Research Inventy: International Journal of Engineering And Science
Vol.14, Issue 5 (May 2024), PP 157-160
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

Lunar Regolith Solar Power Plant – An Approach

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ABSTRACT*: Sun is our weather source and our climate arbiter. A photon of visible light has an energy of 2eV. The sun's luminosity diluted by the square of the distance, radiates a power of 3.8 * 10^{26} watts to earth, at a mean distance of 150million kilometres from the sun. The moon is a solid, rocky, body with an equatorial diameter 3476 km, orbiting earth at a mean distance 384,000 km, reflecting sunlight. The moon's sidereal period is 27.3 days, with an elliptical orbit perigree 356410 km and an apogee 406679km. When directly overhead, sunlight delivers 1.365 kW/m^2 to the lunar surface and photovoltaic cells have an energy conversion factor of 20 percent.*

Keywords*: SUN, Moon, Regolith, photovoltaic cell, albedo.*

Date of Submission: 19-05-2024 Date of acceptance: 03-06-2024

I. INTRODUCTION and LITERATURE SURVEY:

The SUN, our powerhouse, energizes our planet, warming the ground and lighting our days [1].Sun is our weather source and our climate arbiter [1].SUN has 92.1 percent hydrogen atoms,7.8 percent helium atoms and all other heavier atoms make only 0.1 percent [1].The sun radiates continuous energy, called electromagnetic waves travel through the space at a constant speed, velocity of light,299,793 kilometers per second[1]. Sun radiations are in the wavelengths less than 10^{-12} meters to greater than 10^{4} meters [1]. At the atomic level, the natural unit of energy, electron volt (eV), is the energy an electron gains when it passes through the one volt battery terminal [1]. A photon of visible light has an energy of 2eV [1].Photon energy is inversely proportional to the wavelength and directly proportional to the frequency[1]. The extremely massive sun contains 99.9 percent total mass of the solar system, with a radius of about 109 times that of the planet earth [1].The sun's luminosity diluted by the square of the distance, radiates a power of 3.8 * 10^{26} watts to earth, at a mean distance of 150million kilometres from the sun [1]. Unlike the solid earth(mean diameter 12700 kilometers), all of the sun is a hot ball of plasma and has no surface [1].Within the dense, central core, the Sun's temperature rises to 15.6 million Kelvin [1]. At the visible solardisk, the sun's temperature is 5,780 kelvin [1]. The sun shines by nuclear fusion, whereby hydrogen nuclei or protons, fuse into helium nuclei, and the nuclear reactions sequence is called proton-proton chain [1].The innumerable collisions in the radiative zone takes about 170 thousand years for radiation to work its way from sun's core to the bottom of the convective zone[1].The sunlight takes eight minutes to reach earth[1].The sun alongwith planets formed about 4.6 billion years ago[1].The mass of the sun is 2*10^{30} kilograms[1].The sun will run out of hydrogen in about 7 billion years and then engulfs the nearest planet, mercury[1].The sun processed 37 percent of its hydrogen into helium during the past 4.6 billion years[1]. In one billion years from now, the sun will be brightened by ten percent [1]. In about 3 billion years from now, the sun will boil the oceans, making the earth a dead and sterile place [1]. The inner parts of sun are opaque and the convective zone, measured by helioseismology, extends to a depth of 28.7 percent of the visible SUN radius [1]. The sunrise and the daily sun journey in the sky, happens in the photosphere, a few hundred kilometres thick layer, with a temperature 5780 kelvin and a pressure one ten-thousandth(0.0001) of the pressure of the sea level earth's atmosphere[1]. The sunspot cycle varies in a ten year period from a maximum 200 per month to a minimum dozen spots, in two belts at 30 degrees latitude, one north and one south of the equator [1].No sunspots are ever found at the polar regions of the SUN [1].The magnetic polarity of SUN reverses at the beginning of each cycle every eleven years, thus an average 22 years full magnetic cycle, Hale's law [1]. The bipolar sunspot magnets flip around the leading spots in each hemisphere with opposite magnetic polarities during successive 11 year cycles [1]. The solar gases above the photosphere encircled by a narrow band of light, called corona, are momentarily seen for eight minutes during the total eclipse of the SUN [1]. Every second, the sun blows away a million tons perpetual flow of electrified matter called solar wind [1].At the sunspot maximum, solar flares are sudden outbursts of energy equivalent to 100-megaton hydrogen bombs simultaneous explosion [1].Solar flares disturb long-distance radio communications and affect satellite orbits [1]. Eight minutes after a solar flare, a strong blast of x-rays and extreme ultraviolet radiation radically alters the ionosphere with an increased amount of free electrons, causing radio blackouts [1]. Radio waves travel in straight lines and cannot pass through the solid earth, but get reflected by the highly ionized free electrons in the ionosphere along the earth's curvature, and extend into space roughly 70 kilometers above the