Title:

Lighter than air platform for optimized solar power generation

Abstract:

A Lighter than air platform for optimized solar power generation is disclosed. The proposed system is comprised of five modules namely the solar power generation module, mounting module, positioning module, power module and monitoring module which work in a synchronised way to enable optimised solar power generation.

We Claim:

1. A lighter than air platform for solar power generation, comprising:

   a solar power generation module capable of generating solar power;

   a mounting module to provide a mounting base with reduced contour angle to the solar power generation module, wherein; the mounting module is capable of proving optimized aerodynamic stability to the mounted solar power generation module when air-borne.

   a positioning module couplable with the mounting module and capable of maintaining it with stability at a desired angle and elevated with respect to the ground level;

   a power module connected with the solar power generation module and capable of transferring and storing the power generated by the solar power generation module;

   a monitoring module capable of monitoring and computing multiple parameters during solar power generation by the solar power module and controlling the positioning module accordingly to optimize the solar power generated by the solar power generation module.

2. A lighter than air platform for solar power generation as claimed in claim 1, wherein the solar power generation module comprises of flexible solar photovoltaic modules to generate solar power.

3. A lighter than air platform for solar power generation as claimed in claim 1, wherein the mounting module comprises of a GNVR shaped aerostat with an additional horizontal wing-span from the center of the aerostat and enclosed

by an enveloping material; wherein the additional horizontal wings provide the mounting base with reduced contour angle to the solar power generation module.

4. A lighter than air platform for solar power generation as claimed in claim 3, wherein the enveloping material is polyurethane coated nylon.

5. A lighter than air platform for solar power generation as claimed in claim 1, wherein the reduced contour angle is any angle less than or equal to 15^0

6. A lighter than air platform for solar power generation as claimed in claim 1, wherein the positioning module consists of automated geared winches actuable by the monitoring module and coupled to the mounting module using tethers.

7. A lighter than air platform for solar power generation as claimed in claim 1, wherein the power module comprises of a battery to store a part of the power generated by the solar power generation module; power transfer cables to transfer surplus power generated by the solar power generation module; an on-ground power storage device for storing the surplus power transferred by the power transfer cables, wherein; the surplus power generated by the solar power generation module is equal to the sum of all parts of the power generated by the solar power generation module other than the part stored by the battery.

8. A lighter than air platform for solar power generation as claimed in claim 7, wherein the on-ground power storage device comprises of batteries

9. A lighter than air platform for solar power generation as claimed in claim 7, wherein the battery is a lithium-ion battery.

10. A lighter than air platform for solar power generation as claimed in claim 7, wherein the power transfer cables are power over Ethernet cables

11. A multi-purpose lighter than air platform for solar power generation as claimed in claim 1, wherein the monitoring module comprises of:
sensors positioned onboard the aerostat which continuously detect data pertaining to multiple parameters during solar power generation by the solar power module and convert this data into digital signals;
a wireless digital server coupled with the aerostat module for relaying the digital signal from the sensors;
an on ground wireless router to receive the digital signal relayed by the wireless digital server;
an on-ground computer for displaying ,storing and computing the signal received by the on ground wireless router and sending an output signal for controlling the positioning module accordingly;

12. A multi-purpose lighter than air platform for solar power generation as claimed in claim 11, wherein the on-ground computer computes the input signal and sends an output signal for controlling the positioning module and thereby the angle of the mounting module by applying predetermined values of solar irradiance to the aerostat and varied angular positions at a certain altitude in derived equations.

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17 JAN 2014

TITLE:

Lighter than air platform for optimized solar power generation

FIELD OF THE INVENTION:

The present invention relates to lighter than air platforms for optimized solar power generation, more particularly to a modified single body aerodynamically stable aerostat for providing a minimum contour surface for mounting solar power generation modules with the aerostat maintained at a controlled elevated position in the atmosphere using an arrangement of tethers and automated winches.

BACKGROUND OF THE INVENTION:

Solar powered Lighter than air platforms (SPLTAP) are enjoying renewed interest in a variety of applications. In addition to traditional uses such as advertising and promotion, there is also increased interest in SPLTAP platforms for both civil and military Intelligence, Surveillance, Reconnaissance, and Communications (ISR&C) applications.

