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# Strat Sheet

**This is the supplement and updates file for the Solar Powered Satellites Aff (SPS). This includes:**

**- The major questions of feasibility and solvency for the Aff, as well as some more cards for the Neg.**

**- A new water wars advantage that expands the concept from just an add-on in the previous file. The internal link is based off of the satellites providing power for desalination plants which would solve water problems.**

**- Updates to the leadership and warming advantages which more brink and solvency evidence.**

**- Updated Aff answers to popular case arguments which can be included in updated 1AC’s.**

**- Neg evidence to update DA links and case answers.**

**- Add-Ons**

**There are also CP’s:**

**- Aerostats: Deploys things in different altitude orbits to solve (troposphere) – avoids DA links because it is isn’t going into space and isn’t funded under NASA for politics.**

**- Boeing: Specific private actor CP that uses Boeing tech to do the plan**

**- DoD: Agent CP that solves commercial action.**

**- CSP: Concentrated solar thermal power plants that use ground-based systems.**

**There is also some space weapons work at the end – and an internal link to an advantage.**

# \*\*\*AFF\*\*\*

# SPS Solves – 1 Gigawatt

**We have the tech now – only economic barriers**

**Coopersmith** 2-3-**11**, Professor of History and Texas A&M, “The cost of reaching orbit: Ground-based launch systems” [http://www.sciencedirect.com/science/article/pii/S026596461100035X]

Space-based solar power (SBSP) promises GW of electric power with minimum environmental damage. While it was too ambitious when proposed in 1968, technological advances and growing concern about providing environmentally friendly electricity have renewed interest in collecting solar energy and transmitting it to Earth” A 2007 study by me National Space Security office (NSSO) of the Department of Defense stated building a I-GW solar power station in geosynchronous orbit was technically feasible." the major economic challenge will be launching the 3000 metric tons of material and equipment to construct an SBSP station The NSSO study concluded. "The nation’s existing EELV [Evolved Expendable Launch Vehicle-based space logistic infrastructure could not handle the volume or reach the necessary cost efficiencies In support a cost-effective SBSP system".2' Only drastic reductions in launch costs will make SBSP economically feasible. as Table 1 indicates. For SBSP to become a reality. reducing the cost of reaching orbit is as important as the SBSP technology.

# SPS Solves – Needs Development

**SPS will work with development.**

**Boechler et al,** School of Aerospace Engineering, Georgia Institute of Technology, Atlanta GA, **6**

[Nicholas Boechler, Sameer Hameer, Sam Wanis, Narayanan Komerath; “An Evolutionary Model for Space Solar Power”; 2006; <http://www.adl.gatech.edu/archives/adlp06020701.pdf>; Boyce]

By carefully integrating environmental and energy policy issues, and rethinking the concept of SSP, we show that a viable, realistic, socially and politically acceptable technical path can be laid to reach the dream of Space Solar Power. While a simplistic calculation of end-to-end efficiency shows beamed power transmission to be far inferior to transmission via high voltage lines, **a space-based power grid opens up various markets and opportunities that are otherwise closed**. The single most important point of the present concept is that it provides the long-sought Evolutionary Path towards Space Solar Power. The inverted thinking of SPG, where we initially beam power into space rather than from it, is the key. Initial system size and scope are kept small to enable deployment and revenue generation, giving time for market forces to identify the opportunities. The production/deployment cost of a 36satellite system is covered to at least 50% from transmission line costs of the power transacted, with substantial added benefits from carbon cost savings. Advancement to Stage 2 will require improved microwave power handling (waveguide) technology, and in nanoscale fabrication for direct conversion to microwaves

**SPS works but needs development**

**Matsumoto**, 1973: Ph.D., Kyoto University, 2000-2002 Professor, Radio Science Center for Space and Atmosphere, Kyoto University, 2008: President, Kyoto University, Japan; **2**

[Hiroshi Matsumoto; “Research on Solar Power Satellites and Microwave Power Transmisison in Japan; December 2002; <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01145674>; Boyce]

The SPS will be a central attraction of space and energy technology in coming decades. At present, technological development of the MPT at 2.45 and 5.8 GHz is still ongoing. However, the overall efficiency goal of 64% from dc provided by the solar panels to dc output from the rectennas is not far away. The target of 80% at both transmitting and receiving systems is achievable in the near future. However, large-scale retrodirective power transmission has not yet been proven and needs further development. Another important area of technological development will be the reduction of the size and weight of individual elements aboard the space section of the SPS. SPS researchers in Japan are interested in designing and launching an experimental power satellite with a scale of 10-100 kW in low Earth orbit (LEO) to prove technical feasibility. In this article we have mainly discussed only MPT. Other key technologies to be considered include large-scale transportation and robotics for the construction of large-scale structures in space. Technical hurdles will be removed in the coming one or two decades. The difficult issue of radio regulation is to be overcome with a long-term philosophy of radio usage in this century. To this end, a special working group was formed in 2002 within the International Union of Radio Science (URSI) to have a serious discussion on this matter, including communication engineers, SPS engineers, radio astronomers, and bioradio scientists. This working group and the Scientific Committee on Telecommunications within URSI will make an effort to contact the International Telecommunications Union, which is a regulatory organization of radio spectrum.

**Beam technology development feasible – requires government incentives and initiatives**

**Chowdhary et al 09** (G.; Gadre, R.; Komerath, N., Georgia Institute of Technology) "Policy issues for retail Beamed Power transmission," Science and Innovation Policy, 2009 Atlanta Conference on , vol., no., pp.1-6, 2-3 Oct. 2009 <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5367855&isnumber=5367807> Herm

BPTS systems provide an efficient tool for providing power to units of the armed forces operating in remote locations on the battlefield. On realization, this technology has the potential to provide sufficient power to any field unit without having to carry independent power source. It would be natural to protect such technology through ITAR restrictions. However, it should be noted that given the current economic scenario, and the fact that delivery of energy is a global problem, significant global collaboration will be required for development of BPTS. Allowing for global cooperation without threatening national interest is a significant policy issue that needs to be addressed early on in the design. Significant government involvement will be needed to mature the complete potential of this high risk technology. Based on increasing technological risk, the required policy initiatives can be roughly separated in the following levels: Level 1: Encourage small scale private sector innovations relying on beamed power by recognizing the environmental benefits. Level 2: Encourage public .– private sector large scale projects that use direct beamed power for powering subsytems. Level 3: Encourage large scale augmentation of retail wired power systems with beamed power. It is suggested that policy initiatives should be created that encourage the development of technology simultaneously on all three levels with financial support concentrated on level 1 in early stages and concentrated on level 2 and 3 in later stages. This allows for distribution of risk and gradual across the spectrum incorporation of the technology into main stream applications.

**Tech development is needed to get SPS of the ground.**

**Potter**, Research Scientist, New York University; Member of Board of Directors of the Space Frontier Society of New York , **98**

[Seth Potter; “Solar Power Satellites: An Idea Whose Time Has Come”; last rev 12/27/1998; <http://www.freemars.org/history/sps.html>; Boyce]

Spurred on by the oil crises of the 1970's, the US Department of Energy and NASA jointly studied the SPS during that decade. The result of this study was a design for an SPS which consisted of a 5 x 10 kilometer (3 x 6 mile) rectangular solar collector and a 1-kilometer-diameter (0.6 mile) circular transmitting antenna array. The SPS would weigh 30,000 to 50,000 metric tons. The power would be beamed to the Earth in the form of microwaves at a frequency of 2.45 GHz (2450 MHz), which can pass unimpeded through clouds and rain. This frequency hasbeen set aside for industrial, scientific, and medical use, and is the same frequency used in microwave ovens. Equipment to generate themicrowaves is therefore inexpensive and readily available, though higher frequencies have been proposed as well. The rectenna array would be an ellipse 10 x 13 kilometers (6 x 8 miles) in size. It could be designed to let light through, so that crops, or even solar panels, could be placed underneath it. The amount of power available to consumers from one such SPS is 5 billion watts. (A typical conventional power plant supplies 500 million to 1 billion watts.) The peak intensity of the microwave beam would be 23 milliwatts per square centimeter (148 milliwatts per square inch). The US standard for industrial exposure to microwaves is 10 milliwatts per square centimeter, while up to 5 milliwatts per square centimeter are allowed to leak from microwave ovens. US standards are based on heating effects. Stricter standards are in effect in some countries. So far, no non-thermal health effects of low-level microwave exposure have been proven, although the issue remains controversial. Nevertheless, even the peak of the beam is not exactly a death ray. Underneath the rectenna, microwave levels are practically nil. The reason that the SPS must be so large has to do with the physics of power beaming. The smalle rthe transmitter array, the larger the angle of divergence of the transmitted beam. A highly divergent beam will spread out over a great deal of land area, and may be too weak to activate the rectenna. In order to obtain a sufficiently concentrated beam, a great deal of power must be collected and fed into a large transmitter array. Interest in the SPS concept waned after the 1970's due to the end of the oil crisis and the failure of inexpensive launch systems to materialize. In recent years, there has been a renewed interest in the SPS, due to concerns about a possible global warming resulting from carbon dioxide emissions from fossil fuel combustion. A study commissioned by the [Space Studies Institute (SSI)](http://www.ssi.org/) has shown that about 98% of the mass of the SPS can consist of materials mined from the moon. A lunar infrastructure would have to exist for this to occur. My own SSI-sponsored work, based on earlier work by Geoffrey Landis and Ronald Cull at the NASA Lewis Research Center, has shown that an SPS could be built using thin-film solar cells deposited on lightweight substrates. Such an SPS could deliver perhaps ten times as much power per unit mass as older designs. The combination of lightweight materials, inexpensive launch systems, and a space infrastructure can make the SPS a reality. No breakthroughs in physics would be required. However, a significant commitment to technology development would be needed.

# SPS Necessary – Power Low Now

**Current electric power on earth is insufficient**

**Chowdhary et al 09** (G.; Gadre, R.; Komerath, N., Georgia Institute of Technology) "Policy issues for retail Beamed Power transmission," Science and Innovation Policy, 2009 Atlanta Conference on , vol., no., pp.1-6, 2-3 Oct. 2009 <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5367855&isnumber=5367807> Herm

Currently, most electric power on Earth is transmitted using wired power transmission systems. In this system, electrical power is transmitted from the source of power generation to the point of power consumption through an appropriately shaped conductive material. The wired method of energy transfer has various disadvantages: 1. Large infrastructure is required for transfer of power using conventional wired grid transmission. 2. Land areas and right-of-way required for transmission lines. 3. Damage to ecosystems, most evident from the swaths of forest cleared to keep power lines free from tree limbs. 4. Wired power transmission is highly susceptible to attacks and accidents. 6. Wired power transmission systems require high maintenance, and are highly susceptible to outage due to wind and ice storms. 5. The conventional grid is not conducive to micro-renewable energy resource exploitation since wired power transmission is only cost effective over long distances.

# SPS Solves – Feasible

**Resources are on the decline – SPS is the only feasible option**

**Ramos 2k** – US Air Force Major, Thesis submitted for the AIR COMMAND AND STAFF COLL MAXWELL Air Force Base (Kim, “Solar Power Constellations: Implications for the United States Air Force,” April, http://handle.dtic.mil/100.2/ADA394928)

Currently the United States relies on fossil fuels to generate electrical power. The United States acquires fossil fuels from both domestic sources and imports. Scientific predictions indicate a “sharp decline in [fossil fuel] availability over the next 40 years.” 1 As the world population increases, and natural resources to produce energy decrease, alternative methods to produce sustainable, environmental friendly, cost effective energy are required. One solution to the lack of renewable energy resources is solar power satellites. A solar power satellite collects energy from the sun and beams that energy to a receiving antenna, which converts the energy into electricity. Peter Glaser first proposed solar power satellites in the late 60s. During the energy crises in the 70s, the government took a hard look at them. The studies generated by this inquiry essentially reported that solar power satellites were technologically possible but their cost and launch requirements were not. Fifteen years later NASA conducted a study to determine if anything had changed. The study concluded that costs were still high but they were not as high as originally predicted and that there were no technological showstoppers. Utility companies and many other nations are taking a close look at solar power satellites. Not only are they looking at them as sources of power on Earth but as sources of power for satellites to reduce their size and launch costs.

**SPS technologically feasible**

Johnathan **Coopersmith** historian of technology **10** (AIP Conference Proceedings “Solar Power Satellites: Creating the Market for Beamed Energy Propulsion, May 6, 2010 -- Volume [1230](http://scitation.aip.org/dbt/dbt.jsp?KEY=APCPCS&Volume=1230), pp. 103-110, <http://link.aip.org/link/?APCPCS/1230/103/1>) Herm

Space-Based Solar Power (SBSP) has great potential to supply baseload electric power to Earth with minimum environmental damage. The tempting promise of gigawatts of electricity, harvested from kilometer-wide arrays of solar cells in geosynchronous orbit and beamed by microwave to receiving stations on earth, was technologically too ambitious when first proposed by Peter Glaser in 1968 [10]. Interest in SBSP has grown in recent years due to technological advances and growing concern about providing future baseload electricity in environmentally friendly and economically feasible ways [11-15]. SBSP technology has matured greatly since first studied in the 1970s. Advances in solar cells, microwave transmission, and construction techniques in space have made SBSP much more attractive technically. The most recent major study, by the National Space Security Office (NSSO) of the American Department of Defense in 2007, concluded that a one GW solar power station could be built in geosynchronous orbit [16]. Growing interest in SBSP is reflected by papers like the Naval Research Laboratory’s 2008 SBSP study [17], websites [18], and conferences like Space Canada International Symposium on Solar Energy from Space [19]. The International Academy of Astronautics will complete an exhaustive study in 2010 on the main technological options and provide a roadmap forward [20].

**SPS is a feasible prospect that solves – network of small satellites**

Basant V. **Sagar** **&** Ryan M. **McLinko** [(Department of Mathematics, MIT; SM Candidate (2011), Department of Aeronautics and Astronautics, Space Systems Laboratory, Massachusetts Institute of Technology) **10** Society of Photo-optical Instrumentation Engineers, “Space-based solar power generation using a distributed network of satellites and methods for efficient space power transmission.” International Conference on Space Information Technology 2009. April 2010 <http://hdl.handle.net/1721.1/57581> Herm]

Space-based solar power (SSP) generation is being touted as a solution to our ever-increasing energy consumption and dependence on fossil fuels. Satellites in Earth’s orbit can capture solar energy through photovoltaic cells and transmit that power to ground based stations. Solar cells in orbit are not hindered by weather, clouds, or night. The energy generated by this process is clean and pollution-free. Although the concept of space-based solar power was initially proposed nearly 40 years ago, the level of technology in photovoltaics, power transmission, materials, and efficient satellite design has finally reached a level of maturity that makes solar power from space a feasible prospect. Furthermore, new strategies in methods for solar energy acquisition and transmission can lead to simplifications in design, reductions in cost and reduced risk. The key architecture needed for such a campaign to be feasible is the use of a distributed network of small satellites to collect solar energy and beam it back to Earth. Most designs for space-based solar power involve launching monolithic self-assembling structures into orbit, which are some of the most troublesome aspects of this concept. As is shown below, the key drivers in this design are the cost of launching satellites in to space and the cost of photovoltaic cells. Both of these costs can be reduced further in the long-run by invoking quantities of scale and learning effects, but remain high cost barriers at this point.

# SPS Solves – Studies

**SPS feasible – NASA’s studies are outdated**

**MSNBC '07** (MSNBC, Oct. 12, 2007, Power from space? Pentagon likes the idea. <http://www.msnbc.msn.com/id/21253268/page/2/>) Herm

"The issue here is not technology, OK?" said Miller, who was a contributor to the study. "You could figure out how to do space solar power in the '70s. [But] you couldn't close the business case in the '70s. You couldn't close it in the '90s. How do you close the business case? That is the No. 1 question to be answered." Economic equation is changing The report — which was done on an unfunded basis and took advantage of [online collaboration](http://cosmiclog.msnbc.msn.com/archive/2007/09/07/350320.aspx) with outside contributors — notes that several factors have changed in the decade since NASA took its most recent in-depth look at the space power concept [(PDF file)](http://www.nss.org/settlement/ssp/library/1997-Mankins-FreshLookAtSpaceSolarPower.pdf). Today's best solar cells are about [three times as efficient](http://www.renewableenergyaccess.com/rea/news/story?id=46765) as they were in 1997, while crude-oil prices are roughly [three times as high](http://www.wtrg.com/prices.htm). And in the post-9/11 era, energy security has taken on far more importance. "The technology has advanced vastly, and the security situation has changed quite a bit, as well as the economic situation," Marine Lt. Col. Paul Damphousse, who took over the study from Smith last month, told msnbc.com. "Those things warranted another look."

**SPS is feasible- NASA study proves**

**Smith 3**, Director at Moon Society; Founder and President at Long Island Space Society, (Arthur,“The Case For Space Based Solar Power Development: solar energy on Earth and in space might be the first large scale space industry” http://www.spacedaily.com/news/ssp-03b.html, 8-11-03, MA) // CCH

  Space is big - there is an awful lot of energy out there, and the crumbs we fight about here on Earth are laughably tiny in comparison. Zettawatts from the Sun pass just through the region between Earth and Moon - that's enough energy for each man, woman and child in the US to sustainably power an entire US economy all to themselves. Even our terrestrial energy choices, fossil or renewable, fission or wind, almost all derive from the energy profligacy of our Sun and other stars before it. Gathering power in space and transmitting it to Earth should not be a mystery to us in this 21st century. Communications satellites already do it routinely. One significant obstacle to power applications, however, is regulatory: there is no spectrum allocated to power transmission, as there is for communications. Since frequency of operation has a significant impact on transmitter design which may alter the design of the overall solar power system, the earlier we have a frequency allocation decision, the better. The Federal Communications Commission and the International Telecommunications Union should be prodded to start work on this issue now. The potential for power from space has been recognized for over thirty years (1). Studies in the late 1970's by NASA and the Department of Energy produced a reference design for solar power satellites using then-current technology that showed technical feasibility, but also high cost. NASA returned to the subject with an exploratory study from 1999 to 2001. A review by the National Research Council (2) found the program to have a credible plan which required significant funding increases. Rather than strengthening the program, however, all funding for the space solar power group ceased after September 2001, and essentially no R&D work on power from space is now being done in the US.

**SPS is feasible- studies prove**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

Space-based solar power first conceived of in the late 1960′s, during the widely supported Apollo program. It was patented by Dr. Peter Glaser in 1968, when gasoline was a quarter a gallon, access to space was still a new frontier and technologies like photovoltaics and wireless power transmission were new and undeveloped. World population was much lower than today and so was the demand for energy. The business case for space-based solar power no where near closing. The world has changed in significant ways since then. Space-based solar power has been studied several times by government agencies over last 40 years. It was examined extensively during the late 1970s by the D.o.E. and NASA and then reexamined by NASA from 1995-1997 in the “fresh look” study. The concept was studied again in 1998 in a “concept definition study” by NASA, which was followed in 1999-2000, when NASA undertook the SSP Exploratory Research and Technology (SERT) program. During 2001-2002, NASA pursued an SSP Concept and Technology Maturation (SCTM) program follow-on to the SERT and also in 2001, the U.S. National Research Council (NRC) released a major report, providing the results of a peer review of NASA’s SSP strategic research and technology study. Most recently, the National Space Security Office released an updated feasibility study “Space Based Solar Power As an Opportunity for Strategic Security” in October of 2007. What are the results of all these Space-based solar power studies? The good news is that each time it has been studied, the technology and business cases are closer to being feasible and much of the basic knowledge for space-based solar power is already in place. The bad news is that most citizens have not yet heard of space-based solar power, it is not a part of the national conversation on energy and it is not yet a part of national policy or roadmap for America’s energy future.

**SPS is feasible and economically competitive- technology exists**

**Prado 2**, - physicist, former U.S. DOD space engineer and consultant multinational engineering and construction companies (Mark, “Environmental Effects of SPSs on Earth,” <http://www.permanent.com/p-sps-ec.htm>, MA) // CCH

Even though SPS is technically feasible, environmentally attractive, and electricity is highly flexible and clean, will SPS be economically competitive? Yes. I have worked in the construction industry, and also intensely studied different energy supply technologies, and can produce this basic, common sense analysis: Compared to today's energy sources, the SPS and rectenna system offers an economically competitive large scale energy source, and in fact appears to offer a much less expensive energy source once significant space-based infrastructure is established. In addition, the SPS and rectenna system has strong advantages in terms of environmental issues. It appears that SPS will eventually become the premier energy source for Earth. The sooner, the better. In this section, the SPS is compared to both conventional energy sources (fossil fuels and nuclear), as well as alternative energy sources. The SPS is solar energy, so that it falls under the category of alternative energy. Compared to other solar energy concepts to date, the SPS is clearly the most feasible long-term, large scale solar power source for our economies, as well as the most economical. Compared to today's energy sources Currently, the world gets about 95% of its energy from coal, oil and natural gas, and almost all of the other 5% from nuclear power and hydroelectric dams. The SPS concept appears to have inherent promise to be a most economical source of electric power to our economies, relative to today's electricity sources and all other energy sources seriously projected for the forseeable future. The economics of energy supply consists of two elements: the cost of building the power plant and its supporting infrastructure, i.e., the front end capital cost, and the cost of operating the power plant, e.g., mines, fuel processing facilities, transportation infrastructure, and waste disposal. Let's first look at a coal fired power plant for comparison. In terms of front end capital costs, a coal fired power plant has massive generators and mechanical systems constructed from a great variety of precision parts which are expensive. A SPS consists of a very small variety of simple parts mass produced in great quantity. A SPS needs no fuel supply and waste handling systems. The SPS consists mainly of a flat plane of silicon solar cells on a beam structure, with electric busbars feeding a large antenna with waveguides and tubes. The satellite is made mostly from a small variety of simple parts mass produced in space. The satellite has only small quantities of precision or special parts. The receiving antenna on Earth would be mainly screens, posts, and concrete. Practically no moving parts. The mass of the rectenna would be a little bit less that a coal fired power plant with the same output, assuming a safe, low power density SPS beam, and the satellite in space is about a tenth the mass of a coal fired power plant, to give you a picture of what we're dealing with. Once built, the SPS and rectenna would continuously supply energy passively with no pollution. In contrast, a coal fired plant of equal power output to an SPS would have to burn tonnages of coal in excess of 20 TIMES the combined weight of the SPS and its ground-based rectenna, and also mine, transport, process and dispose of the ash of these tonnages, each and every year!! This is a massively expensive operation, yet it is the least expensive electricity source today which can reliably supply electrical energy in quantities large enough for our demands. A nuclear power plant is much more complex than a coal plant, i.e., composed of an even greater variety of specialized and expensive components. A nuclear power plant is about twice as massive as a rectenna, considering just the power plant and not all the facilities required for nuclear fuel mining, transport, purification, enrichment, rod fabrication, spent fuel temporary storage, reprocessing and disposal facilities. Nuclear power plants have very high front-end capital costs (especially with ever-changing safety regulations and the need for nuclear safety), but lower operating costs compared to coal-fired plants. Nuclear power also has long pending nuclear waste disposal issues. The most important case against adding more nuclear fission power plants is that it takes only 20 kilograms (45 pounds) of plutonium, about the size of a grapefruit, to produce a bomb. It's been 50 years since the first nuclear bomb was made, and advanced technical knowhow is now widespread. Much smaller amounts of plutonium are sufficient for a terrorist to fatally poison areas. The more nuclear plants there are, the greater the chances of an offensive person obtaining the material one way or another in the fuel cycle. Nuclear fission is a risky energy source for the world's growing energy needs, and the sooner we start moving away from it, the better. Coal and nuclear are more economical and reliable large scale power sources than alternative energy sources, which is the bottom line of why they are prevalent, so in the discussion here I will not give a long analysis of wind turbines, geothermal, and ground based solar energy sources (especially considering unreliable supplies and expensive storage needs for ground-based solar and wind power). The following table below summarizes the weak points of alternative energy, e.g., cost per unit of power produced, whether there's enough of it to power a significant percentage of our electricity needs, environmental problems, versatility (e.g., passive solar space heating reduces energy consumption but does not provide other energy so it's a partial solution), and location of the energy source relative to demand. Nuclear fusion using hydrogen will be technically feasible some day, but it does not look any more economical at this point in time than fission or coal. The power plants will be complex. Plus, fusion is not clean. Fusion produces dangerous radioactive gases, e.g., tritium hydrogen, which are much harder to contain than the solid waste products of nuclear fission. Hydrogen is the most difficult element of all to contain. These radioactive gases must be contained during production (breeding) and extraction, purification, plasma fueling and of course disposal of radioactive wastes and ancillary equipment. If we spent the same amount of money on SPSs as we do on oversold fusion, we would have a more economical and environmentally clean alternative energy source, sooner. There are no significant advances in technology required for SPSs, in contrast to the advances in technology required for fusion. The spinoffs of space development far outweigh the spinoffs due to fusion power. You can see that the SPS and rectenna have some natural economic advantages over conventional energy sources, once space based infrastructure in emplaced. Convincing arguments can be made that the SPS will be the main power source for Earth from an economic standpoint in the long-term future. However, the environmental advantages are also significant, as covered in another section, after we look at the pure economics and feasibility of other alternative energy sources. Compared to "alternative" power sources

# SPS Solves – Spills Over

**Beamed power is legitimate and catalyzes the market – empirics**

**Chowdhary et al 09** (G.; Gadre, R.; Komerath, N., Georgia Institute of Technology) "Policy issues for retail Beamed Power transmission," Science and Innovation Policy, 2009 Atlanta Conference on , vol., no., pp.1-6, 2-3 Oct. 2009 <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5367855&isnumber=5367807> Herm

To counter the disadvantages of wired power transmission, Beamed Power Transmission ([2][3][11]) can be used. Beamed (wireless) power transmission uses electromagnetic radiation (microwave or lasers) for power transfer. First demonstrated in 1897 by Nikola Tesla using radio frequencies, and using microwaves in 1964 (Brown, 1992), wireless transmission was extended to tens of kilowatts by NASA in 1975. In the 1980s, beams of up to 1GW were considered (and possibly demonstrated) under the Strategic Defense Initiative (aka .“Star Wars.”). The concept of bringing solar power from large satellites in space or on the Moon, have been explored since the 1960s, both in the USA and outside, notably in Japan. These concepts have generally been stymied by the very large infrastructure needed to convert and transmit microwave beams over very large distances. On the other hand, there has been a revolution in the use of wireless transmission of information. Satellite television, cellular telephones and wireless internet connections are the best-known examples, and these together comprise a very large marketplace with billions of customers. These clearly involve beamed transmission of electric power, but the intent has been to transmit information encoded in the beams, rather than power itself. Communication satellites send out fairly narrow beams, but the 10,000 to 36,000 kilometer distances from earth to their orbits means that generally, the beam is spread out and covers a large area when it reaches Earth.’s surface. The emphasis in this market has been to continually reduce the amount of power needed to ensure a clear signal, and this effort has received a major boost with the advent of digital high-frequency transmission and reception. Thus there are already billions of devices operating every day, that have the capability to receive electromagnetic waves and decode the information contained in them with extremely high rates of processing.

# SPS Solves – Specific Info

**SPS works- 3 components**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/> , MA)

There are three fundamental elements to space-based solar power. The first element consists of large solar panels in space near the Earth. These solar panels could be up to several square miles in size, depending on the capacity required. They would be placed in one of several orbits, including Low Earth Orbit (LEO), Geo synchronous (or stationary) Orbit (GEO), or even Sun Synchronous Orbit (SSO). Eventually, a constellation of satellites would be required. Another location for the space-based solar panels would be on the surface of the Moon. Wherever they are placed, these solar panels would continuously collect massive amounts of electromagetic (light) energy, since solar radiation is eight times more intense in space than on the ground and they would not be subject to the day-night cycles of the Earth’s revolution or impeded by varying weather conditions. These solar panels would most likely employ photovoltaics (PV) similar to current ground-based solar panel technology for conversion of light to electricity, although other conversion methods have also been considered. The second element consists of the wireless power transmission (WPT) from the solar power satellite to the surface of the Earth. Electromagnetic energy would be beamed wirelessly back to earth at frequencies most efficient to carry energy through the atmosphere. These frequencies would most likely be in the microwave range, although the beam would be similar in intensity to 1/6 that of noon sunlight. The third element consists of the rectifying antennas (rectennas) which would receive the wireless power transmission from the solar power satellites and convert it to alternating current power that would be connected directly into the existing electrical power distribution grid as a source of baseload power. This power could also be used to manufacture synthetic hydrocarbon fuels (synfuels) in a liquid form or even to be used as low-intensity broadcast power beamed directly to consumers.

# SPS Solves – Laundry List

**SPS is the best alternative- laundry list of reasons**

**Prado 2**, - physicist, former U.S. DOD space engineer and consultant multinational engineering and construction companies (Mark, “Environmental Effects of SPSs on Earth,” <http://www.permanent.com/p-sps-ec.htm>, MA) // CCH

Unlike other solar energy concepts, the SPS would supply solar energy 24 hours per day. It would be reliable, too. Unlike the SPS, ground-based solar energy can't supply power at night unless it has expensive storage equipment plus extra generating capacity during the day. Further, power from terrestrial solar power plants requires backup power for cloudy days, and power generated and stored varies with the seasons. Unreliability and planning needs make conventional solar energy inconvenient and unattractive to responsible utility companies -- an economy can't be held hostage to the whims of the weather. Reasons why "alternative energy" concepts like wind power and ground-based solar cells have not caught on is because each concept suffers from one or more of the following issues: abundance concentration of energy supply reliability cost per kilowatt Regarding reliability, an economy can't shut down because the wind stops blowing the wind power generators as much, causing demand/supply fluctuations in energy prices, rationing or power failures. Also, it takes a lot of wind generators in a windy place to power a small city, for example. Geothermal energy, hydroelectric dams, and other renewable sources of energy exist, but there is not nearly enough of it to power our economies, especially at costs nearly competitive to fossil fuels. In contrast, the SPS is an abundant, reliable and a natural 24-hour supplier of energy, and rectennas can be located within sufficient proximity to consumers everywhere. The SPS poses a clear alternative to coal and nuclear power plants. But what about oil and natural gas? Can the SPS reduce the vulnerability of the world economy to oil cutoffs (e.g., due to a Middle East war, terrorism, or embargoes)? Would it be wise to divert our budgets away from wasteful military hardware and invest it into space development (by direct government subsidization and/or massive tax incentives)? Do we need a lead time well before oil supply starts to fall short of oil demand? Yes. The "Electric Economy" concepts -- electric heat, electric vehicles, synthetic liquid fuels made with the help of electrical energy -- would reduce the growing world economies' vulnerability to energy shortages. This means using clean electrical energy in place of natural gas heating, and making synthetic liquid fuels from natural gas, coal, and hydrogen gas from water electrolysis. Electric cars would be more popular if parking lots at work, shopping centers, etc., were equipped with simple plug-in recharge meters. Electric cars are clean and quiet. Liquid fuel for long range vehicles is the main energy source which SPS electricity cannot substitute for directly. However, it can substitute indirectly by providing energy in making synthetic fuels. Also, by using electrical energy in place of oil and natural gas wherever possible, oil and natural gas are liberated for use in long range vehicles. This requires a willingness to change a little of our infrastructure for the better, e.g., setting up plugs for electric vehicle chargers in parking lots (e.g., office buildings, shopping malls, restaurants, etc.), and opening quick-battery-swapping service stations on the road. Pumping petrol will become a thing of the past for those who choose electric vehicles. Analyses of the costs of electric vehicles reveals that the cost of electric cars would be roughly the same as present day automobiles in a scenario of mass production of electric vehicles anywhere near the current production of gasoline (petrol) cars. The electric cars are currently more expensive because of the cost of the batteries (front-end capital cost), but the operating costs of electric cars is less since electricity costs less than gasoline, and less maintenance is required on an electric vehicle than a car powered by an internal combustion engine. Again, a main impediment is that there's no plug to charge your car at the office parking lot, at the shopping center, at restaurants, etc. It's worth noting that from the 1920s through World War II, oil-starved Germany made synthetic gasoline on a massive scale from coal and natural gas, enough to supply the massive Nazi military machine almost exclusively. Synthetic liquid fuels are made by hydrogenating coal and/or getting natural gas to bond into bigger molecules to form liquids. Petrol (i.e., gasoline) consists of hydrocarbons, i.e., molecules made up of carbon chains surrounded by hydrogen. Coal is pure carbon. To produce synthetic fuels from coal, you combine it with hydrogen. The hydrogen can be supplied by using electricity to split up water into hydrogen and oxygen. In the late 1970s, the U.S. funded synthetic fuels research in response to the Arab oil cutoffs, but those budget items were cut in the early 1980s, which coincided with the time an international oil shortage became an oil glut. Today, we rely on military spending and realpolitik to protect the world economies from oil cutoffs. Oil makes up 40% of modernised countries' energy consumption. Western Europe, Japan, and the U.S. (WEJUS) consume more than 60 million barrels each and every day! We can readily replace city car gasoline consumption by using electric cars instead. By doing so, we need replace only 12 of the 60 million barrels per day equivalent in electricity, because electric cars are more than 80% efficient whereas gasoline cars are only 15% efficient (yes, most of the energy goes out the tailpipe as heat instead of motion). Electric cars of range approximately 100 miles (150 km) at highway power without recharge are just recently starting to becomeeconomically attractive to consumers. Charging at parking lots can readily be done, though this kind of infrastructure is hard to get started, and is a great barrier to realization -- a chicken-or-egg situation. However, we are eventually going to have to face the fact that fossil fuel production can't keep up with growing demand for fossil fuel energy because of both depletion of resources and the increased demand due to rapid development of less developed countries. Tax incentives and other measures may need to be emplaced by governments to deal with the situation, to the detriment of our future economic fluidity. It's a simple fact that new oil discoveries have not kept pace with consumption. In the relatively oil-rich USA, oil reserves have fallen steadily since the 1960s despite technological improvements in exploration and drilling plus significantly increased drilling rates. The US imports more than 50% of its oil, today more than at any other time in history, and US dependence on imported oil only continues to increase. Europe imports more than 70%, and Japan and most free Asian nations import nearly 100% of their oil. Modern analyses project that profitable synthetic gasoline would go to market at about $2 per gallon using slightly improved German methods from the 1920s -- about twice the price of today's gasoline in the US, or about the current price in Japan and Europe where gasoline is heavily taxed to discourage overconsumption. Synthetic fuel is not produced anywhere since Middle East oil is so much cheaper and drives synthetic fuels out of the market at the present time. There is no place on Earth like the Persian Gulf in terms of oil abundance and cheap production. As the rest of the world grows, we can expect the Free World to become increasingly dependent on the volatile Middle East for its oil, and thus potentially hostage to a cutoff for any reason. If and when that happens, you can expect worldwide economic recession and hardships, and excuses for outside armies to go in and try to get the oil flowing back out (and which may not be successful despite strong efforts and presences), resulting in the vast spread of terrorism, perhaps with plutonium in hand. We can expect to maintain high military spending. However, taking a small fraction of military spending and putting it into SPS development would ultimately enhance our security permanently, and be much more economically productive and positive. Even a beefed up military will not be enough one day, as growing world demand for oil will eventually outstrip supply. We've been tapping most of the best oil producing geologies for decades, and more than 100 million barrels of oil each and every day is a lot of pumping from the Earth. Increasing demand from newly industrializing countries will eventually cause stiff competition for oil and price rises. However, production of synthetic liquid fuels from coal is polluting and poses formidable environmental challenges. We are going to have to find an alternative to consuming massive quantities of oil. If we cut out a big chunk of oil consumption by replacing half our city cars with electric cars, we will significantly relieve consumption of fossil fuels and synthetic fuels. Putting off the problem until later only makes the problem worse. The sooner we make a committment to solving this problem, the slower we will consume fossil fuels, the less vulnerable our interdependent economies will become, and the better our futures will be. Better sooner than later. Conservation can help, but it's not the answer. The bulk of the growth in oil consumption is coming from the less developed countries which are industrializing. It's bad enough to see the US, Japan and Western Europe alone consuming around 80 million barrels or more of oil every day for the indefinite future. When you see the industrialization of the other 80% of the world, you get an idea of the magnitude of the problem. I've worked and lived in less developed countries, including for multinational engineering and construction companies helping to develop these countries. Indeed, I'm writing this on my notebook portable PC in a bus heading down a highway on the Thailand peninsula, a country with a low per capita income by Western standards but which has been growing at an average rate (percent of GNP) about 4 times that of the industrialized world over the past 15 years. So I'll use this country as an example: The applications of SPSs are immediately apparent in less developed countries like this. Instead of building deep sea ports for ocean tankers, and so many refineries, pipelines, and petrol stations, for handling imports of Middle East oil, they could be supporting SPS development with the energy piped in by simple electric power lines. They would pay less for electricity than for oil, thus improving their trade balance. Electrical power lines are less destructive to the environment than the alternatives. Instead of trying to increase domestic oil and gas production by offshore drilling, which is polluting the beautiful beaches and unique underwater sealife, long-term planning could consider substitutions of electrical energy. Already, countries like Thailand have suffered great environmental damage downwind from coal fired power plants and downstream from coal mines, and is seriously considering nuclear power beyond Thailand's current small research generators. Electricity is expensive here. Unlike in industrialized countries, liquified natural gas is popular here, largely from offshore drilling, and used for cooking and many new taxis (as in Australia). Again, better to offer SPSs sooner than later. In poor countries where people struggle to survive, environmental preservation is a luxury. Alternatives to environmentally destructive lifestyles must be economically available, feasible and attractive. Electricity is a most convenient, flexible and clean modern energy source. The rectennas are simple, relatively cheap construction items, requiring little technical know-how, and can have dual use as irrigation structures or fish farming upon bodies of water. Development around SPS electricity would be much more financially attractive for developing countries to importing oil and coal, compared to the alternatives. It seems that positive natural market mechanisms will come to bear worldwide when we make progress on SPS development, as well as political decisions. Really, if Thailand is considering nuclear power, don't you think they would prefer solar power satellites and rectennas? As for non-market mechanisms, it's worth noting that the US spends 300 billion dollars a year on its military to police the world, while practically nothing is spent on developing energy alternatives. If instead, tax incentives were budgeted for private sector space development of SPS, with perhaps government subsidation (e.g., matching funds for leading companies or consortiums for the first few years just to speed up the development process), we would all get a whole lot more for our money. It's win-win for everyone in every country, especially compared to the alternatives. It will also be the advent of new energy exporters -- of solar power, up in space far from political radicals. In any case, it seems fairly clear that SPSs and rectennas will be a major long-term power source of choice all over the world, and whatever entity develops the source and gets the patents will create a wealthy, glorious and historic legacy. It's only a matter of when, and who.