earth's surface [1]. The ionosphere has three reflecting layers D, E and F, at respective altitudes 70, 100 and200 to 300 kilometers, while the atmosphere is only 12 kilometers from the earth's surface [1]. The sun's ultra-violet rays strike a diatomic oxygen molecule to dis-associate it into two oxygen atoms and these atoms attach to an oxygen molecule forming the ozone molecules with three oxygen atoms [1]. The ozone layer in the stratosphere at altitudes between 15 and 50 kilometers, shields earth by absorbing ultra-violet rays, with a maximum concentration of $5*10^{18}$ molecules per cubic meter [1]. The solar radiation varies over the 11 year magnetic activity, modulated over a 100 year time intervals [1]. In photosynthesis, the tree trunk carbon intake varieties come in stable carbon 12 and radioactive carbon 14[1]. Cosmic rays from the outer space produce the radioactive type and the type reveals how active the Sun was at the time [1]. The radioactive carbon 14 production is inversely proportional to the sun's activity [1]. Space weather refers to the time variable conditions in the space environment that may affect space-borne or ground based technological systems, and in the worst case, endanger human health or life [2]. The national oceanic and atmospheric administration introduced space weather scales viz. Geomagnetic storms (five categories G1 to G5), solar radiation storms and radio blackouts [2]. G1, a minor (900 days per cycle) storm has weak influence on power systems and some grid fluctuations can occur [2]. G2: moderate (360 days per cycle), high latitude power systems may experience voltage alarms, long duration storms may cause transformer damage [2].G3: strong (130 days per cycle), voltage corrections needed on power systems, intermittent satellite navigation and low frequency radio navigation problems possible [2]. G4: severe (60 days per cycle), power systems have widespread voltage control problems and some protective systems will mistakenly trip out the grid key assets [2].G5: extreme (4 days per cycle), along with voltage control problems, some grid systems completely collapse and transformers damage; high frequency radio propagation impossible for one or two days, satellite navigation degraded for days, low frequency radio navigation blocked for hours[2].Solar radiation storms(S1 to S5) measured by the flux of ions 10 Mev and above[2].S1: minor(ion flux about 10), there are no effects on biological systems and satellite operations, no danger for astronauts and there are 50 events per solar cycle[2].S2: moderate(ion flux about 100), no biological influences, infrequent single event upsets possible for satellite operations and there are about 25 events per cycle[2]. S3: strong (ion flux 1000), radiation hazard avoidance recommended for astronauts on extra vehicular activities; commercial jets passengers and crew at high latitudes may receive low level radiation exposure, approximately 1 chest x-ray[2]. There might be 10 events per cycle [2]. S4: severe (ion flux 10000), unavoidable radiation hazard to astronauts on EVA and approximately 10 chest x-rays equivalent radiation exposure to passengers and crew in commercial jets at high latitudes possible, satellites experience memory device problems and noise on imaging systems and degraded efficiency of solar panels, and there will be 3 such events per cycle[2].S5: extreme(ion flux 1,00,000) unavoidable high radiation hazard to astronauts on EVA, approximately 100 chest x-rays equivalent radiation exposure to passengers and crew in commercial jets at high latitudes possible and out-of-operation satellites memory impacts cause loss of control, image date noise and permanent damage to solar panels [2].Such events may be fewer than 1 per cycle[2]. Radio blackouts, R1 to R5 in the range 0.1-0.8nm w/m^2[2].R1(M1 And 10^{-5}): minor: a minor degradation of high frequency radio communication on the sunlit side as well as occasional loss of radio contact, low frequency navigation degraded for brief intervals [2]. 2000 such perturbances per cycle occur in 950 days per cycle[2].R2(M5 and flux to $5*10^{-5}$): moderate: limited blackout of high frequency radio communication on sunlit side, radio contact loss for 10 minutes and there will be 350 events per cycle in 300 days per cycle[2]. R3(X1 and flux 10^{-4}): strong: a wide area blackout of high frequency communication as well as a likely loss of radio contact for about an hour on the sunlit side of earth[2]. There may be 175 events per cycle in 140 days per cycle [2].R4(X10 and flux 10^{-3}): severe: high frequency radio contact loss and radio communication blackout for one or two hours on the sunlit side of the earth, and there may be eight events per cycle in eight days per cycle [2].R5(X20 and flux $2*10^{-3}$): extreme: a complete high frequency radio blackout on the entire sunlit side of the earth for a number of hours and it may be less than 1 events per cycle[2]. DS1 solar panels are the most efficient solar panels which convert about 22 percent of the available energy into electrical power whereas solar panels on people's earth convert about 14 percent [2]. Solar panels lose 1-2 percent of their effectiveness per year [2]. DS1 use nickel-hydrogen batteries [2].