Recent research finds that, rare earth materials like uranium, thorium, lanthanum, cerium, yttrium etc. are found to be used for future energy production. Thus exploration of rare earth materials under the geological surfaces becomes prime concern for further research. Rather conducting the exploration in a conventional manner through satellite imaging, it can be done using locally installed aerial high spectroscopy cameras. This camera is being installed on an airborne tethered platform which would have limited mobility in a circular circumferential area. This platform is supported by buoyant force which is being generated by using lighter than air (LTA) gases like hydrogen and helium. Airborne tethered platform can do multipurpose tasks apart from assisting exploration of rare earth materials which are given in following. 1. Exploration of underground water. 2. Hyper-spectral remote sensing. 3. Remote area power generation and supply so this airborne tethered platform is used both for the exploration and surveillance. To conduct both the operations successfully, the sophisticated electronics equipments (hyper spectroscopy camera, thermal imaging camera, GPS receiver, sensor network) installed on the platform requires some power. That required power either supplied through battery or through tether from the ground. Mostly exploration and surveillance operations are conducted in remote areas without having any power supply station. Then supplying power from the ground to the airborne tethered platform through tether requires DG set and battery. Both of these two arrangement increases the running cost of the operations. Then the need of locally power generation through solar PV panels for the smooth operation of the airborne tether platform is nurtured.

Use of a lighter- than-air platform for power generation has been described by many authors both in patent and journal literatures.

[US Patent 4361295A] Wenzel (1982) has described a system which needs to be raised and lowed frequently and is not optimized for power generation.

[US Patent 4364532A] Stark (1982) has described multiple designs for this purpose but most of his structures, if airborne, would suffer from problems of instability due to wind.

[US Patent 7997532B2] Tillotson (2011) has described an airborne solar power generation system where mounted solar modules have capability of sun tracking through rotating axle arrangement. But power optimization and stability concerns of the invention has not been mentioned in this description.

[US Patent 7938364B2] Tillotson (2011) has demonstrated an aerostat based power generation system which transmits the power to the ground through a microwave wireless system. However, optimization of the structure of the aerostat for this application has not been reported.

The problem of transmitting the power from the airborne structure to a ground based station has also been studied by a few. [US Patent 6919847B2] Caplan et al. (2005) has suggested wireless transmission. However, losses during this process are likely to be too high for its commercial application.

Sharma et al. (2010) reported characteristics of flexible solar modules where they described effect of contour-ability in power generation. They described that more than 6^0 contour angle reduces the power output of the solar panels [Sharma10]. They found ~25 % power reduction take place at 22^0 contoured angle (θ22) compared to a flat layout in an amorphous-Si based flexible solar modules. They carried out their experiment under static condition which further needs to be explored under dynamic conditions under varying environmental constraints (wind, humidity, moisture, rain).

Aglietti et al. (2008, 2010) develops a concept of high altitude solar power generation by static airborne platform and power transmission through tether. But they did not mention the dynamic power optimization techniques for their concept.

Hillsdon et al. (2000) [WO 00/47466] demonstrates a concept of orientation of solar cell array in airship by using cables for optimized power. However they did not reported any payload optimization and dynamic stabilization of the system.

Vermillion et al. (2012) [WO 2013043586 A2] explains a concept of stabilizing and controlling attitudes of aerostats by using multiple tethers to an actuation platform. But they did not address the issue of power optimization and structural de-stabilization due continuous permeation of lifting gas.

Thus there is a need for developing a lighter than air platform for solar power generation which addresses the present problems of aerodynamic stability and optimizes the solar power generation.

OBJECTS OF THE INVENTION:

1. It is the primary objective of the present invention to provide an aerodynamically stable lighter than air platform for power generation.
2. It is another objective of the present invention to generate solar power using solar power generations modules mounted onboard an aerodynamically stable lighter than air platform at an altitude from the ground level.
3. It is another objective of the present invention to maximize the available active exposure surface area available for the solar modules onboard the lighter than air platform in order to optimize the generation of solar power.
4. It is another objective of the present invention to track the sun by controlling the tension on the tethers with the help of automated winches in order to maximize the available active exposure surface area available for the solar modules onboard the lighter than air platform in order to optimize the generation of solar power.
5. It is another objective of the present invention to intelligently control the stability and position of the lighter than air platform by using an arrangement of tethers and automated winches.