**SPS solves- many uses**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

U.S. Department of Defense would make a great early adopter / first customer for space-based solar power. At least one estimate from the war in Iraq claim that the totally burdened cost to deliver a of gallon of fuel to the troops is between $20 – $80. That may seem very high until it is compared with the cost in human life. Many soldiers have been killed or injured when their fuel convoys were attacked en route. A portable rectenna receiving power beamed directly from a solar power satellite could eliminate the need for most of those fuel convoys. Worldwide disaster relief efforts are another area where space-based solar power might first be used. After Katrina, if portable rectennas could have been helicoptered in to provide temporary power to local grids, if they were still intact or using wireless power transmission if they weren’t operational, mobile hospital units, food banks, pumping stations and many other critical disaster relief services could have been up and running much sooner than they were. Remote, isolated populations would benefit greatly from space-based solar power. Rural electrification technology, consisting of a low cost rectenna and electrical distribution system would dramatically improve the quality of life almost immediately. A remote African village that suddenly had access to sanitation, water purification, refrigeration, lighting air conditionin and heat and communication would be able to provide for the health and human needs of its people. An AP article in the December 24, 2007 Atlanta Journal-Consitution titled “`Drilling Up’ Into Space for Energy” contained some very interesting quotes: “American entrepreneur Kevin Reed proposed that Palau’s uninhabited Helen Island would be an ideal spot for a small demonstration project, a 260-foot-diameter “rectifying antenna,” or rectenna, to take in 1 megawatt of power transmitted earthward by a satellite orbiting 300 miles above Earth.” “The climate change implications are pretty clear. You can get basically unlimited carbon-free power from this,” said Mark Hopkins, senior vice president of the National Space Society in Washington. To Robert N. Schock, an expert on future energy with the U.N.’s Intergovernmental Panel on Climate Change, space power doesn’t look like science fiction. “I wouldn’t be surprised at the beginning of the next century to see significant power utilized on Earth from space – and maybe sooner.”

**SPS good-many reasons**

**Nansen, 95 -** led the Boeing team of engineers in the Satellite Power System Concept Development and Evaluation Program for the Department of Energy and NASA, and President Solar Space Industries (Ralph, Sun Power, <http://www.nss.org/settlement/ssp/sunpower/sunpower09.html>, MA)

Solving our energy, environmental, and economic dilemma is certainly worthy of our total commitment. The solar power satellite solution can focus our national purpose on a single effort that will give us “energy independence” by providing a way of directly converting energy from the sun to power our future. It will utilize the technology investment we have already made in space. It will provide economical energy from a source we cannot deplete. It will bring energy to the earth in a form that can be used directly without polluting our environment. It can be expanded to fulfill the needs of all people on the earth as they develop. It will not subject the people of this country to the dragging chains of everlasting inflation driven by fuel costs. It is not a machine of war, yet it would raise our technology capabilities as did the Saturn/Apollo program. It could utilize the capability of the aerospace industry as they turn away from building weapons.

# SPS Spillover – Markets Now

**Markets are available for SPS now.**

**Landis**, “American scientist, working for the National Aeronautics and Space Administration (NASA) on planetary exploration, interstellar propulsion, solar power and photovoltaics.[2][3] He has patented eight designs for solar cells and photovoltaic devices”, **4**

[Geoffrey A. Landis Glenn Research Center, Cleveland, Ohio; “Reinventing the Solar Power Satellite”; 2/2004t; <http://www.nss.org/settlement/ssp/library/2004-NASA-ReinventingTheSolarPowerSatellite.pdf>; Boyce]

There are a large number of potential markets for space solar power. The greatest need for new power is in the industrializing third world; unfortunately, this market segment is by most analyses the least able to pay. Possibly the most interesting market is third-world "Mega-cities," where a "Mega-city" is defined as a city with population of over ten million, such as São Paolo, Mexico City, Shanghai, or Jakarta. By 2020 there are predicted to be 26 mega-cities in the world, primarily in the third world; the population shift in the third world from rural to urban has been adding one to two more cities to this category every year, with the trend accelerating. Even though, in general, the third world is not able to pay high prices for energy, the current power cost in mega-cities is very high, since the power sources are inadequate, and the number of consumers is large. Since the required power for such cities is very high-- ten billion watts or higher-- they represent an attractive market for satellite power systems, which scale best at high power levels since the transmitter and receiver array sizes are fixed by geometry. In the future, there will be markets for power systems at enormous scales to feed these mega-city markets. Therefore, it is very attractive to look at the mega-city market as a candidate market for satellite power systems. For more near-term economic feasibility, however, it is desirable to look at electricity markets within the United States. **The economic climate of the United States is more likely to allow possible investment in large-scale electric power projects than the poorer "developing" nations**, and hence it is more likely that the first satellite-power projects will be built to service the electrical market in the U.S. Although in the long term the third-world mega-cities may be the region that has the greatest growth in electrical power demand, the initial economic feasibility of a space solar project will depend on the ability of such a facility to be competitive in the U.S. electric market.

# SPS Solves – Long-Term

**SPS is the best option- long lasting**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

Let me start with some important definitions. A baseload power plant is one that provides a steady flow of power regardless of total power demand by the grid. Baseload power plants are usually fueled with coal or nuclear fission. Peaking power plants are power plants that generally run only when there is a high demand for electricity. Peaking power plants are usually natural gas, oil or hydroelectric powered. Comparing space-based solar power to fossil fuels (oil, coal, natural gas, etc.), both provide baseload power but the burning of fossil fuels create harmful emissions which may be contributing to global warming. Space-based solar power creates emissions only upon construction of the equipment and launching it into orbit. Fossil fuels will eventually run out and the demand is increasing with population growth and increases in per capita energy consumption around the world. Space-based solar power will run out when the sun burns out … and when that happens, we’ll have bigger fish to fry! Comparing space-based solar power to nuclear power, both provide baseload power but current nuclear fission creates radioactive waste, of which we have already already accumulated thousands of tons which must be safely tracked and stored long into the future, perhaps as long as 10,000 years. Space-based solar power radiates heat generated during the conversion of light to electricity back into deep space. Comparing space-based solar power to wind power, both are clean sources of energy but wind power is intermittent, so it can’t reliably provide baseload power. Wind power is well suited to certain geographical areas whereas space-based solar power can be delivered anywhere on the Earth. Comparing space-based solar power to ground solar power, both are clean sources of energy but ground solar power is intermittent, so it can’t reliably provide baseload power. Ground solar power is well suited to certain geographical areas. Solar energy in space is eight times more intense than after passing through the atmosphere and again, space-based solar power can be delivered anywhere on the Earth. Comparing space-based solar power to biofuels, biofuels (such as corn or sugar ethanol) require tremendous amounts of agricultural production. So far, biofuels have less energy per unit than fossil fuels. Space-based solar power does not compete with food production.

**SPS creates a long-term benefit**

**Nansen, 95 -** led the Boeing team of engineers in the Satellite Power System Concept Development and Evaluation Program for the Department of Energy and NASA, and President Solar Space Industries (Ralph, Sun Power, <http://www.nss.org/settlement/ssp/sunpower/sunpower09.html>, MA)

If we were to make the decision as a nation to move ahead and dedicate ourselves to developing the solar power satellite as our next major energy source, what would be the benefits? Let us select the option to pay as we go for developing the space-oriented infrastructure. The commercial utility industry could pay for most of the development costs for the power generation part of the system (the satellite and rectenna) through their contribution to the Electric Power Research Institute (EPRI). Funds for the space infrastructure development could be raised by charging a surtax on imported oil, applying a small tax on energy systems that pollute the atmosphere, and applying some moneys from the military budget. The government sources of money would actually have a positive long-term benefit. The tax on imported oil would be an incentive to US producers, the tax on polluting systems would be an incentive to expand nonpolluting systems, and the diversion of military funds would help keep the aerospace industry strong and ready if needed in the future for expanded military applications.

# SPS Adaptable

**SPS is adaptable.**

**Landis**, “American scientist, working for the National Aeronautics and Space Administration (NASA) on planetary exploration, interstellar propulsion, solar power and photovoltaics.[2][3] He has patented eight designs for solar cells and photovoltaic devices”, **4**

[Geoffrey A. Landis Glenn Research Center, Cleveland, Ohio; “Reinventing the Solar Power Satellite”; 2/2004; <http://www.nss.org/settlement/ssp/library/2004-NASA-ReinventingTheSolarPowerSatellite.pdf>; Boyce]

It is clear from these figures that, although conventional designs for a solar power satellite will produce a constant amount of power independent of the demand, the actual demand for electricity varies with time of day and with the day of the year, and hence the price that electrical power can be sold for varies as well, by an amount that varies from roughly a factor of two to over a factor of four, depending on market. The conventional solar power satellite design tracks the sun, and provides continuous power, except for a period near the spring and autumnal equinox, when it is eclipsed by the Earth around midnight. **Since a solar power satellite beams power long distances, would it be possible to use a single power satellite to provide power to two different geographical markets that are substantially separated in longitude** (and hence buy peak-rate power at different times)? This would be the power-beaming equivalent of "wheeling" power from one geographic location to another. Since the peak price period lasts nearly twelve hours (e.g., 8 AM to 8 PM for New York), for a single satellite to provide power to two separate markets at peak rates for both markets would require the two markets be at longitudes separated by nearly 180 degrees. If the downlink power beam is allowed to reach the Earth at 90-degree incident angle (i.e., from a satellite on the horizon), then a single geosynchronous satellite could service two sites on the equator separated by no more than 162 degrees of longitude. In reality, grazing-incidence is not practical. (Among other things, it would require a verticallyoriented rectenna.) NASA/TM—2004-212743 8 For a more practical case, assume that the maximum allowable zenith angle is 45 degrees. In this case two locations served by the same geosynchronous orbit solar power satellite can be at most 80 degrees (5.3 hours) apart. This geometry is shown in figure 6 (top). The maximum separation is lower if the sites are not on the equator. This would be sufficient separation to extend the period over which the satellite is providing high-price power from roughly 12 hours per day to roughly 17 hours per day. Note that in this case, the ground infrastructure of rectenna, land, and distribution system is doubled. This trade-off is only reasonable if the ground infrastructure cost is not the major fraction of the power cost. If the beam could be diverted through a relay satellite (figure 6, bottom), then larger separations could be achieved; in principle up to the most desirable case of a 180 degree separation. (In the geometry shown in figure 6, where the relay satellite is in a lower orbit than the beaming satellite, several relay satellites would be required to provide continuous coverage; each relay satellite, however, can sequentially service several markets.) Although a power relay satellite in principle is just a passive microwave mirror, in practice it will have to contain tracking, guidance, and orbit maintenance avionics of a sophistication equal or greater that of the solar power satellite. If the cost is a substantial fraction of the cost of the solar power satellite itself, then it makes more sense to simply build a second SPS, rather than the relay satellites. While it is not currently clear that a power relay satellite will be enough lower in cost to make servicing two markets with a power relay practical, the fact that this would allow power to be sold at high price during a period when otherwise the satellite would be selling power at low price means that this concept deserves study. Servicing the Spot Market Even higher revenue could be achieved if the solar power satellite could service the spot market, where instantaneous price of electricity can, for brief periods, rise to an order of magnitude higher than the peak-power cost. This would require a power satellite with the ability to switch beams from one ground location to a different ground location rapidly (within a few tens of seconds). Since instant spot demands are short, such a satellite would have to serve perhaps ten different utilities or more to average enough high-price demand markets; the cost of the ground infrastructure may make this prohibitive. A satellite which serves the short-term spot market cannot, between high-price spikes, sell power at peak power rates, since the ability to command premium rates is contingent on reliability of power supply. If the power is taken offline to service a peak demand elsewhere, the service cannot be relied on, and hence cannot sell for premium rates; conversely if the power is supplied to a utility at peak-power rates, the beam cannot be momentarily diverted to service a utility with a temporary demand spike. There is probably not enough money represented by the brief high-price spikes to make this concept worthwhile in light of the cost of replicating the ground infrastructure over ten or more sites, but if the ground infrastructure is low enough in cost, it may be worthwhile.

# Action Now Key

**America must react to China’s attempt to intimidate them**

**The Economist, 08**(“Disharmony in the spheres - The militarisation of space”, 1/19, lexis)

The missile shot put America on notice that it can be challenged in space. The Chinese routinely turn powerful lasers skywards, demonstrating their potential to dazzle or permanently blind spy satellites. “They let us see their lasers. It is as if they are trying to intimidate us,” says Gary Payton, a senior Pentagon official dealing with space programmes. The only conclusion, he argues, is that “space is no longer a sanctuary; it is a contested domain.” In a report to Congress in November, a commission examining America's relations with China gave warning that “the pace and success of China's military modernisation continue to exceed US government estimates.” China's principal aim, the report said, is to develop the wherewithal to delay or deter American military intervention in any war over Taiwan. The ASAT test intensifies the concern of those who already find plenty to worry about in Chinese military literature. A study for the American Enterprise Institute, a think-tank, cites a Chinese theorist who argues that China should adopt a policy of overt deterrence in space. Other Chinese argue that their country's territorial sovereignty extends to space. This kind of thing reinforces the hawkishness of American hardliners. Ashley Tellis, a senior associate at the Carnegie Endowment, another think-tank, believes China ultimately seeks to build a “Sinocentric order in Asia and perhaps globally.” Any attempt to negotiate arms-control agreements in space would be futile, he argues, and America “has no choice but to run the offence-defence space race, and win.”

**Space race inevitable – American unilateral action key**

**Eisendrath 6**, (Craig, a senior fellow at the Center for International Policy in Washington, D.C., is an adjunct professor of American Studies at Temple University, Philadelphia, “Waging War in the Heavens: Profit and Power Go Hand in Hand as the U.S. Gears Up to Spread Its Military Influence to Vet Another Vast Region-Outer Space” USA Today (Society for the Advancement of Education), Vol. 135, November 2006) // CCH

According to Mike Moore, former editor of The Bulletin of the Atomic Scientists and author of Space Cop, "Space warriors are part of a professional belief community whose members have certain overarching paradigms--one being that conflict in Space is probable, if not inevitable, and the United States must therefore prepare for it by taking unilateral action that would give [it] control of space in a time of conflict." This view is championed by Secretary of Defense Donald Rumsfeld, who holds that the U.S. has been so derelict in not arming space that it is vulnerable to a potential "Space Pearl Harbor." A version of this space-control mindset appeared in the U.S. Space Command-issued document, "Vision of 2020." On the first page, in oversize type, it reads, "U.S. Space Command--dominating the space dimension of military operations to protect U.S. interests and investment. Integrating Space Forces into war-fighting capabilities across the full spectrum of conflict." Citing the development of sea and air power, the report states, "Over the past several decades, space power has primarily supported land, sea, and air operations--strategically and operationally," as in the first Gulf War or the invasion of Iraq, when space was used to identify targets and guide weapons. "During the early portion of the twenty-first century, space power will also evolve into a separate and equal medium of warfare. Likewise, space forces will emerge to protect military and commercial national interests and investment in the space medium due to their increasing importance."

# SPS Solves – Testing

**SPS is successful – Moon testing’s prove**

Henry W. **Brandhorst et al.** Auburn University Space Research institute, “A solar electric propulsion mission for lunar power beaming” [http://www.sciencedirect.com/science/article/pii/S0094576509000629#secx3]

This preliminary study of an estimated 4343 kg mass SEP vehicle going to the moon and beaming laser power to bases at 45° N or S has shown that two satellites in lunar equatorial orbit can provide substantial power to these bases. Over a two year period, there were only eight times when the lack of view time of the 45°N location reached 84 h. Over the rest of the two year mission, the times when the satellites did not view the sites dropped to less than 54 h. Thus the need for energy storage on the lunar surface drops dramatically with this approach. The surface array was assumed to be made of GaAs cells in a SLA with a surface power in the day time of 60 kW. The power delivered by one satellite was 18 kW and there are many times when both satellites are in view of the site. This offers the opportunity of further increasing the power to the site; however the surface array would have to be a non-concentrating array. With this planar array, the power delivered to the surface could then double to 36 kW. Depending on the need and location of the surface sites, these elliptical orbits can also cover the back side of the moon and help provide communications to those locations. The radiation loss in traversing the Van Allen radiation belts will certainly be less than the 10% conservative value used here. In addition, advances in the efficiency of diode lasers in this wavelength range are expected to make this option increasingly attractive for providing power to the lunar surface.

**The solar power can be successfully beamed to earth**

**Ramos 2k** – US Air Force Major, Thesis submitted for the AIR COMMAND AND STAFF COLL MAXWELL Air Force Base (Kim, “Solar Power Constellations: Implications for the United States Air Force,” April, http://handle.dtic.mil/100.2/ADA394928)

Receiving methods for the beam involve the use of a rectenna. The rectenna intercepts the beam of energy from the solar power satellite and converts it back into electricity. 7 The rectenna consists of long wires connected to rectifying diodes. 8 Rectifying diodes convert RF energy into electricity. Since the rectenna intercepts the beam and allows most sunlight to pass through, the land beneath the rectenna still has a variety of available uses. One concept proposes to use the land beneath the rectenna to grow crops or raise cattle. 9 A rectenna may be located on earth, another satellite, or on an aircraft.

# Water Wars Advantage

**\*Needs more impact work based off of water shortages and solvency for desalination (ill do this tmoro)**

**Water shortages are increasing now.**

**Tobiska**, Chief Scientist, Space Environment Technologies, AIAA Member, **9**

[W. Kent Tobiska; “Vision for Producing Fresh Water Using Space Power”; 2009; <http://www.spacewx.com/Docs/SET_SPACE_2009.pdf>; Boyce]

The IPCC reports that climate change is affecting the water infrastructure around the planet. This infrastructure includes hydropower, flood defense, drainage, and irrigation systems as well as water management practices. The adverse effects of climate change on freshwater systems aggravate the impacts of other stresses such as those from population growth, changing economic activity, land-use changes, and urbanization. Globally, water demand is projected to grow in the coming decades primarily due to population growth and increasing affluence. Regionally, more demand for irrigation water is expected. Because changes in moisture precipitation patterns affect agricultural and urban water use, malnutrition and water scarcity on a global scale may become the most important health consequences of climate change. For the western U.S., the projected warming by 2050 is very likely to cause large decreases in snowpack, earlier snowmelt, more winter rain events, increased peak winter flows and flooding, and reduced summer flows with secondary consequences of increased drought conditions, lower crop yields, and forest fires. Overall, the reduced water supplies, coupled with increases in demand, are likely to exacerbate state-to-state and urban–rural competition for over-allocated water resources. Seawater Desalination as a Coastal Solution Coastal Populations are Large and Growing It is no coincidence that the world’s population centers, along with those in the U.S., are heavily concentrated along coastal areas. Moderate climates and access to global seaports as well as commerce have accelerated this historical population growth trend. Approximately 153 million people (53 percent of the U.S. population) live in coastal counties as of 2003 3 and 3 billion people worldwide live within 200 kilometers of a coastline 4 . This large growth of coastal populations makes it economically feasible to consider using seawater desalination as a source for metropolitan water supplies. This trend has accelerated in California coastal communities, for example. For comparative purposes later in this paper, we note that Santa Barbara, California (a small city) had a 2004 population of 90,305. Seawater Desalination as a Mature Technology Seawater desalination has existed for decades and is a mature technology. Fresh water is reclaimed from seawater with an efficiency of 15-50%, depending upon the production process. The California Coastal Commission (CCC) compares the two main technologies, i.e., distillation and reverse osmosis (RO). An advantage of distillation plants is their economy of scale. Distillation plants do not shut down their operations for cleaning or replacement of equipment as often as RO plants, although tube bundles do need occasional replacement and cleaning. Pretreatment requirements for distillation plants are less because coagulants are not needed to settle out particles before water passes through the membranes as in RO plants. Additionally, distillation plants do not generate waste from backwash of pretreatment filters. An advantage of RO plants is that feedwater generally does not require heating, which means that the thermal impacts of discharges are lower. RO plants have fewer problems with corrosion, they usually have lower energy requirements, and they tend to have higher recovery rates for seawater, e.g., around 45%. The RO process can remove unwanted contaminants, such as trihalomethane-precursors, pesticides, and bacteria and they take up less surface area than distillation plants for the same amount of water production.

**SPS solves water shortages but desalination is available.**

**Tobiska**, Chief Scientist, Space Environment Technologies, AIAA Member, **9**

[W. Kent Tobiska; “Vision for Producing Fresh Water Using Space Power”; 2009; <http://www.spacewx.com/Docs/SET_SPACE_2009.pdf>; Boyce]

There is an escalating climate crisis that is stressing the Earth’s environment partially a result of the increasing accumulation of carbon dioxide and methane greenhouse gases in the lower atmosphere. One area that is significantly affected is the water infrastructure around the planet including hydropower, flood defense, drainage, and irrigation systems. The effect of adverse climate change on freshwater systems aggravates population growth, weakening economic conditions, land-use changes, and urbanization. In the western U.S., for example, reduced water supplies plus increased demand are likely to provoke more interstate and urban–rural competition for over-allocated water resources. Seawater desalination has existed for decades and is a proven technology for supplying water in coastal areas. Continued population growth in coastal areas makes it economically feasible to begin considering seawater desalination as a larger source for metropolitan water supplies. It is noted that offshore oil and gas platforms already use seawater desalination to produce fresh water for platform personnel and equipment. It is proposed that as California coastal oil and gas platforms come to the end of their productive lives, they be re-commissioned for use as large-scale fresh water production facilities. Solar arrays, mounted on the platforms, are able to provide the power needed for seawater desalination during the daytime. However, for efficient fresh water production, including on oil platforms, a facility must be operated 24 hours a day. The use of solar power transmitted from orbiting satellites (Solar Power Satellites – SPS) to substantially augment the solar array power generated from natural sunlight is a feasible concept. The advantage of a SPS in geosynchronous orbit (GEO) is that it is able to produce power at nighttime, thus enabling 24 hours a day operations. A SPS would be conceptually similar to existing commercial communication satellites but with a much larger solar array. A single satellite could power at least one seawater distillation plant on a converted offshore oil platform during the night and supplement the power during the day to provide clean energy and water for urban or agricultural on-shore areas. Production of industrial quantities of fresh water on re-commissioned oil and gas platforms, using energy transmitted from solar power satellites, is a breakthrough concept for addressing the pressing climate, water, and economic issues of the 21 st Century. It is a novel combination of mature technologies that provides new solutions and expert team feasibility studies are the next step to evaluate this vision for producing fresh water using space power.

**Using SPS for water shortages works even if the tech doesn’t function in other realms.**

**Tobiska**, Chief Scientist, Space Environment Technologies, AIAA Member, **9**

[W. Kent Tobiska; “Vision for Producing Fresh Water Using Space Power”; 2009; <http://www.spacewx.com/Docs/SET_SPACE_2009.pdf>; Boyce]

Historically, SPS were envisioned for providing large-scale electricity to towns or small cities. This is based on the fact that a single kilometer-wide band of space at GEO experiences nearly enough solar flux in one year to equal the amount of energy contained within all known recoverable conventional oil reserves on Earth today. The size of an orbital solar array is still technically prohibitive to provide power for cities. However**, our concept would use a satellite that is conceptually similar to existing commercial communication satellites but with a much larger solar array** 7 . For comparison, the International Space Station (ISS) has a completed total power of 120 kW using 16 solar panels of approximately 5600 m 2 . A 2 MW SPS would require approximately 16 times the number of solar panels as the ISS, i.e., a configuration that is certainly much larger and technically challenging, but not unfeasible. A single 2 MW-class satellite can provide power for a Santa Barbara-class seawater distillation plant on a converted offshore platform during the night and can supplement the power for operations during the day. Inefficiencies in the system are not considered here. SPS power received at the Earth’s surface is about ! Sun in the center of the beam, day and night. Added to the normal daily solar power, this can provide enough power to run fresh water production facilities.

**Water shortages cause multiple problems in the U.S. – action is key.**

**GAO, 3**

[United States Government Accountability Office Study, United States General Accounting Office; “FRESHWATER SUPPLY States’ Views of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages”; 7/2003; <http://www.gao.gov/new.items/d03514.pdf>; Boyce]

National water availability and use has not been comprehensively assessed in 25 years, but current trends indicate that demands on the nation’s supplies are growing. In particular, the nation’s capacity for storing surface-water is limited and ground-water is being depleted. At the same time, growing population and pressures to keep water instream for fisheries and the environment place new demands on the freshwater supply. The potential effects of climate change also create uncertainty about future water availability and use. State water managers expect freshwater shortages in the near future, and the consequences may be severe. Even under normal conditions, water managers in 36 states anticipate shortages in localities, regions, or statewide in the next 10 years. Drought conditions will exacerbate shortage impacts. When water shortages occur, economic impacts to sectors such as agriculture can be in the billions of dollars. Water shortages also harm the environment. For example, diminished flows reduced the Florida Everglades to half its original size. Finally, water shortages cause social discord when users compete for limited supplies. State water managers ranked federal actions that could best help states meet their water resource needs. They preferred: (1) financial assistance to increase storage and distribution capacity; (2) water data from more locations; (3) more flexibility in complying with or administering federal environmental laws; (4) better coordinated federal participation in water-management agreements; and (5) more consultation with states on federal or tribal use of water rights. Federal officials identified agency activities that support state preferences. While not making recommendations, GAO encourages federal officials to review the results of our state survey and consider opportunities to better support state water management efforts. We provided copies of this report to the seven departments and agencies discussed within. They concurred with our findings and provided technical clarifications, which we incorporated as appropriate.

**Water shortages outweigh other impacts.**

**Evans-Pritchard**, international business editor of the Daily Telegraph, **8**

[Ambrose Evans-Pritchard, The Telegraph; “Water crisis to be biggest world risk”; 6/5/2008; <http://www.telegraph.co.uk/finance/newsbysector/utilities/2791116/Water-crisis-to-be-biggest-world-risk.html>; Boyce]

A catastrophic water shortage could prove an even bigger threat to mankind this century than soaring food prices and the relentless exhaustion of energy reserves, according to a panel of global experts at the Goldman Sachs "Top Five Risks" conference. Nicholas (Lord) Stern, author of the Government's Stern Review on the economics of climate change, warned that underground aquifers could run dry at the same time as melting glaciers play havoc with fresh supplies of usable water. "The glaciers on the Himalayas are retreating, and they are the sponge that holds the water back in the rainy season. We're facing the risk of extreme run-off, with water running straight into the Bay of Bengal and taking a lot of topsoil with it," he said. "A few hundred square miles of the Himalayas are the source for all the major rivers of Asia - the Ganges, the Yellow River, the Yangtze - where 3bn people live. That's almost half the world's population," he said. California faces water rationing due to drought Will climate change destroy us this century? I doubt it More of Ambrose Evans-Pritchard Lord Stern, the World Bank's former chief economist, said governments had been slow to accept the awful truth that usable water is running out. Fresh rainfall is not enough to refill the underground water tables. "Water is not a renewable resource. People have been mining it without restraint because it has not been priced properly," he said. Farming makes up 70pc of global water demand. Fresh water for irrigation is never returned to underground basins. Most is lost through leaks and evaporation. A Goldman Sachs report said water was the "petroleum for the next century", offering huge rewards for investors who know how to play the infrastructure boom. The US alone needs up to $1,000bn (£500bn) in new piping and waste water plants by 2020. "Demand for water continues to escalate at unsustainable rates. At the risk of being alarmist, we see parallels with Malthusian economics. Globally, water consumption is doubling every 20 years. By 2025, it is estimated that about one third of the global population will not have access to adequate drinking water," it said. China faces an acute challenge. It makes up 21pc of humanity but controls just 7pc of the water supply. The water basin in parts of northern China is falling by one meter a year due to overpumping. In Heibei province the aquifer fell three meters last year. An increasing number of rivers are running dry. Disputes over cross-border water basins have already prompted Egypt to threaten military action against any country that draws water off the Nile without agreement. The shift to an animal protein diet across Asia has added to the strain. It takes 15 cubic metres of water on average to produce 1kg of beef, compared to six for poultry, and 1.5 for corn. Goldman Sachs advises investors to focus on the high-tech end of the world's $425bn water industry. But beware the consumer "backlash" against bottled water, now viewed as an eco-hostile waste of fuel. It is eyeing companies that produce or service filtration equipment (which can now extract anything from caffeine to animal growth hormones by using nanotechnologies), ultraviolet disinfection, desalination technology using membranes, automated water meters and specialist niches in water reuse. It is difficult to find a "pure play" on water equities. GE is a market leader in the field, but the sector makes up just 2pc of its colossal turnover. The revenue share of the world's top water companies that comes from the sector is Veolia (34pc), Suez (16pc), Ferrovial (20pc), Sabesp (100pc), Severn Trent (100pc), RWE (23pc), ITT Corp (32pc) and Pentair (75pc). Goldman Sachs said the best option is to spread investments across a basket of small "potential takeout candidates" such as Badger Meter, Calgon Carbon, Clarcor, Pentair, Pall, Instituform, Hyflux, Tetra Tech, Acqua America and Watts Water. Stanford professor Donald Kennedy said global climate change was now setting off a self-feeding spiral. "We've got droughts combined with a psychotic excess of rainfall," he said. "There are 800m people in the world who are 'food insecure'. They can't grow enough food, or can't afford to buy it. This is a seismic shift in the global economy."

**Water shortages lead to water wars.**

**UN 7**

[United Nations, quotes statement from Secretary General Ban Ki-moon, “Secretary-General calls for solution to water crisis”; 12/3/2007; <http://www.un.org/apps/news/story.asp?NewsID=24885&Cr=water&Cr1>; Boyce]

3 December 2007 – United Nations Secretary-General Ban Ki-moon today called for solutions to urgent water problems which threaten to roll back economic and social gains. “Throughout the world, water resources continue to be spoiled, wasted and degraded,” Mr. Ban said in a video address to the first-ever Asia-Pacific Water Summit being held in Beppu, on the southern Japanese island of Kyushu. The water situation in the Asia-Pacific region is especially worrisome, he said, due to high population growth, unsustainable consumption, pollution and poor management of clean water sources. Climate change – manifested in receding glaciers, worsening floods and increasingly severe droughts – is exacerbating the problem, but “despite these warning signs, water care remains an underserved and underappreciated field,” Mr. Ban observed. “The consequences for humanity are grave,” he cautioned. Water scarcity undercuts environmental sustainability, impedes efforts to reach the Millennium Development Goals (MDGs) – eight targets to slash poverty, hunger and other ills by 2015 – and could set off wars and conflict, the Secretary-General said. Solving the crucial problem promises tremendous gains, he noted, as up to $34 can be saved on health, education and social and economic development for every dollar spent. “Of course, the benefits of clean water cannot be measured in dollars and cents alone,” he said. “There is no price tag on transforming lives, or on giving every child a real chance for a healthy, productive future.” The two-day summit is expected to be attended by leaders of nearly 50 Asian-Pacific countries and regions, as well as by government representatives, members of the private sector, academic, civil society representatives and journalists.

# Water Wars Adv – Impact Ext

**Water shortages lead to a laundry list of impacts.**

**Vidal**, Environment Editor at The Guardian, talks of expert reports, **6**

[John Vidal, environment editor The Guardian; “Cost of water shortage: civil unrest, mass migration and economic collapse”; 8/17/2006; <http://www.guardian.co.uk/environment/2006/aug/17/water.internationalnews>; Boyce]

Cholera may return to London, the mass migration of Africans could cause civil unrest in Europe and China's economy could crash by 2015 as the supply of fresh water becomes critical to the global economy. That was the bleak assessment yesterday by forecasters from some of the world's leading corporate users of fresh water, 200 of the largest food, oil, water and chemical companies. Analysts working for Shell, Coca-Cola, Procter & Gamble, Cargill and other companies which depend heavily on secure water supplies, yesterday suggested the next 20 years would be critical as countries became richer, making heavier demands on scarce water supplies. In three future scenarios, the businesses foresee growing civil unrest, boom and bust economic cycles in Asia and mass migrations to Europe. But they also say scarcity will encourage the development of new water-saving technologies and better management of water by business. The study of future water availability, which the corporations have taken three years to compile, suggests water conflicts are likely to become common in many countries, according to the World Business Council on Sustainable Development, which brought the industrial groups together. Lloyd Timberlake, spokesman for the council, said: "The growing demand for water in China can potentially lead to over-exploitation and a decline in availability for domestic, agricultural, industry and energy production use. This inevitably leads to loss of production, both industrial and agricultural, and can also affect public health - all of which in turn will ultimately lead to an economic downturn. The question is how can business address these challenges and still make a profit." The corporations were yesterday joined by the conservation group WWF and the International Water Management Institute, the world's leading body on fresh water management, which said water scarcity was increasing faster than expected. In China, authorities had begun trucking in water to millions of people after wells and rivers ran dry in the east of the country. "Globally, water usage has increased by six times in the past 100 years and will double again by 2050, driven mainly by irrigation and demands of agriculture. Some countries have already run out of water to produce their own food. Without improvements ... the consequences will be even more widespread water scarcity and rapidly increasing water prices," said Frank Rijsberman, director of the institute. The institute, funded by government research organisations, will report next week that a third of the world's population, more than 2 billion people, is living in places where water is overused - leading to falling underground water levels and drying rivers - or cannot be accessed. Mr Rijsberman said rising living standards in India and China could lead to increased demand for better food, which would in turn need more water to produce. He expected the price of water to increase everywhere to meet an expected 50% increase in the amount of food the world will need in the next 20 years. According to the institute's assessment, Egypt imports more than half of its food because it does not have enough water to grow it domestically and Australia is faced with water scarcity in the Murray-Darling Basin as a result of diverting large quantities of water for use in agriculture. The Aral Sea in central Asia is another example of massive diversion of water for agriculture in the Soviet era causing widespread water scarcity, and one of the world's worst environmental disasters. Researchers say it is possible to reduce water scarcity, feed people and address poverty, but the key trade-off is with the environment. "People and their governments will face some tough decisions on how to allocate and manage water," says the institute's report. In a further paper, WWF said yesterday that water crises, long seen as a problem of only the poorest, are affecting the wealthiest nations. "In Europe, countries along the Atlantic are suffering recurring droughts, while water-intensive tourism and irrigated agriculture are endangering water resources in the Mediterranean. In Australia, salinity is a major threat to a large proportion of its key agricultural areas", said Jamie Pittock, director of WWF's freshwater programme. In the United States, Mr Pittock said, large areas are already using substantially more water than can be naturally replenished. "This situation will only be exacerbated as climate change is predicted to bring lower rainfall, increased evaporation and changed patterns of snow melting." Three visions of the future 1. Misery and shortages in the megacities and drought in Africa By 2010, 22 megacities with populations larger than 10 million face major water and sewerage problems. The situation is gravest in China, where 550 of the country's 600 largest cities are running short. Growing demand for water by industry leads to serious over-exploitaion with less and less water available for consumers and farmers. This leads to a fall in Chinese food production, which in turn leads to more imports and impacts on other countries. Friction and unrest grow worldwide as the middle classes struggle to pay bills. Businesses are exposed to charges of moral culpability and litigation over water use. Waves of immigrants flood in to Europe from increasingly drought-torn Africa 2. China leads recycling rush as world moves to a new hydro economy By 2010, the water shortage in many developing countries is recognised as one of the most serious political and social issues of the time. Lack of water is stopping development and in many countries the rural poor suffer as their water and other needs take second place to those of swelling cities and industry. Local government worldwide is increasingly distrusted over water allocation, and historical divides between rich and poor are exacerbated by water shortages. However, by 2025 a worldwide hydro economy is developing, led by China. Vast new investments are made in recycling water and the cost of desalination is greatly reduced. Innovative small-scale water treatment processes become the norm 3. Water is the means of social control as floods and disease devastate world Water becomes a key symbol of protest around the world and is seen as the most serious social and political issue of the generation. By 2015, multinational companies are accused regularly of taking too much water in developing countries, cholera breaks out in London, and governments start to use water as a form of social control, subsidising some sectors and rationing it to others. Great floods follow each other in quick succession. Deforestation leads to massive mudslides in Asia and increasing flooding affects Europe, damaging industry. A second New Orleans flood destroys the city again. Global focus grows on the "export" of water via crops such as wheat or fruit

**Short timeframe for water shortages-2030**

**Arsenault,** Reporter for Al Jazeera, **6/29**/2011 [“Water wars: 21st century conflicts?”, June 29th, 2011, http://english.aljazeera.net/indepth/features/2011/06/2011622193147231653.html]

After droughts ravaged his parents' farmland, Sixteen-year-old Hassain and his two-year-old sister Sareye became some of the newest refugees forced from home by water scarcity. "There was nothing to harvest," Hassain said through an interpreter during an interview at a refugee camp in Dadaab, Kenya which is housing some 160,000 Somalis displaced by a lack of water. "There had been no rain in my village for two years. We used to have crops." As global warming alters weather patterns, and the number of people lacking access to water rises, millions, if not billions, of others are expected to face a similar fate as water shortages become more frequent. Presently, Hassain is one of about 1.2 billion people living in areas of physical water scarcity, although the majority of cases are nowhere near as dire. By 2030, 47 per cent of the world’s population will be living in areas of high water stress, according to the Organisation for Economic Co-operation and Development's Environmental Outlook to 2030 report. Some analysts worry that wars of the future will be fought over blue gold, as thirsty people, opportunistic politicians and powerful corporations battle for dwindling resources. Dangerous warnings Governments and military planners around the world are aware of the impending problem; with the US senate issuing reports with names like Avoiding Water Wars: Water Scarcity and Central Asia’s growing Importance for Stability in Afghanistan and Pakistan. With rapid population growth, and increased industrial demand, water withdrawls have tripled over the last 50 years, according to UN figures."The war was also a reason why we left," Hassain said. "There was a lot of fighting near my village." "Water scarcity is an issue exacerbated by demographic pressures, climate change and pollution," said Ignacio Saiz, director of Centre for Economic and Social Rights, a social justice group. "The world's water supplies should guarantee every member of the population to cover their personal and domestic needs." "Fundamentally, these are issues of poverty and inequality, man-made problems," he told Al Jazeera. Of all the water on earth, 97 per cent is salt water and the remaining three per cent is fresh, with less than one per cent of the planet's drinkable water readily accessible for direct human uses. Scarcity is defined as each person in an area having access to less than 1,000 cubic meters of water a year. The areas where water scarcity is the biggest problem are some of the same places where political conflicts are rife, leading to potentially explosive situations. Some experts believe the only documented case of a "water war" happened about 4,500 years ago, when the city-states of Lagash and Umma went to war in the Tigris-Euphrates basin. But Adel Darwish, a journalist and co-author of Water Wars: Coming Conflicts in the Middle East, says modern history has already seen at least two water wars. "I have [former Israeli prime minister] Ariel Sharon speaking on record saying the reason for going to war [against Arab armies] in 1967 was for water," Darwish told Al Jazeera. Some analysts believe Israel continues to occupy the Golan heights, seized from Syria in 1967, due to issues of water control, while others think the occupation is about maintaining high ground in case of future conflicts. Senegal and Mauritania also fought a war starting in 1989 over grazing rights on the River Senegal. And Syria and Iraq have fought minor skirmishes over the Euphrates River. Middle East hit hard UN studies project that 30 nations will be water scarce in 2025, up from 20 in 1990. Eighteen of them are in the Middle East and North Africa, including Egypt, Israel, Somalia, Libya and Yemen. Darwish bets that a battle between south and north Yemen will probably be the scene of the next water conflict, with other countries in the region following suit if the situation is not improved. Yemen's capital Sanaa, from where president Ali Saleh left the country after he was injured during protests, could effectively run out of water by 2025, hydrology experts say. Water shortages could cost the unstable country 750,000 jobs, slashing incomes in the poorest Arab country by as much as 25 per cent over the next decade, according to a report from the consulting firm McKinsey and Company produced for the Yemeni government in 2010. Living in one of the driest countries on earth, Yemenis depend on fresh water from rapidly depleting underground aquifers and infrequent rainfall. "We expect many of the private wells to dry up soon," Yemen's then minister for water resources Abdul Rahman Fadhl Iryani, told The Los Angeles Times newspaper in 2009. "After that, we will have to find a new source, or keep drilling deeper." It is a story being repeated with various degrees of severity across the Middle East, parts of Asia and even the American south-west. Iryani recently resigned his post to protest president Saleh’s crackdown on protesters. Commentators frequently blame Yemen's problems on tribal differences, but environmental scarcity may be underpinning secessionist struggles in the country's south and some general communal violence. "My experience in the first gulf war [when Iraq invaded Kuwait] is that natural resources are always at the heart of tribal conflicts," Darwish told Al Jazeera. "The world Sharia [Islamic law] has its linguistic origins in 'water from a well'." The Nile is another potential flash point. In 1989, former Egyptian president Hosni Mubarak threatened to send demolition squads to a dam project in Ethiopia. The current tenuous political situation in Egypt means that "if the army wants to divert attention away from criticism it would probably do something against Ethiopia," Darwish said. "The Egyptian army still has jungle warfare brigades, even though they have no jungle." On the Nile, cooperation would benefit all countries involved, as they could jointly construct dams and lower the amount of water lost to evaporation, says Anton Earle, director of the Stockholm International Water Institute think tank. "If you had an agreement between the parties, there would be more water in the system," he told Al Jazeera. The likelihood of outright war is low, he says, but there is still "a lot of conflict" which "prevents joint infrastructure projects from going ahead".