METHODOLOGY and DISCUSSION: The moon is a solid, rocky, body with an equatorial diameter 3476 km, orbiting earth at a mean distance 384,000 km, reflecting sunlight [3].IN truth, moon and earth, both orbit their barycentre or common center of mass [3].The ratio of distances from each body to the barycentre is the inverse ratio of their masses[3]. The moon's mass is $7.35*10^{22}$kg and that of earth is $5.98 *10^{24}$kg, while the barycenter is in the ratio 81:1[3]. The barycenter lies inside the earth's globe [3]. The moon's sidereal period is 27.3 days, with an elliptical orbit perigree 356410 km and an apogee 406679km [3]. A Danjon scale 0 to 4 eclipse respectively varies from the darkest, very dark with a deep-brown or grey umbra, deep red or reddish brown colour, brighter still though the umbra looks coppery red with bright yellow edge, the moon bright orange or even yellow at mid-totality[3]. Every 18 years(6585 days), the earth-moon-sun regain very similar positions relative to one another, called Saros [3]. The attractive force between earth and moon amounts to a colossal $2*10^{20}$N [3]. The moon's albedo is 0.07 i.e. moon reflects 7 percent of the sunlight [3].The roughy and hummocky highlands of lunar topography has features and nomenclature viz maria (smoother), craters, mountains(generic name mons) and groups of peaks(montes), mare, valli, clefts, rima(e) [3].Catena is a chain of small craters and catena Abulfeda is 210km long chain of small craters near the major crater Abulfeda [3]. In an emergency, astronauts return to earth from moon in three days [4]. The sunlight received on moon can be converted into electricity (terawatts) with lunar-made solar panels, for global exploration and development [4]. The lunar soil (regolith) has iron, aluminium, calcium, silicon, titanium and oxygen as well as traces of carbon, sulphur and nitrogen [4]. At the moon's equator, regolith temperature ranges from 127^{o}C at midday to -173^{o}C before lunar dawn [4].The largest features of moon-orientale basin,the Imbrium basin and the south pole-Aitkin basin, are atleast 300km in diameter and can be seen from earth with naked eye [4]. The south pole-Aitkin basin is the largest known impact crater, with a diameter 2500km and a maximum depth 12 to 13 km [4]. Comets and asteroids strike the moon with an average speed 20km/s resulting in craters ten to twenty times larger than the impacting object [4].The round, dark, low areas of the moon, called maria, cover 16 percent surface on the near side of the moon [4]. Thirty percent surface on the lunar near side is mare (volcanic) material and have gravity anamolies, called mascons; spacecraft accelerate near maria and decelerate beyond them [4]. The lack of an atmosphere on the moon permits the cosmic radiation and solar wind plasma to reach the lunar surface unimpeded[4].When directly overhead, sunlight delivers 1.365 kW/m^2 to the lunar surface and photovoltaic cells have an energy conversion factor of 20 percent [4]. The lunar power can be transferred from moon-to-earth as microwave or laser beams, both forms of electromagnetic radiation, with advances in beaming technologies, reconverted into electricity at the receiving site [4].