SUMMARY OF THE INVENTION:

The present invention provides an aerodynamically stable lighter than air platform for solar power generation usinga modified single body aerodynamically stable aerostat which provides a minimum contoured surface for mounting solar power generation modules onboard the aerostats, increasing the active exposure area of the Solar modules and thereby optimizes the solar power generation. The position of the SPLTAP at an altitude is maintained at optimum position using an arrangement of tethers and automated winches which are actuated manually. The present invention also provides the onboard instruments (hyper-spectroscopy camera, synthetic aperture radar (SAR)) to be powered by the power generated by the solar power modules and the remaining power to be transmitted back to ground.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figure 1 shows the schematic of the single body flats solar powered lighter – than – air platform.

Figure 2 shows the cross sectional isometric view of a single body flat solar powered lighter-than-air platform.

Figure 3 shows the cross sectional back view of single body flat solar powered lighter-than-air platform.

Figure 4 exhibits the schematic of the single body contoured solar powered lighter – than – air platform.

Figure 5 depicts the cross sectional view of the single body contoured solar powered lighter-than-air platform.

Figure 6 shows the cross sectional back view of the single body contoured solar powered lighter-than-air platform with 22.5^0 contoured layout.

Figure 7 shows the power-voltage plot of two serially connected amorphous silicon solar modules on contoured layout.

Figure 8 shows the power-voltage plot of those two serially connected modules on a horizontal flat layout structure equivalent to 0^0 contours.

Figure 9 shows solar zenith angles for single body flat SPLTAP.

Figure 10 shows solar zenith angles for single body contoured SPLTAP

DETAILED DESCRIPTION OF THE INVENTION:

Figure 1 shows the schematic of the single body lighter than air platform which comprises of five modules, wherein the first module is the solar power generation module which is capable of generating solar power and comprises of flexible solar photovoltaic modules (5). There are several flexible solar cell technologies available – like CIGS (Copper indium galium di selenide), amorphous –Silicon, thin film polycrystalline, GaAs etc. but selection of solar modules for the system considers two important selection parameters, Watts/kg and Watts/m2 in terms of efficiency. Determination of active surface area and payload capability are required to be known as a prerequisite of selecting solar panels for a system. Table 1 provides an example of selecting solar panels in terms of Watts/kg and Watts/m2 parameters.

Manufacturer	SPV Technology	Peak power (W_p)	Area(m^2)	Weight (kg)	Current, Voltage @ W_p	Watt-p /kg	Watt-p /m^2
Global Solar *PowerFlex* [Global Solar12]	CIGS	300	2.843	9.9	5.5 A 54.3 V	30.3	105.52
Sunset Solar	Mono-	310	1.97	26.2	8.8 A	11.8	157.3

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AS-310-72	crystalline silicon				46.6 V	3	6
HighFlex Solar HF315-6-36 [Bat-Sol13]	Thin film crystalline Si	315	1.95	3.6	8.62 A 36.5 V	87.5	161.5
Power Film Solar FM16-7200	Amorphou s silicon	120	1.26	2.95	7.2 A 15.4V	40.6 8	39.47
First Solar FS-390	Cadmium Telluride	90	0.72	12	1.83A 49.2V	7.5	125

Table 1

According to table 1, High-Flex SolarHF315-6-36 thin film c- Si based flexible solar photovoltaic modules are found to be most optimum in terms of watts/kg and watts/m2. 4 units of such PV modules can generate 1.2 Kw_p power. In addition with these PV modules, a power storage unit comprised of light weight lithium ion batteries is required to store this power. Genasun battery's both GLI-24-100 and GLI-12-100 model are selected for this purpose.

Flexible solar photovoltaic modules (5) are laid in 2 x 2 square layouts both in series and parallel connection. Both these series and parallel configuration controls voltage and current respectively. Consequently optimized power is achieved as both voltage and current can be controlled in this configuration.

Area requirement for 2 x 2 layout = 2 x (2 + 2) x (1 + 1) m2

= 8 m2

The second module is the mounting module which provides a mounting base with reduced contour angle to the solar power generation module, wherein; the mounting module is capable of proving optimized aerodynamic stability to the mounted solar power generation module when air-borne. The mounting module comprises of a GNVR shaped aerostat (10) with an horizontal wing-span (15) from the center of the aerostat (10). The horizontal wing-span (15) helps to construct a near flat surface for mounting the flexible solar photovoltaic modules (5) within the range of contour ability of $8^0 - 15^0$ according to requirement.