**Water shortages destroys human rights-**

**Arsenault,** Reporter for Al Jazeera, **6/29**/2011 [“Water wars: 21st century conflicts?”, June 29th, 2011, http://english.aljazeera.net/indepth/features/2011/06/2011622193147231653.html]

Strife over water, like conflicts more generally, will increasingly happen within states, rather than between them, Barlow says, with large scale agribusiness, mining and energy production taking control over resources at the expense of other users. Back in the Kenyan refugee camp, on the front line of the world’s water crisis, Hassain hopes to start a new life, away from the parched fields, dead cattle and social violence ruining communities in his native Somalia. "I have never been to school," he said. "I want to go now that I am here." Dealing with water refugees like Hassain is a global challenge, and it is expected to get worse. The IPPC, the UN panel which analyses climate science, concluded that: "Water and its availability and quality will be the main pressures on and issues for, societies and the environment under climate change." Dealing with these pressures will require improved technologies, political will and new ideas about how humans view their relationship with the substance that sustains life. "A human rights approach to water, for Hassain, means he doesn't have to accept his fate as some inevitable tragedy," said Ignacio Saiz. "People have the right to expect access to a basic life resource like water by virtue of being human, regardless of the social situation they are born into. Alongside the worrying development of water scarcity, I am hopeful that we will see increasing struggles to see access to water as a right, and not a priviledge."

# Water Wars Adv – Solvency Ext

**SPS solves water shortages- desalinization (The card also talks about how SPS energy spills over to create electric cars)**

**Nansen, 95 -** led the Boeing team of engineers in the Satellite Power System Concept Development and Evaluation Program for the Department of Energy and NASA, and President Solar Space Industries (Ralph, Sun Power, <http://www.nss.org/settlement/ssp/sunpower/sunpower09.html>, MA)

The real potential, however, is the ability to add generating capacity as the demands for energy grow. After meeting new energy requirements we could start replacing the existing fossil fuel plants and obsolete nuclear plants. A large percentage of the current power plants in the country are wearing out, and maintenance costs are accelerating as they reach the end of their useful life. They could be replaced with solar power satellites, thus eliminating the demand for fossil fuels as our major energy source and starting the process to clean up our atmosphere. Once this is done, a more natural growth can occur. With the availability of ample low-cost electricity, the move could be made to replace a large share of the transportation requirements with electric power vehicles as well. With abundant, low-cost, pollution-free electricity, we would be able to build giant desalinization plants to make fresh water from the sea and eliminate water shortages in much of our nation and the world. In other areas, far from the sea, we could use the energy to recycle waste water to high purity and use it over and over again to supplement nature’s cycle.

# Leadership Internal Link

**Declining aerospace leadership directly facilitates the emergence of hostile global rivals**

**Snead, 07** - Aerospace engineer and consultant focusing on Near-future space infrastructure development (Mike, “How America Can and Why America Must Now Become a True Spacefaring Nation,” Spacefaring America Blog, 6/3, http://spacefaringamerica.net/2007/06/03/6--why-the-next-president-should-start-america-on-the-path-to-becoming-a-true-spacefaring-nation.aspx) Herm

Great power status is achieved through competition between nations. This competition is often based on advancing science and technology and applying these advancements to enabling new operational capabilities. A great power that succeeds in this competition adds to its power while a great power that does not compete or does so ineffectivelyU or by choice, Ubecomes comparatively less powerfulU. Eventually, it loses the great power status and then must align itself with another great power for protection. UAs the pace of science and technology advancement has increased, so has the potential for the pace of change of great power statusU. While the U.S. "invented" powered flight in 1903, a decade later leadership in this area had shifted to Europe. Within a little more than a decade after the Wright Brothers' first flights, the great powers of Europe were introducing aeronautics into major land warfare through the creation of air forces. When the U.S. entered the war in 1917, it was forced to rely on French-built aircraft. Twenty years later, as the European great powers were on the verge of beginning another major European war, the U.S. found itself in a similar situation where its choice to diminish national investment in aeronautics during the 1920's and 1930's—you may recall that this was the era of General Billy Mitchell and his famous efforts to promote military air power—placed U.S. air forces at a significant disadvantage compared to those of Germany and Japan. This was crucial because military air power was quickly emerging as the "game changer" for conventional warfare. Land and sea forces increasingly needed capable air forces to survive and generally needed air superiority to prevail. UWith the great power advantages of becoming spacefaring expected to be comparable to those derived from becoming air-faring in the 1920's and 1930's, a delay by the U.S. in enhancing its great power strengths through expanded national space power may result in a reoccurrence of the rapid emergence of new or the rapid growth of current great powers to the point that they are capable of effectively challenging the U.S. UMany great powers—China, India, and Russia—are already speaking of plans for developing spacefaring capabilities.U Yet, today, Uthe U.S. retains a commanding aerospace technological lead over these nations. A strong effort by the U.S. to become a true spacefaring nationU, starting in 2009 with the new presidential administration, Umay yield a generation or longer lead in spaceU, not just through prudent increases in military strength but also through the other areas of great power competition discussed above. This is an advantage that the next presidential administration should exercise.

**SPS increases leadership- demonstrates democracy and freedom**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

Yes, several very important ones. U.S. manufacturing and technology companies are concerned about being able to hire enough capable employees to replace the experienced workforce, a large percentage of which will be elgible to retire within the next ten years. Our domestic “intellectual feedstock” is very low, which is one of many reasons we haven’t built any new nuclear facilities in the last twenty-five years. Like the Apollo and other U.S. space programs did so many years ago, space-based solar power will inspire new generations of U.S. science and technology graduates. The U.S. domestic manufacturing base is badly eroded, and while some economists say that we are moving towards a service-based economy, common sense tells me that we should regain our independence and self-sufficiency in many areas necessary to support our society. Now that what seems like the majority of our clothing, computers, cars, oil, toys and electronics are imported, space-based solar power will support the development of new domestic manufacturing industries. We will also benefit from spin-offs similar to the original space program (microelectronics, internet, velcro, Tang, etc.) Better earth-based solar power efficiences will be gained. Low cost and reliable access to space will support many new industries. Perhaps a space tourism industry will be the forerunner of space colonization. Manufacturing in zero gravity and the hard vacuum of space will yield new materials and new products. Moon and asteroid based operations, such as the mining of natural resources from the Moon and asteroids will provide a platform for planetary protection from NEO (meteor / asteroid) strikes.The U.S. could become a major exporter of affordable energy and of energy and conservation technologies. But most importantly, the development of space-based solar power would demonstrate our nation’s belief in democracy and freedom for the entire human race. Space-based solar power gives the United States a great opportunity to regain a respected leadership role, not by force, but by example.

# Leadership Uniqueness

**US is falling behind in aerospace leadership**

**Kaufman, 08**  (Mark, “US Finds It’s Getting Crowded Out There: Dominance in Space Slips as Other Nations Step Up Efforts”, Washington Post, 7/9, <http://www.globalpolicy.org/empire/challenges/competitors/2008/0709space.htm>) Herm

Although the United States remains dominant in most space-related fields -- and owns half the military satellites currently orbiting Earth -- experts say the nation's superiority is diminishing, and many other nations are expanding their civilian and commercial space capabilities at a far faster pace. "We spent many tens of billions of dollars during the Apollo era to purchase a commanding lead in space over all nations on Earth," said NASA Administrator Michael D. Griffin, who said his agency's budget is down by 20 percent in inflation-adjusted terms since 1992. "We've been living off the fruit of that purchase for 40 years and have not . . . chosen to invest at a level that would preserve that commanding lead." In a recent in-depth study of international space competitiveness, the technology consulting firm Futron of Bethesda found that the globalizing of space is unfolding more broadly and quickly than most Americans realize. "Systemic and competitive forces threaten U.S. space leadership," company president Joseph Fuller Jr. concluded.

**U.S. aerospace leadership on the brink- Russia and China prove**

**Waller 1**, (J. Michael, “Militarizing Space” Insight on the News, Vol. 17, 3-19-01) // CCH

Russia is ahead of the United States on meeting the new challenge. On Jan. 25, the Kremlin created a new military service for space warfare. It did so by splitting the Strategic Rocket Forces, Russia's military service in charge of intercontinental ballistic missiles, pulling out its two main components responsible for military space activity: the Space Missile Force and the Rocket and Space Defense Forces. The former is in charge of Russian-military satellite programs, while the latter administers the space-based components of Moscow's early-warning system. The new service will assume the name of one of its components, the Space Missile Force. Less than three weeks later, on Feb. 13, a Chinese state-run information agency published a statement advocating preparation for space warfare. Official government propaganda warning of a "dangerous arms race in space" has been increasing in frequency and pitch in recent months, made more shrill by January war games at the U.S. Space Warfare Center in Colorado, which reportedly envisioned a conflict with China in the year 2017. Russia's ongoing economic crisis has curtailed the advanced military-space programs it inherited from the Soviet Union, but the Center for Security Policy roundtable on space power found that Moscow "remains among the world's most advanced and comprehensive counterspace capabilities, including the doctrine for its employment. They [the Russians] understand the idea." The People's Republic of China is aggressively pursuing a military space program and is acutely aware of the importance of space dominance. Beijing "could emerge over the next 15 years as a leading threat to U.S. space operations" according to a Center for Security Policy paper on threats to U.S. space access. "China is making an enormous investment in space-launch vehicles, satellites and manned space systems" the policy paper asserts. "Chinese military theorists have written a great deal about the U.S. use of space during the Gulf War, and China's air-force academy recently increased the number of courses offered in space war theory.... China understands space power and is rapidly developing both the infrastructure and wherewithal to challenge America's current space-information dominance." Beijing is building a global ground-based space-tracking network, with new facilities in its sphere of influence and on the island of Tarawa in the South Pacific and in Namibia, as well as aboard China's growing naval fleet and its massive merchant marine. One of China's newest space weapons is a microsatellite, which Beijing calls a "parasite satellite" designed to attach itself to target satellites like a limpet and to damage or disable the target satellite on command. The United States has deployed no defenses against them. While the Russians, Chinese and others have forged ahead with space-based weapons, the Clinton/Gore administration deliberately sought to deny the United States access to that high military frontier. Clinton line-item vetoed congressionally mandated funding for the military space plane, a low-cost craft that could launch and reach anywhere on the planet in 45 minutes or less; for the KE-ASAT; and for the Clementine, a lunar-exploration probe that doubled as a component of a missile-defense system. China gets the bulk of its technology from Russia -- and its financing from the West. `An emerging dimension of China's ability to militarize space and challenge our assets there is that of finance or the funding side," says Roger Robinson, a key National Security Council official in the Reagan administration who is chairman of the William J. Casey Institute at the Center for Security Policy. "We have been looking at China in this regard -- that is, the national-security dimensions of their use of our capital markets and our bond markets over the past four years, in what we call a capital-markets transparency initiative, and have come up with some troubling findings. There are firms, state-owned firms, in particular, that are very close to the Chinese PLA [People's Liberation Army], as well as their military-intelligence capability, that are attracting hundreds of millions of dollars in our markets" (see "China Cashes In" Feb. 24, 2000).

**Our space leadership is at an all-time low – other countries are getting their game on**

**Kaufman, 08** (Mark, “US Finds It’s Getting Crowded Out There: Dominance in Space Slips as Other Nations Step Up Efforts”, Washington Post, 7/9, http://www.globalpolicy.org/empire/challenges/competitors/2008/0709space.htm)

Although the United States remains dominant in most space-related fields -- and owns half the military satellites currently orbiting Earth -- experts say **the nation's superiority is diminishing,** and many other nations are expanding their civilian and commercial space capabilities at a far faster pace. "We spent many tens of billions of dollars during the Apollo era to purchase a commanding lead in space over all nations on Earth," said NASA Administrator Michael D. Griffin, who said his agency's budget is down by 20 percent in inflation-adjusted terms since 1992. "We've been living off the fruit of that purchase for 40 years and have not . . . chosen to invest at a level that would preserve that commanding lead." In a recent in-depth study of international space competitiveness, the technology consulting firm Futron of Bethesda found that the globalizing of space is unfolding more broadly and quickly than most Americans realize. "Systemic and competitive forces threaten U.S. space leadership," company president Joseph Fuller Jr. concluded. Six separate nations and the European Space Agency are now capable of sending sophisticated satellites and spacecraft into orbit -- and more are on the way. New rockets, satellites and spacecraft are being planned to carry Chinese, Russian, European and Indian astronauts to the moon, to turn Israel into a center for launching minuscule "nanosatellites," and to allow Japan and the Europeans to explore the solar system and beyond with unmanned probes as sophisticated as NASA's. While the United States has been making incremental progress in space, its global rivals have been taking the giant steps that once defined NASA: . Following China's lead, India has announced ambitious plans for a manned space program, and in November the European Union will probably approve a proposal to collaborate on a manned space effort with Russia. Russia will soon launch rockets from a base in South America under an agreement with the European company Arianespace, whose main launch facility is in Kourou, French Guiana. . Japan and China both have satellites circling the moon, and India and Russia are also working on lunar orbiters. NASA will launch a lunar reconnaissance mission this year, but many analysts believe the Chinese will be the first to return astronauts to the moon. The United States is largely out of the business of launching satellites for other nations, something the Russians, Indians, Chinese and Arianespace do regularly. Their clients include Nigeria, Singapore, Brazil, Israel and others. The 17-nation European Space Agency (ESA) and China are also cooperating on commercial ventures, including a rival to the U.S. space-based Global Positioning System. . South Korea, Taiwan and Brazil have plans to quickly develop their space programs and possibly become low-cost satellite launchers. South Korea and Brazil are both developing homegrown rocket and satellite-making capacities. This explosion in international space capabilities is recent, largely taking place since the turn of the century. While the origins of Indian, Chinese, Japanese, Israeli and European space efforts go back several decades, their capability to pull off highly technical feats -- sending humans into orbit, circling Mars and the moon with unmanned spacecraft, landing on an asteroid and visiting a comet -- are all new developments.

# Leadership Turns DA’s

**Loss of space leadership turns their impacts.**

**Dolman, 5**—Professor of Comparative Military Studies at the US Air Force’s School of Advanced Air and Space Studies

(Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, http://www.e-parl.net/pages/space\_hearing\_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf)

No nation relies on space more than the United States—none is even close—and its reliance grows daily. For both its civilian welfare and military security, **a widespread loss of space capabilities would prove disastrous.** America’s economy, and along with it the world’s, would collapse. Its military would be obliged to hunker down in defensive crouch while it prepared to withdraw from dozens of then-untenable foreign deployments. For the good of its civilian population, and for itself, the United States military—in particular the United States Air Force—is charged with protecting space capabilities from harm and ensuring reliable space operations for the foreseeable future. As a martial organization, the Air Force naturally looks to military means in achievement of its assigned ends. And so it should.

**Adversaries to American dominance will be aggressive in space**

**The Economist, 08**(“Disharmony in the spheres - The militarisation of space”, 1/19, lexis)

The Taliban or al-Qaeda can do little about America's space power except hide themselves from its intelligence-gathering satellites. But the Pentagon worries about what would happen if America came up against a major power, a “near-peer” rival (as it calls China and Russia), able to intercept space assets with missiles and “space mines”, or to disable them with lasers and electronic jammers. “There are a lot of vulnerabilities,” admits an American general, “There are backups, but our space architecture is very fragile.” The precise nature of these weaknesses is a well-guarded secret. But wargames simulating a future conflict over Taiwan often end up with the “Red Force” (China) either defeating the “Blue Force” (America) or inflicting grievous losses on it by launching an early attack in space, perhaps by setting off one or more nuclear explosions above the atmosphere. “I have played Red and had a wonderful time,” says the general, “It is pretty easy to disrupt Blue. We should not expect an enemy to play by established norms in space. They will play dirty pool.”

**Leadership solves Space Debris**

Kirk **Woellert 09,** Navy Intelligence Officer with space system experience. Graduate of Space Policy Institute, George Washingtion University. “Space Debris: Why the U.S. cannot go it alone” [http://www.thespacereview.com/article/1373/1]

Conclusion Space debris concerns all spacefaring nations and should be addressed as an international issue utilizing a multilateral approach. International cooperation takes significant time to build consensus and on occasion has led to ineffectual results. Nevertheless, the US can best protect its interests in space not by unilateral action but **by using its influence and leadership to establish an effective international response to mitigating—and perhaps one day eliminating—the hazard of space debris.**

# Leadership – Aerospace Update

**Plan reinvigorates the industry - Aerospace workforce key to competitiveness**

**Muellner, 7** – American Institute of Aeronautics and Astronautics (George K, “A New Year’s Resolution for 2008,” Aerospace America, 12-07, Herm)

For the past several years, the long-term viability of the aerospace workforce in the United States has been a major concern. An aging workforce coupled with predictions of a looming shortfall of skilled professionals threatens the vitality of the aerospace industry and makes it difficult to maintain our competitiveness and technological edge in the world. A journalist described the problem as the “Crisis in Aerospace.” Congress responded to these issues by passing HR 758 in October 2005. This bill created a federal inter-agency task force on Aerospace Workforce Revitalization. Recently, the challenge of developing and sustaining a world-class aeronautics workforce became a specific principle of the National Aeronautics Research and Development Policy endorsed by Executive Order in December 2006. Revitalization of the aerospace workforce is a complex valuestream that starts with focus on Science, Technology, Engineering and Mathematics (STEM) education, continues into college and graduate programs, and includes the education, training, and experience our professionals get when they enter the workforce. Maintaining our world-class aerospace workforce is a challenge that requires integrated actions at all steps in this process. Both inspiration and leadership are required to maintain the quality and quantity of aerospace professionals, and AIAA has a major role to play in this process. We represent today’s aerospace workforce and can, and should, assume a leadership role in insuring its vitality into the future. Events like “Education Alley” at the recent AIAA 2007 Space Conference & Exposition attracted many potential aerospace professionals, got them excited about what we do, and allowed many of you to dazzle them with your war stories. Your stories on connecting the world through advances in commercial aviation, providing for the National Security through military aircraft and space systems, and placing men on the moon and robots on Mars inspired another generation of aerospace professionals.

**Aerospace industry key to economy – jobs and GDP**

**Herrnstadt, 8** -- Associate General Council of International Associations of Machinists and Aerospace Workers; Director of International Policy (Owen E., “Offsets and the lack of a Comprehensive U.S. Policy,” Economic Policy Insitute Briefing Paper #201, 04-14-08, <http://www.sharedprosperity.org/bp201.html>) // Herm

Aerospace is an especially important industry for a nation's economic and physical security, and perhaps no other country has benefited more from the aerospace industry than the United States.9 The Final Report of the Commission on the Future of the United States Aerospace Industry states that the industry "contributes over 15 percent to our Gross Domestic Product and supports over 15 million high quality American jobs" (Aerospace Industry Commission 2002, 1-2). U.S. aerospace has been identified as a major source of "technical innovation with substantial spillovers to other industrial and commercial sectors" and "high-wage employment, which spreads the benefits of rising productivity throughout the U.S. economy.…" The Aerospace Commission also noted the industry's contribution to the nation's "economic growth, quality of life, and scientific achievements…." (Aerospace Industry Commission 2002, 1-2). Despite the importance of aerospace, the deterioration of the industry at home has continued at a dramatic rate. Nearly 500,000 jobs have been lost in the U.S. aerospace industry since 1990 (Aerospace Industry Commission 2002, 8-12; see also AIA 2007), and several hundred thousand more workers have lost their jobs in related industries. Sadly, the fact of these enormous job losses comes as no surprise. More than 10 years ago, in *Jobs on the Wing*, authors Randy Barber and Robert Scott predicted that "up to 469,000" jobs in the aerospace and related industries "could be eliminated by 2013 because of offset policies and increased foreign competition" (Barber and Scott 1995, 2). In a later study, Scott predicted that by 2013 the industry would suffer a loss of over 25% "of the total jobs in aircraft production in 1995" (Scott 1998). These gloomy predictions are apparently reinforced by U.S. government reports. According to the Department of Labor, the outlook for employment in the U.S. aerospace industry is not rosy: between 2002 and 2012 aerospace employment in the United States will "decrease by 18 percent" (U.S. Department of Labor 2004). The future health of the industry depends in large part on its ability to attract new workers, but the crisis in employment and the prediction that the crisis will deepen does not bode well for attracting new workers. In its final report, the Aerospace Commission summarized this concern: The U.S. aerospace sector, once the employer of choice for the "best and brightest" technically trained workers, now finds it presents a negative image to potential employees. Surveys indicate a feeling of disillusionment about the aerospace industry among its personnel, whether they are production/technical workers, scientists or engineers. The majority of newly dislocated workers say they will not return to aerospace. In a recent survey of nearly 500 U.S. aerospace engineers, managers, production workers, and technical specialists, 80 percent of respondents said they would not recommend aerospace careers to their children. (Aerospace Industries Commission 2002, 8-5) While the Aerospace Commission found that "U.S. policy toward domestic aerospace employment must reaffirm the goal of stabilizing and increasing the number of good and decent jobs in the industry," this policy has yet to be embraced, let alone implemented (Aerospace Industries Commission 2002, 8-12).

**Aerospace competitiveness key to the economy**

**Augustine, 5** – retired chairmen and CEO of Lockheed Martin Corp., charied National Academics Committee on Prospering in the Global Economy of the 21st Century (Norman R., Aviation Week and Space Technology, “US Science and Technology is on a Losing Path” Pg. 70 Vo. 163 No. 17 10-31-05, LN) // Herm

This transition to a borderless economy provides great opportunities for companies that are prepared to take advantage, as the history of the aerospace industry amply demonstrates. But in any dynamic, technology-intensive industry, leadership can be lost very quickly. Thus, many other industries are now joining the aerospace industry in learning to compete in an uncertain and quickly changing world. Today, candidates for many jobs that currently reside in the US are just a mouse click away in Ireland, India, China, Australia and dozens of other countries. At first, manufacturing jobs were the ones most susceptible to moving overseas. I recently traveled to Vietnam, where the hourly cost of low-skilled workers is about 25 cents, less than 1/20th of the US minimum wage. But the competitive disadvantage is not confined to so-called low-end jobs. Eleven qualified engineers can be hired in India for the cost of just one in the US. At the same time, other countries are rapidly enlarging their innovation capacity. They are investing in S&T and encouraging their highly trained citizens who are working abroad to return home. Even more important, these countries are creating the well-funded schools and universities that will produce future scientists and engineers. The US is not competing well in this new world. Other nations will continue to have the advantage of lower wages, so America must take advantage of its strengths. But those strengths are eroding even as other countries are boosting their capacities. Throughout the 20th century, one of America's greatest strengths has been its knowledge-based resources – particularly its S&T system. But today, that system shows many signs of weakness. This nation's trade balance in high-technology goods swung from a positive flow of $33B in 1990 to a negative flow of $24B in 2004. In 2003, foreign students earned 59% of the engineering doctorates awarded by US universities. In 2001, US industry spent more on tort litigation and related costs than on R&D. A major factor determining US competitiveness is the quality of the workforce, and the public school system provides the foundation of this asset. But that system is failing specifically in the fields most important to the future: science, engineering and mathematics. In a recent international test involving mathematical understanding, US students finished 27th among the participating nations. In China and Japan, 59% and 66% of undergraduates, respectively, receive their degrees in science and engineering, compared with 32% in the U.S. In the past, the US economy benefited from the availability of financial capital. But today it moves quickly to wherever a competitive advantage exists, as shown by the willingness of companies to move factories to Mexico, Vietnam and China. One of America's most powerful assets is its free enterprise system, with its inherent aggressiveness and discipline in introducing ideas and flushing out obsolescence. But other nations have recognized these virtues and are seeking to emulate the system. The aerospace industry is especially susceptible to these broader economic trends. Without well-educated scientists and engineers, the industry will not be able to compete with well-organized programs in countries with abundant engineering talent. In addition, security issues in the industry highlight its reliance on homegrown talent, as opposed to importing its people from abroad. Troubles in the aerospace industry also could have implications throughout the US economy. In particular, the industry has been especially effective at making use of and producing systems engineers, some of whom eventually move to other industries. If aerospace were to decline, a considerable portion of these valuable individuals would be lost.

# Warming – Ocean Acidification Impact

**Ocean acidification is anthropogenic and risks extinction**

Scott C. **Doney et al** 1Marine Chemistry and Geochemistry,Woods Hole Oceanographic Institution **08** Annual Review of Marine Science, “Ocean Acidification: The Other CO2 Problem” August 29, 2008 <http://fcm.ens.uabc.mx/~hbustos/TS%20OCQ/Ocean%20acidif%20Doney.pdf> Herm

Over the past 250 years, atmospheric carbon dioxide (CO2) levels increased by nearly 40%, from preindustrial levels of approximately 280 ppmv (parts per million volume) to nearly 384 ppmv in 2007 (Solomon et al. 2007). This rate of increase, driven by human fossil fuel combustion and deforestation, is at least an order of magnitude faster than has occurred for millions of years (Doney & Schimel 2007), and the current concentration is higher than experienced on Earth for at least the past 800,000 years (L ¨ uthi et al. 2008). Rising atmospheric CO2 is tempered by oceanic uptake, which accounts for nearly a third of anthropogenic carbon added to the atmosphere (Sabine & Feely 2007, Sabine et al. 2004), and without which atmospheric CO2 would be approximately 450 ppmv today, a level of CO2 that would have led to even greater climate change than witnessed today. Ocean CO2 uptake, however, is not benign; it causes pH reductions and alterations in fundamental chemical balances that together are commonly referred to as ocean acidification. Because climate change and ocean acidification are both caused by increasing atmospheric CO2, acidification is commonly referred to as the “otherCO2 problem” (Henderson 2006,Turley 2005). Ocean acidification is a predictable consequence of rising atmospheric CO2 and does not suffer from uncertainties associated with climate change forecasts. Absorption of anthropogenic CO2, reduced pH, and lower calcium carbonate (CaCO3) saturation in surface waters, where the bulk of oceanic production occurs, are well verified from models, hydrographic surveys, and time series data (Caldeira & Wickett 2003, 2005; Feely et al. 2004, 2008; Orr et al. 2005; Solomon et al. 2007). At the Hawaii Ocean Time-Series (HOT) station ALOHA the growth rates of surface water pCO2 and atmospheric CO2 agree well (Takahashi et al. 2006) (**Figure 1**), indicating uptake of anthropogenic CO2 as the major cause for long-term increases in dissolved inorganic carbon (DIC) and decreases in CaCO3 saturation state. Correspondingly, since the 1980s average pH measurements atHOT, the Bermuda AtlanticTime-Series Study, and European Station forTimeSeries in the Ocean in the eastern Atlantic have decreased approximately 0.02 units per decade (Solomon et al. 2007). Since preindustrial times, the average ocean surface water pH has fallen by approximately 0.1 units, from approximately 8.21 to 8.10 (Royal Society 2005), and is expected to decrease a further 0.3–0.4 pH units (Orr et al. 2005) if atmospheric CO2 concentrations reach 800 ppmv [the projected end-of-century concentration according to the Intergovernmental Panel on Climate Change (IPCC) business-as-usual emission scenario]. Fossil fuel combustion and agriculture also produce increased atmospheric inputs of dissociation products of strong acids (HNO3 and H2SO4) and bases (NH3) to the coastal and open ocean. These inputs are particularly important close to major source regions, primarily in the northern hemisphere, and cause decreases in surface seawater alkalinity, pH, and DIC (Doney et al. 2007). On a global scale, these anthropogenic inputs (0.8 Tmol/yr reactive sulfur and 2.7 Tmol/yr reactive nitrogen) contribute only a small fraction of the acidification caused by anthropogenic CO2, but they are more concentrated in coastal waters where the ecosystem responses to ocean acidification could be more serious for humankind.

**CO2 emissions risks extinction of marine species- we are on the brink**

**Reuters 6/21/**2011 [“Ocean life on the brink of mass extinctions: study”, June 21st, 2011, <http://www.reuters.com/article/2011/06/21/us-oceans-idUSTRE75K1IY20110621>, MA]

Life in the oceans is at imminent risk of the worst spate of extinctions in millions of years due to threats such as climate change and over-fishing, a study showed on Tuesday. Time was running short to counter hazards such as a collapse of coral reefs or a spread of low-oxygen "dead zones," according to the study led by the International Programme on the State of the Ocean (IPSO). "We now face losing marine species and entire marine ecosystems, such as coral reefs, within a single generation," according to the study by 27 experts to be presented to the United Nations. "Unless action is taken now, the consequences of our activities are at a high risk of causing, through the combined effects of climate change, over-exploitation, pollution and habitat loss, the next globally significant extinction event in the ocean," it said. Scientists list five mass extinctions over 600 million years -- most recently when the dinosaurs vanished 65 million years ago, apparently after an asteroid struck. Among others, the Permian period abruptly ended 250 million years ago. "The findings are shocking," Alex Rogers, scientific director of IPSO, wrote of the conclusions from a 2011 workshop of ocean experts staged by IPSO and the International Union for Conservation of Nature (IUCN) at Oxford University. Fish are the main source of protein for a fifth of the world's population and the seas cycle oxygen and help absorb carbon dioxide, the main greenhouse gas from human activities. OXYGEN Jelle Bijma, of the Alfred Wegener Institute, said the seas faced a "deadly trio" of threats of higher temperatures, acidification and lack of oxygen, known as anoxia, that had featured in several past mass extinctions. A build-up of carbon dioxide, blamed by the U.N. panel of climate scientists on human use of fossil fuels, is heating the planet. Absorbed into the oceans, it causes acidification, while run-off of fertilizers and pollution stokes anoxia. "From a geological point of view, mass extinctions happen overnight, but on human timescales we may not realize that we are in the middle of such an event," Bijma wrote.

**Action key – Ocean acidification exponential**

**The Royal Society 2005** “Ocean acidification due to increasing atmospheric carbon dioxide” June 2005 [www.royalsoc.ac.uk](http://www.royalsoc.ac.uk) Herm

Organisms will continue to live in the oceans wherever nutrients and light are available, even under conditions arising from ocean acidification. However, from the data available, it is not known if organisms at the various levels in the food web will be able to adapt or if one species will replace another. It is also not possible to predict what impacts this will have on the community structure and ultimately if it will affect the services that the ecosystems provide. Without significant action to reduce CO2 emissions into the atmosphere, this may mean that there will be no place in the future oceans for many of the species and ecosystems that we know today. This is especially likely for some calcifying organisms.

**We must act now – acidification is increasing more each year**

**Guinotte**, J. M. **and Fabry**, V. J. (**2008**),[ Marine Conservation Biology Institute, Bellevue, Washington, California State University] Ocean Acidification and Its Potential Effects on Marine Ecosystems. Annals of the New York Academy of Sciences, 1134: 320–342. <http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/pdf> Herm

The carbonate system (pCO2, pH, alkalinity, and calcium carbonate saturation state) of the world oceans is changing rapidly due to an influx of anthropogenic CO2 ([Skirrow & Whitfield 1975](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b142); [Whitfield 1975](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b152); [Broecker & Takahashi 1977](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b22); [Broecker et al. 1979](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b20); [Feely & Chen 1982](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b43); [Feely et al. 1984](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b46); [Kleypas et al. 1999a](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b77); [Caldeira & Wickett 2003](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b28); [Feely et al. 2004](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b45); [Orr et al. 2005](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b113)). Ocean acidification may be defined as the change in ocean chemistry driven by the oceanic uptake of chemical inputs to the atmosphere, including carbon, nitrogen, and sulfur compounds. Today, the overwhelming cause of ocean acidification is anthropogenic atmospheric CO2, although in some coastal regions, nitrogen and sulfur are also important ([Doney et al. 2007](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b37)). For the past 200 years, the rapid increase in anthropogenic atmospheric CO2, which directly leads to decreasing ocean pH through air–sea gas exchange, has been and continues to be caused by the burning of fossil fuels, deforestation, industrialization, cement production, and other land-use changes. The current rate at which ocean acidification is occurring will likely have profound biological consequences for ocean ecosystems within the coming decades and centuries. Presently, atmospheric CO2 concentration is approximately 383 parts per million by volume (ppmv), a level not seen in at least 650,000 years, and it is projected to increase by 0.5% per year throughout the 21st century ([Petit et al. 1999](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b117); [Houghton et al. 2001](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b67); [Augustin et al. 2004](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b4); [Siegenthaler et al. 2005](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b141); [Meehl et al. 2007](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b103)). The rate of current and projected increases in atmospheric CO2 is approximately 100× faster than has occurred in at least 650,000 years ([Siegenthaler et al. 2005](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b141)). In recent decades, only half of anthropogenic CO2 has remained in the atmosphere; the other half has been taken up by the terrestrial biosphere (ca. 20%) and the oceans (ca. 30%) ([Feely et al. 2004](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b45); [Sabine et al. 2004](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b136)). Since the Industrial Revolution, a time span of less than 250 years, the pH of surface oceans has dropped by 0.1 pH units (representing an approximately 30% increase in hydrogen ion concentration relative to the preindustrial value) and is projected to drop another 0.3–0.4 pH units by the end of this century ([Mehrbach et al. 1973](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b104); [Lueker et al. 2000](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b95); [Caldeira & Wickett 2003](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b28); [Caldeira et al. 2007](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b30); [Feely et al. 2008](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b44)). [Note: The pH scale is logarithmic, and as a result, each whole unit decrease in pH is equal to a 10-fold increase in acidity.] A pH change of the magnitude projected by the end of this century probably has not occurred for more than 20 million years of Earth's history ([Feely et al. 2004](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b45)). The rate of this change is cause for serious concern, as many marine organisms, particularly those that calcify, may not be able to adapt quickly enough to survive these changes.

**We must act now – Ocean acidification is directly caused by fossil fuel burning and causes mass extinctions**

**Guinotte**, J. M. **and Fabry**, V. J. (**2008**),[ Marine Conservation Biology Institute, Bellevue, Washington, California State University] Ocean Acidification and Its Potential Effects on Marine Ecosystems. Annals of the New York Academy of Sciences, 1134: 320–342. <http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/pdf> Herm

It is clear that human-induced changes in atmospheric CO2 concentrations are fundamentally altering ocean chemistry from the shallowest waters to the darkest depths of the deep sea. The chemistry of the oceans is approaching conditions not seen in many millions of years, and the rate at which this is occurring is unprecedented ([Caldeira & Wickett 2003](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b28)). [Caldeira and Wickett](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b28) (2003, p. 365) state “Unabated CO2 emissions over the coming centuries may produce changes in ocean pH that are greater than any experienced in the past 300 million years, with the possible exception of those resulting from rare, catastrophic events in Earth history” ([Caldeira and Rampino 1993](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b27); [Beerling and Berner 2002](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b12)). Recent evidence suggests ocean acidification was a primary driver of past mass extinctions and reef gaps, which are time periods on the order of millions of years that reefs have taken to recover from mass extinctions ([Stanley 2006](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b144); [Veron 2008](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b151)). [Zachos and colleagues (2005)](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b154) calculated that if the entire fossil fuel reservoir (ca. 4500 GtC) were combusted, the impacts on deep-sea pH and biota would probably be similar to those in the Paleocene–Eocene Thermal Maximum (PETM), 55 million years ago. The PETM likely caused a mass extinction of benthic foraminifera ([Zachos et al. 2005](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b154)). Projected anthropogenic carbon inputs will occur within just 300 years, which is thought to be much faster than the CO2 release during the PETM and too rapid for dissolution of calcareous sediments to neutralize anthropogenic CO2. Consequently, the ocean acidification-induced impacts on surface ocean pH and biota will probably be more severe than during the PETM ([Zachos et al. 2005](http://onlinelibrary.wiley.com/doi/10.1196/annals.1439.013/full#b154)).

# Warming – Impact Work

**CO2 emissions lead to mass extinction of ocean’s ecosystem – must act now**

**NYT 6/21** (David Jolly, “Oceans are at Dire Risk, Team of Scientist Warn” June 21, 2011, <http://green.blogs.nytimes.com/2011/06/21/oceans-are-at-dire-risk-team-of-scientists-warns/>) Herm

The state of the oceans is declining far more rapidly than most pessimists had expected, an international team of experts [has concluded](http://www.stateoftheocean.org/pdfs/1906_IPSO-LONG.pdf), increasing the risk that many marine species — including those that make coral reefs — could be extinct within a generation. Coral bleached as a result of stresses including global warming and acidification. The scientists, who gathered in April at the University of Oxford, cited the cumulative impact of the stresses on the oceans, which include ocean acidification related to growing carbon dioxide emissions, a global warming trend that is reducing the polar ice caps, pollution and overfishing. ‘‘This examination of synergistic threats leads to the conclusion that we have underestimated the overall risks and that the whole of marine degradation is greater than the sum of its parts, and that degradation is now happening at a faster rate than predicted,’’ they wrote in the report, released on Monday. The April workshop, organized by the International Program on the State of the Ocean in concert with the International Union for Conservation of Nature, brought scientists from a broad range of disciplines together to talk about the problems in the marine environment and what steps can be taken to arrest the collapse of ocean ecosystems. Chris Reid, a professor of oceanography at the Marine Institute of Plymouth University who took part in the workshop, described the report as ‘‘a synthesis of existing work.’’ ‘‘When we added it all up, it was clear that we are in a situation that could lead to major extinctions of organisms in the oceans,’’ he said by telephone. The scientists said that studies of the earth’s past have indicated that global warming, ocean acidification and hypoxia, or reduced oxygen content in the seas, are three symptoms of a disturbance in the carbon dioxide cycle that have been ‘‘associated with each of the previous five mass extinctions on Earth.’’ While speaking in the measured language of science, the report calls for a complete rethinking of humans’ relationship with the oceans. ‘‘It is clear that the traditional economic and consumer values that formerly served society well, when coupled with current rates of population increase, are not sustainable,’’ it said. “Deferring action will increase costs in the future leading to even greater losses of benefits,” the scientists added. They warned that in addition to steep declines in the populations of many commercially important commercial species, the oceans are at risk for ‘‘an unparalleled rate of regional extinctions of habitat types,’’ including mangroves and seagrass meadows. ‘‘We now face losing marine species and entire marine ecosystems, such as coral reefs, within a single generation,’’ the report said. Mr. Reid said corals were particularly at risk because they were suffering both from the bleaching effect caused by rising sea temperatures and from acidification, which deprive the tiny organisms of the calcium carbonate they need to build their homes. The authors **call for immediate action to take the pressure off ocean ecosystems, including measures to reduce carbon dioxide emissions** and ‘‘coordinated and concerted action’’ by governments in national waters and on the high seas to enact sustainable fisheries polices and reduce pollution.