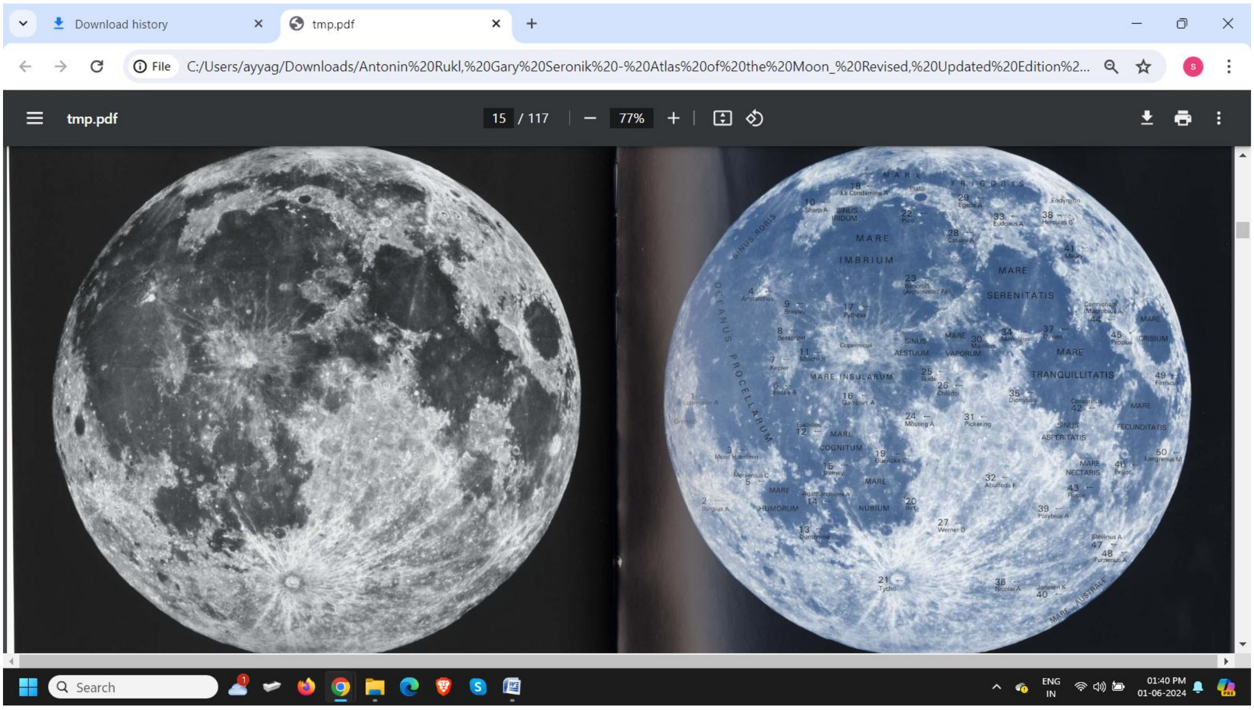

Fig1: full moon and the lunar features[5].

II. CONCLUSION:

The regolith made photovoltaic cells have higher conversion factor and be helpful in all future space missions, besides satisfying the earthly energy needs. However, the available electricity transmission mechanism from moon to earth is still an optimistic scientific investigation and the paper concludes a practical but cumbersome approach. A humanoid robot goes to the moon to separate the nickel-hydrogen battery and build it into a spherical ball, to avoid any spatial magnetic influences. The humanoid robot plays the spherical ball attitude control as if a space soccer along the geodesic, upto the troposphere. From the troposphere, the spherical ball falls under earth's gravity onto deserts across the world. The fallen spherical ball collected and dis-mantled to utilise the stored energy in the battery.

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