The aerostat (10) is covered by an enveloping material. Polyurethane coated nylon is selected for envelope material. Polyurethane has very low helium permeability with permeability rate of 3.2 liter/m2/day(max) at 25 cm woven coating and 2 liter/m2/day(max) at 25 cm woven fabric for the He and H2 gas respectively . To retain the gas in the envelope black coloured polyester elastomer is bonded with polyurethane coated nylon by using adhesive. This polyester elastomer has tensile strength order of 253.1 – 386.7 kg/cm2 and density order of 1.17 – 1.25 g/cm3. For weatherability another layer of white coloured polyester is bonded with the envelope material.

The third module is the positioning module couplable with the mounting module and capable of maintaining it with stability at a desired angle and elevated with respect to the ground level. The positioning module comprises of a set of automated geared winches (20) which are coupled to the mounting module using tethers (25). The automated geared winches (20) are designed depending on tether (25) profile, tether (25) tension, tether (25) winding rate and drum size. These automated geared winches (20) help to control the tension on tether (25) through which stability and the desired angle of aerostat (10) is calculated under variable wind speed, by applying derived equations, for value of solar irradiance to the aerostat, at varied angular positions at a certain altitude. Appropriate selection of tether (25) material and automated geared winch (20) design is required for this purpose. Tethers (25) are supposed to have required tensile strength to hold the mounting module at maximum buoyancy. Based on required payload specific tether (25) material is selected. The drag due to wind flow generates a lateral displacement of aerostat (10) position which is termed as 'blow by'. Due to this phenomenon operational height of aerostat (10) becomes low. In order to achieve a steady operational height under normal wind condition, selection of tether (25) material plays an pivotal role. This tether (25) must have a high tensile strength, low density and small diameter. These features in tether material help to get better control through winch. Cortlands plasma @12 strand and Vectran@ 12 strand fibre ropes of each 1.75 mm and 3mm diameter are being explored for this purpose. Amongst these ropes Plasma @ 12 strand of 1.75 mm diameter found to be optimum for our system. The detail properties of these ropes are given in table A.

	Rope diameter	Rope circumference	Nominal mass	Breaking force
Plasma@ 12 strand	1.75 mm	5.334 mm	2 gm/m	2.9 kN [Cortland cable12]
Vectran@ 12 strand	3 mm	9.525 mm	9 gm/m	12.5 kN [Cortland cable12]

Table A

Figure 1 also shows a carrier (30) suspended from the aerostat (10)

The fourth module is the power module which is connected with the solar power generation module and capable of transferring and storing the power generated by the solar power generation module. The power module comprises of atleast one battery which is placed in the carrier (30) suspended from the aerostat (10) and which stores some part of the power generated by the solar power generation module, an on ground power storage device (35) for storing the power transferred to it from the solar power generation module and lastly comprises of atleast one power transfer cable (40) for transferring power from the solar power generation module to the on ground power storage device (35). The power transfer cable (40) is preferably a power over Ethernet cable. The battery placed in the carrier (30) is a light weight lithium ion battery with Genasun batteries (GLI-24-100 and GLI-

12-100) model being preferred. The on ground power storage device (35) comprises of batteries and super-capacitors.

. Design approach of on ground power storage unit:

Flexible Solar photovoltaic modules (5) are kept on the system 2x2 matrix arrangements. Each module produces max current of 8.6 Amp under 1000 W/m^2 solar insolation. Thus 2 parallel flexible solar photovoltaic modules (5) would generate 8.6 x 2 = 17.2 Amp current.

It is assumed that daily 8 hours, 1000 W/m^2 solar insolation at 25^0 C is available for the system.

Thus total ampere hour (Ah) generated by 2 parallel arranged flexible Solar photovoltaic modules (5) is

= 8 x 17.2 Ah

= 137.6 Ah

assuming that system voltage is 24 V. Then the flexible Solar photovoltaic modules (5) need to supply the energy to the battery bank at 24 V. Hence the watt-hour (Wh) generated by these flexible Solar photovoltaic modules (5)

= 24 x137.6 Wh

= 3302.4 Wh

Battery efficiency of these Genasun batteries = 90%

Thus the energy stored in on ground battery bank is = 3302.4 x 0.9 Wh

= 2972.16 Wh

Thus charge capacity of the battery bank would be $= \frac{2972.16}{24\text{ V}}$ Ah

= 123.84 Ah

There are 12V, 100 Ah batteries are used for ground storage unit. Due to Depth of Discharge (DoD) (80% in this case) not all the batteries can be used.