**Global warming ruins the planet**

The **Guardian** (U.K.), **2007** [Environmental failures 'put humanity at risk', October 26th, 2007, <http://www.guardian.co.uk/environment/2007/oct/26/climatechange>, MA]

The future of humanity has been put at risk by a failure to address environmental problems including climate change, species extinction and a growing human population, according to a new UN report. In a sweeping audit of the world's environmental wellbeing, the study by the UN Environment Programme (UNEP) warns that governments are still failing to recognise the seriousness of major environmental issues. The study, involving more than 1,400 scientists, found that human consumption had far outstripped available resources. Each person on Earth now requires a third more land to supply his or her needs than the planet can supply, it finds. Meanwhile, biodiversity is seriously threatened by the impact of human activities: 30% of amphibians, 23% of mammals and 12% of birds are under threat of extinction, while one in 10 of the world's large rivers runs dry every year before it reaches the sea. The report - entitled Global Environment Outlook: Environment for Development - reviews progress made since a similar study in 1987 which laid the groundwork for studying environmental issues affecting the planet. Since the 1987 study, Our Common Future, the global response "has in some cases been courageous and inspiring," said the environment programme's executive director Achim Steiner. The international community has cut ozone-damaging chemicals, negotiated the Kyoto protocol and other international environmental treaties and supported a rise in protected areas which cover 12% of the world. "But all too often [the response] has been slow and at a pace and scale that fails to respond to or recognise the magnitude of the challenges facing the people and the environment of the planet," Mr Steiner said. "The systematic destruction of the Earth's natural and nature-based resources has reached a point where the economic viability of economies is being challenged - and where the bill we hand to our children may prove impossible to pay," he said. Climate change is a global priority that demands political leadership, but there has been "a remarkable lack of urgency" in the response, which the report characterised as "woefully inadequate". The report's authors say its objective is "not to present a dark and gloomy scenario, but an urgent call to action". It warns that tackling the problems may affect the vested interests of powerful groups, and that the environment must be moved to the core of decision-making. The report said irreversible damage to the world's climate will be likely unless greenhouse gas emissions drop to below 50% of their 1990 levels before 2050. To reach this level, the richer countries must cut emissions by 60% to 80% by 2050 and developing countries must also make significant reductions, it says. It addresses a number of areas where environmental degradation is threatening human welfare and the planet, including water, over-fishing and biodiversity - where the UNEP says a sixth, human-induced, extinction is under way.

# Warming – Brink Ev

**Warming is speeding up now.**

**Tobiska**, Chief Scientist, Space Environment Technologies, AIAA Member, **9**

[W. Kent Tobiska; “Vision for Producing Fresh Water Using Space Power”; 2009; <http://www.spacewx.com/Docs/SET_SPACE_2009.pdf>; Boyce]

The Intergovernmental Panel on Climate Change (IPCC) reports 1 that the trend in the global surface-to-stratosphere temperature is a warming of 0.74°C per century (1906–2005). There has been an escalation in the warming rate over the past 50 years. In that period, the sea level has risen about 150 millimeters (6 inches) and it is continuing to rise at about 3 millimeters (an eighth of an inch) per year 2 . One reason for the acceleration of global warming may be the increase in methane. As the arctic permafrost thaws, more of this gas is released and this amplifies the warming trend. Some of the measureable effects of this temperature rise are melting polar cap ices, rising sea levels, and more severe storms. By 2050, climate change is projected to decrease the annual average river runoff and water availability in the mid-latitude drier regions and the dry tropics while increasing runoff at high latitudes and in some wet tropical areas. What this means for the average person is that many semi-arid and arid areas such as the Mediterranean Basin, western USA, southern Africa, Australia, and northeastern Brazil will likely see a decrease in their water supply. This trend will be contrasted with increased flooding, including during the winter, for northern Europe, central and northern USA, northern China, and the wet tropical regions in Southeast Asia, Africa, and South America. The IPCC notes that there may be longer-term consequences of climate change than were previously thought. Their report identifies that carbon dioxide is increasingly absorbed into the world’s oceans, which raises their heat content and changes their circulation patterns. The latency, or ocean’s ability to transfer heat out, occurs on time-scales of several hundreds of years and this suggests that climate change will continue on the order of many centuries rather than decades. Since the ocean heat is exchanged with the atmosphere through thermal coupling, there are probable consequences such as an additional rise in sea surface height due to thermal expansion and an intensification of regional climate variability with hot–cold as well as dry–wet extremes due to ocean circulation changes.

**Now is key- futures energy crises are more severe**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

I see energy independence not as an isolationist concept but as broadened choices of cleaner, more plentiful energy for entire world. The definition of energy independence must also include independence from non-renewable fossil fuels (oil, coal, natural gas, etc.). Energy independence is so important because it affects several critical areas to our country, such as national security, the economy and the environment. I can remember when gasoline was about 25 cents a gallon in the 1960′s. Today it is often over $3.00 a gallon and crude oil is $100 a barrel. In 1960, the U.S. population was about 180 million and today it is nearly 310 million. There have been several energy crises (increased price or decreased supply) in the U.S. since the 1960′s. The 1973 oil crisis was caused by an OPEC oil export embargo and the 1979 energy crisis was caused by an Iranian revolution. Again in 1990, a spike in the price of oil was caused by the Gulf War. During 2000-2001, a California electricity crisis was caused by failed government deregulation coupled with several instances of business corruption. The most recent oil price increases of 2004-2007 have been caused by increasing demand from the U.S and China, the falling state of the U.S. dollar and stagnation of production due to the war in Iraq. Energy crises of the future will likely be more severe. Energy scarcity will give rise to even more international conflicts in the future. As world population grows, the laws of supply and demand will eventually break when the demand for natural resources exceeds the total capacity of the planet to sustainably supply them. World population is projected to rise from today’s 6.6 billion to 9.2 billion by 2050. (United Nations Population Division, 2007). Abundant, affordable energy is required to sustain our most basic needs for clean air, clean water and a safe food supply. President Bush, in the 2006 State of the Union Address said, “America is addicted to oil.” The U.S. currently imports between 50% – 60% of the crude oil we use and we pay between $400 and $500 billion per year for that imported crude oil. This makes us dependent on many who are not necessarily our friends. Threats of price increases or limitations of supply and come from energy cartels (OPEC) or energy superpowers (Iran, Venezuala, etc.). Carbon emission price increases, penalties and pressure to reduce emissions can come from international bodie like the United Nations and its Intergovermental Panel on Climate Change (IPCC). The Kyoto Protocol (reduction of greenhouse gas emissions) would put significant financial penalties on the U.S. for failing to meet the requirements of the treaty. Our reliance on foreign energy gives others a lever (or a stick) to use against us. Energy independence will give us many more political options when dealing with these external forces. Space-based solar power addresses many of the issues related to energy independence. Nearly every source of energy we use today can be traced back to the Sun, which is a huge nuclear (hydrogen fusion) furnace. Space-based solar power is a potentially unlimited source of clean energy and it could eventually supply all of our country’s needs. Instead of importing vast amounts of fossil fuels, the U.S. could become a major exporter of energy & technology. America can use the platform of energy to once again set an example of what being a good citizen-nation of the world is all about. Bill Richardson, governor of New Mexico and former Secretary of Energy (1997-2001), has published his vision for our energy future in a book titled “Leading by Example”. He offers the warning “America is just one crisis away from an energy emergency that will completely disrupt daily life, sharply increase energy prices, and perhaps even lead to military intervention in the world energy markets.” And he also offers hope for our energy future when he states “The American people are full of optimism and ingenuity. The people of the world want to believe that we are responsible and compassionate, that we are committed to freedom and basic fights, and that we want to participate constructively in world affairs. Visionary leadership, and visonary action to implement a new role for the United States, will turn the situation around quickly, and America will find itself surrounded by friends and allies once again.”

**US must take the lead in SPS- it’s the “Silver Bullet”**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

The development of space-based solar power will help other renewable energy technologies with spin-off technologies in the areas of photovoltaics, exotic materials, manufacturing techniques and many more. Space-based solar power is a long-term solution with huge social and economic potential. It could actually be the game-changing energy technology, the elusive “silver bullet”, that is needed to address many of the energy and environment related problems we face today. Some estimates put space-based solar power at potentially a one trillion dollar a year industry. Here’s a quote from the GA Tech Space Solar Power Workshop: “Escalating tension between our environment and energy choices drove us to search for the best energy choice. That choice is Space Solar Power – the cleanest electricity generation process known. Gathered by satellites in geosynchronous orbit for use on Earth, pure clean energy would be beamed gently to earth. Space Solar Power should become the major source of the world’s energy and electric power to minimize our environmental footprint.” I believe space-based solar power should be the cornerstone technology in our energy future. The United States must take the lead role in it’s development, deployment and management. There is great value in being first to market with any new product, let alone a breakthrough application of technology.

# Warming – Biosphere Loss Impact

**Minor biosphere loss causes extinction**

**Danovaro 8** [Professor Roberto Danovaro, Scitizen.Com, February 12, 2008. “Deep-Sea Biodiversity Conservation Needed to Avoid Ecosystem Collapse”. http://scitizen.com/stories/Biodiversity/2008/02/Deep-Sea-Biodiversity-Conservation-Needed-to-Avoid-Ecosystem-Collapse/]

The exploration of the abysses of our planet is one of the last frontiers of ecological research. The dark portion of the biosphere likely hosts millions of undiscovered-yet new species. A global scale study conducted on biodiversity collected down to 8000 m depth reveals for the first time that small invertebrates (including worms and crustacea) play a key role in sustaining the overall functioning of these ecosystems. This study concludes that even a minor loss of biodiversity can cause a major impact on the functioning of the global biosphere. In the future, we should start protecting not only large ?flag species?, but also the almost invisible and sometime monstrous creatures that inhabit the abyss and the ocean interior. Hard to believe, but so far we dedicated more efforts on the exploration of the Moon or on searching the life on Mars than on exploring the deep interior of our oceans. The total amount of seafloor recovered from depths higher than 4 km (which is the average depth of the oceans) is equivalent to less than the surface of a football pitch. Till few decades ago, we believed that deep-sea habitats were the equivalent of the terrestrial deserts, devoid of life. But recently we accumulated evidence that the dark side of the biosphere is plenty of life and characterized by an enormous number of species. Despite the deep-sea ecosystems are apparently far from us and difficult to reach and investigate there is an increasing evidence that they are susceptible to the direct and indirect impact of human activities. At the same time they help sustaining human life by providing essential goods and services (including food, biomass, bioactive molecules, oil, gas, minerals) and contribute to climate regulation, nutrient regeneration and supply to the upper ocean. The oxygen produced in the upper ocean, for instance, is about half of the total oxygen produced on Earth and largely depends on the availability of the nutrients regenerated in the deep-sea floor. Therefore, for their profound involvement in global biogeochemical and ecological processes deep seas are essential for the air, water and food we consume and consequently crucial for the sustainable functioning of our biosphere and for human wellbeing.

# AT: GEO Orbit

**GEO orbit necessary – anything else fails**

Geoffrey A. **Landis,** NASA Glenn Research Center **09** Presented at the XXIth Space Photovoltaic Research and Technology Conference (SPRAT-2009), *“*SOLAR POWER FROM SPACE: SEPARATING SPECULATION FROM REALITY” October 6-8, 2009 <http://www.mitenergyclub.org/assets/2010/2/13/Landis_SPS-SPRAT09.pdf> Herm

Only GEO orbit puts satellite over ground station with 100% usage fraction, and hence any lower orbit will have an immediate disadvantage that it will be out of direct beaming line of sight of the ground station for much of the time. In addition to the non-stationary nature of lower orbits, another difficulty of low orbit is that these orbits will have to be non-equatorial if we want to get power to northern hemisphere users. Thus, low-orbit view factors are 9 low; for example, for an orbital altitude of 1000 km, the time in view above ten degrees of elevation is only 12.6 minutes, twice a day. This results in a total use fraction of 25.2 minutes out of 24 hours, which is too low a usage fraction to be economically feasible. One possible solution would be to make multiple ground stations for the power, receiving power at whatever location is in sight of the ground station, and likewise multiple power satellites, so that a satellite is available over each customer at any time. However, to make this work for low orbits would require a large number of ground stations dotted uniformly around the world, including in many locations where there are few customers for the power, such as the Pacific Ocean. The cost of such a system is several orders of magnitude higher than the baseline, since the number of satellites is much higher. It is difficult to make this economic case.

# AT: Talent

**SPS solves lack of talent- develops technological base**

**Nansen, 95 -** led the Boeing team of engineers in the Satellite Power System Concept Development and Evaluation Program for the Department of Energy and NASA, and President Solar Space Industries (Ralph, Sun Power, <http://www.nss.org/settlement/ssp/sunpower/sunpower09.html>, MA)

Some of the very reasons for not developing the solar power satellite concept are also the best reasons to develop it. First of all, if we were to commit to its development it would give us national purpose. We would no longer be wondering what to do the next time we run short of oil or a megalomaniac threatens to take control of a major oil-producing nation. We would be concentrating on a single common goal—not a generalized wish for energy independence, but a specific solution. It would be a greater task than going to the moon in the 1960s, but it would focus the nation’s talents, its energies, and its imagination in much the same way as did that lofty accomplishment. It would challenge our young people to take their place in history building a future for themselves and their children. They would become known as a generation of visionaries who stood at the crossroads of history and chose the pathway of growth rather than stagnation. It would utilize the talents of scientists, engineers, and companies who have been working on military hardware, which is no longer a number one priority with the ending of the cold war. It would develop a new high-level technological base, which is so important to a highly developed nation like the United States in order to maintain our competitive place in the world economy. It would create a massive number of jobs that would bring growth to our economy.

# AT: Launcher Shortages

**Assembly in space solves economic impacts and creates 3 jobs per 1 MW of useful power**

Aleksander **Zidanšek et al** Department of Physics, Faculty of Natural Sciences and Mathematics, University of Maribor **11** [(Milan Ambrožič Maja Milfelner Robert Blinc and Noam Lior Jožef Stefan Institute, Jamova cesta 39, Ljubljana, Slovenia b Jožef Stefan International Postgraduate School, Jamova cesta 39, Ljubljana, Slovenia c Department of Physics, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška 160, Maribor, Slovenia d University of Pennsylvania, Department of Mechanical Engineering and Applied Mechanics, Philadelphia, PA 19104-6315, USA) [Energy](http://www.sciencedirect.com/science/journal/03605442) [Volume 36, Issue 4](http://www.sciencedirect.com/science?_ob=PublicationURL&_tockey=%23TOC%235710%232011%23999639995%233036740%23FLA%23&_cdi=5710&_pubType=J&view=c&_auth=y&_acct=C000034138&_version=1&_urlVersion=0&_userid=655046&md5=fd84d738ed361ad4ebdd2c8b539fb893), April 2011, Pages 1986-1995 “Solar Orbital Power: Sustainability Analysis” <http://www.sciencedirect.com/science/article/pii/S0360544210005931#affc>] Herm

We have analysed some economic, environmental and social aspects of sustainability for electricity production in solar space power plants using current technology. While space solar power is still way too expensive for launches from the Earth, there are several technological possibilities to reduce this price. For a large scale application of orbital power stations both environmental impact and costs can be significantly reduced. The first option is to build and employ reusable space vehicles for launching the satellites, instead of rockets, which is the main recommendation by NASA, and the second option is to build the satellites and rockets in space (e.g. on the Moon). An old NASA estimate shows that this would be economical for as few as 30 orbital satellites with 300 GWe of total power [17]. The costs could be even further reduced, if the first satellite is launched into the low Earth orbit, and then uses its produced energy to lift itself into a higher GEO orbit or even to the Moon [35]. If the satellites and rockets are then built on the Moon in robotic factories, we estimate that: - The environmental impact of the orbital solar power plants would become significantly lower than for any Earth-based power plant except perhaps nuclear fusion. Measured by CO2 emissions, it would be about 0.5 kg perWof useful power, and this number would even decrease with improved technology and larger scope; - The production cost of the orbital solar power plants could also become significantly lower than for any Earth-based power plant except perhaps nuclear fusion. It is estimated as about US $1 per W of useful power, and would also decrease with improved technology and larger scope; - The social impact of cheap and clean energy from space is more difficult to estimate, because space power satellites seem to be connected to a significant loss of jobs. It is however difficult to estimate the benefits of a large amount of cheap clean energy, which would most likely more than offset the negative effects of lost jobs, and we estimate that about 3 jobs would be created in the economy per 1 MW of installed useful power. One could therefore expect a net positive effect of solar power satellites on sustainability. These effects seem to be the most positive, if thermal power satellites are used, which are built in a robotic factory on the Moon and then launched into the GEO orbit. The concept presented in this paper has some significant advantages over many other proposed concepts for large scale energy production on Earth. For example, nuclear fusion promises to become a clean and cheap source of energy, however even in the best case scenario it can’t become operational before 2040. Solar orbital power concept can become operational in less than a decade and produce large amounts of energy in two decades. It is also important that the price as well as environmental impact of solar orbital power are expected to decrease with scale. In addition to expected increase in employment this makes solar orbital power an important alternative to other sustainable energy sources.

**Initial cost small compared to capital, return infinite**

Geoffrey A. **Landis,** NASA Glenn Research Center **09** Presented at the XXIth Space Photovoltaic Research and Technology Conference (SPRAT-2009), *“*SOLAR POWER FROM SPACE: SEPARATING SPECULATION FROM REALITY” October 6-8, 2009 <http://www.mitenergyclub.org/assets/2010/2/13/Landis_SPS-SPRAT09.pdf> Herm

The economic return for space solar power requires return on investment. If a SPS is to be commercially viable, it must charge the utilities to which it is selling power price (per kW-hr) less than the utility's cost of generating new power. Note that it is important to beat the utilities' cost, not the customer's electric cost. This cost may include the cost for externalities (e.g., possible penalties to be imposed for generating with coal), if any. As a minimum, even if operating cost is zero (i.e., small compared to the capital) and operating lifetime is infinite, the invested money must be returned.

**The U.S. has the best capabilities now including launchers.**

**Center for New American Security**

( Abraham M. Denmark is a Fellow at the Center for a New American Security. Chris Evans is a Senior Consultant at Delta Risk Consulting. Robert D. Kaplan, a National Correspondent for The Atlantic and a Senior Fellow at the Center for a New American Security, is writing a book on the Indian Ocean. Jason Healey is the Washington D.C. Office Director for Delta Risk Consulting. Frank Hoffman wrote his chapter when he was a Fellow at the Foreign Policy Research Institute and the Potomac Institute for Policy Studies. He now works for the Department of the Navy. Oliver Fritz is the Assistant Director of Strategic Planning at Headquarters, U.S. Air Force. Lt Col Kelly Martin (USAF) is a Senior Military Fellow at the Center for a New American Security. Dr. James Mulvenon is Vice-President of Defense Group Inc.’s Intelligence Division and Director of DGI’s Center for Intelligence Research and Analysis. Dr. Greg Rattray is a Partner at Delta Risk Consulting, is Chief Internet Security Advisor at the Internet Corporation for Assigned Names and Numbers (ICANN), and is a member of the Cyber Conflict Studies Association Board. Eric Sterner is a Fellow at the George C. Marshall Institute.) 2010 “ Contested Commons: The Future of American Power in a Multipolar World” 2010 (<http://www.cnas.org/files/documents/publications/CNAS%20Contested%20Commons_1.pdf>) [Pitman]

The United States is the world’s leader in space, in civilian and government uses. The U.S. Government is the most active customer for space in the United States, and has the largest budget for it (Table 1). The United States is also the world’s leader in civilian space infrastructure and capabilities. In 2007, U.S. satellite manufacturers held contracts to produce 50 percent of commercial geosynchronous communications satellites on back-order, and the United States was scheduled to conduct 36 percent of back-ordered space launches for the world. 9 Of 21 new orders for geosynchronous communications satellites placed in 2008, U.S. manufacturers received 11 orders, followed by the Europeans with seven, and the Russians, Chinese and Japanese each won one order. 10

**Launch costs are improving- many solutions to save money**

**Smith 3,** Director at Moon Society; Founder and President at Long Island Space Society, (Arthur,“The Case For Space Based Solar Power Development: solar energy on Earth and in space might be the first large scale space industry” http://www.spacedaily.com/news/ssp-03b.html, 8-11-03, MA) // CCH

Lower launch costs is a major goal of all space advocates. The X Prize contenders, Musk's Space-X, even the major aerospace "EELV" program all have the intention of significantly reducing launch costs. Whether any rocket based system will succeed remains to be seen - perhaps we will have to wait for space elevators to see much reduction in cost to orbit. But there are some indicators that we could see a factor of 3-5 improvement, and perhaps more, over the next decade with a sufficiently large and competitive launch market. Competition in the commercial launch market already has some providers such as Sea Launch offering $4000-$5000 per kg prices to low earth orbit. Use of solar electric propulsion allows higher orbits at only slightly higher cost. Given the multi-trillion-dollar potential market for space-based power, increased funding for launch systems development to accelerate these improvements would also be a worthy investment. There is another way to reduce launch costs. In David Criswell's Lunar Solar Power proposal (5), instead of launching the final components from Earth, manufacturing facilities are sent from Earth to the Moon to build the solar power system components there. And to save even further on launch costs, the solar components stay on the Moon and transmit power directly from there. The initial capital investment is higher than for an Earth-launched system primarily due to the much larger antennas needed to transmit power efficiently from Moon to Earth, but overall costs per delivered Watt should be much lower, and the costs for such an approach are less dependent on reducing launch costs from Earth.

# AT: Generic Spending/Problems

**Spending problems and other missteps can be solved with government work.**

**Sadeh, 08** - an Associate Director for the Center for Space and Defense Studies at the United States Air Force Academy (Eligar, The Space Review, “Space policy questions and decisions facing a new administration”, 6/9, http://www.thespacereview.com/article/1146/1)

Do space programs take too long to develop and cost too much? Issue In the United States, it takes 10 to 15 years or more to deploy a space capability and at a cost that exceeds the budgetary resources that are available. The means to address cost and development issues are to reform space acquisition policies and processes. Discussion Space programs and projects are developed on the basis of cost and budgetary considerations. This basis results in cost overruns and long development times. This is all the more important as the budgets for space programs are likely to decline in real terms, or at best remain stagnant. Costs and development times are driven by the United States Government buying and contacting behavior that is driven more by budgetary, as opposed to programmatic or strategic, considerations. Space acquisitions are an on-going process. A key part of successful acquisitions is going from research to an operational transition. This cannot be driven by the push of technology alone. There must be technology pull. The desired end state of minimizing risk on the operational end requires a strategy that mitigates risk early-on, in the research and development and in the science and technology phases. More responsive and affordable space capabilities enabled by acquisition reforms are vital to address United States national security concerns in space. In this context, support to the warfighter is linked to what industry can deliver. The military has the problem of aging systems and technology, which necessitates upgrades to space assets. The United States is struggling to get space capabilities deployed due to acquisition challenges. Policy Choice Address space acquisition challenges through a sustained commitment to acquisition reforms or by augmenting that commitment through strategic guidance for space programs. Space acquisition problems have been addressed over the past decade through reforming acquisition processes. A sustained commitment and further expansion of these reforms is vital for sound acquisition processes to better meet the security and civil space goals/objectives of the United States. The key elements of reform include: grounding in system engineering processes; reductions in cost and time during the acquisition cycle through independent reviews and cost-estimating; clear and coherent requirements and standards; risk-taking in technology development; risk-mitigation by making use of mature technologies; and the design of flexible systems that can integrate new technologies as they mature. Reforms in space acquisition processes, the traditional avenue to fix the way the United States government and aerospace industry develop and build space asserts, is not the complete answer to space acquisition challenges. A commitment to addressing space acquisition policy does provide a more complete answer. Policy guidance is needed to direct space programs on the basis of strategic choices. It is important to think and act strategically as the United States and the aerospace industry design and develop systems to avoid short-term fiscal pressures that cause acquisition problems. An examination of the strategic picture fosters more effective requirements definition that will result in lower costs and improved timelines for development. This expanded approach to reform space acquisitions does depend on the political wherewithal to formulate a national space strategy.

# AT: Co-Op DA

**ITAR complitcates cooperation- SBSP viewed as arms**

Joseph D**. Rogue**, Associate director of National Security Space Office, 20**07** [“Space‐Based Solar Power

As an Opportunity for Strategic Security”, October 10, 2007, http://science.ksc.nasa.gov/shuttle/nexgen/Nexgen\_Downloads/SBSPInterimAssesment0.1.pdf]

The SBSP Study Group found in order to successfully address major world problems in energy, environmental and national security, the U.S. needs to identify and then reduce or eliminate all unnecessary barriers to effective international cooperation on, and private industry investment in, the development of SBSP. Regardless of the form of international cooperation, Space‐Based Solar Power will require modification or special treatment under International Trafficking in Arms Regulations (ITAR). • Partnerships between U.S. and foreign corporations are often much easier to create and implement than government to government level partnerships, and more effective when the purpose is fostering economically affordable goods and services. • Application of the International Traffic Arms Regulations (ITAR) may constitute a major barrier to effective partnerships in SBSP and negatively impact national security. Right now ITAR greatly restricts and complicates all space‐related business, as it treats all launch and satellite technologies as arms. This has had the effect of causing America’s competitors to develop ITAR‐free products, and had a negative impact on our domestic space industries, which can no longer compete on level ground. Many participants in the feasibility study were very vocal that including satellite and launch technology in ITAR has had a counterproductive and detrimental effect on the U.S.’s national security and competitiveness—losing control and market share, and closing our eyes and ears to the innovations of the competition while selling ourselves on a national illusion of unassailable space superiority. Effective collaboration, even with allies on something of this level, could not take place effectively without some special consideration or modification.

**SBSP requires international cooperation- countries are interested**

Joseph D**. Rogue**, Associate director of National Security Space Office, 20**07** [“Space‐Based Solar Power

As an Opportunity for Strategic Security”, October 10, 2007, http://science.ksc.nasa.gov/shuttle/nexgen/Nexgen\_Downloads/SBSPInterimAssesment0.1.pdf]

FINDING: The SBSP Study Group found that no outright policy or legal showstoppers exist to prevent the development of SBSP. Full‐scale SBSP, however, will require a permissive international regime, and construction of this new regime is in every way a challenge nearly equal to the construction of the satellite itself. The interim review did not uncover any hard show‐stoppers in the international legal or regulatory regime. Many nations are actively studying Space‐Based Solar Power. Canada, the UK, France, the European Space Agency, Japan, Russia, India, and China, as well as several equatorial nations have all expressed past or present interest in SBSP. International conferences such as the United Nations‐connected UNISPACE III are continually held on the subject and there is even a UN‐affiliated non‐governmental organization, the Sunsat Energy Council, that is dedicated to promoting the study and development of SBSP. The International Union of Radio Science (URSI) has published at least one document supporting the concept, and a study of the subject by the International Telecommunications Union (ITU) is presently ongoing. There seems to be significant global interest in promoting the peaceful use of space, sustainable development, and carbon neutral energy sources, indicating that perhaps an open avenue exists for the United States to exercise “soft power” via the development of SBSP. That there are no show‐stoppers should in no way imply that an adequate or supportive regime is in place. Such a regime must address liability, indemnity, licensing, tech transfer, frequency allocations, orbital slot assignment, assembly and parking orbits, and transit corridors. These will likely involve significant increases in Space Situational Awareness, data‐sharing, Space Traffic Control, and might include some significant similarities to the International Civil Aviation Organization’s (ICAO) role for facilitating safe international air travel. Very likely the construction of a truly adequate regime will take as long as the satellite technology development itself, and so consideration must be given to beginning work on the construction of such a framework immediately.

# AT: Aerostat CP

**Aerostats are vulnerable- weather and enemies**

Christopher **Bolkcom,** Specialist in National Defense Foreign Affairs, Defense, and Trade Division, 20**06** [“CRS Report for Congres”, September 1st, 2006, http://www.fas.org/sgp/crs/weapons/RS21886.pdf]

The operational need for aerostats and their ability to satisfy this need appears the most mature of the three distinct lighter-than-air platforms. These systems are currently fielded and their capabilities and limitations appear well-documented. The role that they appear most suited for is persistent surveillance. Aerostats’ primary advantages over other platforms capable of providing elevated, persistent surveillance (manned aircraft and UAVs) appear to be low life cycle cost and long dwell time. 11 The primary operational concerns with employing aerostats appear to be vulnerability to weather and enemy ground fire. U.S. and foreign aerostats have been lost to severe weather, as have manned aircraft and UAVs. Aerostats tend not to fail in benign weather, however, while aircraft and UAVs, which are more complex and dynamic systems, suffer accidents caused by factors such as human error and mechanical failure. 12 The vulnerability of aerostats to enemy ground fire is debated. Opponents argue that aerostats are big targets within range of many enemy weapons. Proponents argue that despite their large size, aerostats are survivable because of a low radar cross section and their ability to endure numerous punctures before gradually losing altitude. Low flying aircraft and UAVs are also vulnerable to enemy ground fire.

**Spherical aerostat work- wind and oscillations**

C. **Lambert et al**, Dept. of Mechanical EngineeringMcGill University, 20**03** [A. Saunders , C. Crawford and M. Nahon, “Design of a One-Third Scale Multi-Tethered Aerostat System for PrecisePositioning of a Radio Telescope Receiver”, 2003, http://www.scribd.com/doc/48815838/aerostat]

The aerodynamic performance of the spherical aerostat is characterized by a single drag force on the hull which is proportional to its constant spherical cross section. To compare the drag coefficient of aspherical and streamlined aerostat, a reference Re of 10 6 was chosen which represents typical operating conditions of the scaled aerostat. The drag coefficient for a spherical body is about 0.15,while for a streamlined body of fineness ratio 2.4, it is in the approximately 0.05. 8 When the fins are added to the streamlined aerostat, its drag coefficient increases to 0.073. In addition to having a drag coefficient of about half that for a spherical shape, the streamlined aerostat also has a frontal area 1.7 times smaller for the same internal volume of Helium. Thus, the drag force acting on a streamlined aerostat is about 3.5 times smaller than on an equivalent spherical aerostat. The reduced drag of th estreamlined aerostat has important advantages for the tethered system. From a static perspective, the loading on the tether structure would be reduced and therefore the design can be lighter and mor eefficient, as was reported in the original analysis of the LAR concept. 3 As well, the disturbances to the tether tension structure due to wind gusts should be reduced which would result in smaller position errors of the receiver. Spherical bodies also tend to be subject to vortex shedding oscillations in steady flow 9 . These could substantially degrade the performance of the system with a spherical aerostat. This again suggests that a streamlined aerostat may be preferable for our application as asteadier leash tension is considered desirable

**Aerostats are problematic- ground handling and mooring**

C. **Lambert et al**, Dept. of Mechanical EngineeringMcGill University, 20**03** [A. Saunders , C. Crawford and M. Nahon, “Design of a One-Third Scale Multi-Tethered Aerostat System for PrecisePositioning of a Radio Telescope Receiver”, 2003, http://www.scribd.com/doc/48815838/aerostat]Ground handling and mooring are among the most difficult problems encountered in the operation of tethered aerostats 10 . The support system for handling the aerostat near or on the ground is often more complex and costly than the aerostat itself. The ground handling equipment for the streamlined aerostat must accommodate its tendency to rotate into the wind. If the aerostat is unableto rotate freely, the loading from even mild side winds is strong enough to generate very large forces.If the mooring station does not permit the aerostat to rotate freely, then it must completely shelter theaerostat from the wind. In this case, additional equipment is required to transport the aerostat from theshelter to the launch site. By contrast, the ground handling equipment for the spherical aerostat wouldbe substantially simpler since it does not need to weathervane.

# AT: Weapons/Microwaves

**SPS cannot be used as a weapon and the microwave stuff is just fear.**

**Osepchuk**, PhD, Full Spectrum Consulting, **2**

[John M. Osepchuk; “How Safe Are Microwaves and Solar Power from Space?”; 2002 published in IEE Microwave Magazine, December; <http://electricalandelectronics.org/wp-content/uploads/2008/10/01145676.pdf>; Boyce]

In the popular press, the potential danger of an SPS turned into a weapon has often been raised, but at lower microwave frequencies, this is ruled out by physical limits on focusing. Beneficial weather modification, such as preventing damaging freezes in orange groves, does seem feasible. More dramatic applications, like the proposal to suppress tornadoes [13], would require more highly focused beams and, hence, higher frequency than that suitable for SPS. Well before the SPS or the more futuristic applications of microwave beams from space become reality, public perception of “microwaves” will have to be changed from that of mysterious, unseen “radiation” to a recognized extension and amplification of the solar spectrum that already exists—per the oversimplified and should not be encouraged. Instead, the best antidote to such philosophy and the fears they precipitate is the strengthening of broad-consensus safety standards developed under due process, such as by the International Committee on Electromagnetic Safety (ICES) [15], sponsored by the IEEE. The IEEE is the world’s largest technical professional society, with over 350,000 members (over 33% are outside of the United States). At present, ICES members outside of the United States comprise about 20% of ICES. Trends both in the IEEE and ICES indicate about 50% non-U.S. participation by 2010. ICES operates in a transparent manner, with full documentation, consensus balloting, and input invited from all stakeholders, including that of industry. ICES cooperates with other national and international groups like the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the International Electrotechnical Commission (IEC), which are more restricted in membership, process, and stakeholder input. It is increasingly clear that the development of SPS systems with MPT, along with the resolution of environmental issues, will be a global endeavor. It is also clear that the increasingly global economy means that sources of key components for advanced technology, with low-cost manufacturing, are outside the United States [16] and, indeed, often in the underdeveloped parts of the world. For example, almost all the mass manufacture of cooker magnetrons is now carried out in Korea, Thailand, and China. On the other hand, electrophobia has spread from the United States around the world, and today the most intense fears of EM energy are found outside the United States, particularly in Europe, China, and part of the bloc of former communist countries in Eastern Europe. Thus, the activities of ICES and the IEEE become very relevant in achieving the goal of rational, international safe exposure standards, as well as international consensus on regulation of RFI, such as through the Comité International Spéciale der Perturbations Radioélectriques (CISPR/IEC). The realization of the SPS concept holds great promise for solving energy crises and improving the lot of mankind. Serious discussions and education are required before most of mankind accepts this type of technology with global dimensions. Fears are based mostly on ingrained perceptions built up over the years as irrational attacks have been made on each successive wave of EM technology—from the microwave oven and radar to today’s wireless phone. In the history of man, great strides in human welfare have occurred after the acceptance of air-conditioning, the automobile, modern appliances, and airplanes. Man has progressed not by demanding absolute proof of safety before developing technology but by learning as work pro gresses [17], along with reasonable precautions based on science. Furthermore, fears of changing the environment should be dispelled if we realize, as Huber teaches [18], that efficient use of land and resources is possible only by applying the best hard technology (big, not small). Finally, we look forward to universal acceptance of the premise that EM energy is a key tool to improve the quality of life for mankind. It is not a “pollutant” but, more aptly, a man-made extension of the naturally generated electromagnetic spectrum that provides heat and light for our sustenance. From this viewpoint, the SPS is merely a down frequency converter from the visible spectrum to microwaves.

# Terrestrial Renewables Add-On

**A switch to renewable is inevitable- oil will run out**

**Walker,** writer for National Geographic, 20**04** [Cameron, “The Future of Alternative Energy”, October 28th, 2004, <http://news.nationalgeographic.com/news/2004/10/1028_041028_alternative_energy.html>, MA]

Residential energy use in the United States will increase 25 percent by the year 2025, according to U.S. Department of Energy (DOE) forecasts. A small but increasing share of that extra power will trickle in from renewable sources like wind, sunlight, water, and heat in the ground. Last year alternative energy sources provided 6 percent of the nation's energy supply, according to the DOE. "The future belongs to renewable energy," said Brad Colllins, the executive director of the American Solar Energy Society, a Boulder, Colorado-based nonprofit. Scientists and industry experts may disagree over how long the world's supply of oil and natural gas will last, but it will end, Collins said. While renewable energy is generally more expensive than conventionally produced supplies, alternative power helps to reduce pollution and to conserve fossil fuels. "People sometimes get caught up in cost-effectiveness," said Paul Torcellini, a senior engineer at the DOE's National Renewable Energy Laboratory (NREL) in Golden, Colorado. "But it can be a question of values and what we spend our money on." Below, a look at some recent developments in renewable-energy technology: Solar Power Photovoltaic, or solar-electric, systems capture light energy from the sun's rays and convert it into electricity. Today these solar units power everything from small homes to large office buildings. Technological improvements have made solar-electric modules more cost-effective. In the 1980s the average price of energy captured with photovoltaics was 95 U.S. cents per kilowatt-hour. Today that price has dropped to around 20 cents per kilowatt-hour, according to Collins, of the American Solar Energy Society. The cheaper rate is still more expensive than the average national price of electricity, which in 2003 was a little over 8 cents per kilowatt-hour, according to the U.S. Department of Energy's Annual Energy Review. Other recent advances include "thin film" photovoltaic technology, a high-tech coating that converts any surface covered with the film into a solar-electric power source. Boats and RVs that use the film are now on the market.

# Prolif Add-On Update

**SPS solves for proliferation- increases security**

Joseph D**. Rogue**, Associate director of National Security Space Office, 20**07** [“Space‐Based Solar Power

As an Opportunity for Strategic Security”, October 10, 2007, http://science.ksc.nasa.gov/shuttle/nexgen/Nexgen\_Downloads/SBSPInterimAssesment0.1.pdf]

FINDING: The SBSP Study Group found that in the long run, SBSP offers a viable and attractive route to decrease mankind’s reliance on fossil fuels, as well as provides a potential global alternative to wider proliferation of nuclear materials that will almost certainly unfold if many more countries in the world transition to nuclear power with enrichment in an effort to meet their energy needs with carbon neutral sources. To the extent mankind’s electricity is produced by fossil fuel sources, SBSP offers a capability over time to reduce the rate at which humanity consumes the planet’s finite fossil hydrocarbon resources. While presently hard to store, electricity is easy to transport, and is highly efficient in conversion to both mechanical and thermal energy. Except for the aviation transportation infrastructure, virtually all of America’s energy could eventually be delivered and consumed as electricity. Even in ground transportation, a movement toward plug‐in hybrids would allow a substantial amount of traditional ground transportation to be powered by SBSP electricity. For those applications that favor or rely upon liquid hydrocarbon fuels, America’s national labs are pursuing several promising avenues of research to manufacture carbon‐neutral synthetic fuels (synfuels) from direct solar thermal energy or radiated/electrical SBSP. The lab initiatives are developing technologies to efficiently split energy‐neutral feedstocks or upgrade lower‐ grade fuels (such as biofuels) into higher energy density liquid hydrocarbons. Put plainly, SBSP could be utilized to split hydrogen from water and the carbon monoxide (syngas) from carbon dioxide which can then be combined to manufacture any desired hydrocarbon fuel, including gasoline, diesel, kerosene and jet fuel. This technology is still in its infancy, and significant investment will be required to bring this technology to a high level of technical readiness and meet economic and efficiency goals. This technology enables a carbon‐neutral (closed carbon‐cycle) hydrocarbon economy driven by clean renewable sources of power, which can utilize the existing global fuel infrastructure without modification. This opportunity is of particular interest to traditional oil companies. The ability to use renewable energy to serve as the energy feedstock for existing fuels, in a carbon neutral cycle, is a “total game changer” that deserves significant attention. Both fossil and fissile sources offer significant capabilities to our energy mix, but dependence on the exact mix must be carefully managed. Likewise, the mix abroad may affect domestic security. While increased use of nuclear power is not of particular concern in nations that enjoy the rule of law and have functioning internal security mechanisms, it may be of greater concern in unstable areas of rouge states. The United States might consider the security challenges of wide proliferation of enrichment‐based nuclear power abroad undesirable. If so, having a viable alternative that fills a comparable niche might be attractive. Overall, SBSP offers a hopeful path toward reduced fossil and fissile fuel dependence.

