grid connection of the hydro plant. This could possibly multiply the total energy delivered from the original hydro plant by two, just by adding the solar collectors on the dam. One could also envision a condition where pumped-storage hydro could be employed to reuse the same water many times between two storage dams, fully storing the solar power, but this is a higher rate option better suited to lower rainfall areas

B. Traditional and Solar-Enhanced Hydro

Hydropower is normally used as a supplement to fossil fuels as it is limited by the amount of water. It has available to use on a daily and seasonal basis. Chart 1 below shows how, say, coal and hydro are often combined to provide base and peak power loads.

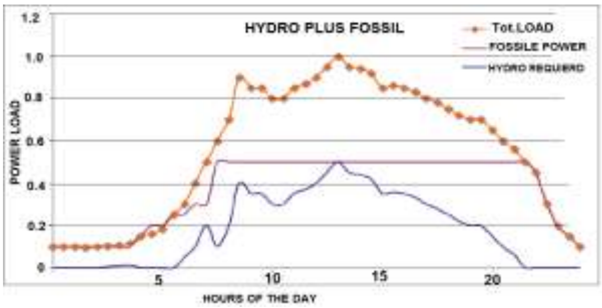

Fig. 6.1 Chart1 power load vs hours of the day

If the solar generation capacity equivalents or exceeds the maximum hydroelectric output, almost no water need be used from 8am to 4pm on most days, as the power could be supplied LSA; with the hydro-generator continuously being available to fill in through cloudy periods and night-time. Chart 2 below illustrates how they would combine.

The basic assets of hydropower dams are the yearly flow, the volume of water stored and the head of water which together determine the power and energy outputs achievable. The LSA gives the dam an additional asset in its water surface area, using it to provide supplementary solar power. If the solar generation capacity equals or exceeds the maximum hydroelectric output, we could believe that almost no water need be consumed from 8am to 4pm on most days, as nearly all the power could be supplied from the solar component; but with the hydro-generator permanently being available to fill in through cloudy periods and night- time.

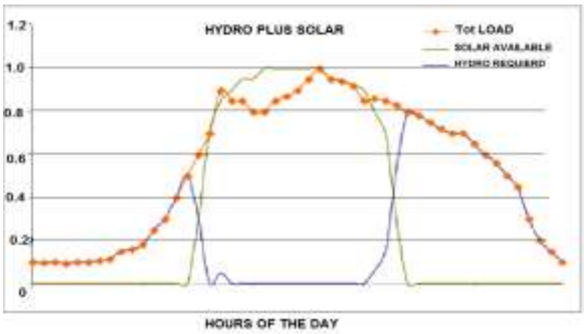

Fig. 6.2 Chart 2 Hours of the day

VII. Some Examples

For instance, a study of three hydropower dams privately owned in India presented the following: There is a total existing power generation capacity of 447 MW. To generate 447 MW of power with LSA would require only 9.3sq km of water area using 3,724,851 LSA (125W) units @ 2.5sq m water surface per unit.

The entire water surface area of these dams is 250sq km so only 3.7% of this is required to match the hydropower output typically most power is consumed in the 8am to 8pm period, with local variations of course. If the solar system is capable to take nearly all the load from 8am to 4pm most days (8hrs) this leaves only four hours where full power is likely to be wanted from the hydro generator on average days. Therefore we might expect a potential reduction in water consumption of 66% if no changes are made to the hydro generator. An complete saving of just 50% water usage would potentially double the revenue of the hydro operation when this saved water is used to generate more power. In general, it is possible to mount very large LSA solar capacity on suitable dams at around 25 sq- km of water surface area per Giga watt. If the solar array is less than or equal to the hydro power capacity, very little change is need to the dam's infrastructure to greatly increase the total energy produced: only the solar collectors need to be added. An interesting opportunity then arises to perhaps triple the turbine and generator peak capacity while overall using the same amount of water, going for instance from 500MW to 1500MW hydro capacity. As long as the solar component matches the increased peak hydro capacity, the peak capacity of the whole system is effectively tripled; though specific details depend on the daily load profile. This is a relatively cheap option as changes to be done to the dam are modest and thus it suits existing hydro installations (but larger transmission lines are required for this case).

The LSA is designed to be scaled up for industrial applications and this is a key strategy to drive the manufactured cost per Watt down; through economies of scale from mass production. Hydropower dams are perfect industrial applications as they have both large areas of water and a substantial grid connection.The dual use of water removes the need, costs and complications related with land acquisition to set up regular land based solar PV or solar thermal (CSP) systems.

VIII. Conclusion

The LSA system is designed specifically for economical large-scale solar power generation on bodies of freshwater such as dams and natural lakes. This paper shows how the LSA fits perfectly with the characteristics of most existing hydropower installations to greatly increase their energy production at minimal cost, while providing fully backed-up solar power.

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