Therefore the numbers of the batteries required would be

$$= \frac{123.84}{100 \times 0.8}$$

= 1.54, i.e., 2 batteries

of 100 Ah capacities are required to store the charge capacity. These two batteries must be connected in parallel. As these batteries are of 12 V, the battery bank needs to supply the charge at 24 V (system voltage). Therefore in order to match with 24 V system voltage, two 12 V batteries is collected in series. Hence, in total there will be four batteries of 100 Ah capacity is kept in 2 x 2 matrix configuration.

Once the charging of the on board battery is finished, the charging of on ground battery bank takes place. The fully charged on board battery provides power supply to the on board electronic instruments during the night. Due to constraints of weight and system voltage, single 24V, 100 Ah battery is used for on board instruments.

The fifth module is the monitoring module which is capable of monitoring and computing multiple parameters during solar power generation by the solar power module and controlling the positioning module accordingly to optimize the solar power generated by the solar power generation module. The monitoring module comprises of atleast one type of sensor which is placed in the carrier (30) and which continuously detect data pertaining to multiple parameters during solar power generation by the solar power module and convert this data into digital signals, a wireless digital server coupled with the aerostat (10) for relaying the digital signal from the sensors, an on ground wireless router to receive the digital signal relayed by the wireless digital server and an on-ground computer for displaying ,storing and computing the signal received by the on ground wireless router and sending an output signal for controlling the positioning module accordingly. The on-ground computer computes the input signal and sends an output signal for controlling the positioning module and thereby the angle of the mounting module by applying predetermined values of solar irradiance to the aerostat (10) and varied angular positions at a certain altitude in derived equations

The sensor communicates with the ground based main control unit through a wireless server. It has 3 switch selectable RS 232/422/485 ports which accept sensor inputs. Here the digital wireless server provides a wireless link to the ground based control computer through a wireless Ethernet network. The software on the ground based computer communicates through the Digital wireless server using TCP sockets. Each sensor is connected to the Digital wireless server through a serial connection. On the other hand the ground based computer monitors the airborne platform, surrounding atmosphere, output from the solar panels, records wind sensor data and processes the control algorithm that will be used to determine the actuation of the winch. The ground based computer communicates with the airborne wireless server through a D-Link wireless router which is configured as an access point.

Serial No:	Sensors	Function
1	Wind sensor	Record the wind flow data at a particular instant of time.
2	Load cell	Record the tension at respective tethers.
3	Light sensor	Collect the incident solar insolation data on solar PV modules.
4	Temperature sensor	Record the temperature profile of the outer surface of the system and solar PV modules.
5	Pressure sensor	Collect the change of pressure data of the system due to continuous permeation of the lifting gas.
6	Current sensor	Record the continuous current output data of the solar PV modules.
7	Voltage sensor	Record the continuous voltage output data of the solar PV modules.
8	Humidity	Record the change of humidity data of the surrounding atmosphere of the system.
9	Strain gauge	Indicate the change of shape and aerodynamic destabilization due to continuous permeation of the lifting gas through the envelope.

10	Tilt sensor	Indicate the aerodynamically stable positioning of the system at a particular wind profile.
11	Gas sensors	Indicate presence of respective gas profiles and its effects on the system at the surrounding atmosphere.

Given above is a table enlisting a list of sensors which can be used:

Figure 2 shows the cross sectional isometric view of a single body flat solar powered lighter-than-air platform consisting of an aerostat (10) with horizontal wing span (15)

Figure 3 shows the cross sectional back view of single body flat solar powered lighter-than-air platform consisting of an aerostat (10) and horizontal wing-span (15) where it has 15.4^0 contoured layout structures.

Figure 4 exhibits the schematic of the single body contoured lighter – than – air platform. This platform consists of a single GNVR shaped aerostat (10) of 500 m3 volume which can take payload of 290 kg for setting a 1 kW_p power generation unit.

Figure 5depicts the cross sectional view of the single body contoured solar powered lighter-than-air platform consisting of an aerostat (10). This kind of platform generates 22.5^0 contoured layout for generating 1 kW_p solar power by using HighFlex SolarHF315-6-36 flexible solar photovoltaic modules under optimum condition.