# Econ Add-On

**SPS helps the economy-increases jobs, opens market, saves oil**

**Nansen, 95 -** led the Boeing team of engineers in the Satellite Power System Concept Development and Evaluation Program for the Department of Energy and NASA, and President Solar Space Industries (Ralph, Sun Power, <http://www.nss.org/settlement/ssp/sunpower/sunpower09.html>, MA)

When the energy starts to flow from the sky it would bring a continuing stream of wealth into our country. We would no longer be dependent on foreign oil. We would no longer participate in the massive exploitation of the earth’s resources. We would eliminate the need to burn huge quantities of fossil fuels and thus reverse the deterioration of the earth’s atmosphere. It would dramatically extend the life of precious oil for use as a petrochemical and fuel for airplanes and ships, so it could last far into the future. It would build the infrastructure of space development, which would open the space frontier for massive commercial development. Traumatic changes would certainly affect some existing industries. The coal mining industry would be directly impacted as new solar power satellites came on-line and the old coal plants could be shut down and dismantled. This would not happen overnight, but rather over an extended period of time, giving the labor force an opportunity to acquire new jobs in the expanding economy. Companies would have time to branch out and enter new facets of the energy business as coal mining closed down. Oil companies would also face a shrinking market, but their products would have the advantage of maintaining a viable market for a much longer period of use. Their product base could be modified to encompass the new evolving energy field, which will include solar cells, batteries, and many other components.

**SPS boosts economy- creates millions of jobs**

**Nansen, 95 -** led the Boeing team of engineers in the Satellite Power System Concept Development and Evaluation Program for the Department of Energy and NASA, and President Solar Space Industries (Ralph, Sun Power, <http://www.nss.org/settlement/ssp/sunpower/sunpower09.html>, MA)

The major task during the development phase would be a new fully reusable space freighter to replace the costly Space Shuttle. Other space transportation vehicles for moving parts from one orbit to another would need to be designed and built. These projects would require a work force similar to several modern airplane companies. The design and development of the assembly base to be operated in space would require a new breed of workers. Skilled laborers, like those needed to build the pipeline in the Alaskan North Slope oil fields, would have to learn how to build giant structures in space using robotic assembly tools. Development of the ground receiving antenna would require a large number of people familiar with heavy construction, earth moving, and field assembly. As the program moves from the design and development phase into manufacturing of the initial satellite, the majority of jobs would be involved in building and operating the space transportation system, fabricating the components and subassemblies for the satellite, and constructing the ground receiving antenna. Only a relatively small crew would be required for assembly in space. When I say small, that is only relative to the total work force required, but quite large by any space operations we have today. The total number required will be dependent on how many will be required to monitor the robotic assembly machines and to handle cargo transfer between the heavy lift launch vehicles and orbit transfer vehicles carrying cargo from low earth orbit to geosynchronous orbit. This project would grow to provide hundreds of thousands of jobs in many different disciplines, encompassing the entire spectrum from highly educated scientists to hourly laborers. The number of jobs generated in periphery fields to support this work force would reach into the millions.

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# Exploration Add-On Update

**SPS fuels space exploration- best opportunity**

Joseph D**. Rogue**, Associate director of National Security Space Office, 20**07** [“Space‐Based Solar Power

As an Opportunity for Strategic Security”, October 10, 2007, http://science.ksc.nasa.gov/shuttle/nexgen/Nexgen\_Downloads/SBSPInterimAssesment0.1.pdf]

The SBSP Study Group found that SBSP directly supports the articulated goals of the U.S. National Space Policy and Vision for Space Exploration which seeks to promote international and commercial participation in exploration that furthers U.S. scientific, security, and economic interests, and extends human presence across the solar system. No other opportunity so clearly offers a path to realize the Vision as articulated by Dr. Marburger, Science Advisor to the President: “As I see it, questions about the vision boil down to whether we want to incorporate the Solar System in our economic sphere, or not. Our national policy, declared by President Bush and endorsed by Congress last December in the NASA authorization act, affirms that, ‘The fundamental goal of this vision is to advance U.S. scientific, security, and economic interests through a robust space exploration program.’ So at least for now the question has been decided in the affirmative.” No other opportunity is likely to tap a multi‐trillion dollar market that could provide an engine to emplace infrastructure that could truly extend human presence across the solar system and enable the use of lunar and other space resources as called for in the Vision.

# Plan Popular

**Plan Popular & could be done by 2012 – Pentagon**

**MSNBC '07** (MSNBC, Oct. 12, 2007, Power from space? Pentagon likes the idea. <http://www.msnbc.msn.com/id/21253268/page/2/>) Herm

A new Pentagon study lays out the roadmap for a multibillion-dollar push to the final frontier of energy: a satellite system that collects gigawatts’ worth of solar power and beams it down to Earth. The military itself could become the “anchor tenant” for such a power source, due to the current high cost of fueling combat operations abroad, the study says. The 75-page report, released Wednesday, says new economic incentives would have to be put in place to “close the business case” for space-based solar power systems — but it suggests that the technology could be tested in orbit by as early as 2012.

**Boeing likes SPS. \*\*\*DON’T READ IF THEY READ THE BOEING CP**

**Boeing Frontiers**, Boeing corp’s magazine/history, **9**

[Boeing, By Eve Dumovich; “The Sun: The decades-long quest to power Earth from solar power satellites in space”; May 2009; <http://www.boeing.com/news/frontiers/archive/2009/may/i_history.pdf>; Boyce]

The proposal called for Boeing solar power satellites to be constructed either in low-Earth orbit for later transfer to higher geosynchronous orbit, or constructed directly at the higher orbit. Large space freighters, known as heavy-lift launch vehicles, would carry outsized cargo pallets into low-Earth orbit where they would be deposited at a space construction base. A modified Space Shuttle Orbiter would carry the personnel needed to the orbiting construction site. “Everything was falling into place,” Nansen said. “Applications poured into the company from engineers and scientists who wanted to work on solar power satellites.” Early studies indicated that the revenue from one solar power satellite, producing and beaming down to earth 10,000 megawatts of electricity sold then at a rate of 4 cents per kilowatt hour, would produce $105 billion in 30 years, according to Boeing reports. In 1995, NASA began a “Fresh Look” study of space solar power techniques and concepts. In 1998, Congress authorized modest funding for further concept definition and technology development. Boeing studies included not only a constellation of satellites but also solar power satellite technology applications in a laser-powered lunar rover and solar-powered propellant production depots in low-Earth orbit and on the moon that would use solar power to convert water into cryogenic propellants for moon and Mars exploration. Fast-forwarding to present day, Boeing continues to lead in solar power research and technology. In November 2008, Boeing’s wholly owned subsidiary, Spectrolab Inc., in Sylmar, Calif., received the 2008 SpotBeam Award for Space Innovation from the California Space Authority in recognition of its 50 years of advancements in photovoltaic solar cell technology, solar panels and related products. Spectrolab has long been the world’s leading supplier of solar panels for communication satellites. Continuing advances in solar cell efficiency (now demonstrated at more than 40 percent under concentrated solar radiation), along with many other advances in space technology, have made the prospects for an economical space solar power system better than ever. Recently, the U.S. Defense Advanced Research Projects Agency selected Boeing to conduct the second phase of the Fast Access Spacecraft Testbed program, a multiphase effort to design and develop a ground-test prototype of a new high-powergeneration, ultra-lightweight spacecraft solar array. Boeing is also developing both radio frequency and laser power transmission and reception technologies, which will allow space- and Earth-based users to request and receive satellite-generated power on demand. “Boeing is currently combining these capabilities into a network-centric power system for near-term space solar power demonstrators,” Dean Davis said. He’s senior principal aerospace scientist/engineer and Space Solar Power study leader with the Boeing Phantom Works Analysis, Modeling, Simulation & Experimentation team in El Segundo, Calif. Davis added, “We hope these projects will lead to full-scale power satellites that, when combined with terrestrial solar, hydroelectric, geothermal and wind-power sources, will be able to provide independence from fossil-fuel energy within the next 50 years.”

# Spending Link Turn

**Even if they win the plan costs a lot of money, we save infinitely more in the long term**

**Macauley and Shih** 4-10-**07**, Research Director and Senior Fellow at Resources For the future, “ Satellite solar power: Renewed interest in an age of climate change?” [http://www.sciencedirect.com/science/article/pii/S0265964607000264]

As noted above. a cost index links the supply and demand components of the model. The index formulation is an extension of an approach pioneered by Bresnahan [16]. Who developed an index for measuring net benefits to society from part investment in new technologies? Bresnahan`s index compares the price and performance of a new product against the price and performance of a best available product had the technical advance not occurred. The approach builds on consumer price indices in which. to the extent possible. Quality differences among goods and services are incorporated. An advantage of an index-based approach is that under certain general mathematical assumptions. the index is a function only of observed costs. adjusted for quality differences. and the share of expenditure represented by the product in total expenditures. The index is also ideal for applying to derived demand rather than final demand for a product. For example. Bresnahan applies the index to consumer demand for new computer technologies as inputs into financial and other sectors of the economy. By analogy. the model here is applied to demand for SSP as an input into the production of electricity. We extend Bresnahan`s approach in two directions. The first extension makes the index prospective in order to evaluate the potential future gains from investment in SSP. This adjustment allows for gradual diffusion of a new technology. The extension is obtained by expressing the model’s parameters as probability distributions to reflect uncertainty over future or estimated parameter values for both SSP and conventional. or "defender” technology. The second extension adjusts for differences among all the technologies in their environmental effects and reliability-to capture costs and benefits that are not fully reflected in capital and operating costs. Testing of the model includes sensitivity analyses by shifting parameter locations to assess the robustness of assumptions about uncertain parameters. **The result is a theoretically grounded economic model of future social benefits.** The output is a rigorous yet transparent index that can be used to assemble R&D portfolios from a selection of competing projects, or to indicate performance of prospective investment in new technologies. In this way, the index can be a useful tool for managers and engineers. The output also includes the discounted present value of expected benefits, an understandable and meaningful measure to communicate the potential value of SSP to decision makers.

# SPS Spills Over

**SPS spills over to solve space radar and other satellites. (add-on???)**

**The Space Review 7**, (Taylor Dinerman, “Solar power satellites and space radar” http://integrator.hanscom.af.mil/2007/July/07262007/07262007-16.htm, July 16, 2007) // CCH

One of the great showstoppers for the Space Radar (SR) program, formerly known as Space Based Radar, is power. It takes a lot of energy to transmit radar beams powerful enough to track a moving target on Earth from space. What is called the Ground Moving Target Indicator (GMTI) is what makes SR so much better than other space radar systems, such as the recently-launched German SAR-Lupe or the NRO’s Lacrosse system. While many of the details are classified, the power problem seems to be the main reason that the US Congress, on a bipartisan basis, has been extremely reluctant to fund this program. In order to achieve the power levels needed for an effective GMTI system using current technology, very large solar arrays would be needed. Even if these were to use the new Boeing solar cells that, according to the company, are more than 30% efficient, the arrays would still be much bigger than anything on any operational satellite. Such large arrays would make the SR spacecraft easy targets for enemy antisatellite weapons and would also produce so much drag while in low Earth orbit (LEO) that their lifespan would be shorter—perhaps much shorter—than current-generation reconnaissance satellites. Why, then, does such a system need to rely 100% on its own power? If solar power satellites (SPS) were available in geosynchronous orbit and could beam electricity to the SR satellites in LEO, this might allow the radar satellites to have as much power as their power control systems and heat radiators could handle. Power could be transmitted by a tightly focused laser or microwave beam to one or two receptors, integrated into the spacecraft’s bus. If the radar antenna were integrated into the skin of the satellite the way it is on a B-2 bomber, such satellite would be difficult to detect and track. Using power from an SPS, such a satellite would be able to liberally use its ion engines to change its orbit. These engines would never be powerful enough to make the kind of quick responsive maneuvers that some space operations commanders would like to see in future LEO-based spacecraft, but they would be a step in the right direction. The demise of the E-10 program that had been intended to replace the Air Force’s JSTARS and AWACS surveillance aircraft has left a hole in future US situational awareness capabilities that neither unmanned aerial vehicles (UAVs), such as the Predator and Global Hawk, nor existing satellite programs can possibly fill. Space Radar could do so, but only if the program is restructured to make it at once more ambitious in terms of future capability and less ambitious in terms of near-term operations. The first steps in such a program would be to begin work on an experiment to prove that power transmission in space via laser is possible. Already lasers are being used for communications in civil and military applications; taking this one step beyond to encompass power should be within the state of the art. At the same time the US Defense Department and NASA could begin joint work on a new generation of high-capacity power systems for future spacecraft. The power management and thermal control needs of a spacecraft that will carry a human crew to Mars may not be all that different from those of an SPS or an SR satellite. The bulk of the development work on the radars themselves can be left until later in the program. Meanwhile, the US could profitably study less ambitious space radar programs such as Canada’s Radarsat. Launching one or two modest technology development satellites over the next five or ten years would be a helpful way to set the stage for a new SR program. In the long term, say, by around 2010, the GMTI radar could be replaced and supplemented by an Air Moving Target Indicator (AMTI), which would need even more power. Instead of using a single large antenna or multiple smaller ones on the same spacecraft, a future stealthy SR could use radars on multiple satellites. Formation flying is now commonplace and coordinating multiple beams from two or three satellites in different orbits should not be that hard. The biggest problem will be to prove to Congress that the technology is ready for prime time. Almost all of America’s major military space programs are too far along to effectively incorporate the lessons of China’s ASAT test. SR, due to repeated budget cuts, is the great exception. Other satellite programs that could be modified to incorporate the needs of the new space warfare requirements include the T-SAT Transformational Communications project and the possibly the NRO’s problem-plagued Future Imagery Architecture (FIA). The stealthiness and robustness of all these programs, or their successors, would benefit from being able to draw electricity from a set of SPSs in GEO. The solar power satellites themselves would not necessarily have to be owned by the US government. They could be built privately based on a contract that promises that the Defense Department would buy a given amount of power at a predetermined price. This would be similar to the “power by the hour” contracts that are sometimes signed with jet engine manufacturers or the privately-financed initiative that the British RAF has established with a consortium for a new squadron of Airbus refueling tanker aircraft. In GEO an SPS is a large and conspicuous target. A realistic new space architecture would have to find ways to give both active and passive protection to such valuable assets. At the same time, these measures must not detract from the commercial profitability of the operation. The Civil Reserve Air Fleet system is a possible model; airlines buy some planes that are modified for possible military use in an emergency and the government compensates them for the extra weight they carry while in normal commercial use. Space solar power is, in the long run, inevitable. The Earth’s economy is going to need so much extra power over the next few decades that every new system that can be shown to be viable will be developed. If the US were to develop space solar power for military applications it would give the US civilian industry a big head start. As long as the military requirements are legitimate, there is no reason why this cannot be made into a win-win outcome.

# Sino-US Space Race Impact

**A Sino-American space race would have multiple implications**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies (Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>)

A key question is whether the United States can prevent potential adversaries from using space for military purposes without making its own space assets more vulnerable. United States doctrine envisions using a range of diplomatic, legal, economic and military measures to limit an adversary's access to space. However China will almost certainly be able to use indigenous development and foreign technology to upgrade its space capabilities. Non-military means may limit Chinese access to some advanced technologies, but they will not prevent the PLA from using space. Despite U.S. economic and technological advantages, an unrestrained space race would impose significant costs and produce few lasting strategic advantages unless the United States can dominate both offensively, by destroying an adversary's space assets, and defensively, by protecting U.S. space assets. Otherwise, the likely result would be mutual (albeit asymmetrical) deterrence, with China building just enough ASATs to threaten U.S. space capabilities. This outcome would also legitimize anti-satellite weapons.

**There are many incentives for China to avoid a space race with the U.S.**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies (Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>)

There are some incentives to avoid confrontation. Proliferation of space weapons would inhibit scientific cooperation and raise costs of commercial satellites. (The global trend in both sectors is towards international collaboration to reduce costs.) Actual use of anti-satellite weapons could create space debris that might damage expensive commercial satellites. Commercial users of space are therefore likely to resist efforts to deploy counter-space capabilities. Beijing's strategic incentives may also change over time. Mindful of the Soviet Union's demise due to excessive military spending, Chinese leaders are wary of entering into an open-ended space race with the United States. Moreover, as Chinese military space capabilities improve and are integrated into PLA operations, the negative impact of losing Chinese space assets may eventually outweigh the potential advantages of attacking U.S. space capabilities. Despite incentives to avoid a space race, arms control solutions face significant obstacles. China has long advocated a treaty to prevent an arms race in outer space. The joint Sino-Russian U.N. working paper, tabled in May 2002, called for a ban on weapons in orbit and on any use of force against outer space objects. The United States has been skeptical about the utility of such a treaty, believing verification would be difficult and that it might limit future missile defense options. A ban on ASAT weapons would be one means of protecting U.S. satellites, but a verifiable ban would be hard to negotiate.

# \*\*\*NEG\*\*\*

# SPS Fails – Barriers

**SPS looks good on paper, but there’s too many barriers to solve – cost, cell disruption, and communication failure**

**Ramos 2k** – US Air Force Major, Thesis submitted for the AIR COMMAND AND STAFF COLL MAXWELL Air Force Base (Kim, “Solar Power Constellations: Implications for the United States Air Force,” April, http://handle.dtic.mil/100.2/ADA394928)

Current barriers to implementation are the cost for the system, the high cost of launch services, solar cell inefficiencies, and possible communication frequency interference. The type of solar power satellite architecture proposed has a lot to do with cost. Regardless of the architecture all the designs are on an order of several billions of dollars. This price tag has a tendency to scare away potential investors. The high cost of launches contributes to that estimate. Until the price per pound to put a payload in orbit comes down, this will continue to be a barrier. In addition to cost, the inefficiencies of solar cells are also a barrier to implementation. Solar cells, the main method for harnessing solar power currently have efficiencies in the range of 20%. This means that the solar arrays must be kilometers in size to generate enough power worth beaming back to earth. The final barrier to implementation is frequency interference. In the arena of communications, before scientists conducted experiments, many supposed that there was a potential for interference from the beam on communications systems, radar, and aircraft communications in the geographic area of the beam. 21 A Japanese study conducted in 1993 demonstrated that a high power microwave beam would not be strong enough to interfere with telecommunications. 22 However, most of the articles and research supporting solar power satellites still list frequency or communications interference as an issue to resolve

# SPS Not Feasible

**Obsessions with SPS have nothing to do with feasibility.**

**Day**, “American space historian and policy analyst and served as an investigator for the Columbia Accident Investigation Board”, **8**

[Dwayne A. Day; “Knights in shining armor”, The Space Review; 6/9/2008t; <http://www.thespacereview.com/article/1147/1>]

The reason that SSP has gained nearly religious fervor in the activist community can be attributed to two things, neither having to do with technical viability. The first reason is increased public and media attention on environmentalism and energy coupled with the high price of gasoline. When even Reese’s Peanut Butter Cups are advertised with a global warming message, it’s clear that the issue has reached the saturation point and everybody wants to link their pet project to the global warming discussion. SSP, its advocates point out, is “green” energy, with no emissions—other than the hundreds, or probably thousands, of rocket launches needed to build solar power satellites. The second reason is a 2007 study produced by the National Security Space Office (NSSO) on SSP. The space activist community has determined that the Department of Defense is the knight in shining armor that will deliver them to their shining castles in the sky.

**SPS isn’t feasible- no technology right now**

**EDMONTON JOURNAL 6/12**/2011 [“Solar satellites key to green energy”, June 12th, 2011, <http://www.edmontonjournal.com/technology/Solar+satellites+green+energy/4933251/story.html> MA]

There is a significant design flaw keeping these satellites from production. One of the major shortfalls in the design of SPSs is simply in getting the power from point A to point B. This remains the most controversial aspect of SPSs: the use of microwaves to transmit power from high orbit to the ground. Critics often cite the dangers of microwave radiation to humans and wildlife, however, the strength of the radiation from these beams would be equal to the leakage from a standard microwave oven, which is only slightly more than a cellphone. A NASA report from 1980 reveals that the major concern with solarpowered satellites was problems with the amplifier on the satellite itself. Several workable solutions were proposed in that same report. The report also recommended that NASA develop and invest in SPS technology, so that by the 2000s, these satellites would be a viable alternative fuel source. This recommendation was ignored. We should already have the technology and the infrastructure in place for green energy, but we don't. Instead, we are engaged in a mad dash for the quickest, cheapest alternative to oil and that may be the source of our downfall.

# NSSO Indict

**Their NSSO evidence is a failure.**

**Day**, “American space historian and policy analyst and served as an investigator for the Columbia Accident Investigation Board”, **8**

[Dwayne A. Day; “Knights in shining armor”, The Space Review; 6/9/2008t; <http://www.thespacereview.com/article/1147/1>]

The NSSO study is remarkably sensible and even-handed and states that we are nowhere near developing practical SSP and that it is not a viable solution for even the military’s limited requirements. It states that the technology to implement space solar power does not currently exist… and is unlikely to exist for the next forty years. Substantial technology development must occur before it is even feasible. Furthermore, the report makes clear that the key technology requirement is cheap access to space, which no longer seems as achievable as it did three decades ago (perhaps why SSP advocates tend to skip this part of the discussion and hope others solve it for them). The activists have ignored the message and fallen in love with the messenger. But in this case, the activists touting the NSSO study do not understand where the NSSO fits into the larger military space bureaucracy. The National Security Space Office was created in 2004 and “facilitates the integration and coordination of defense, intelligence, civil, and commercial space activities.” But any office that “facilitates” the activities of other organizations has limited influence, especially when those other organizations are much bigger and have their own interests and connections to the senior leadership. The NSSO has a minimal staff and budget and does not command any assets—it does not fly any satellites, launch any rockets, or procure any hardware, all of which are measures of power within the military space realm. Simply put, the NSSO exists essentially as a policy shop that is readily ignored by the major military space actors such as Strategic Command, Air Force Space Command, and the National Reconnaissance Office whenever it suits them. As one former NSSO staffer explained, the office consists of many smart, hardworking people who have no discernible influence on military space at all. In fact, for several years there have been persistent rumors that the NSSO was about to be abolished as unnecessary, irrelevant, and toothless. Add to this the way in which the NSSO’s solar power satellite study was pursued—the study itself had no budget. In Washington, studies cost money. If the Department of Defense wants advice on, say, options for space launch, they hire an organization to conduct the study such as the RAND Corporation, or they employ one of their existing advisory groups such as the Air Force Scientific Advisory Board. All of this requires money to pay for the experts to perform the work. Even if the study is performed by a committee of volunteers, there are still travel, printing, staff support, overhead, and other expenses. Costs can vary widely, but at a minimum will start in the many tens of thousands of dollars and could run to a few million dollars. In contrast, the NSSO study of space solar power had no actual funding and relied entirely upon voluntary input and labor. This reflects the seriousness by which the study was viewed by the Pentagon leadership. If all this is true, why is the space activist community so excited about the NSSO study? That is not hard to understand. They all know that the economic case for space solar power is abysmal. The best estimates are that SSP will cost at least three times the cost per kilowatt hour of even relatively expensive nuclear power. But the military wants to dramatically lower the cost of delivering fuel to distant locations, which could possibly change the cost-benefit ratio. The military savior also theoretically solves some other problems for SSP advocates. One is the need for deep pockets to foot the immense development costs. The other is an institutional avatar—one of the persistent policy challenges for SSP has been the fact that responsibility for it supposedly “falls through the cracks” because neither NASA nor the Department of Energy wants responsibility. If the military takes on the SSP challenge, the mission will finally have a home. But there’s also another factor at work: naïveté. Space activists tend to have little understanding of military space, coupled with an idealistic impression of its management compared to NASA, whom many space activists have come to despise. For instance, they fail to realize that the military space program is currently in no better shape, and in many cases worse shape, than NASA. The majority of large military space acquisition programs have experienced major problems, in many cases cost growth in excess of 100%. Although NASA has a bad public record for cost overruns, the DoD’s less-public record is far worse, and military space has a bad reputation in Congress, which would never allow such a big, expensive new program to be started. Again, this is not to insult the fine work conducted by those who produced the NSSO space solar power study. They accomplished an impressive amount of work without any actual resources. But it is nonsensical for members of the space activist community to claim that “the military supports space solar power” based solely on a study that had no money, produced by an organization that has no clout.

# Warming Defense

**Warming isn’t anthropogenic- IPCC is false**

**Kemm,** nuclear physicist and is the CEO of Stratek Business StrategyConsultants, **7/1/**2011 [Kelvin, “ IPCC not an authority on climate change”, July 1st, 2011, <http://www.engineeringnews.co.za/article/ipcc-far-from-an-authority-on-climate-change-2011-07-01> MA]

The Intergovernmental Panel on Climate Change (IPCC), a body of the United Nations, is often projected as the world authority on climate change. This is far from the truth. The IPCC has always projected a very scary image of the world being plunged into disaster as a result of the actions of mankind. The IPCC supports the theory that man-made carbon dioxide (CO2) is the cause of global warming. Despite significant evidence that any global warming observed is probably due to the incidence of cosmic rays from the stars, the IPCC refuses to be scientifically honest and to take this scientific evidence into account. In one of its reports, the IPCC relied heavily on the now infamous Hockey Stick graph, which purported to show a great increase in temperature rise during the twentieth century. This graph has now been totally discredited, and the IPCC has withdrawn it. In 2009, the Climategate affair was made public. In Climategate, a group of scientists led by Phil Jones, of the Climate Research Unit of the University of East Anglia, in the UK, manipulated results to falsely show that the earth was warming more than was the truth. This affair gave rise to the phrase ‘Hide the decline’, when many emails were discovered that had been passed between this group of people in which they plotted their deception. They were writers of a chapter of the IPCC report known as AR4. Last year, the IPCC was forced to apologise that it had grossly overstated the threat to the melting of the Himalayan glaciers. Well, the IPCC is in hot water again. It has just been revealed that an IPCC report released in May, stating that the whole world could be running on 77% renewable energy by 2050, was largely written by a prominent member of Greenpeace. The man who led the campaign to expose Climategate was Steve McIntyre, a Canadian engineer. McIntyre is playing a role in exposing the latest scandal. On 17 June, Mark Lynas, a journalist, refer- ring to the Greenpeace person’s major role in the current IPCC report, wrote on his blog, http://www.marklynas.org/2011/06/questions-the-ipcc-must-now-urgently-answer/: “Here’s the scenario. An Exxon-Mobil employee – admittedly an energy specialist with an engineering background – serves as a lead author on an important IPCC report looking into the future of fossil fuels. The Exxon guy and his fellow lead authors assess a whole variety of literature, but select for special treatment four particular papers – one produced by Exxon-Mobil. This paper heralds great things for the future of fossil fuels, suggesting they can supply 80% of the world’s energy in 2050, and this headline is the first sentence of the ensuing IPCC press release, which is picked up and repeated uncritically by the world’s media. “Pleased, the Exxon employee issues a self-congratulatory press release, boasting that his paper had been central to the IPCC effort and urging the world’s governments to get on with opening up new areas to oil drilling for the benefit of us all. “Well, you can imagine the furore this would cause at Greenpeace. The IPCC would be discredited forever as an independent voice. There would be pious banner-drops by Greenpeace activists abseiling down Exxon HQ and harshly criticising the terrible stranglehold that fossil fuel interests had achieved over supposedly independent science. Campaigners everywhere would be up in arms. Greenpeace would feel doubly justified in taking direct action against new oil wells being opened up in the Arctic, and its activists could demonstrate new feats of gallantry and bravery as they took on the might of the world’s oil industry with some ropes and a rubber dinghy somewhere near Greenland. “How is the Exxon scenario different from what has just happened with the IPCC’s renew- ables report? And why – when confronted with this egregious conflict of interest and abuse of scientific independence – has the response of the world’s green campaigners been to circle the wagons and cry foul against the whistle-blowers themselves? That this was spotted at all is a tribute to the eagle eyes of McIntyre. Yet I am told that he is a ‘denier’, that all his deeds are evil, and that I have been naively led astray by him. Well, if the ‘deniers’ are the only ones standing up for the integrity of the scientific process, and the independence of the IPCC, then I too am a ‘denier’. Indeed, McIntyre and I have formed an unlikely double act, posing a series of questions – together with the New York Times’ Andy Revkin – to the IPCC report’s lead author, rofessor Ottmar Edenhofer, to which he has yet to respond. “Here’s some classic closing of ranks by Stefan Singer, of the WWF, riding to the rescue of his embattled Green-peace colleagues in a comment on my original blog post: ‘Yes, I am biased as well, I am director for energy policy at the WWF – we scandalously dared to publish a global energy scenario a few months ago, showing how the world can go to even 95% renewables by 2050 and, even more shocking, we also showed in that scenario how global energy consumption can indeed be reduced globally with substantive energy conservation and efficiency policies without curtailing growth and economic activities. Moreover, if we want to combat climate change effectively (which, I rea- lise, not everyone supports on this exchange), what is wrong with showing that renewables can contribute 80% or even more to global energy supply? Mark Lynas, in case you take that serious (sic), you should thank Greenpeace and the NGOs to drive that debate.’” What the IPCC always does, and did in this case, is that it issues a ‘summary’ of the report a month before the actual report is made public. So the press get the summary and report on it. It is then a whole month later when the actual substance of the report can be examined. The current report, in its depths, assumes that there will be huge world reduction in electricity consumption. They are talking of real consumption, not efficiency improvements, or reduction in growth rates. This effectively means that, in the whole of Africa, no substantive extra electricity can be used. So South Africa’s plans to double electricity production would be a no-no, according to the WWF and Greenpeace.

**Warming is false- Earth is cooling**

**Kemm,** nuclear physicist and is the CEO of Stratek Business StrategyConsultants, **7/1/**2011 [Kelvin, “ IPCC not an authority on climate change”, July 1st, 2011, <http://www.engineeringnews.co.za/article/ipcc-far-from-an-authority-on-climate-change-2011-07-01> MA]

In the meantime, another piece of news has just emerged. The current cooling trend of the earth, which gave rise to the two years of severe winters in Europe and the US, may continue. Journalist Lewis Page, of The Register, wrote on June 14: “What may be the science story of the century is breaking this evening, as heavyweight US solar physicists announce that the sun appears to be headed into a lengthy spell of low activity, which could mean that the earth – far from facing a global warming problem – is actually headed into a mini Ice Age. “The announcement made on June 14 comes from scientists at the US National Solar Observatory (NSO) and the US Air Force Research Laboratory. Three different analyses of the sun’s recent behaviour all indicate that a period of unusually low solar activity may be about to begin. The sun normally follows an 11-year cycle of activity. The current cycle, Cycle 24, is now supposed to be ramping up towards maximum strength. Increased numbers of sunspots and other indications ought to be happening, but . . . results so far are most disappointing. Scientists at the NSO now suspect, based on data showing decades-long trends leading to this point, that Cycle 25 may not happen at all. “This could have major implications for the earth’s climate. A statement issued by the NSO, announcing the research, stated: ‘An immediate question is whether this slowdown presages a second Maunder Minimum, a 70-year period with virtually no sunspots [which occurred] during 1645–1715.’ “As Nasa notes: ‘Early records of sunspots indicate that the sun went through a period of inactivity in the late seventeenth century. Very few sunspots were seen on the sun from about 1645 to 1715. Although the observations were not as extensive as in later years, the sun was, in fact, well observed during this time and this lack of sunspots is well documented. This period of solar inactivity also corresponds to a climatic period called the Little Ice Age, when rivers that are normally ice free froze and snow fields remained year round at lower altitudes. There is evidence that the sun has had similar periods of inactivity in the more distant past.’ “During the Maunder Minimum and for periods either side of it, many European rivers which are ice free today – including the Thames – routinely froze over, allowing ice skating and even for armies to march across them in some cases. “‘This is highly unusual and unexpected,’ says Dr Frank Hill, of the NSO. ‘But the fact that three completely different views of the sun point in the same direction is a powerful indicator that the sunspot cycle may be going into hibernation.’

# Energy Impacts Inevitable

**A switch to renewable is inevitable- oil will run out**

**Walker,** writer for National Geographic, 20**04** [Cameron, “The Future of Alternative Energy”, October 28th, 2004, <http://news.nationalgeographic.com/news/2004/10/1028_041028_alternative_energy.html>, MA]

Residential energy use in the United States will increase 25 percent by the year 2025, according to U.S. Department of Energy (DOE) forecasts. A small but increasing share of that extra power will trickle in from renewable sources like wind, sunlight, water, and heat in the ground. Last year alternative energy sources provided 6 percent of the nation's energy supply, according to the DOE. "The future belongs to renewable energy," said Brad Colllins, the executive director of the American Solar Energy Society, a Boulder, Colorado-based nonprofit. Scientists and industry experts may disagree over how long the world's supply of oil and natural gas will last, but it will end, Collins said. While renewable energy is generally more expensive than conventionally produced supplies, alternative power helps to reduce pollution and to conserve fossil fuels. "People sometimes get caught up in cost-effectiveness," said Paul Torcellini, a senior engineer at the DOE's National Renewable Energy Laboratory (NREL) in Golden, Colorado. "But it can be a question of values and what we spend our money on." Below, a look at some recent developments in renewable-energy technology: Solar Power Photovoltaic, or solar-electric, systems capture light energy from the sun's rays and convert it into electricity. Today these solar units power everything from small homes to large office buildings. Technological improvements have made solar-electric modules more cost-effective. In the 1980s the average price of energy captured with photovoltaics was 95 U.S. cents per kilowatt-hour. Today that price has dropped to around 20 cents per kilowatt-hour, according to Collins, of the American Solar Energy Society. The cheaper rate is still more expensive than the average national price of electricity, which in 2003 was a little over 8 cents per kilowatt-hour, according to the U.S. Department of Energy's Annual Energy Review. Other recent advances include "thin film" photovoltaic technology, a high-tech coating that converts any surface covered with the film into a solar-electric power source. Boats and RVs that use the film are now on the market.

# Spending Link

**SPS is expensive- each launch costs 5 billion**

**EDMONTON JOURNAL 6/12**/2011 [“Solar satellites key to green energy”, June 12th, 2011, <http://www.edmontonjournal.com/technology/Solar+satellites+green+energy/4933251/story.html> MA]

So, with so many points in its favour, why hasn't anyone built one yet? Obviously, putting anything into outer space takes a lot of money. Many governments claim there simply isn't any money in the budge t for launching satellites into space, but in 2010, amid an economic crisis, the United States managed to find $426 million for nuclear fusion research and $18.7 billion for NASA, a five-per-cent increase from 2009. The most recent projections, made in the 1980s, put the cost of launching an SPS at $5 billion, or around 8-10 cents/ kWh. Nuclear power plants cost a minimum of $3 billion to $6 billion, not including cost overruns, which can make a plant cost as much as $15 billion. In the U.S., nuclear power costs about 4.9 cents/kWh, making SPS power supply only slightly more expensive. But these estimates are over two decades old and the numbers likely need to be re-examined. The idea for space-based solar energy has been around since the '60s; given the technological advancements since then, surely governments would have invested in making an SPS power supply more budget-friendly. That is not the case. Governments and investors are rarely willing to devote funding to something that doesn't have quick cash returns. The projected cost of launching these satellites once ranged from $11 billion to $320 billion. These figures have been adjusted for inflation, but the original estimates were made back in the 1970s, when solar technology was in its infancy, and may have since become grossly inaccurate.

# Co-Op DA – Solves Peace

**Cooperation key – sustains world peace**

**Mahan, 07 -** founder of Citizens for Space Based Solar Power (Rob, SBSP FAQ, based on a Bright Spot Radio interview from December 28th, 2007, <http://c-sbsp.org/sbsp-faq/>, MA)

The U.S. Government must take a lead role in creating an environment that will enable the development of space-based solar power. Congress must organize a public – private effort because existing agencies, such as the U.S. House Committee on Science & Technology, the Department of Energy, the Advanced Research Projects Agency – Energy, the Pentagon’s National Security Space Office and NASA, are not set up for the large scale manufacturing that will be required. The U.S. private sector will be key in the development of space-based solar power, and there is much precedent for Congress to foster just that kind of private sector development. The 1984 Commerical Space Launch Act was signed by President Reagan and the 1990 Launch Services Purchase Act was signed by President Bush. These Acts resulted in the private partnership, the United Launch Alliance (ULA), which places most U.S. payloads in orbit today. Arianespace, another private company, is similarly responsible for most European payloads. Commercial Orbital Transportation Services (COTS), such as Space Exploration Technologies (SpaceX) and Rocketplane Kistler (RpK) are already competing for U.S. orbital services contracts. Virgin Galactic, owned and operated by Sir Richard Branson and Burt Rutan, are already making inroads in space tourism. U.S. Allies, composed of 26 NATO Allies (United Kingdom, Canada, Germany, etc.) and 14 Major Non NATO Allies (Australia, Egypt, Japan, etc.) will also play vital roles in the development of space-based solar power. Space-based solar power should eventually benefit every citizen of the world. Georgia Tech supports a congressionally chartered public / private corporation, much like the 1862 Transcontinental Railroad Act which opened the West and the 1962 Commercial Satellite (COMSAT) Act which is now $100 Billion industry. The Georgia Tech Space Solar Power Workshop recommends the next great Congressional Act be called the SunSat Corporation. Here is an excerpt from the already written Charter – General Provisions – Opening Policy Statement: “The Congress declares that it is the policy of the United States to establish, in conjunction and in cooperation with other countries, as expeditiously as practicable a commercial space solar power satellite system, as part of environmentally enhanced and improved global electric power generation and networks, which will be responsive to public needs and national objectives, which will serve the growing electric power needs of the United States and other countries, and which will contribute to world peace, understanding, harmony and increased sustainable electric power generation and economic development.”

**Aerospace dominance inevitably starts a space race- tensions are high**

**The Washington Times, 8** (David. R Sands, “China, India hasten arms race in space; U.S. dominance challenged,” 6-25-08, Lexis, MA)

On the planet’s final frontier, more and more countries are beefing up their border guards. India became the latest country to boost its defense presence in space, announcing last week plans to develop a military space program to counter the fast-growing space defense efforts of neighboring China. India, which has an extensive civilian space satellite program, must “optimize space applications for military purposes,” army Chief of Staff Gen. Deepak Kapoor said at a defense conference in New Delhi. “The Chinese space program is expanding at an exponentially rapid pace in both offensive and defensive content.” Last month, Japanese lawmakers passed a bill ending a decades-old ban on the use of the country’s space programs for defense, although officials in Tokyo insist that the country has no plans to develop a military program in space. French President Nicolas Sarkozy, in the first major review of France’s defense and security policy in more than a decade, has proposed nearly doubling spending for space intelligence assets, including spy satellites, to more than $1 billion annually. “I don’t think what you are seeing is coincidental,” said Wade Boese, a researcher at the Washington-based Arms Control Association. “Countries are increasingly aware of the potential for military development in space, and increasingly aware that other countries are moving ahead.” The issue of an arms race in space took on new prominence in January 2007, when China stunned Western military analysts by using a medium-range ballistic missile to shoot down a defunct weather satellite. Pentagon planners said two orbiting U.S. spacecraft were forced to change course to avoid being hit by the thousands of pieces of space debris caused by the surprise test. China insists the exercise was not conducted for military reasons. “We are against weaponization or an arms race in space,” Zhou Wenzhong, China’s ambassador to the United States, said in an interview at The Washington Times earlier this month. “This was a scientific experiment.” But in what many around the world saw as at least in part a return salvo to the Chinese action, the U.S. Navy in February shot down a wayward U.S. spy satellite over the Pacific, arguing that the action was needed to prevent the craft from crashing to Earth and spreading potentially toxic fuel. India, which competes for influence with China even as trade relations between the two Asian giants have blossomed, made no effort to hide its concerns about Beijing’s plans for space. “With time we will get sucked into a military race to protect our space assets and inevitably there will be a military contest in space,” Lt. Gen. H.S. Lidder, one of India’s most senior officers, said last week in comments reported by the Indian Express newspaper and confirmed by the country’s defense ministry. “In a life-and-death scenario, space will provide the advantage,” Gen. Lidder said. Although the United States holds a vast technological and spending edge in space defense programs, the military’s reliance on satellites and space-based assets exposes the United States more than any other country to military threats in space. Nancy Gallagher and John D. Steinbruner, researchers at the University of Maryland’s Center for International Studies, argue in a study that the Pentagon cannot hope to dominate space through technological and material superiority.

**Dependence on space risks space war with China**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies

(Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>, MA)

The U.S. military also makes extensive use of space for intelligence, communications, meteorology and precision targeting. Chinese analysts note that that the United States employed more than 50 military-specific satellites plus numerous commercial satellites in the 2003 Iraq war. They also highlight the extensive U.S. reliance on GPS to support precision-guided munitions. The United States' space dependence will deepen as transformation and network-centric warfare increase the importance of rapid collection and dissemination of information down to tactical units and individual soldiers. Satellites also play a crucial role in U.S. missile defenses. As U.S. dependence on space increases, concerns have grown about the potential for adversaries to attack U.S. space assets. According to current Department of Defense (DOD) doctrine, "The United States must be able to protect its space assets ... and deny the use of space assets by its adversaries. Commanders must anticipate hostile actions that attempt to deny friendly forces access to or use of space capabilities." The 2001 Rumsfeld Commission report warned of a potential "space Pearl Harbor" if adversaries attack U.S. satellites. Underpinning these concerns is the possibility that China might target U.S. space assets in a future conflict. exploited. As one defense analyst wrote: "for countries that can never win a war with the United States by using the method of tanks and planes, attacking the U.S. space system may be an irresistible and most tempting choice." Chinese strategists have explored ways of limiting U.S. use of space, including anti-satellite (ASAT) weapons, jamming, employing lasers to blind reconnaissance satellites, and even using electro-magnetic pulses produced by a nuclear weapon to destroy satellites. A recent article highlighted Iraq's efforts to use GPS jammers to defeat U.S. precision-guided munitions. Chinese scientists have conducted theoretical research relevant to ASAT weapons, including the use of lasers to blind satellite sensors, kinetic kill vehicles, computations for intercepting satellites in orbit, and maneuvering small satellites into close formation. Efforts to develop high-powered lasers and mobile small-satellite launch capabilities involve technologies with both commercial and ASAT applications. China probably already has sufficient tracking and space surveillance systems to identify and track most U.S. military satellites. The extent to which interest in exploiting U.S. space dependence has translated into actual ASAT development programs remains unclear. Some reports claim that Beijing is developing microsatellites or direct-ascent weapons for ASAT purposes, but the open source literature does not provide definitive proof. However, based on Chinese strategic writings, scientific research and dual-use space activities, it is logical to assume China is pursuing an ASAT capability.

**US space domination risks US-Sino space war.**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies

(Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>, MA)

Efforts to exploit space for military purposes, and strategic incentives to target U.S. space assets, have put China on a collision course with a U.S. doctrine that emphasizes protecting U.S. space assets and denying the use of space by adversaries. Whether a Sino-American space race can be avoided will depend on strategic decisions by both sides and the priority placed on space control versus commercial, scientific and other military applications of space. A key question is whether the United States can prevent potential adversaries from using space for military purposes without making its own space assets more vulnerable. United States doctrine envisions using a range of diplomatic, legal, economic and military measures to limit an adversary's access to space. However China will almost certainly be able to use indigenous development and foreign technology to upgrade its space capabilities. Non-military means may limit Chinese access to some advanced technologies, but they will not prevent the PLA from using space. Despite U.S. economic and technological advantages, an unrestrained space race would impose significant costs and produce few lasting strategic advantages unless the United States can dominate both offensively, by destroying an adversary's space assets, and defensively, by protecting U.S. space assets. Otherwise, the likely result would be mutual (albeit asymmetrical) deterrence, with China building just enough ASATs to threaten U.S. space capabilities. This outcome would also legitimize anti-satellite weapons. There are some incentives to avoid confrontation. Proliferation of space weapons would inhibit scientific cooperation and raise costs of commercial satellites. (The global trend in both sectors is towards international collaboration to reduce costs.) Actual use of anti-satellite weapons could create space debris that might damage expensive commercial satellites. Commercial users of space are therefore likely to resist efforts to deploy counter-space capabilities. Beijing's strategic incentives may also change over time. Mindful of the Soviet Union's demise due to excessive military spending, Chinese leaders are wary of entering into an open-ended space race with the United States. Moreover, as Chinese military space capabilities improve and are integrated into PLA operations, the negative impact of losing Chinese space assets may eventually outweigh the potential advantages of attacking U.S. space capabilities. Despite incentives to avoid a space race, arms control solutions face significant obstacles. China has long advocated a treaty to prevent an arms race in outer space. The joint Sino-Russian U.N. working paper, tabled in May 2002, called for a ban on weapons in orbit and on any use of force against outer space objects. The United States has been skeptical about the utility of such a treaty, believing verification would be difficult and that it might limit future missile defense options. A ban on ASAT weapons would be one means of protecting U.S. satellites, but a verifiable ban would be hard to negotiate. U.S. policymakers must address a number of difficult questions. Is space domination an achievable, affordable and sustainable objective? Will efforts to dissuade Beijing from developing ASAT weapons require tolerating significant improvements in Chinese military space capabilities? Can arms control protect U.S. space assets? The United States has legitimate security concerns about China's improving space capabilities, but will face tough choices in deciding on its best response.

# Space Debris DA – Link

**Solar sats get destroyed by space debris.**

**Brandhorst**, Space Research Institute at Auburn University, **2**

[Henry W. Brandhorst, Jr.; “ HYPERVELOCITY IMPACT STUDIES OF HIGH VOLTAGE SOLAR ARRAY SEGMENT”; 2002 – copyright International Astronautical Federation; <http://www.auburn.edu/research/vpr/sri/papers/hyper/wsc_iaf_hyperpaper.pdf>; Boyce]

From the series of tests performed here, several conclusions may be drawn. Based on the testing done to date, it appears as if solar arrays with unprotected contacts are susceptible to arcing independent of hypervelocity particle impacts. Although cover glasses were penetrated during HYPER testing and other cell contacts also damaged, no arcing occurred at those sites to the best of our detection ability. The GaAs samples had numerous areas with zero cover glass over hang so bias voltages above -200V could not be obtained. With larger coverglass overhang and better insulation of bare interconnects it may be possible to achieve voltages near 1000V on regular solar cells. The SLA samples had both cells and contact strips that were fully insulated. These samples showed no arcing upon hypervelocity particle impact at velocities as high as 11.6 km/sec and bias voltages up to -1000V. Thus it appears that these preliminary tests have uncovered basic design approaches that can lead to high voltage (up to at least 1000 V) solar arrays. This finding coupled with careful theoretical analyses promise a new era of high voltage array designs for high power applications.

# Space Debris DA – Impact

**Space debris collision causes electrical discharge- prevents satellites from working**

Y. **Akahoshi et al.**, Professor at Kyushu Institute of Technology, **08** [ T. Nakamuraa(Kyushu Institute of Technology) , S. Fukushigea (Kyushu Institute of Technology), N. Furusawaa (Kyushu Institute of Technology) , S. Kusunokia (Kyushu Institute of Technology), Y. Machidaa (Kyushu Institute of Technology), T. Kouraa (Kyushu Institute of Technology), K. Watanabeb (Osaka University), S. Hosodab (Osaka University, T. Fujitac (JAXA) and M. Choa (Kyushu Institute of Technology), International Journal of Impact Engineering, Volume 35, Issue 12, Pages 1678-1682, “Influence of space debris impact on solar array under power generation”, December 2008, <http://www.sciencedirect.com/science/article/pii/S0734743X0800170X#aff1>, MA]

Recently, long duration operations spacecraft, higher in power, higher in potential, and the solar array especially higher in potential have been proposed for the actualization of large space platform for industrial use, such as the space factory, the space hotel, and solar power satellite. The use of high power in future space missions calls for high voltage power generation and transmission to minimize the energy loss and the cable mass. Satellites after their end of life, upper stages of rockets and the parts and fragments from them are called space debris. Solar arrays that are designed for long periods of operation are more likely to be impacted by space debris. The potential for impact is greater as the size of the satellites is larger. Collision of space debris with active solar arrays may cause generation of high-density plasma induced by impact. Then plasma grows up by surrounding plasma, and the phenomenon called discharge might take place. Space debris poses an obvious mechanical damage hazard to space assets, and may also precipitate a catastrophic electrical discharge that disrupts or disables onboard systems [1]. This discharge results in short circuits on the solar array and current does not ﬂow into the satellite. This fact yields to the reduction of electric power of the solar array, and the impact inﬂuences on the satellite missions. Many debris and dust impacts were conﬁrmed on fuselage of retrieved satellite SFU and solar array of satellite Eureca. Generation of the discharge phenomenon by debris impact is not yet conﬁrmed, but such possibility will be increasingly important. For example, the discharge phenomenon called ‘‘sustained arc’’ is suggested as a cause of trouble of geostationary satellite Tempo-2.

**Plasma causes electrical discharge-Experiment proves**

Y. **Akahoshi et al.**, Professor at Kyushu Institute of Technology, **08** [ T. Nakamuraa(Kyushu Institute of Technology) , S. Fukushigea (Kyushu Institute of Technology), N. Furusawaa (Kyushu Institute of Technology) , S. Kusunokia (Kyushu Institute of Technology), Y. Machidaa (Kyushu Institute of Technology), T. Kouraa (Kyushu Institute of Technology), K. Watanabeb (Osaka University), S. Hosodab (Osaka University, T. Fujitac (JAXA) and M. Choa (Kyushu Institute of Technology), International Journal of Impact Engineering, Volume 35, Issue 12, Pages 1678-1682, “Influence of space debris impact on solar array under power generation”, December 2008, <http://www.sciencedirect.com/science/article/pii/S0734743X0800170X#aff1>, MA]

In this study, hypervelocity impact tests were performed on solar array under pseudo power generation by an external circuit and collected data about short circuit between solar array and the substrate, in order to evaluate discharges and sustained arcs induced by space debris impact, the plasma created by hypervelocity impact was reasoned as well as the circuit current and the string voltage in the external circuit. In the results, it was determined the electron temperature and the electron density function of the impact velocity. Especially, the electron density increases exponentially. Spread plasma created by hypervelocity impact can initiate discharge which is able to become sustained arc on detached point. We will carry out tests using a real solar array coupon in order to conﬁrm sustained arc on the solar array coupon in the future.

# AT: Debris Add-On

**The plan can’t solve debris – technical incapability’s and needs international cooperation**

Kirk **Woellert 09,** Navy Intelligence Officer with space system experience. Graduate of Space Policy Institute, George Washingtion University. “Space Debris: Why the U.S. cannot go it alone” [http://www.thespacereview.com/article/1373/1]

A recent article in The Space Review claims the US should deal with the issue of space debris unilaterally (see “Unilateral orbital cleanup”, May 4, 2009). A complete analysis of individual space debris removal strategies is beyond the scope of this forum. For that matter, even the question of a passive or active strategy for dealing with space debris is a complex issue by itself. The purpose herein is to look at one active space debris strategy proposal and point out some technical and policy implications. The conclusion is the US cannot afford to, nor should it attempt to, deal with space debris on its own. Considering the assertion in that article: *“What is required is a new type of space maneuver vehicle, one that can rendezvous with, catch, and store a bit of debris, and then proceed to the next one. Such a vehicle would not need to move very fast: the process would be a leisurely one, and thus would allow for the use of a highly efficient space propulsion system such as a pulse plasma thruster or ion engine.”* The proposal is for a dedicated spacecraft to maneuver and capture individual pieces of space debris. The proposed vehicle would rely on ultra-efficient propulsion such as ion or plasma arc-jet thrusters. On the surface the concept may appear sound. However, it’s worthwhile to delve into a bit of orbital mechanics. First, there are thousands of space debris objects actively tracked and many thousands more that are not tracked. Although on a large scale there are clusters and gaps in the debris field, each of these objects are in unique orbits. Various types of orbital maneuvers would need to be continuously executed. These maneuvers will include changes in the vehicle altitude, period, right ascension, and inclination. A first order analysis of the mission profile would consider the most costly maneuver in terms of energy, a change in orbital inclination. Typically such analysis calculates the change in velocity or “deltaV” required to perform a maneuver. Although there are relative concentrations at select inclinations between roughly 60° and 100°, space debris takes on many inclination values spanning 0°–100°. Atmospheric drag dominates for circular orbits below about 200 kilometers. Hence any space debris orbiting at or below these altitudes will decay in a reasonable period of time. For purposes of this discussion, consider a space debris collection satellite performing an inclination change at an altitude of 500 kilometers. The orbital velocity for a satellite at any altitude is given by: (1) V = GMe/r where; G = universal gravitational constant Me = mass of the earth r = Radius of the earth plus the altitude of the satellite Using these values, the orbital velocity V = 7613 m/s. This would be the initial velocity of the spacecraft prior to any maneuver. Next let’s calculate the velocity change required for an inclination plane change. The formula for deltaV for an inclination change is: (2) deltaV = 2 x (Vi) x Sin (theta/2), where: Vi = initial velocity of the spacecraft prior to the maneuver Theta = angle between the planes of the initial and final orbits As a minimal case, what is the deltaV required for a 1° inclination change? From equation (2); Vi = 7613 m/s, theta = 1, resulting in a deltaV = about 66 m/s. Ion propulsion is very efficient and while propellant requirements are important, in this context they are less of a mission driver than the time required for maneuvers. How long must a typical ion thruster fire to achieve a deltaV of 66 m/s? A review of the literature shows calculating this involves tradeoffs and intermediate calculations that are probably beyond the scope of this forum. Instead we can draw upon real world experience and observations of aerospace professionals. The NASA Dawn spacecraft, which utilizes a contemporary ion thruster, can be a reference case. The Dawn web site quotes its ion engines at full thrust can achieve a velocity change of “0-60mph in 4 days”. That is equivalent to a deltaV of 27 m/s in 4 days. For this discussion the acceleration in this case should be computed: v = 27 m/s t = 4 days = 345,600 sec (1) a = v/t = (27 m/s) / (345600 sec) = 7.8 x 10e-5 m/sec2 or .00078 m/sec2 How long would the Dawn spacecraft need to achieve a 66 m/sec deltaV? Solving for t in equation (1): t = v/a = (66 m/sec) / (.00078 m/sec2) = 844,800 sec = 9.7 days Per the aforementioned analysis, a 1° change in inclination would require 9.7 days. This time does not include fine orbit maneuvers required to close to within a reasonable distance to the target debris. Another limiting factor to this concept is the mission profile does not allow for the advantage of continuous acceleration often cited for ion propulsion. Continuing on with the analysis, NORAD tracks about 19,000 objects in orbit. Assume half of these objects, or 9,500, require an inclination plane change maneuver of at least 1° for the vehicle to achieve co-orbit with the target. This implies the time to capture these objects would be (9,500 x 9.7 days) = 254 years. Admittedly this analysis is simplistic but it gives some sense of the time scale involved. Ion engine operation is limited by erosion of thruster elements caused by exposure to charged particles of the exhaust stream. Current ion thruster technology has demonstrated continuous firing for 3.5 years. The ion thrusters on the Dawn spacecraft launched in 2007 have a design mission life of 5.5 years. In either case, it’s well short of the two and half centuries for a single spacecraft to address a significant portion of all debris on orbit. An ongoing program to replace aged vehicles would be needed. To achieve practical results in a reasonable time frame, a constellation of such vehicles would be needed. A program of such scope is obviously a multi-billion dollar initiative. It should be noted that many of the logistical and technical challenges of removing space debris are similar to those involved with ballistic missile defense. A space debris collector capturing a space debris object is subject to the same orbital mechanics as a kinetic ASAT. A space- or ground-based laser used to vaporize small pieces of debris is subject to the same physics as a laser used for destroying ballistic missile or adversary satellites. The US has not elected unilaterally field a global ballistic missile defense system in part due to the huge costs and technical challenges. Why would a space debris removal system be any different? It seems reasonable to assume, based on this “back of the envelope” analysis that the technical and resource challenges involved with eliminating the space debris hazard would be daunting for the US to achieve on its own. Policy From a policy perspective a unilateral approach by the US is counter to historical precedent and trends in US space policy. The ISS the most audacious example to date of international cooperation cost an estimated $100 billion to design and deploy. Would the ISS exist today if the U.S. were the only country willing to pony up the money? Space science program managers appear to want more international cooperation. Indeed, as noted in this publication, NASA and ESA are actively working to promote international cooperation in space science programs as a way to address limited budgets (see “Doing more for less (or the same) in space science”, The Space Review, May 4, 2009). The U.S. civil space budget is already under considerable stress with the competing requirements of safely retiring the Space Shuttle, operating the ISS, and pursuing the Constellation program. It seems improbable Congress would appropriate the additional funding for NASA to effectively clean up space debris. The assertion that space debris is a problem best left to the DOD seems misguided. The US military budget is already committed to fighting wars in Iraq, Afghanistan, and, as evident in recent news, may need to commit resources to stabilize Pakistan. The DOD space acquisition track record is not exactly a paragon of success with several major programs experiencing major cost and schedule overruns (e.g. NPOESS, FIA). More fundamentally, assigning the responsibility of cleaning up space debris to the DOD has implications for the US as a signatory to the Outer Space Treaty. As space assets are dual-use by nature, what prevents a space debris removal vehicle from also performing in the role as a space adversary ASAT?

**Status quo solves space debris – Russia**

Jaymi **Heimbuch,** 11-29-**10**, Managing Editor of EcoGeek with an English degree from California Polytechnic institute, [http://www.treehugger.com/author/jaymi-heimbuch-san-francisco-c-1/]

We've seen some crazy ideas for getting rid of space debris, a problem that sounds absurd in itself but is actually a real issue for satellites and even astronauts in the International Space Station. However, Russia is set on a concept that they think is worth serious investment -- about a $2 billion investment. Energia, Russia's space corporation, is planning to build a "pod" that will knock junk out of orbit and back down to earth. According to Fast Company, the pod will have a nuclear power core to keep it running for about 15 years while it orbits the earth knocking defunct satellites out of orbit so that it can either burn up in the atmosphere or drop into the ocean (hopefully not on somewhere populated...). The pod will be constructed by 2020 and the company hopes it will be in operation by 2013. One of the company's representatives, Victor Sinyavsky, states "The corporation promised to clean up the space in ten years by collecting about 600 defunct satellites on the same geosynchronous orbit and sinking them into the ocean subsequently," Space Daily reports. This seems like a more legitimate idea than others we've heard of, including shooting junk with water or using giant nets. Silly as it sounds, concepts for removing space debris are getting serious attention as the area around our planet is increasingly clogged with everything from old satellites to spacecraft parts.

**Ground based lasers solve space debris cheaply**

Jonathan **Campbell 2k,** 12-02, Advanced projects manager in the Advanced Projects Office of the National Aeronautics and Space Administration (NASA) at the Marshall Space Flight Center in Alabama. Worked for over 20 years in the space program a number of advanced research projects. Served as the project manager on Project ORION, [http://www.au.af.mil/au/awc/awcgate/cst/csat20.pdf]

The USAF Space Command maintains a catalog of space objects. Depending on the altitude and radar cross-section of these objects, it can reliably track objects that are larger than 10-30 cm in diameter in low-earth orbit. That catalog contained roughly 8000 objects in 1997. While roughly six percent of the cataloged objects were active payloads, the remainder consisted of inactive payloads, rocket bodies, and smaller fragments, many of which were produced during more than 100 breakups of space systems in orbit. Most of these breakups were caused by explosions, but collisions with other objects cannot he ruled out. For example, the breakup on July 24, 1996 of the French Cerise satellite has been linked to a collision with a cataloged object. Fragmentation generally produces large numbers of objects that are too small to he tracked reliably. High-velocity impact tests have shown that shields that are designed to protect satellites can he effective against objects that are less than about 1-2 cm in diameter. Such shielding is part of the design for the International Space Stat ion. Depending on environmental requirements, satellites and space vehicles may require shielding, or active protection from impacts with small particles, notably orbital debris and micrometeoroids. For particles that are larger than 2 cm, the cost of shielding a space vehicle is prohibitive. There have been numerous surveys of debris in the 1-10 cm diameter range. Radar and optical surveys, when used in conjunction with computer models, reveal that there is roughly 150,000 objects in orbits below 1500 kilometers. The problem is that each of these objects is quite capable of causing catastrophic damage to shielded spacecraft, and yet are too small to he tracked reliably by avoidance sensors. The likely composition of the debris was considered by the Orion study. The debris was classified into five representative groups, with objects made of aluminum, steel, sodium/potassium metal, carbon phenolic, and multi- layer insulation (MLI). 1 Based on the number of objects in low-earth orbit, and using the Iridium satellite system as an example, if we assume that the replacement cost of one of the 66 satellites in the $3.450 billion system is roughly $50 million, then the total cost to LEO satellites from orbital debris is Using Lasers in Space estimated to be roughly $40 million per year. Debris-related expenses that are on the order of tens of millions of dollars per year should he compared with estimates from the Orion study for debris removal. It estimated that eliminating debris in orbits tip to 800 km in altitude within 3 years of operation would not exceed $200 million. It was for this reason that the study team has proposed a technology demonstration project as a next step, which is estimated to cost roughly $13-28 million. Laser Propulsion of Uncooperative Debris. Laser propulsion is one technique for using radiant energy rather than fuel on space vehicles for the purpose of propulsion. In the case of removing orbital debris, the surface material of the debris becomes the propellant. In essence, the intensity of the laser must he sufficiently great to cause the material on the surface of the object to form a vapor, which as this hot vapor expands imparts a force or thrust to the object. For a given material and duration of a laser pulse there is an optimum intensity above which the ability to couple laser energy onto the material decreases.2 This is because the resulting ionization of the vapor from the material effectively absorbs the energy of the laser: This means that a series of short pulses is the most effective way to generate propulsion for orbit debris.3 Since orbital debris consists of many materials, a debris removal system must be designed with this in mind. The Orion study considered laboratory experiments that were conducted with representative materials and found useful models for the coupling of metals and nonmetals, as shown in Figure 1. The optimum intensity is higher for metals than for nonmetals, since energy tends to he conducted to the interior of the metal. At higher intensities, however, the coupling is higher for metals than for nonmetals because the onset of plasma formation above the optimum intensity for nonmetals occurs at lower intensities.4 This system would he effective against both metallic and nonmetallic targets in space, and could be effective against materials that arc at higher orbital altitudes.

# Launchers Update

**Launcher capabilities deter SBSP- each SPS needs 135 launches**

Joseph D**. Rogue**, Associate director of National Security Space Office, 20**07** [“Space‐Based Solar Power

As an Opportunity for Strategic Security”, October 10, 2007, http://science.ksc.nasa.gov/shuttle/nexgen/Nexgen\_Downloads/SBSPInterimAssesment0.1.pdf]

Space Solar Power Satellites are very large structures and require substantially greater lift and in‐space transportation than has ever previously been attempted. Consequently, they also require a significantly expanded supporting infrastructure. The International Space Station is currently the largest structure in space with a mass of 232 MT, at an orbit of only 333 km. It has the largest solar arrays in space, with a total power of approximately 112 kW. In contrast, a single Space Solar Power Satellite is expected to be above 3,000 MT, several kilometers across, and most likely be located in GEO, at 42,124km, likely delivering between 1 to 10 GWe. From the perspective of today’s launch infrastructure, this may seem unimaginably large and ambitious, but in another sense it is well within the relative scale of other human accomplishments which at their time also seemed astounding creations‐‐the Eiffel Tower is 8,045 Tons; the Sear’s Tower 222,500 tons; the Empire State Building 365,000 – 392,000 tons, the largest of our supertankers is 650,000MT, and the Great Pyramid at Giza is 5,900,000 MT. Contemplating a space solar power satellite today is probably analogous to contemplating the building of the large hydro‐electric dams, which even today cause observers to marvel. Today the United States initiates less than 15 launches per year (at 25MT or less). Construction of a single SBSP satellite alone would require in excess of 120 such launches. That may seem like an astounding operations tempo until one considers the volume of other transportation infrastructure. For instance, in 2005, Atlanta International Airport saw 980,197 takeoffs & landings alone, an average of 1,342 takeoffs/day, or about 1 every minute 24 hours a day. In the same year, Singapore’s 41 ship cargo berths served 130,318 vessel arrivals (about 15 per hour), handling about 1.15 billion gross tons (GT), and 23.2 million twenty‐foot equivalent units (TFUs).

# Politics – Solar Getting Cut

**The solar energy sector is facing cuts and problems.**

**Time 6-28**

**[Time Magazine, By BRYAN WALSH; “The Fading Era of Big Solar: Will Budget Woes Swamp the Industry?”;** [**http://www.time.com/time/health/article/0,8599,2080176,00.html**](http://www.time.com/time/health/article/0,8599,2080176,00.html)**; Boyce]**

Big solar producers should be feeling very, er, sunny. New solar power doubled last year globally, with the world adding 16 gigawatts worth of new photovoltaic energy. In the first quarter of 2011, installations of solar power increased 66% over the previous year in the U.S. Just last week the Obama Administration offered a $1.4 billion loan guarantee to help fund what will be the world's largest rooftop solar project, which put at least 733 megawatts worth of photovoltaic panels on commercial buildings across nearly 30 states while creating 10,000 jobs. Even bad news for the industry is good: a front-page story in Monday's Washington Post raised questions about why more than half of President Obama's out-of-town private-business visits had been to renewable-energy companies. Considering that the renewable-energy industry had to fight for any attention from Obama's hydrocarbon-loving predecessor, being criticized for getting too close to the White House seems like a significant step up. But there are clouds on the horizon for solar power — especially for big producers who want to build utility-scale projects, not just slap panels on rooftops. The miniboom in solar in the U.S. is being driven chiefly by U.S. Treasury grants — most funded by the 2009 stimulus — which have helped fill the gap created by the evaporation of private capital after the recession. The only problem is that stimulus funding is just about tapped out, the tax credits are set to expire in December and the mood on Capitol Hill is utterly hostile to more spending. If that government money simply vanishes and private capital fails to appear, the U.S. renewable-energy industry could be set back by years. And no one is at greater risk than those who want to build large-scale solar. (Watch "The Truth About Solar Power.") "There's a big buildup in the industry pipeline right now," says Arno Harris, the CEO of Recurrent Energy, a utility-scale solar developer. "Financing could fall off a cliff." To understand why big solar is at such risk, you have to understand the brave new world of renewable-energy financing. Solar projects and wind farms can be risky — in some cases you're dealing with new technology, and you're usually producing electricity at higher prices than your fossil-fuel competitors. So straightforward private financing isn't always easy to come by. Renewable-energy companies could claim tax credits on the money they spend on projects, but of course, until they actually begin selling electricity they have little to zero profits, and therefore no tax bill to worry about in the first place. They need that money up front. Before the recession, there was a vibrant market in banks matching up renewable developers with companies that needed to offset the tax bill on their profits — but after the recession there were, to say the least, significantly fewer profits and little need by anyone, especially in the financial sector, for tax credits. If the government hadn't stepped in, the renewable industry might have been one of many victims of the 2007-08 financial crisis and recession. Federal stimulus spending not only saved the solar industry and its partners, it actually helped them thrive. Those billions in funds and loan guarantees were especially timely because European nations had begun winding down their expensive feed-in tariffs — long-term government-set contracts for renewable energy at favorable prices — that had helped build the global renewable-energy industry. (Even now, Germany and Italy account for two-thirds of the worldwide solar market, thanks chiefly to years of government support.) As a result of stimulus spending and a bit of help from Europe's global investments, "the U.S. has 30 gigawatts of utility-scale solar in the construction and permitting pipeline," says Harris. (See photos of a solar-powered airplane.) The problem is, should those tax credits expire — as they're currently set to do by 2016 — and little additional government funding come through, solar companies could find themselves back where they were at the start of the recession. They can hope that private financing will begin to flow, but there's little evidence yet that banks are eager to lend out money for big renewable projects — especially with the national energy policy so uncertain. Big solar projects — many of which are done on federally managed land — are also held back by permitting headaches. The Sierra Club and other environmental groups have sued major solar-thermal projects in the deserts of the West on the grounds that construction may threaten endangered species. "Large-scale projects can take three to five years to get all the permits," says Kevin Smith, the CEO of SolarReserve, a California-based solar-thermal company. "That's significant." As fast as solar installation has grown in recent years, we still only get about 0.1% of the world's electricity directly from the sun. If solar energy is going to become something more than a rounding error, green groups may need to do everything they can to accelerate big-solar projects. And if private capital isn't yet ready to step up to the plate, the government needs to extend the loan guarantees and other funding that have proven so effective over the past couple of years. Otherwise we'll risk experiencing a rerun of the 1980s, when the U.S. was the undisputed world leader in solar and other renewable technology — only to surrender that supremacy when government support collapsed. "I'm optimistic, but I work in solar — I have to be optimistic," says Harris. I wish I could be so optimistic, but unless there's change of heart in Washington, the future may dim fast for American solar.

# Politics Link – Private Sector Popular

**Space shifting to private sector post-Shuttle**

**Reuters 4-5** [Reuters, By Irene Klotz; “US looks to private sector as shuttle program ends”; 4/5/2011; <http://www.reuters.com/article/2011/07/05/uk-space-shuttle-commercial-idUSLNE76404L20110705>; Boyce]

CAPE CANAVERAL, Florida (Reuters) - After the U.S. space shuttle program ends this month, NASA will rely on Russia and its Soyuz craft to deliver Americans to the International Space Station -- at a cost of more than $50 million a seat. That could change relatively soon as three companies develop commercial space taxis to launch from the United States -- Boeing Co (BA.N: Quote, Profile, Research, Stock Buzz), Space Exploration Technologies, also known as SpaceX, and Sierra Nevada Corp. Boeing and SpaceX, owned by Internet entrepreneur Elon Musk, propose capsule-style ships that descend to Earth on parachutes, rather than glide like the shuttle to a runway landing. Sierra Nevada is working on a shuttle-like winged vehicle called the Dream Chaser. All three spaceships are designed to carry up to seven people or a mix of crew and cargo. The companies share NASA contracts worth $247 million to help pay development costs and all hope to win work flying crews to the space station. The U.S. space agency also has a $22 million contract with Blue Origin, a start-up owned by Amazon (AMZN.O: Quote, Profile, Research, Stock Buzz) founder Jeff Bezos that is focusing first on suborbital flight. "This has been painted as a revolutionary approach and it's really not as big of a deal as it's made out to be," said Garrett Reisman, a former astronaut now at SpaceX. "NASA has been working with contractors since the very beginning. It was contractors that built the space shuttle and the Apollo rockets. What's really different this time round is something as mundane as contracting -- the way the government does business." For large programs, NASA, like most federal agencies, traditionally reimburses contractors for all costs and adds bonuses for performance. "That can provide good people with the wrong kinds of incentives," Reisman said. The new commercial model is fixed-priced and milestone-based. FLIGHTS FOR TOURISTS, RESEARCH "If we hit a stumbling block technically and we have to invest some money to get past that, that's SpaceX money that gets spent so we have skin in the game. We have a real incentive to keep it cost-effective," said Reisman. Beyond ferrying U.S. astronauts to the International Space Station, companies would be able to sell flight services to tourists, businesses and research organizations. NASA has not yet decided whether it wants to lease new spaceships for its astronauts like a rental car or buy rides like a taxi service. Any future providers will need to prove safety and reliability, most likely with their own employees. As NASA awaits the rollout of approved commercial vehicles -- not expected before 2015 -- it will buy rides to the space station on Russia's Soyuz craft. NASA's commercial space initiative has drawn strong rebukes from some of its traditional supporters in Congress and longtime aerospace contractors. "The main thing that people are fighting over right now in this whole commercial thing is the ability to preserve money for their companies and I believe it's really an ugly side of the business," said Ken Bowersox, another former astronaut also working for SpaceX. Bowersox, a veteran of five shuttle flights and a long-duration stint on the station, is particularly sensitive to accusations the new commercial ships will not be as safe as NASA-owned vehicles. "When people start to throw out the 'Oh, we need to protect our astronauts' card, I usually start looking for my wallet and seeing what else they're trying to take from me, because what they're really after is money," Bowersox said. "If they were really worried about astronaut safety, I can tell you they'd be worrying about different things than what they complain about." Being able to provide safe and reliable transportation to and from space is just as important for the companies as it is for NASA, Reisman said. "Your business case is really, really bad if your rocket doesn't work," he said. Before buying rides for astronauts, NASA is testing the commercial concept with cargo deliveries. SpaceX, which debuted its cargo-version Dragon capsule in December, and aerospace company Orbital Sciences Corp (ORB.N: Quote, Profile, Research, Stock Buzz) plan to begin freighter flights to the space station next year. (Editing by Tom Brown and John O'Callaghan)

# Politics Link – Solar Unpopular

**Solar power unpopular in Congress – subsidies could be cut.**

**USA Today 6-30** [By Erin Kelly, USA TODAY; “Future of federal solar programs in doubt”; 6/30/2011; <http://www.usatoday.com/money/industries/energy/2011-06-28-solar-energy-congress_n.htm>; Boyce]

WASHINGTON — The solar power industry is facing a double threat from a Congress that may turn off the flow of federal subsidies and take a pass on mandating renewable-energy standards that would increase demand. The Republican-led House, focused on cutting spending and philosophically opposed to subsidizing solar power and clean energy, has targeted federal grant and loan guarantee programs to reduce or eliminate. One is a U.S. Treasury grant program, set to expire at the end of this year, that solar companies say has kept them alive through the recession. The other is an Energy Department loan guarantee program, part of which would end Oct. 1, that has provided nearly $35 billion in loan guarantees for solar, wind, geothermal and other clean energy projects that have generated more than 68,000 U.S. jobs, according to the department. Meanwhile, hopes for a national clean energy standard that could boost demand for solar power also are dimming in a Congress that doesn't support government mandates about what kind of energy Americans should use. "Is the solar industry going to die if we lose these programs? No, but we're going to stall," said Roger Efird, managing director of Suntech America. Its parent company, Suntech Power, which has offices in San Francisco, China and Europe and a manufacturing plant in Arizona, is the world's largest producer of solar panels. "We'll certainly lose a lot of jobs. There's no doubt about that," Efird said.

**Solar energy is more popular with Obama and the Senate.**

**USA Today 6-30** [By Erin Kelly, USA TODAY; “Future of federal solar programs in doubt”; 6/30/2011; <http://www.usatoday.com/money/industries/energy/2011-06-28-solar-energy-congress_n.htm>; Boyce]

The solar industry has an ally in President Obama, who has called for a national clean energy standard that sets the goal of the nation generating 80% of its electricity from clean sources by 2035. Although it's unlikely Congress will approve that ambitious goal, the administration could take steps to help the solar industry by allowing federal agencies to enter into long-term agreements to buy solar power, Resch said. Solar programs also remain popular in the Senate, where Majority Leader Harry Reid, D-Nev., fought off House efforts early this year to end the loan guarantee program that helps solar companies secure financing for their projects. Reid last month announced that the Energy Department will provide conditional guarantees for the Crescent Dunes Solar Energy Project in Tonopah, Nev., creating nearly 5,000 jobs in his struggling state, which has the nation's highest jobless rate. Solar lobbyists said they believe the loan guarantee program will survive, although it's not yet clear how much funding it will get this year. McClintock and other conservatives wrote letters in early June asking the House Appropriations Subcommittee on Energy and Water Development to end innovative technology loan guarantees and other renewable energy programs. The subcommittee approved $160 million for loan guarantees, far less than the $1 billion sought by the Obama administration but enough to keep the program alive.

**Solar energy subsidies will be tough to extend in the House.**

**USA Today 6-30** [By Erin Kelly, USA TODAY; “Future of federal solar programs in doubt”; 6/30/2011; <http://www.usatoday.com/money/industries/energy/2011-06-28-solar-energy-congress_n.htm>; Boyce]

The future is less certain for the U.S. Treasury program that gives cash grants to solar and other renewable-energy companies. Solar companies can get a grant equal to 30% of the cost of a solar system as an incentive to develop solar projects. It was intended to help companies that were not making enough profit in the sluggish economy to take advantage of a 30% tax credit. Extending the program beyond its expiration date at the end of this year will be tough in the House, because the grant was part of the American Recovery and Reinvestment Act, the stimulus bill passed by the House in 2009 when it was led by Democrats. Republicans say the act spent billions while creating few jobs. "I think we've got a 50-50 chance of getting the grant program renewed," Efird said. Solar advocates say they believe they can change some minds in the House when they point out that there are solar companies in every state. "I think solar is sometimes mistakenly thought of as a small, niche industry when it has actually created jobs all across the country," Caperton said. "It's not just California and Arizona. There are manufacturing companies in Mississippi, Alabama, Michigan, all over the place. When members of Congress hear that, they start to listen, and things start to change."

# GEO Link

**SPS sends microwaves and uses the GEO orbit** (neg card as set up to the Neg’s turn)

**Potter**, Research Scientist, New York University; Member of Board of Directors of the Space Frontier Society of New York , **98**

[Seth Potter; “Solar Power Satellites: An Idea Whose Time Has Come”; last rev 12/27/1998; <http://www.freemars.org/history/sps.html>; Boyce]

The solar energy collected by an SPS would be converted into electricity, then into microwaves. The microwaves would be beamed to the Earth's surface, where they would be received and converted back into electricity by a large array of devices known as a rectifying antenna, or rectenna. (Rectification is the process by which alternating electrical current, such as that induced by a microwave beam, is converted to direct current. This direct current can then be converted to the "slower" 50 or 60 cycle alternating current that is used by homes, offices, and factories.) At geostationary orbit (36,000 kilometers or 22,000 miles high), the SPS would have a 24-hour orbital period. It would therefore always hover over the same spot on the equator and can keep its beam fixed on a position at a higher latitude. Since the Earth's axis is tilted, an SPS orbiting over the equator wouldswing above or below the Earth's shadow during its daily orbit. Sunlight would not be blocked, except for a period of about an hour eachnight within a few weeks of the equinoxes.