Figure 6 shows the cross sectional back view of the single body contoured solar powered lighter-than-air platform consisting of an aerostat (10) with 22.5^0 contoured layout.

Figure 7 shows the power-voltage plot of two serially connected amorphous silicon solar modules on a contoured layout.

Figure 8 shows the power-voltage plot of two serially connected modules on a horizontal flat layout structure equivalent to 0^0 contours.

Figure 9 and 10 shows the solar zenith angles for single body flat solar powered lighter than air platform comprising of an aerostat (10) and horizontal wing span (15) and single body contoured solar powered lighter than air platform consisting of an aerostat (10) respectively. There are very few solar zenith angles available for single body flat solar powered lighter than air platform when compared to solar zenith angles available for single body contoured platform. Few solar zenith angles mean lesser non-uniformity in available solar insolation for solar photovoltaic modules on the active surface area. Surface morphology of active surface area changes along the structure for the single body contoured platform. It is responsible to generate different zenith angles at different points on active surface area. Hence uniform solar insolation is not available to solar photovoltaic modules on single body contoured platform and is improved for single body flat solar powered lighter than air platform.

Given below is a table which gives details of payload estimation for the solar powered lighter than air platform:

Group name	Sub group	Weight in kg.
Envelope	Envelope group	176
	Envelope	130.2
	Ballonet	42
	Rigging hooks (24 nos) and patches (8 nos.)	1

	Nose battens	2
	Gas filling hose	0.8
Fin	Mass of fin group	20
	Mass of used fabrics	20
Tether	Tether group	26
	Tether(2 km of length)	4
	Cat 5 PoE cable	19
	Pivot with payload frame	1
	Confluence lines support distribution wires	1
	Other	1
Power system	Power system	50
	HighFlex SolarHF315-6-36 thin film c- Si based flexible solar PV modules (4 No.s)	14
	Genasun Li-ion battery (24V, 100 Ah)	29
	Sensor network	7
Extra	Gondola (PVC) + Platform (PVC)	18
	Total Payload	292
Extra infrastructural payload for Single body flat LTAP	Mass of additional 2 wings + PVC platform + ropes	(8 + 1 + 1) = 10
	Total Payload for Single body flat LTAP	300

Given below is experimental data of derived Parameter Look-up-Table (LUT) :

Flexible solar power modules output power is a function of available solar insolation and module temperatures. But in the present system the output power is also function of contour. Look-up-table is a derived relation between output power with the immediate effect of available solar irradiance, temperature and contoured structure.

In order to generate the table, flexible solar power modules are first kept on ground in a 2 x 2 configuration flat layout. Then output power readings, solar insolation and module temperature readings are recorded at the same time throughout the day. Temperature coefficient of -0.5 %/ ^{0}C is considered for each flexible solar power modules.

Sr. No.	Solar insolation (Watts/m^2)	SPV module temperature (degrees)	Output Power (Watts)
1	A1	B1	X1
2	A1	B2	X1-0.005X1.(B2-25^0)
3	A2	B2	X3
4	A3	B3	X1-0.005X1.(B3-25)
5	A4	B4	X4
6	A5	B6	X5

Table 1 Output performance of flexible solar power modules on flat layout

In second staged of recording readings, flexible solar power modules are layered on lighter than air platform as follows. The following relational table of parameters is prepared.

Sr. No.	Solar insolation (Watts/m^2)	SPV module temperature (degrees)	Output Power (Watts)
1	A1	B1	Y1
2	A1	B2(B2>B1)	Y2 = Y1-0.005Y1.(B2-25^0)
3	A2	B2	Y3
4	A3	B3(B3>B2)	Y4 = Y1-0.005Y1.(B3-25)
5	A4	B4(B4>B3)	Y5

Table 2 Output performance of SPV modules on a contoured layout

By comparing these two tables, performance of output power under different contour is clearly visible. Even the experimental results justify this effect of dynamic contouring.