**Aerostats CP 1NC**

**Text: The United States Federal Government should deploy aerostats to the troposphere**

**Aerostats are more effective-increases output and decreases costs**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

The manufacturers of commercially available PV modules for example, BP solar 16–18 rate the panels at standard test conditions (i.e., temperature of the PV cells 258C, intensity of radiation 1 kW/m 2 , and the spectral distribution of the light corresponding to the spectrum of sunlight that has been ﬁltered by passing through 15 thickness of the Earth’s atmosphere). These conditions correspond to noon on a clear sunny day with the sun about 60 degrees above the horizon. Generally, in these conditions, the commercially available panels have efﬁciency in the region of 7–15% (although there are cells with efﬁciency up to approximately 30% for specialist applications e.g., solar arrays for satellites). However, the manufacturers and distributors also declare that the power output decreases approximately linearly with cloud amount, down to 5–10% of the peak value for dark overcast weather, which means that at times the output from a square meter panel can drop to a few watts. Another reason for the relatively high cost of electric solar energy is the shortage of silicon that is used in cells. However this is expected to be soon replaced by alternative products (see e.g., Reference 19) so that the cost of the cells should start to decrease in the next few years. A fact sheet from Ecoﬁrst 20 states that ‘‘a well designed 1 kWp grid connected PV system, in the UK, will produce around 750 kWh per year’’ (these ﬁgures can be independently veriﬁed working in terms of average number of PSH in England). Considering a life of 15 years and PV cells at 4$ per W—this means a cost of over 0.35 cents per kWh. However, if the solar radiation was captured at high altitude (above the clouds) a much higher output could be achieved. Here a 1 kWp PV system directly illuminated by the sun for an average of almost 12 h per day (regardless the weather conditions) for 365 days would produce between 4000 and 4500 kWh (i.e., up to six times more power than if it was ﬁxed on the ground in the UK). The basic concept is that the aerostat supporting the PV cells would ﬂoat above the clouds (see Figure 1), usually at an altitude of 6–9 km according to the weather conditions. As the solar energy collector will be ﬂoating, this would also allow easier tracking of the sun orientation using the aerostat attitude control. Therefore, in theory, an aerostat for electrical power generation (AEPG) could bring down the cost by the same factor as it increases the energy produced. In practice this theoretical gain in performance has to be off set by the cost of the infrastructure (i.e., the aerostat and tether including its operations), and this is the crucial point which will decide the economical viability of these devices. This topic will be addressed in more detail in Section ‘‘Cost analysis.’’

**Net Benefit: (Disads)**

**Aerostats solves- feasible, cheap, reliable, easily deployed**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

This paper has investigated the possibility of using a high altitude aerostatic platform to support PV modules to increase substantially their output by virtue of the signiﬁcantly enhanced solar radiation at the operating altitude of the aerostat. Based on realistic values for the relevant engineering parameters that describe the technical properties of the materials and subsystems, a static analysis of the aerostat in its deployed conﬁguration has been carried out. The results of the computations, although of a preliminary nature, demonstrate that the concept is technically feasible. A parametric costing of the facility has also been carried out using data available from various sources. This cost model shows that there is an optimal size of the aerostatic platform that minimizes the cost of the electricity produced, and that this cost could be signiﬁcantly lower than what can be achieved by PV panels based on the ground in the UK. In addition this method to produce electric energy could also reduce the issue of unreliability which characterizes ground based solar panels as well as electricity generated from wind power. Finally as the AEPG requires minimum ground support and could be relatively easily deployed, there are several applications where these facilities could be advantageous with respect to other renewables. It is acknowledged that the concept mathematical model and its costing are of a preliminary nature. However they do indicate that there is the potential for a new facility to enter the renewable energy market, and further work should be carried out to investigate this possibility more in depth.

**Aerostats avoids all disad links- launched in the troposphere 7.5km**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

Most of the clouds are in the region below the 6 km altitude, and subsonic aircraft generally cruise in an altitude range of 9–13 km. Therefore an altitude between 6 and 9 km seems appropriate as a design altitude for the aerostatic platform. Although cloud tops can well extend above 6 km and sometime also above 9 km altitude, the probability of this occurrence at the location of the aerostat is so low that it does not justify an extension of the aerostat design envelope to accommodate this unlikely occurrence. Therefore 7.5 km altitude is taken here as the design altitude. However it is considered that the aerostat could be required to fly at higher altitudes. Good statistical knowledge of the atmospheric conditions in which the aerostat is due to operate is available from various sources (e.g., ESDU data sheets or the UK meteorological office), and a detailed and statistically representative environment can be calculated for any location in the UK or abroad. However here, for sake of simplicity 100 mph will be considered as the maximum wind that the aerostat should be able to withstand. Most of the aerostats of comparable size and performance currently on the market (e.g., Reference 13) are able to operate under most weather conditions and quote the capability to withstand winds up and beyond 100 mph, therefore this is a reasonable requirement.

**Aerostats – Avoids DA**

**Aerostats avoid space based disads- float at 6-9km**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

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**Aerostats launched in the troposphere- 7.5km**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

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**Aerostats – Better than SPS**

**Aerostats are better than SPS- cheap and technological feasible**

**Aglietti et al.,** School of Engineering Sciences, **09** [G. S. Aglietti, Stefano Redi, Adrian R. Tatnall, and Thomas Markvartr, “Harnessing High-Altitude Solar Power”, June 2009 <http://ieeexplore.ieee.org/> /stamp.jsp?tp=&arnumber=4957576, MA]

A completely different approach was proposed by Glaser [2] in the 1970s, and his idea has captured the imagination of scientists up to this day. The basic concept was to collect solar energy using a large satellite (which would be able to capture the full strength of the solar radiation continuously), and transmit it to the ground using microwave radiation. The receiving station would then convert the microwave radiation into electric energy to be made available to the users. The original concept was revisited in 1995 [3] in view of the considerable technological advances made since the 1970s, and research work on this concept is still ongoing. However, a mixture of technical issues (such as the losses in the energy conversions and transmission), safety concerns (regarding the microwave beam linking the satellite with the ground station), and cost, have denied the 0885-practical implementation of this concept. The latter is a substantial hurdle as the development of satellite solar power (SSP) cannot be carried out incrementally, in order to recover part of the initial cost during the development, and use it to fund the following steps, but it requires substantial funding upfront (tens of billions of dollars according to [3]) before there is any economical return. As a compromise between Glaser’s SSP and ground-basedPV devices, it is proposed in this paper to collect the solar energy using a high-altitude aerostatic platform [4], [5]. This approach allows most of the issues related to the weather condition to be overcome, as the platform will be above the clouds except for very extreme weather situations. At the same time, as the platform is above the densest part of the troposphere, the sun beam will travel through considerably less air mass than if it was on the ground (in particular, for early morning and evening), and this will further improve the energy output. Therefore, this method enables considerably more solar power to be collected than on the ground (in this paper, it will be shown that at altitudes above 6 km, it is possible to collect over four times more energy than using panels fixed on the ground in the U.K.). In addition, the mooring line of the platform can be used to transmit the electric energy to the ground in relative safety and with low electrical losses. Although this approach enables between onethird and half of the energy that could be harvested using an SSP, the cost of the infrastructure is orders of magnitude lower, and this approach allows an incremental development with a cost to first power, i.e., a few orders of magnitudes smaller than that necessary for SSP).

**Aerostats – Avoids Spending**

**Aerostats are cheap- only 4.5 million**

**Aglietti et al.,** School of Engineering Sciences, **09** [G. S. Aglietti, Stefano Redi, Adrian R. Tatnall, and Thomas Markvartr, “Harnessing High-Altitude Solar Power”, June 2009 http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4957576, MA]

Due to the relatively early stage of the design, it is quite difficult to establish the exact cost of the system described in the previous sections. However, a reasonable estimate can be obtained from the unit cost of the materials and/or extrapolating from the cost of similar systems/subsystems available on the market. Starting from the Aerostat, the cost of solar cells partial cladding and the cost of the gas filler can be obtained easily from their unit costs (4$/W for the cells and 5$/m3 for the helium, respectively). The cost of the aerostat envelope and internal subsystems (e.g., balloonette for altitude control) can be obtained by extrapolating from the cost of other aerostats available in the market. Using weight as parameter to extrapolate the cost, based on a survey of aerostats currently on the market, it is estimated that 2 million dollars (excluding gas and PV cells) should cover the envelope cost. It should also be stressed that today there are only a relatively small number of commercial companies that produce airships or aerostats, and their sales are mainly for the military market, rather than for civil applications. Most of the products are heavily customized with characteristics and payloads to suit the need of the specific customers, resulting in unique combinations of hull, subsystems, and payload. Therefore, the number of “build to print” is very limited and the nonrecurring costs are very high compared with the cost of the “materials.” In addition, the aerostat advocated here is essentially a sphere filled in with helium, and therefore much simpler than most of the aerostats currently on the market. To maximize the profit, the system must be maintained in operation ideally for a time similar to the duration of the solar cells (which is around 15 years), and therefore maintenance and ground support will be necessary. For an aerostat, the item most subject to degradation is the hull, where the damage is mainly produced by the solar radiation. However, here the part of the aerostat exposed to the sun is mostly covered by the solar cells, and this should significantly reduce the material degradation. Concerning helium leakages, using modern materials, it is possible to reduce the total loss to a fraction of a meter cube per day, which means that even six months of continuous operation would produce only a negligible loss of lift. The system is designed to be autonomous; therefore the running cost should beminimal, and essentialmaintenance if possible should be carried out at night or in good weather in order not to produce interruption of the energy harvesting. The grounding for extreme weather conditions will also be rare, say approximately 14 days/year on average, and as this will mostly be in the winter (with shorter daylight) also the impact on the production will be limited. Overall, the complete system should cost in the region of 4.5 million dollars, but it must be stressed that this is the cost for the production of a single unit. It is likely to imagine applications (like “farms”) with several identical balloons deployed, and this would dramatically reduce their unit cost. Deployment of the system described in Section IV at 6 km would allow production of about 1.7×106 kWh/year. In addition, to be conservative, this design has considered 15% efficiency cells. However, in the market there are cells whose efficiency approaches 30% and therefore should this type of cells be used, the facility outlined in this paper would produce nearly twice as much energy. If the aforementioned system (∼0.5 MW output) could be maintained in operation for say 15 years the cost of the energy produced could be in the region of 17 cents/kWh. However, if several units are produced, the lower cost per unit would considerably reduce the cost of the energy, and their deployment in a “farm” configuration could produce several megawatts that is comparable to the current wind farms. Considering that in the U.K., the cost of solar energy is approximately 1$/kWh [25], this concept could present a considerable advantage. This advantage is reduced for countries that enjoy naturally higher solar radiations (e.g., Mediterranean countries, or southern states of the USA) where solar energy produced on the ground can cost in the region of 20–30 cents/kWh.

**Aerostats are cheap- 3 factors**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

The three most signiﬁcant elements that make up the cost mentioned above are the cost of the aerostat envelope, the cost of the solar cells, and that of the gas. Simply by using hydrogen rather than helium the cost of the energy produced would drop to 29.3 cents per kWh. However better results, in terms of the cost of the energy, can be achieved by decreasing the size of the facility. In fact the energy produced is proportional to the surface, but some of the costs are proportional to the volume. By plotting the energy cost as function of the size of the aerostat (see Figure 4) it becomes apparent that there is an optimum size of facility which is smaller than that considered earlier. It must be remembered that this concept implementation implies that the aerostat generates enough lift to support itself plus the mass of all the subsystems, including the tether, with enough margin to avoid excessive sagging in the tether. Therefore as the design altitude was set to 7.5 km the radius must be larger than 20 m to generate enough lift, and possibly about 30 m to have enough lift margin to remain at an appropriate altitude in the presence of a strong wind (see Subsection ‘‘Tether displacement’’). In this speciﬁc case, the cost elements associated with the volume are considerably smaller and using the parameters described before, the overall cost of the facility should be lower than 3.5 million dollars. The power output at ground level results 312 kW, and the cost of the energy 17.7 cents per kWh. This cost can be reduced to 14.3 cents per kWh by using hydrogen rather than helium and assuming that the voltage of the transmission can be increased from 1500 to 3000 V. The ﬁgures quoted above are indeed approximations, but they show that the concept cannot be dismissed a priori on the basis of its cost. To carry out a detailed costing an appropriate preliminary design has to be carried out, and this was beyond the scope of the current paper.

**Aerostats are cheap and effective- costs offset each other**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

Overall, compared to ground based solar panels installed in England, the concept described in this paper could achieve a reduction in the cost of solar energy by a factor 2.45. The parametric costing has shown that there is an optimal size of the facility that for the conditions considered in this paper is approximately 300 kW. Therefore in order to produce considerable quantities of energy (i.e., several MW) a signiﬁcant number of AEPG should be built, and due to the advantage of the economy of scale, this would decrease the cost of the facilities (and hence the energy produced) even further. In-fact the costs per units of material used in this work refer to aerostats that were unique specimens or part of a very small batch. Therefore it is reasonable to assume that the production of a signiﬁcant number of specimens will lower their cost per unit. In addition, as aerostat technology is relatively unsophisticated and long lasting it is likely that the facility could last in operation much longer than the 15 years. For the AEPG, the cost of the maintenance was not included. However, this is also not included in the cost of the ground based panels and in addition for the ground based panels the cost of the installation was not included either. Therefore taking that these costs will be much lower than the capital cost of the facilities, and that they can off set each other, the preliminary comparison of the cost of the energy between these two types of facilities is still legitimate.

**Aerostats – Solves Warming**

**Aerostats own other renewable-reliable and fast**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

Although the cost of the electricity produced by the AEPG might still be higher than other renewables, for example, wind turbine, the aerostat should enjoy far higher reliability, which has always been an issue for wind turbines and ground based PV modules. To increase the productivity of wind turbines various researchers have proposed the use of ﬂying electrical generators, 25 based on the concept of a tethered rotocraft, where the turbine is located at high altitude (e.g., to exploit the jet stream). However this type of system is considerably more complex than the AEPG. The possibility of a relatively rapid deployment of AEPG and the fact that they require minimum ground support will also be of very great beneﬁt in areas stricken by disasters such as ﬂooding or areas with unsuitable surroundings for installation of conventional solar panels (e.g., lighthouses, or offshore platforms). Due to its mobility the aerostat could be used to supply clean energy at speciﬁc locations without having to rely on the national grid. These are just a few of the many applications and segments of the market where these devices could ﬁnd commercial applications. Clearly the deployment of AEPG poses some risks, like an increased hazard for aircraft operations. However these risks can be mitigated by setting up an appropriate regulatory framework in consultation with the Civil Aviation Authority, for example, by designating appropriate areas to deploy these systems, to minimize interference with the other users of the airspace. There are also the risks of lightning strikes to aerostats. However modern aerostats and tethers are already designed to withstand lightning strikes. 13 To summarize, practical technical risks during the operations of an AEPG are very similar to those already faced by the aerostats currently used for surveillance operations, and the risk mitigation strategy implemented so far has been very successful.

**Aerostats -- 2NC Solvency**

**Aerostats are feasible- past launches and studies prove**

**Aglietti et al.,** School of Engineering Sciences, **08** [G. S. Aglietti , T. Markvart, A. R. Tatnall and S. J. Walker, “Solar Power Generation Using High Altitude Platforms Feasibility and Viability”, January 28th, 2008, <http://onlinelibrary.wiley.com/doi/10.1002/pip.815/pdf>, MA]

Lighter-than-air craft (aerostats) have been progressively neglected by the main stream research in aerospace engineering during the second half of the past century after having made remarkable technological progress that culminated in the 1930s with the construction of over 200m long airships.4,5 There have been some developments of historical interest6 but little of significance. However, in the last few years, aerostats have attracted a renewed interest. Their typical market niches (scientific ballooning, surveillance/reconnaissance7,8) are expanding, and more researchers have proposed several different applications, ranging from high altitude aerostats as astronomical platforms to infrastructures for communication systems.10,11 Amongst the most recent achievements in scientific ballooning are the successful launches in 2002 of a ultra-high altitude balloon (UHAB) of nearly 17 million cubic meters (the balloon was developed for NASA and reached the altitude of 49 km) and that of the Institute of Space and Astronautical Science (ISAS) of Japan that successfully launched an ultra-thin film balloon which carried a 10 kg payload to a worldrecord altitude of 53 km. Tethered aerostats are limited to lower altitudes due to the weight of the tether, which increase linearly with height. Currently aerostats can fly up to 12 km9 but various studies have been conducted to prove that considerably greater altitudes can be reached. For example, the Johns Hopkins University Applied Physics Laboratory (JHU/APL) has conducted a successful feasibility study (although not experimentally demonstrated) on a high altitude (20 km) tethered balloon-based space-to-ground optical communication system.10 The US Air Force has made extensive use of aerostat as surveillance systems,7 and there are available in the market aerostats (like the PUMA Tethered Aerostat,12 or the TCOM’s 71M13) that can fly up to approximately 5 km tethered with payloads of 2250and 1600 kg, respectively. The typical performances of some of the aerostats currently on the market are listed in Table I. These aerostats have a mooring cable (i.e., their tether) that supplies the aerostat on board systems and the payload with electric power, and they are designed to be able to withstand lighting strikes and strong winds.

# DoD CP

**Text: The Department of Defense should [do the plan].**

**DOD is the best actor- immediate price drops**

**Eades, 07** - (Jeremy, “US military proposes space-based solar power station”, Futurismic Blog, 10/17, <http://futurismic.com/2007/10/17/us-military-proposes-space-based-solar-power-station/>, MA)

A few weeks ago, Tobias posted about the US military and eco-technology. In it, he jokingly suggested an eco-DARPA. As it turns out, the military seems headed in that direction, specifically with a space-based solar power station that would beam energy down to the surface. The idea is that the Pentagon has decided that energy independence is now a national security issue, and as such falls under their purview. In addition, this orbiting power station would negate the need for long fuel supply lines. Units could have needed energy beamed down directly from orbit. Another benefit of having the military act as the early adopter is that prices should begin to decrease almost immediately, making it more affordable for commercial enterprises to license the technology for civilian consumption.

**DOD purchasing is the number one incentive for SSP development**

**NSSO, 7** (National Security Space Office, Report to the Director, “Space-Based Solar Power As an Opportunity for Strategic Security; Phase 0 Architecture Feasibility Study” October 10, 2007, http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf) Herm

FINDING: The SBSP Study Group found that industry has stated that the #1 driver and requirement for generating industry interest and investment in developing the initial operational SBSP systems is acquiring an anchor tenant customer, or customers, that are willing to sign contracts for high‐value SBSP services. Industry is particularly interested in the possibility that the DoD might be willing to pay for SBSP services delivered to the warfighter in forward bases in amounts of 5‐50 MWe continuous, at a price of $1 or more per kilowatt‐hour. o Recommendation: *The SBSP Study Group recommends that* the DoD should immediately conduct a requirements analysis of underlying long*‐*term DoD demand for secure, reliable, and mobile energy delivery to the war‐fighter, what the DoD might be willing to pay for a SBSP service delivered to the warfighter and under what terms and conditions, and evaluate the appropriateness and effectiveness of various approaches *to signing up as an anchor tenant customer of a commercially‐delivered service, such as the NextView acquisition approach pioneered by the National GeoSpatial‐imaging Agency.* FINDING: The SBSP Study Group found that even with the DoD as an anchor tenant customer at a price of $1‐2 per kilowatt hour for 5‐50 megawatts continuous power for the warfighter, when considering the risks of implementing a new unproven space technology and other major business risks, the business case for SBSP still does not appear to close *in 2007 with current capabilities* (primarily launch costs). This study did not have the resources to adequately assess the economic viability of SBSP given current or projected capabilities, and this must be part of any future agenda to further develop this concept. Past investigations of the SBSP concept have indicated that the costs are dominated by costs of installation, which depend on the cost of launch (dollars per kilogram) and assembly and on how light the components can be made (kilograms per kilowatt). Existing launch infrastructure cannot close the business case, and any assessment made based upon new launch vehicles and formats are speculative. Greater clarity and resolution is required to set proper targets for technology development and private capital engagement. Ideally SBSP would want to be cost‐competitive with other baseload suppliers in developing markets which cannot afford to spend a huge portion of their GDP on energy (4c/kWh), and these requirements are extremely stringent, but other niche export markets may provide more relaxed criteria (35c/kWh), and some customers, such as DoD, appear to be spending more than $1/kWh in forward deployed locations. It would be helpful to develop a series of curves which examine technology targets for various markets, in addition to the sensitivities and opportunities for development. Some work by the European Space Agency (ESA) has suggested that in an “apples‐to‐apples” comparison, SBSP may already be competitive with large‐scale terrestrial solar baseload power. A great range of opinions were expressed during the study regarding the near‐term profitability. It is instructive to note that that there are American companies that have or are actively marketed SBSP at home and abroad, while another group feels the technology is sufficiently mature to create a dedicated public‐private partnership based upon the COMSAT model and has authored draft legislation to that effect. • The business case is much more likely to close in the near future if the U.S. Government agrees to: o Sign up as an anchor tenant customer, and o Make appropriate technology investment and risk‐reduction efforts by the U.S. Government, and o Provide appropriate financial incentives to the SBSP industry that are similar to the significant incentives that Federal and State Governments are providing for private industry investments in other clean and renewable power sources. • The business case may close in the near future with appropriate technology investment and risk‐reduction efforts by the U.S. Government, and with appropriate financial incentives to industry. Federal and State Governments are providing significant financial incentives for private industry investments in other clean and renewable power sources. Recommendation: The SBSP Study Group recommends that in order to reduce risk and to promote development of SBSP, the U.S. Government should increase and accelerate its investments in the development and demonstration of key component, subsystem, and system level technologies that will be required for the creation of operational and scalable SBSP systems. Finding: The SBSP Study Group found that Ua small amount of entry capital by the US Government is likely to catalyze substantially more investment by the private sector. This opinion was expressed many times over from energy and aerospace companies alike. Indeed, there is anecdotal evidence that even the activity of this interim study has already provoked significant activity by at least three major aerospace companies. Should the United States put some dollars in for a study or demonstration, it is likely to catalyze significant amounts of internal research and development. Study leaders likewise heard that the DoD could have a catalytic role byU sponsoring prizes or Usignaling its willingness to become the anchor customer for the product.

# DoD CP – 2NC Solvency

**Military procurement is the only way to jumpstart the civilian market for SPS**

**The Space Review 7,** (Taylor Dinerman, “Solar power satellites and space radar” http://integrator.hanscom.af.mil/2007/July/07262007/07262007-16.htm, July 16, 2007) Herm

The first steps in such a program would be to begin work on an experiment to prove that power transmission in space via laser is possible. Already lasers are being used for communications in civil and military applications; taking this one step beyond to encompass power should be within the state of the art. At the same time the US Defense Department and NASA could begin joint work on a new generation of high-capacity power systems for future spacecraft. The power management and thermal control needs of a spacecraft that will carry a human crew to Mars may not be all that different from those of an SPS or an SR satellite. The bulk of the development work on the radars themselves can be left until later in the program. Meanwhile, the US could profitably study less ambitious space radar programs such as Canada’s Radarsat. Launching one or two modest technology development satellites over the next five or ten years would be a helpful way to set the stage for a new SR program. In the long term, say, by around 2010, the GMTI radar could be replaced and supplemented by an Air Moving Target Indicator (AMTI), which would need even more power. Instead of using a single large antenna or multiple smaller ones on the same spacecraft, a future stealthy SR could use radars on multiple satellites. Formation flying is now commonplace and coordinating multiple beams from two or three satellites in different orbits should not be that hard. The biggest problem will be to prove to Congress that the technology is ready for prime time. Almost all of America’s major military space programs are too far along to effectively incorporate the lessons of China’s ASAT test. SR, due to repeated budget cuts, is the great exception. Other satellite programs that could be modified to incorporate the needs of the new space warfare requirements include the T-SAT Transformational Communications project and the possibly the NRO’s problem-plagued Future Imagery Architecture (FIA). The stealthiness and robustness of all these programs, or their successors, would benefit from being able to draw electricity from a set of SPSs in GEO. The solar power satellites themselves would not necessarily have to be owned by the US government. They could be built privately based on a contract that promises that the Defense Department would buy a given amount of power at a predetermined price. This would be similar to the “power by the hour” contracts that are sometimes signed with jet engine manufacturers or the privately-financed initiative that the British RAF has established with a consortium for a new squadron of Airbus refueling tanker aircraft. In GEO an SPS is a large and conspicuous target. UA realistic new space architecture would have to find ways to give both active and passive protection to such valuable assets. At the same time, these measures must not detract from the commercial profitability of the operation. The Civil Reserve Air Fleet system is a possible model; airlines buy some planes that are modified for possible military use in an emergency and the government compensates them for the extra weight they carry while in normal commercial use. Space solar power is, in the long run, inevitable. The Earth’s economy is going to need so much extra power over the next few decades that every new system that can be shown to be viable will be developed. If the US were to develop space solar power for military applications it would give the US civilian industry a big head start. As long as the military requirements are legitimate, there is no reason why this cannot be made into a win-win outcome.

**Military procurement reduces financial risk to the commerical industry**

**NSSO, 7** (National Security Space Office, Report to the Director, “Space-Based Solar Power As an Opportunity for Strategic Security; Phase 0 Architecture Feasibility Study” October 10, 2007, http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf) Herm

UIncentives would help. These could includeU loan guarantees, availability of balloon loans (where interest payments are deferred until the SBSP system is operational), transferable tax credits, subsidies similar to those already in existence for other alternative energy sources, Uenergy pre‐ Upurchase agreements, Uand/or tax holidays on the sale of the power. The commercial sector needs to see profit potential within a reasonable time frame. Electric utilities understand the need for large amounts of capital for infrastructure development. This can be acceptable as long as the payback is large and for an extended period. The payback period and rate of returns must be attractive after the amortization of the infrastructure costs. Public/private partnerships are a possibility but may not be needed. UAs strictly commercial SBSP Ucorporations develop the confidence in the technologies and in the business case, they would Uprefer to proceed without government intervention or partnership. Having the government as a Uguaranteed customer for the power would reduce the risk for a commercial SBSP enterprise and Ucould help with the availability and terms of financings.

**Plan violates public law – the DoD must develop alt sources of energy installation**

**Ramos 2k** – US Air Force Major, Thesis submitted for the AIR COMMAND AND STAFF COLL MAXWELL Air Force Base (Kim, “Solar Power Constellations: Implications for the United States Air Force,” April, <http://handle.dtic.mil/100.2/ADA394928>) Herm

Solar power satellites may affect terrestrial Air Force operations. One terrestrial application for solar power satellites, or the technologies associated with them, involves unmanned aerial vehicles. Unmanned aerial vehicles are used during contingencies to supplement satellite and piloted (manned) aerial reconnaissance coverage. The unmanned aerial vehicle may be powered by a wireless power transmission, which would increase its endurance. In another area, one of the core competencies of the Air Force is agile combat support, which involves reducing the footprint of deployed forces. The use of solar power satellites to supply the power at deployed locations would reduce the logistics tail by eliminating generators and the support equipment and supplies associated with them. The third area concerns public law. Public law requires the Department of Defense to develop and encourage alternative sources of energy for installations. As an alternative to electricity generated from fossil fuels, solar power satellites fit the bill admirably. Terrestrially, solar power satellites or the technology associated with them enable long duration unmanned aerial vehicles, which receive power through wireless power transmissions, allow for logistical improvements, and assist the Air Force in complying with public law.

**Military procurement key**

**Dolman, 5—**Professor of Comparative Military Studies at the US Air  Force’s School of Advanced Air and Space Studies (Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, <http://www.e-parl.net/pages/space_hearing_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf>) Herm

No nation relies on space more than the United States—none is even close—and its reliance grows daily. For both its civilian welfare and military security, a widespread loss of space capabilities would prove disastrous. America’s economy, and along with it the world’s, would collapse. Its military would be obliged to hunker down in defensive crouch while it prepared to withdraw from dozens of then-untenable foreign deployments. For the good of its civilian population, and for itself, the United States military—in particular the United States Air Force—is charged with protecting space capabilities from harm and ensuring reliable space operations for the foreseeable future. As a martial organization, the Air Force naturally looks to military means in achievement of its assigned ends. And so it should.

# DoD CP – Solves Commercial Space

**A strong commercial space sector is vital to reaping the military benefits of space without triggering adverse international reactions**

**Pena, 02** – defense policy expert at the Cato Institute (Charles, “Future Security in Space: Commercial, Military, and Arms Control Trade-Offs,” Occasional Paper No. 10, ed: Moltz http://cns.miis.edu/pubs/opapers/op10/op10.pdf) Herm

Control of space is at the crux of the debate about the future of U.S. military space policy. It is important to point out that the issue is not whether the United States should militarize space. The militarization of space has already occurred and will continue. Space assets are currently used to great effect to support terrestrial (ground, sea, and air) military operations. The more immediate issue is whether the United States should weaponize space, at least in the near- or mid-term, and more important, whether military uses and requirements in space should be the driving force behind how we think about space and space policy. Advocates of a more aggressive U.S. military policy for space argue that the United States is more reliant on the use of space than is any other nation, that space systems are vulnerable to attack, and that U.S. space systems are thus an attractive candidate for a “space Pearl Harbor.” Critics of such a policy shift are concerned that weaponizing space could trigger a dangerous arms race. They are quick to point out that no country currently has an operational anti-satellite (ASAT) weapon that threatens U.S. satellites or weapons in space and that a U.S. move to deploy weapons (either offensive or defensive) would only provide unneeded impetus for other countries to follow suit. Regardless of how one views the need to weaponize space, one thing is abundantly clear: the U.S. military greatly benefits from using commercial space systems. Former vice chief of staff of the Air Force, General Thomas S. Moorman, asserts that by making maximum use of commercial satellites, “military satellite communications will benefit in terms of access to additional capacity (tremendous increases in available bandwidth and flexibility, as well as multiplicity of alternative communications paths).”1 In all likelihood, in the future, the military will be even more reliant on commercial space systems. As General Moorman has also stated: On the one hand, commercialization is not a total panacea.... On the other hand, the commercial space industry is expanding at such a rate and with such marvelous capabilities that it seems reasonable if not inevitable that a number of missions— heretofore the exclusive province of the government—can be satisfied or augmented commercially. We can also realize significant efficiencies by taking advantage of commercial space.2 Therefore, as U.S. Air Force Lt. Col. Peter Hays and Karl Mueller (both former professors at the School of Advanced Airpower Studies) argue: “It is no longer clear that the relationship between space and national security is, or should be, shaped primarily by international military competition.”3 Indeed, space as it relates to national security may be shaped and influenced more by the future of commercial space activities. If there are significant military and national security advantages to be gained via commercial space, then it is important to recognize that there is the potential for great harm by placing military requirements at the forefront of how we think about space. While the January 2001 Space Commission report (and others) focus on the vulnerability of U.S. space assets and the potential for a “space Pearl Harbor,” there is a “flip side” that must also be considered. John Newhouse, senior fellow at the Center for Defense Information, states: The [Space Commission] report does not call for but implies a U.S. need to accelerate development of antisatellite weapons, some of them space-based. But deploying such weapons will press other countries to develop and deploy countermeasures. And in any such tit for tat, the United States has the most to lose, since it is far more dependent on satellites for commercial communications and data-gathering operations than any other country. Among the effects could be a sharp rise in the cost of insuring commercial satellites and an outcry from industry.4 And, as John Logsdon, director of the Space Policy Institute at the George Washington University points out: “There appears to be no demand from the operators of commercial communication satellites for defense of their multibillion-dollar assets. If there were to be active military operations in space, it could be difficult not to interfere with the functioning of civilian space systems.”5 In other words, weaponizing space could be costly to an American industry that has great promise to grow and increase its contribution to the U.S. (and world) economy. Ultimately, a vibrant commercial space industry will support and enhance U.S. military capabilities far better than letting military requirements dominate space policy. Therefore, the government should avoid overregulating commercial space activities and imposing costly military requirements. Certainly, there are some uses of space that are unique to the military – such as integrated tactical warning and attack assessment (ITW&AA). This is an area where military needs and requirements cannot be met by commercial systems. That is, the military will be the sole user for systems such as DSP (Defense Support Program) satellites, which monitor missile launches worldwide. But virtually all other applications of space are “dual use.” To be sure, military needs and requirements must be recognized. For example, the military and intelligence agencies may have unique requirements for surveillance and reconnaissance that can be met only with their own dedicated satellites—either for reasons of security of data or technical requirements (e.g., resolution, processing time). A similar situation exists with regard to communications. For example, MILSTAR (Military Strategic and Tactical Relay) is a dedicated military satellite communications system that provides secure, jam-resistant, nuclear-hardened communications for all U.S. forces. But, wherever possible, the Department of Defense (DOD) should make use of commercial assets rather than spend needlessly on unique military assets. For example, the military should use existing communications satellites for its nonsecure communications capability. Communications probably represents the single biggest use of space for both the military and civilian/commercial sectors. According to General Moorman: “Space-based communications is the giant in space commerce. The giant clearly will be even more dominant in the future, and the information revolution will be the driver.”6 Although the DOD operates several communications satellites (or payloads on other military satellites to provide communications services)—for example, the Defense Satellite Communications System, Air Force Satellite Communications System (AFSATCOM), Leasat, UHF Follow-On (UFO), and MILSTAR—this segment is largely commercially driven. According to a RAND report: “The technology for new satellite communications, especially high-speed mobile services, is evolving so rapidly that the DOD is planning to make greater use of commercial systems rather than fielding/g its own systems.”7 Another area where the military can also make greater use of commercial assets is in satellite imaging, such as Earth Watch’s EarlyBird 1, Space Imaging’s Ikonos (which offers one-meter resolution, the highest resolution of any commercially available system), and Orbiting Image’s OrbView. According to RAND: “Commercial remote sensing offers the U.S. military potential new sources of remote-sensing data without requiring it to pay for the development of the space system.”8 And General Moorman believes “that these new commercial capabilities will both complement and reduce the numbers of military and intelligence systems required. The resulting savings could be substantial.”9 Indeed, during the U.S.-led military campaign in Afghanistan, the U.S. National Imagery and Mapping Agency (NIMA) purchased exclusive rights to pictures taken of the war zone by Space Imaging’s Ikonos satellite, which has 1-meter black and white resolution and 4-meter color resolution. This “buy to deny” policy is an example that demonstrates the importance of and demand for commercial space assets by the military. Somewhat ironically, these high-tech, high- resolution images were initially delivered via “pony express.” Ikonos imagery was recorded on the satellite and downloaded to Space Imaging ground stations in the United States. From there, it was delivered to NIMA’s Commercial Satellite Imagery Library at Bolling Air Force Base in Washington, D.C. The Air Force had to send someone to the library to manually transfer the data to compact discs, which were then delivered by aircraft to Saudi Arabia. Eventually, the data was transmitted via the Pentagon’s satellite-based Global Broadcast Service. So not only is there a commercial opportunity in imaging itself, but also possibly in how those images are transmitted—especially securely—to the customer. The military should also consider using distributed and redundant commercial satellite systems as a means to reduce vulnerability to attack rather than deploying unique military systems that are likely to be more expensive and take longer to deploy. U For example, it may be more cost-effective to develop and deploy smaller satellites in a distributed system configuration designed to operate at low-Earth orbit and medium-Earth orbit than larger, heavier satellites operating in geosynchronous (stationary) orbit. That approach is especially meritorious if there is a potential shortage of heavy-lift launch capability. It is also important that military requirements should not be imposed on shared nonmilitary satellites. For example, the military should not require hardening against electromagnetic pulse on commercial satellites that are also used by the military. To the extent that such requirements are absolute needs, the military should deploy its own dedicated systems to meet those requirements. Neither commercial satellite operators nor the other users of commercial satellites should shoulder any cost burdens imposed by the military (and clearly, the military must be more realistic about its requirements). UEven if commercial space is not a panacea for the military, it should be the driving force of space and shape space policy. Indeed, commercial space efforts often lead those of the government and the DOD and usually have lower costs, due to market influences and competition. Therefore, defense and national security need to be one component of overall U.S. space policy, but certainly not the primary component. In the post–Cold War environment—with no immediate threat from another great power and none on the horizon (at least in the near- to mid-term)—the U.S. government must avoid establishing inflated and costly military requirements for space-based resources. U.S. space policy should strive to foster an environment that allows commercial space activity to grow and flourish rather than create a new area for costly military.

# Boeing CP

**Text: Boeing Corporation should fund and launch a substantial amount of full-scale solar-powered satellites.**

**Boeing could develop SPS with the current tech.**

**Boeing Frontiers**, Boeing corp’s magazine/history, **9**

[Boeing, By Eve Dumovich; “The Sun: The decades-long quest to power Earth from solar power satellites in space”; May 2009; <http://www.boeing.com/news/frontiers/archive/2009/may/i_history.pdf>; Boyce]

The proposal called for Boeing solar power satellites to be constructed either in low-Earth orbit for later transfer to higher geosynchronous orbit, or constructed directly at the higher orbit. Large space freighters, known as heavy-lift launch vehicles, would carry outsized cargo pallets into low-Earth orbit where they would be deposited at a space construction base. A modified Space Shuttle Orbiter would carry the personnel needed to the orbiting construction site. “Everything was falling into place,” Nansen said. “Applications poured into the company from engineers and scientists who wanted to work on solar power satellites.” Early studies indicated that the revenue from one solar power satellite, producing and beaming down to earth 10,000 megawatts of electricity sold then at a rate of 4 cents per kilowatt hour, would produce $105 billion in 30 years, according to Boeing reports. In 1995, NASA began a “Fresh Look” study of space solar power techniques and concepts. In 1998, Congress authorized modest funding for further concept definition and technology development. Boeing studies included not only a constellation of satellites but also solar power satellite technology applications in a laser-powered lunar rover and solar-powered propellant production depots in low-Earth orbit and on the moon that would use solar power to convert water into cryogenic propellants for moon and Mars exploration. Fast-forwarding to present day, Boeing continues to lead in solar power research and technology. In November 2008, Boeing’s wholly owned subsidiary, Spectrolab Inc., in Sylmar, Calif., received the 2008 SpotBeam Award for Space Innovation from the California Space Authority in recognition of its 50 years of advancements in photovoltaic solar cell technology, solar panels and related products. Spectrolab has long been the world’s leading supplier of solar panels for communication satellites. Continuing advances in solar cell efficiency (now demonstrated at more than 40 percent under concentrated solar radiation), along with many other advances in space technology, have made the prospects for an economical space solar power system better than ever. Recently, the U.S. Defense Advanced Research Projects Agency selected Boeing to conduct the second phase of the Fast Access Spacecraft Testbed program, a multiphase effort to design and develop a ground-test prototype of a new high-powergeneration, ultra-lightweight spacecraft solar array. Boeing is also developing both radio frequency and laser power transmission and reception technologies, which will allow space- and Earth-based users to request and receive satellite-generated power on demand. “Boeing is currently combining these capabilities into a network-centric power system for near-term space solar power demonstrators,” Dean Davis said. He’s senior principal aerospace scientist/engineer and Space Solar Power study leader with the Boeing Phantom Works Analysis, Modeling, Simulation & Experimentation team in El Segundo, Calif. Davis added, “We hope these projects will lead to full-scale power satellites that, when combined with terrestrial solar, hydroelectric, geothermal and wind-power sources, will be able to provide independence from fossil-fuel energy within the next 50 years.”

**Boeing has SPS tech and has been working for years on the project.**

**Boeing**, world aviation company, **No Date**

[Boeing; “Solar Powered Satellite”; No Date; <http://www.boeing.com/history/boeing/solarsat.html>]

By 2008, the Boeing team working on solar power satellites had 30 years experience. Boeing scientists proposed and managed a half-dozen related contracts for NASA and produced about a dozen related publications. These activities included a conceptual design of a robotically constructed GEO satellite and work on smaller-scale, laser-photovoltaic satellites and transmission systems, which used receivers on Earth to produce solar-photovoltaic power. They reworked the Lunar Rover still on Earth to see if a laser-powered Lunar Rover, using wireless power transmission, could reach permanently shadowed lunar polar areas that may contain ice, and they studied the construction of a large solar power satellite to produce cryogenic propellants from water. Boeing scientists also looked at ways a space colony on the moon could find, shape and transport the materials to build the huge satellites more economically than by building them in space, which required launching space solar power satellite components from Earth. They led a study on solar power satellites presented to the National Security Space Office, and they participated in a NASA/DOD study of options for a near-term demonstration of space solar power technology in low Earth orbit. Other Boeing research and development projects also include a range of applications for beamed power technology, including microwave technology for space solar power. In November 2008, Spectrolab Inc., a wholly owned Boeing subsidiary, received the 2008 SpotBeam Award for Space Innovation from the California Space Authority in recognition of its 50 years of advancements in photovoltaic solar cell technology, solar panels and related products. Spectrolab was the world's leading supplier of photovoltaic solar cells, solar panels, searchlights and solar simulators, and Spectrolab cells powered 60 percent of all satellites orbiting the Earth, as well as the International Space Station.