In the third stage of recording readings, the lighter than air platform is kept in aerial condition and output power on ground is measured at discrete times. Then these power values are compared with corresponding solar insolation and temperature values in order to estimate available solar insolation to the flexible solar power modules and module temperatures. To differentiate effect of solar insolation with module temperature, a light meter is used on ground to measure available solar insolation on ground between 12 p.m. – 2 p.m. It is assumed that solar insolation value on ground and at an altitude is same during that time period. This reading approximates the values of available solar insolation at an altitude. During that time period the output power performance effect of module temperatures can be easily differentiated using table 2. A table can be generated w.r.t table 2 illustrating the following data.

Sr. No	Time	Solar insolation (Watts/m^2)	Output power (Watts)	Module temperature (in degrees)
1	12.00 p.m.	A1	Y2	B2
2	12.30 p.m.	A2	Y3	B2
3	1.00 p.m.	A2	Y1	B5(B5<B2)
4	1.30 p.m.	A3	Y4	B3
5	2.00 p.m.	A3	Y5	B6(B6>B4)

Table 3 illustrates flexible solar photovoltaic modules output performance on lighter than air platform at an altitude

Based on table 3, solar insolation and module temperature is predicted for a particular output power of flexible solar power modules on LTAP remotely. Referencing table 3 data, lighter than air platform positioning is done to get better output power at a particular solar insolation. In this way look up table works for this solar powered lighter than air platform system.

We Claim:

1. A lighter than air platform for solar power generation, comprising:

   a solar power generation module capable of generating solar power;

   a mounting module to provide a mounting base with reduced contour angle to the solar power generation module, wherein; the mounting module is capable of proving optimized aerodynamic stability to the mounted solar power generation module when air-borne.

   a positioning module couplable with the mounting module and capable of maintaining it with stability at a desired angle and elevated with respect to the ground level;

   a power module connected with the solar power generation module and capable of transferring and storing the power generated by the solar power generation module;

   a monitoring module capable of monitoring and computing multiple parameters during solar power generation by the solar power module and controlling the positioning module accordingly to optimize the solar power generated by the solar power generation module.

2. A lighter than air platform for solar power generation as claimed in claim 1, wherein the solar power generation module comprises of flexible solar photovoltaic modules to generate solar power.

3. A lighter than air platform for solar power generation as claimed in claim 1, wherein the mounting module comprises of a GNVR shaped aerostat with an additional horizontal wing-span from the center of the aerostat and enclosed

by an enveloping material; wherein the additional horizontal wings provide the mounting base with reduced contour angle to the solar power generation module.

4. A lighter than air platform for solar power generation as claimed in claim 3, wherein the enveloping material is polyurethane coated nylon.

5. A lighter than air platform for solar power generation as claimed in claim 1, wherein the reduced contour angle is any angle less than or equal to 15^0

6. A lighter than air platform for solar power generation as claimed in claim 1, wherein the positioning module consists of automated geared winches actuable by the monitoring module and coupled to the mounting module using tethers.

7. A lighter than air platform for solar power generation as claimed in claim 1, wherein the power module comprises of a battery to store a part of the power generated by the solar power generation module; power transfer cables to transfer surplus power generated by the solar power generation module; an on-ground power storage device for storing the surplus power transferred by the power transfer cables, wherein; the surplus power generated by the solar power generation module is equal to the sum of all parts of the power generated by the solar power generation module other than the part stored by the battery.

8. A lighter than air platform for solar power generation as claimed in claim 7, wherein the on-ground power storage device comprises of batteries

9. A lighter than air platform for solar power generation as claimed in claim 7, wherein the battery is a lithium-ion battery.

10. A lighter than air platform for solar power generation as claimed in claim 7, wherein the power transfer cables are power over Ethernet cables

11. A multi-purpose lighter than air platform for solar power generation as claimed in claim 1, wherein the monitoring module comprises of:
sensors positioned onboard the aerostat which continuously detect data pertaining to multiple parameters during solar power generation by the solar power module and convert this data into digital signals;
a wireless digital server coupled with the aerostat module for relaying the digital signal from the sensors;
an on ground wireless router to receive the digital signal relayed by the wireless digital server;
an on-ground computer for displaying ,storing and computing the signal received by the on ground wireless router and sending an output signal for controlling the positioning module accordingly;

12. A multi-purpose lighter than air platform for solar power generation as claimed in claim 11, wherein the on-ground computer computes the input signal and sends an output signal for controlling the positioning module and thereby the angle of the mounting module by applying predetermined values of solar irradiance to the aerostat and varied angular positions at a certain altitude in derived equations.

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