# CSP CP

**CSP solves- converts solar power**

Christian **Breyerand** Gerhard **Knies,** co-founders of the DESERTEC Foundation, **09** [“GLOBAL ENERGY SUPPLY POTENTIAL OF CONCENTRATING SOLAR POWER”, September 15-18, 2009, <http://www.trec-uk.org.uk/reports/Breyer_paper_SolarPACES_GlobalEnergySupplyPotentialCSP_final_090630_proc.pdf>, MA]

Anthropogenic climate change concerns and ongoing depletion of fossil energy resources created a strong momentum for market diffusion of renewable energy sources and their respective conversion technologies. In order to convert solar energy in energy forms usable for human needs there are several thermodynamic pathways. In general, heat, kinetic energy, electric energy and chemical energy can be provided via solar energy conversion. Concentrating solar thermal power (CSP) plants convert direct solar irradiance into electricity. Suitable sites for CSP plants are located all around the world. Nevertheless, CSP is still a niche application for today’s global energy supply but installations of new CSP plants show high growth rates. On basis of satellite data, potential CSP sites are classified and a worldwide distribution of high quality potential CSP sites is derived. Taking into account population distribution on earth and high voltage direct current (HVDC) power transmission, the global energy supply potential of CSP technology is estimated in the following. In addition to CSP, recent research indicates that large scale photovoltaic (PV) power plants in MENA region may lead to comparable electric and economic characteristics referring to conventional CSP plants

**CSP is effective- high potential**

Christian **Breyerand** Gerhard **Knies,** co-founders of the DESERTEC Foundation, **09** [“GLOBAL ENERGY SUPPLY POTENTIAL OF CONCENTRATING SOLAR POWER”, September 15-18, 2009, <http://www.trec-uk.org.uk/reports/Breyer_paper_SolarPACES_GlobalEnergySupplyPotentialCSP_final_090630_proc.pdf>, MA]

Electricity generated in CSP areas can be transported via high voltage direct current (HVDC) power lines over several thousands of kilometers.[13] HVDC transmission losses can be kept in the range of 3%/1000 km plus HVDC terminal loss of 0.6% per inlet and outlet station. Power transmission over distances up to 3,000 km counts for transmission losses of not more than 10%, whereas high voltage alternating current (HVAC) would cause power losses higher than 20% and investment cost per km significantly higher than HVDC power lines.[13] It should be noted that if generation costs of electricity are low, the increase in transmission cost will not be significant. Identified potential CSP areas are shown in Figure 3. Regions which might be in reach of respective CSP areas by applying HVDC power lines for electricity transmission are indicated by surrounding areas of multiples of 900 km. Power lines might not be built in the shortest possible distance between centers of demand and supply due to land restrictions, therefore multiples of 900 km are taken instead of 1000 km. The energy supply potential of CSP can be assessed if the geographic distribution of the world population is taken into account. Population living close to CSP areas and within multiples of 900 km is shown in Figure 4 and Table 2. A regional breakdown of CSP supply potential shows that North and South America could be completely supplied within 2,000 km of potential CSP areas and the world region Africa/ Europe/ Asia could power 3.5 billion people via CSP within 2,000 km. As shown by Figure 4 and Table 2 energy supply potential of CSP technology for the world population living within 3,000 km distance to potential CSP areas exceed 90% of world population.

**CSP Solves**

Christian **Breyerand** Gerhard **Knies,** co-founders of the DESERTEC Foundation, **09** [“GLOBAL ENERGY SUPPLY POTENTIAL OF CONCENTRATING SOLAR POWER”, September 15-18, 2009, <http://www.trec-uk.org.uk/reports/Breyer_paper_SolarPACES_GlobalEnergySupplyPotentialCSP_final_090630_proc.pdf>, MA]

Based on the CSP energy supply potential (Table 1) and the energy demand for human needs supply coverage of CSP can be estimated. Several assumptions have to be incorporated. HVDC power lines could interconnect centers of CSP supply and energy demand. Power loss of HVDC power transmission is included and accounts for 3%/1000 km plus HVDC terminal loss of 0.6% per inlet and outlet station. Taking all assumptions into account electricity demand of world population on European consumption level would be approximately 44,000 TWh/y. Noteworthy, if all humans lived at European electricity consumption level, 0.4% of the electricity potential of worldwide potential CSP area could supply more than 90% of the world population connectable per grid to deserts. In every world region (Table 1) this number stays well below 0.7%, including only sites of a radiation quality of at least 2000 kWh/m²/y in the calculations. It would be possible to supply 6 billion people with nearly threefold the electricity generation of today and using only CSP. Every other renewable energy source, i.e. wind power, hydro-electric power, photovoltaic power, geothermal power and biomass, at sites not used for CSP generation would even improve access to energy around the world. Proceedings SolarPACES 2009, Berlin, September, 15 – 18 - 6 - A similar consideration can be done for non-electric energy needs. The specific non-electric energy demand is higher than the specific electricity demand. Non-electric energy is normally used in form of thermal energy stored as chemical energy. In principle electricity could be used for such purposes via converting it into hydrogen. Energetically this would not be favourable due to the low efficiency of the total process chain of about 50%. An electricity-to-hydrogen conversion efficiency of 50% including transport is an estimate of losses, reality may be better. Direct use of electricity for heat pumps, electrical heating, electric vehicles, et cetera, is very likely to be a better alternative due to efficiency criteria and the scenario of broad hydrogen use can be considered a worst case assumption. Because of economic reasons electricity would be transmitted to the destination region and converted in hydrogen at the place of demand. The non-electric energy demand of the world population is assumed to be on the today’s European energy consumption level of 26.5 MWhth/capita/y. All other assumptions are identical to the calculations of the electricity demand in the paragraphs above. Taking these assumptions into account including those for HVDC power transmission, non-electric energy demand of world population on today’s European consumption level would be approximately 340,000 TWhel /y. It should be noted that a large fraction of this energy amount is used for today’s vehicles powered by combustion engines and for heating purposes of houses thermally inadequately insulated. In general, improved efficiency standards would significantly decrease energy demand.

# Possible Private CP Stuff

**Using commercial assets means less spending.**

**Pena, 02** – defense policy expert at the Cato Institute (Charles, “Future Security in Space: Commercial, Military, and Arms Control Trade-Offs,” Occasional Paper No. 10, ed: Moltz, <http://cns.miis.edu/pubs/opapers/op10/op10.pdf>)

But, wherever possible, the Department of Defense (DOD) should make use of commercial assets rather than spend needlessly on unique military assets. For example, the military should use existing communications satellites for its nonsecure communications capability. Communications probably represents the single biggest use of space for both the military and civilian/commercial sectors. According to General Moorman: “Space-based communications is the giant in space commerce. The giant clearly will be even more dominant in the future, and the information revolution will be the driver.”6

**Commercial focus in space is key.**

**Pena, 02** – defense policy expert at the Cato Institute (Charles, “Future Security in Space: Commercial, Military, and Arms Control Trade-Offs,” Occasional Paper No. 10, ed: Moltz, <http://cns.miis.edu/pubs/opapers/op10/op10.pdf>)

The military should also consider using distributed and redundant commercial satellite systems as a means to reduce vulnerability to attack rather than deploying unique military systems that are likely to be more expensive and take longer to deploy. For example, it may be more cost-effective to develop and deploy smaller satellites in a distributed system configuration designed to operate at low-Earth orbit and medium-Earth orbit than larger, heavier satellites operating in geosynchronous (stationary) orbit. That approach is especially meritorious if there is a potential shortage of heavy-lift launch capability. It is also important that military requirements should not be imposed on shared nonmilitary satellites. For example, the military should not require hardening against electromagnetic pulse on commercial satellites that are also used by the military. To the extent that such requirements are absolute needs, the military should deploy its own dedicated systems to meet those requirements. Neither commercial satellite operators nor the other users of commercial satellites should shoulder any cost burdens imposed by the military (and clearly, the military must be more realistic about its requirements). Even if commercial space is not a panacea for the military, it should be the driving force of space and shape space policy. Indeed, commercial space efforts often lead those of the government and the DOD and usually have lower costs, due to market influences and competition. Therefore, defense and national security need to be one component of overall U.S. space policy, but certainly not the primary component. In the post–Cold War environment—with no immediate threat from another great power and none on the horizon (at least in the near- to mid-term)—the U.S. government must avoid establishing inflated and costly military requirements for space-based resources. U.S. space policy should strive to foster an environment that allows commercial space activity to grow and flourish rather than create a new area for costly military competition.

# Leadership Brink Ev

**Specifically, China is getting ahead in space – now is key**

**Kaufman, 08** (Mark, “US Finds It’s Getting Crowded Out There: Dominance in Space Slips as Other Nations Step Up Efforts”, Washington Post, 7/9, http://www.globalpolicy.org/empire/challenges/competitors/2008/0709space.htm)

In contrast to the Cold War space race between the United States and the former Soviet Union, the global competition today is being driven by national pride, newly earned wealth, a growing cadre of highly educated men and women, and the confidence that achievements in space will bring substantial soft power as well as military benefits. The planet-wide eagerness to join the space-faring club is palpable. China has sent men into space twice in the past five years and plans another manned mission in October. More than any other country besides the United States, experts say, China has decided that space exploration, and its commercial and military purposes, are as important as the seas once were to the British empire and air power was to the United States. The Chinese space program began in the 1970s, but it was not until 2003 that astronaut Yang Liwei was blasted into space in a Shenzhou 5 spacecraft, making China one of only three nations to send men into space. "The Chinese have a carefully thought-out human spaceflight program that will take them up to parity with the United States and Russia," Griffin said. "They're investing to make China a strategic world power second to none -- not so much to become a grand military power, but because deals and advantage flow to world leaders."

**China has space technology.**

**Kueter, 07** - is president of the George C. Marshall Institute, a nonprofit think tank dediicated to science and technology in public policy (Jeff, New Atlantis, “China's Space Ambitions -- And Ours,” Spring, <http://www.thenewatlantis.com/docLib/TNA16-Kueter.pdf>)

China possesses the facilities, satellite technology, mission control centers, and launchers required of a space power. The Long March series of rockets can place payloads into low-Earth, geosynchronous, and polar orbits. Five satellite constellations are used for communications, meteorology, remote sensing, and navigation. In addition, China has shown great interest in small satellites and has developed a dedicated launcher for them. The Chinese have also engaged in several international cooperative efforts, such as the Galileo navigation satellite system that Europe is developing as an alternative to America’s Global Positioning System (GPS). For all its advances, it is worth noting that China’s space program looks somewhat different from the American or old Soviet space programs. In their early years, those space programs emphasized reconnaissance, nuclear detonation detection, and missile warning. But China hasn’t concentrated on reconnaissance and warning satellites. Whereas the U.S. and Soviet space programs were built with military intelligence in mind, the Chinese space program has decidedly more twenty-first century motivations.

**Japan is smoking us at SPS tech**

**Ramos 2k** – US Air Force Major, Thesis submitted for the AIR COMMAND AND STAFF COLL MAXWELL Air Force Base (Kim, “Solar Power Constellations: Implications for the United States Air Force,” April, http://handle.dtic.mil/100.2/ADA394928)

Japan is the leader in solar power satellite technology today. They are working on several proofs of concept for solar power satellites. The three main projects are the space flyer unit, ISY-METS, and solar power satellite 2000 (SPS2000). The space flyer unit deployed on the8 shuttle and tested various solar power to electricity generating schemes. 23 The ISY-METS, mentioned earlier, proved that one spacecraft could supply power to another in space using wireless power transmission. The SPS2000 experiment has two parts. The first part demonstrated a solar power satellite, suspended several feet off the ground, which beamed 4 watts of power to a rectenna. The rectenna powered a water pump, fan, and lights. 24 The second part will be a small solar power satellite in orbit beaming power to five locations. 25

**Brazil is starting to compete for aerospace dominance**

**Walker et al, 02** - Chair of the Commission on the Futureof the United States Aerospace Industry Commissioners (Robert, Final Report of the Commission on the Futureof the United States Aerospace Industry Commissioners, November, http://www.trade.gov/td/aerospace/aerospacecommission/AeroCommissionFinalReport.pdf)

Brazil is a strong competitor in aerospace manufacturing and produces a wide range of aerospace products. Perhaps best known for producing regional jets, Brazilian manufacturers also make turboprops, military aircraft, agricultural aircraft, business aircraft, helicopters, and other general aviation aircraft. The most well-known Brazilian manufacturer is Embraer, which has delivered more regional jets than its only competitor (Canada‘s Bombardier) each year since 2006. Brazilian firms are highly integrated into the global aerospace supply chain and have embarked on risk-sharing projects and joint ventures with foreign firms both in Brazil and abroad. Brazil is a major supplier to the United States‘ market, though it competes more in sales of final aircraft than in sales of parts and components. In 2009, the Aerospace Industries Association of Brazil estimated that its members earned $7.11 billion in revenue 106 ; according to company information, Embraer‘s portion of that total was around $5.5 billion 107 . Indeed, Brazilian manufacturers claim to import a significant amount of parts and components from non-Brazilian suppliers, including suppliers in the United States. However, it was only in the 2000s that Brazil consistently became one of the top ten U.S. export markets for aerospace equipment, likely due to the increasing success of Embraer‘s regional jet and business aircraft programs. In 2008, U.S. firms exported $5.76 billion worth of aerospace products to Brazil, $2.07 billion of which was complete aircraft and $3.69 billion of which were parts and components. 108

**China poses threats to America’s aerospace leadership**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies

(Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>)

China's October 2003 manned space flight highlighted its dramatic achievements in space technology. Although Chinese space technology is not state-of-the-art, China differs from other developing countries by having a space program that spans the full range of capabilities from satellite design to launch services. China builds satellites on its own, and is involved in international commercial and scientific collaborations with Europe, Russia and Brazil. The People's Republic of China has a robust commercial satellite launch industry capable of launching payloads into geosynchronous and polar orbits. Its space program is also notable for the movement of personnel and technology between the civilian and military sectors. Beijing's space aspirations pose significant security concerns for Washington. Most of China's space programs have commercial or scientific purposes, but improved space technology could significantly improve Chinese military capabilities. China may also seek to offset U.S. military superiority by targeting U.S. space assets**.**

**America faces the possibility of adversaries in outer space**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies

(Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>)

As U.S. dependence on space increases, concerns have grown about the potential for adversaries to attack U.S. space assets. According to current Department of Defense (DOD) doctrine, "The United States must be able to protect its space assets ... and deny the use of space assets by its adversaries. Commanders must anticipate hostile actions that attempt to deny friendly forces access to or use of space capabilities." The 2001 Rumsfeld Commission report warned of a potential "space Pearl Harbor" if adversaries attack U.S. satellites. Underpinning these concerns is the possibility that China might target U.S. space assets in a future conflict.

**Countries such as China are willing to attack US dominance in outer space**

**Saunders, 7**- Senior Research Professor at the National Defense University’s Institute for National Strategic Studies (Dr. Phillip C., “China’s Future In Space: Implications for U.S. Security,” 2007, <http://www.space.com/adastra/china_implications_0505.html?submit.x=94&submit.y=10&submit=submit>)

Chinese strategists view U.S. dependence on space as an asymmetric vulnerability that could be exploited. As one defense analyst wrote: "for countries that can never win a war with the United States by using the method of tanks and planes, attacking the U.S. space system may be an irresistible and most tempting choice." Chinese strategists have explored ways of limiting U.S. use of space, including anti-satellite (ASAT) weapons, jamming, employing lasers to blind reconnaissance satellites, and even using electro-magnetic pulses produced by a nuclear weapon to destroy satellites. A recent article highlighted Iraq's efforts to use GPS jammers to defeat U.S. precision-guided munitions. Chinese scientists have conducted theoretical research relevant to ASAT weapons, including the use of lasers to blind satellite sensors, kinetic kill vehicles, computations for intercepting satellites in orbit, and maneuvering small satellites into close formation. Efforts to develop high-powered lasers and mobile small-satellite launch capabilities involve technologies with both commercial and ASAT applications. China probably already has sufficient tracking and space surveillance systems to identify and track most U.S. military satellites. The extent to which interest in exploiting U.S. space dependence has translated into actual ASAT development programs remains unclear. Some reports claim that Beijing is developing microsatellites or direct-ascent weapons for ASAT purposes, but the open source literature does not provide definitive proof. However, based on Chinese strategic writings, scientific research and dual-use space activities, it is logical to assume China is pursuing an ASAT capability.

# \*\*\*Weaponization Work\*\*\*

# SPS Weapons Internal Link

**Put away generic leadership defense files – SPS is the vital internal link between aerospace technological innovation and tangible benefits to the military that allow battlefield dominance**

**Ramos 2k –** US Air Force Major, Thesis submitted for the AIR COMMAND AND STAFF COLL MAXWELL Air Force Base (Kim, “Solar Power Constellations: Implications for the United States Air Force,” April, <http://handle.dtic.mil/100.2/ADA394928H>) Herm

Solar power satellites may affect terrestrial Air Force operations. One terrestrial application for solar power satellites, or the technologies associated with them, involves unmanned aerial vehicles. Unmanned aerial vehicles are used during contingencies to supplement satellite and piloted (manned) aerial reconnaissance coverage. The unmanned aerial vehicle may be powered by a wireless power transmission, which would increase its endurance. In another area, one of the core competencies of the Air Force is agile combat support, which involves reducing the footprint of deployed forces.U The use of solar power satellites to supply the power at deployed locations would reduce the logistics tail by eliminating generators and the support equipment and supplies associated with them. The third area concerns public law. Public law requires the Department of Defense to develop and encourage alternative sources of energy for installations. As an alternative to electricity generated from fossil fuels, solar power satellites fit the bill admirably. Terrestrially, solar power satellites or the technology associated with them enable long duration unmanned aerial vehicles, which receive power through wireless power transmissions, allow for logistical improvements, and assist the Air Force in complying with public law. Unmanned Aerial VehiclesUnmanned aerial vehicles help achieve information superiority. Both joint and Air Force service visions define information superiority as vital. *Joint Vision 2010* calls information superiority a technological innovation to enable dominant maneuver, precision engagement, focused logistics, and full-dimensional protection. It defines information superiority as “the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary’s ability to do the same.”3 *Global Engagement: A Vision for the 21st Century Air Force* expresses the Air Force’s vision for the future and defines its core competencies. One of the Air Force Core Competencies it describes is information superiority. It goes on to endorse the use of unmanned aerial vehicles to “explore their potential uses over a full range of combat missions ”4 to achieve information superiority. Supported by the highest levels of the Department of Defense, the use of unmanned aerial vehicles to achieve information superiority in regional conflicts is increasing. High altitude and long endurance vehicles are in development for monitoring the atmosphere, environmental impact studies, and more important to the Air Force, for communications relays, surveillance, and missile defenseU.5 Other military uses for such vehicles are reconnaissance, targeting, target designation, and battle damage assessment.6 One of the requirements for these vehicles is that they must have long endurance,7 which currently is not possible. Using a microwave beam for powered flight and to power on-board instrumentation increases the endurance of the vehicle. Theoretically, by powering the craft with a beam it would possess unlimited enduranceU.8 The power transmitted to the unmanned vehicle could come from a solar power satellite in space or from a ground station. These vehicles would be part of a war fighting commander-in-chief’s arsenal. Unmanned aerial vehicles with various detection modules would serve as near earth satellites for regional coverage of events. This is especially important in areas where satellites are not available for coverage, the revisit time of a satellite is too long, or due to limited assets, sharing of satellite time takes place. **Logistics** In addition to information superiority, one of the emerging operational concepts expressed in *Joint Vision 2010* is focused logistics. Focused logistics will be the fusion of information, logistics, and transportation technologies to provide rapid crises response, to track and shift assets even while enroute, and to deliver tailored logistics packages and sustainment directly at the strategic, and tactical level of operations.9 It goes on to say, that focused logistics will accomplish “lightened deployment loads” and “a smaller logistics footprint.”10 In addition to *Joint Vision 2010*, Air Force doctrine also describes logistics as an important part of agile combat support, one of its core competencies. One of the objectives of agile combat support is to “reduce the overall “footprint” of forward-deployed support elements.”11 Power relay satellites, a stepping stone to full solar power satellites, could supply power to deployed locations and be part of focused logistics and agile combat support. Part of the deployment planning process would be identifying the nearest power relay satellite, the coordinates for the reflecting dish, and the amount of power required by the site. The next step, after demonstrating sites powered by a relay satellite, would be employing solar power satellites instead of relaying electricity across the globe. Using power beamed from a relay station or a solar power satellite could eliminate the power generating part of a deployment and reduce airlift.U Incorporating the rectenna or the receiving part of the beam into camouflage netting or into tent tarps creates no additional infrastructure. For example, a typical joint task force communications unit for a bare base deployment requires the generators in Table 1 to supply power for the communications equipment and site. According to the Computer Aided Load Manifest software, used by logistics planners, to bring the generators into theater requires one C-17 or two C-141s. A Kenney Battlelab initiative on replacing aerospace ground equipment recommended alternative sources of power for airfield operations. In the report, it states power producing equipment “is repeatedly singled-out through after action reports … as the number one airlift intensive requirement for Air Expeditionary Force deployment.”12 The report recommends adopting fuel cell technology to solve the problem, however, solar power satellites or power relay satellites are also viable options. In addition to reducing airlift, using power from a satellite would reduce the fuel required for generators, minimize hazardous emissions and waste, reduce heat signatures, and eliminate a plethora of support equipment, war readiness spares kits, tools, and spillage clean up kits.

# Space Mil Inevitable

**No one agrees on space militarization in the status quo – means that weaponization is inevitable – takes out their impacts.**

**Beljac, 08** - a Foreign Policy In Focus contributor, teaches at the University of Melbourne (Marko, “Arms Race in Space”, 4/1, <http://www.fpif.org/fpiftxt/5113>]

When the United States recently shot apart a crippled spy satellite over the Pacific Ocean, it also tested an offensive anti-satellite weapon and the potential for ballistic missile defense. “The shot,” as the Pentagon called the $100 million operation conducted on February 20, came immediately after Russia and China put forward a detailed, but flawed, proposal for a treaty to ban space weapons at the United Nations. In response, the United States immediately reaffirmed its unwillingness to participate in any arms control accord covering space. These developments are just the latest wrinkles in a rapidly unfolding saga that underscores the fact that we’re entering a new strategic era characterized by the weaponization of space. It may sound exciting, but the potential consequences of space weaponization are cataclysmic. “The shot” has important implications for defense planners everywhere. To be sure, as Victoria Samson so eloquently explained, this was an orchestrated operation and didn’t in any way mimic the real-world conditions that would prevail if a missile defense system were to be used to “shield” the U.S. from an enemy-fired weapon. The satellite, after all, was very large and was moving along a predictable trajectory. Of course, all Ballistic Missile Defense tests carried out until now have been highly idealized and largely developmental in nature, as the Government Accountability Office noted in a recent report on the topic. Therefore, it would not be too far off the mark to even characterize this highly idealized action as a developmental weapons test.

# China ASATs Justify US Development

**We secretly like China’s ASAT tests because it justifies U.S. space involvement.**

**Beljac, 08** - a Foreign Policy In Focus contributor, teaches at the University of Melbourne (Marko, “Arms Race in Space”, 4/1, <http://www.fpif.org/fpiftxt/5113>]

It’s important that we understand that the Bush administration’s stated reasons for “the shot” can’t be taken seriously. Given that the fuel tank was most likely not heat shielded it should not have survived re-entry. Even if by remote chance it were to survive re-entry, the pressure and heat of re-entry should have vaporized its hydrazine rocket fuel. Instead, the administration found a convenient way to do what China did last year: test an offensive anti-satellite weapon against its own redundant satellite. We now know that the United States knew that China was going to shoot down one of its own satellites beforehand, but the White House decided not to protest diplomatically before the Chinese test. This puts all the rhetoric directed at Beijing's way following China's anti-satellite test in perspective. **The United States is not responding to Chinese space programs. It secretly welcomes them as public justification for its own drive to weaponize space.**

**China ASAT test makes SB-BMD more popular.**

**Kueter, 07** - is president of the George C. Marshall Institute, a nonprofit think tank dediicated to science and technology in public policy (Jeff, New Atlantis, “China's Space Ambitions -- And Ours,” Spring, <http://www.thenewatlantis.com/docLib/TNA16-Kueter.pdf>)

Ironically, the Chinese ASAT test could boost the prospects for spacebased missile defense. If the international community is truly worried about the debris-generating effects of ASAT weapons, then it ought to embrace—indeed demand—the development and deployment of boostphase missile defenses capable of intercepting missiles carrying ASATs long before they reach their satellite targets. A constellation of orbital interceptors could build upon capabilities developed in a precursor system of rapid-replenishment satellites. Combined with a new emphasis on satellite protection and replenishment capabilities, space-based missile defenses could frustrate any attempts to block the peaceful use of space by America and its allies. Despite the current U.S. lead in space activities, there are serious causes for concern about America’s ability to sustain the quantity and quality of its space activities. Nearly every U.S. space program faces budget overruns and schedule slippages. This is indicative of systemic management concerns, changing requirements, and the complexity of the tasks at hand. Two important indicators—federal R&D dollars spent on space activities and the size of the aerospace workforce and its related academic cohort—are flat or falling, suggesting a perceived lack of priority or faith in the future of these industries and activities. According to the National Science Foundation, federal support for space activities ranged between $7.1 billion and $8.5 billion per year in the 1990s, but fell to between $5.3 billion and $7.1 billion in 2000-2006. This drop ran counter to the overall trend: total federal R&D has jumped from $78 billion to $113 billion since 2000. (All figures are adjusted for inflation.) Meanwhile, the Aerospace Commission, the National Science Board, and many others have voiced concerns about the health of the human capital base of the aerospace industry. The workforce is aging, employment in missiles and space-related fields has dropped precipitously since the end of the Cold War, and the number of U.S. citizens pursuing advanced technical degrees in related fields is outpaced by their foreign colleagues. In a 2005 examination of U.S. space policy, George Abbey and Neal Lane, both of Rice University, concluded, “Over the past few years, the aerospace industry has been unable to develop the experienced workforce that they had dur ing the 1960s due to consolidations and the absence of new programs.” In short, there are questions about the innovative capacity of the U.S. to sustain its present advantages. Only leadership, commitment, prioritization, and investment can reverse those trends. The United States today is in a unique position to take steps to ensure the defense of its interests in space, and to ensure the basic principles of free passage and access for all. Such basic defensive actions are not incompatible with the maintenance of peace and stability; indeed, they are essential to it.

# US Weaponizing Now

**US weaponizing now.**

**Beljac, 08** - a Foreign Policy In Focus contributor, teaches at the University of Melbourne (Marko, “Arms Race in Space”, 4/1, <http://www.fpif.org/fpiftxt/5113>]

Space Weaponization The United States has been quietly working on implementing this vision. Space weaponization is a relatively long-term project that is expected to culminate by 2030. But the pace seems to be quickening. The Pentagon has produced a series of doctrinal documents that clarify what is meant by war in space and how it is to be properly waged. Hitherto, the program has emphasized improving situational awareness in space. It’s impossible to wage war in space without knowing precisely who has what where. However, in the 2008 budget, Congress appropriated $7 million dollars for “offensive counterspace” operations out of a $53 million dollar budget for “counterpace operations” which actually amounts to an increase in the level of funding sort by the White House. That suggests that the United States is moving up a gear on space weaponization and that this has both congressional and White House support which is critical for long-term strategic planning. In fact we have just learnt that the Air Force is working on plans to develop a “counter-ASAT” space weapon system by 2011. Reports suggest that most aspects of these plans are secret but some information has emerged in the public domain that sheds some interesting light on US space weapons planning. The system is known as the Rapid Attack Identification Detection Reporting System (Raidrs) Block 20. The rationale for this program is to develop information in a timely fashion to enable the Pentagon to intercept a direct-ascent anti-satellite weapon, which are launched from the Earth, before it strikes its target in low earth orbit. But if the asset used to achieve this objective is space based then this may well enable BMD hawks to also obtain a space based BMD interception capability and there is no reason to suppose that a “counter-ASAT” weapon could not also function as an offensive space weapon.

# Space Weapons Bad – War

**Space weaponization leads to nuclear war and makes accidental wars a risk.**

**Beljac, 08** - a Foreign Policy In Focus contributor, teaches at the University of Melbourne (Marko, “Arms Race in Space”, 4/1, <http://www.fpif.org/fpiftxt/5113>]

Nascent Asian Space Race As noted, China has tested an anti satellite weapon and Russia has stated that it would not allow other states to control space and threaten its own space assets. In Asia a nascent space race seems to be developing between China, Japan and India. In the far future the large deposits of Helium-3 on the moon's surface could lead to a militarized race to colonize the moon to secure Helium-3 for nuclear fusion energy technologies based on anuetronic fusion reactions in the context of depleting hydro-carbons. Washington argues that it has too much commercially riding on space to allow others to have the potential capability of disrupting U.S. space assets. In 1998 the failure of one satellite, the Galaxy IV, made some 80% of pagers in the U.S. malfunction. Though the latest Russian and Chinese space arms control proposal is flawed, because of the clumsy definition of what constitutes a “space weapon,” this doesn’t mean that space arms control is not possible in principle. A global space arms control regime would protect U.S., Russian, Chinese, and even Australian space assets. An arms race in space will eventually lead other states to catch up with the United States and thereby placing Washington's commercial satellites at risk. **Space weaponization may well have cataclysmic consequences given the link between space weapons and nuclear weapons strategy.** This is because Russia, and the United States, to a certain extent rely on satellites for early warning of nuclear attack. As other space nations with nuclear weapons develop their space capacity it is expected that they will follow suit. The deployment of space weapons means that the first shot in a nuclear war would be fired against these early warning satellites. Currently strategic planners in Moscow have about 10 minutes between warning of an attack and the decision to launch nuclear weapons in response before they impact. Weapons in space would lower this in certain scenarios down to seconds. This would also apply for weapons placed in space that would be considered to be defensive such as say a space based BMD interceptor or a “counter-ASAT” weapon. On occasion, ground warning radars falsely show that a nuclear attack has been launched. In the 1990s a false alarm went all the way up to President Boris Yeltsin and was terminated after approximately eight minutes. We are still here, noted analysts believe, because warning satellites would have given Moscow real time information showing the alarm to be false. Should such a false alarm coincide with an accident involving an early warning satellite when space weapons are known to exist, an accidental nuclear exchange could result. The risk would increase if the false alarm occurred during a crisis. **Space weapons could lead to itchy fingers on nuclear triggers. They would therefore significantly increase the importance nuclear weapon states place upon nuclear deterrence.**

# Arms Control Doesn’t Solve

**Arms control doesn’t solve space weapons.**

**Tellis, 07** - Senior Associate at the Carnegie Endowment for International Peace (Ashley, Survival, Autumn, “China’s Military Space Strategy”, ingenta)

Concerns about an arms race in space ought to be taken seriously, as a threat to both American and global security, but there is, unfortunately, no arms-control solution to this problem. China’s pursuit of counterspace capabilities is not driven fundamentally by a desire to protest American space policies, and those of the George W. Bush administration in particular, but is part of a considered strategy designed to counter the overall military capability of the United States, grounded in Beijing’s military weakness at a time when China considers war with the United States to be possible. The weapons China seeks to blunt through its emerging space-denial capability are not based in space: they are US naval and air forces that operate in China’s immediate or extended vicinity. What are in space are the sensory organs, which find and fix targets for these forces, and the nervous system, which connects the combatant elements and permits them to operate cohesively. These assets permit American forces to detect and identify different kinds of targets; exchange vast and diverse militarily relevant information and data streams; and contribute to the success of combat operations by providing everything from meteorological assessment, through navigation and guidance, to different platforms, weapon systems, and early warning and situational awareness. There is simply no way to ban or control the use of space for such military purposes. Beijing’s diplomats, who repeatedly call for negotiations to assure the peaceful use of space, clearly understand this. And the Chinese military appreciates better than most that its best chance of countering the massive conventional superiority of the United States lies in an ability to attack the relatively vulnerable eyes, ears and voice of American power. The lure of undermining America’s warfighting strengths in this way prompts Beijing to systematically pursue a variety of counterspace programmes even as it persists in histrionic calls for the demilitarisation of space. 22 China’s Janus-faced policy suggests it is driven less by bureaucratic accident or policy confusion than by a compelling and well-founded strategic judgement about how to counter the military superiority of its opponents, especially the United States

**The U.S. shouldn’t waste time looking at space control agreements.**

**Tellis, 07** - Senior Associate at the Carnegie Endowment for International Peace (Ashley, Survival, Autumn, “China’s Military Space Strategy”, ingenta)

Because none of these conditions will be realised any time soon, Washington should not invest time, energy and resources in attempting to negotiate spacecontrol arrangements of the kind advocated by Markey and others. Such regimes are destined to be stillborn because the larger strategic logic conspires against them. This does not imply that the United States should not discuss space security with China and others. Far from it: Washington should seek a better understanding of China’s intentions and the details of its counterspace programmes through conversations with Beijing. It should also encourage other spacefaring nations in Asia – Russia, Japan and India – and elsewhere whose space assets are also at risk because of China’s evolving counterspace capabilities to enter into a dialogue with Beijing about its strategic direction. If the United States is ambitious, it could even contemplate negotiating informal ’rules of the road’ or ’codes of conduct’ governing activities in space, but these mechanisms ought to be appreciated for what they are. 85 **They are, and will always be, primarily confidence-building measures, not verifiable agreements** that would in any way limit China’s evolving space warfare programmes.

# US Wins Sino War

**The U.S. wins a US-China war.**

**Tellis, 07** - Senior Associate at the Carnegie Endowment for International Peace (Ashley, Survival, Autumn, “China’s Military Space Strategy”, ingenta)

Since China is confronted by formidable American military superiority, any effort to defeat the United States through an orthodox force-on-force encounter, centred on simple attrition, is doomed to a sorry end. Ever since the dramatic demonstration of American prowess in Operation Desert Storm in 1991, Chinese strategists have struggled to find ways of overcoming US conventional might. 31 Drawing on China’s indigenous military tradition, which emphasises stealth, deception and indirect approaches to warfare, and opportunities offered by emerging technologies, which enable effective asymmetric strategies focused on attacking an adversary’s weaknesses, the Chinese military has concentrated on developing a wide range of material and non-material capabilities that would make ‘defeating the superior with the inferior’ possible. 32 After a decade of carefully assessing the sources of potency and frailty in American capabilities, Chinese planners concluded, in Michael Pillsbury’s apposite formulation, that ‘U.S. military forces, while dangerous at present, are vulnerable – and can be defeated by China with the right strategy’. 33

# China=Superior

**China’s military tech is superior.**

**Tellis, 07** - Senior Associate at the Carnegie Endowment for International Peace (Ashley, Survival, Autumn, “China’s Military Space Strategy”, ingenta)

Implications China is by no means certain to wrest control of space during any future war with the United States. These programmes, while real, are not all mature and will not end up being equally successful. Moreover, the United States still has immense counter-counterspace capabilities, and many of these emerging threats can be countered, albeit at significant cost. China’s recent anti-satellite test is not an anomaly, however, but an exemplar of a wide-ranging endeavour to develop multiple warfighting instruments to constrain America’s ability to exploit space to produce a rapid and decisive terrestrial military victory over China. When viewed in their entirety, these programmes reveal China’s counterspace investments to be diverse, comprehensive, rapidly improving and deadly serious, exceeding even those of the Soviet Union at its peak. They should leave no doubt that Beijing is determined to negate as far as is possible the operational advantages that accrue from Washington’s space-enabled conventional military dominance. Although the strategic consequences of China’s emerging counterspace capabilities will only be appreciated over time, as current programmes succeed or fail in warfighting terms, three important policy repercussions stand out immediately. Firstly, the history and focus of Chinese investments in counterspace technologies clearly indicate that they are rooted in strategic necessity and not capricious state choices. A programme of such complexity, employing the resources and personnel of some of China’s best scientific institutions and state enterprises, cannot be rationalised as the unintended product of either bureaucratic politics or inefficient state planning. When all is said and done, the United States, and its superior military power, remains the biggest objective constraint on China’s ability to secure its own political interests, whether related to immediate concerns over Taiwan or more remote challenges of constructing a Sinocentric order in Asia and perhaps globally. It should not be surprising that Chinese leaders, who have demonstrated a remarkable capacity for strategic rationality since at least Deng Xiaoping, if not earlier, have tasked their military forces to develop means to defeat the power-projection capabilities of the United States, and thereby protect their national interests. Given that the effectiveness of the American warfighting machine depends heavily on its superior space capabilities, which include assets that are both highly sophisticated and relatively defenceless, preparing to attack these nodes is, from Beijing’s point of view, an operationally optimum solution and the acme of good strategy. In this light, the administration ought to treat cautiously admonitions like Congressman Edward Markey’s that Bush move urgently to guarantee the protection of American space assets ‘by initiating an international agreement to ban the development, testing, and deployment of space weapons and anti-satellite systems’. 84 Although well intentioned, such recommendations are illusory, because China, its rhetoric notwithstanding, will not conclude a space-control agreement that eliminates the best chance it may have of asymmetrically defeating American military power.

# US Needs to Change Policy

**The U.S. needs to change its policy in space.**

**Tellis, 07** - Senior Associate at the Carnegie Endowment for International Peace (Ashley, Survival, Autumn, “China’s Military Space Strategy”, ingenta)

Above all is the need for a longer-term change in the American approach to space. Recognising that this ’final frontier’ will no longer remain the sanctuary it has been, the United States must move away from reliance on a few, large, highly specialised space platforms supported by a complex but narrow ground segment – all of which are disproportionately vulnerable to enemy action and are difficult and costly to replace in case of interdiction – and shift towards smaller and flexible distributed capabilities both in space and terrestrially. Such investments would offer Washington the highest payoffs even in comparison to offensive capabilities, which are more useful for deterring attacks rather than for nullifying them or remedying their consequences. 93 Finally, the growing Chinese capability for space warfare implies that a future conflict in the Taiwan Strait would entail serious deterrence and crisis instabilities. If such a clash were to compel Beijing to attack US space systems at the beginning of a war, the very prospect of such a ‘space Pearl Harbor’ 94 could, in turn, provoke the United States to contemplate pre-emptive attacks or horizontal escalation on the Chinese mainland. Such outcomes would be particularly likely in a conflict in the next decade, before Washington has the opportunity to invest fully in redundant space capabilities. Already, US Strategic Command officials have publicly signalled that conventionally armed Trident submarine-launched ballistic missiles would be appropriate weapons for executing the prompt strikes that might become necessary in such a contingency. 95 Such attacks, even if employing only conventional warheads, on space launch sites, sensor nodes and command and control installations on the Chinese mainland could well be perceived as a precursor to an all-out war. It would be difficult for all sides to limit the intensification of such a conflict, even without the added complications of accidents and further misperception.

# Weaponization Good

**One strategy is weaponization but it’s tough.**

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A better approach to coping with the new realities of space security, some analysts argue, would be for the United States to develop the means to quickly react against any other nation deploying weapons to space. But this approach greatly overestimates the ease of putting systems into space. Space is a challenging environment, and the design and production of new systems is complicated, expensive, and subject to frequent reversals. The industrial and academic base on which U.S. space prowess depends is not currently capable of surging production of existing systems or developing new ones to meet such demands. And even if it were, such a reactive course would still leave U.S. assets already in space vulnerable, opening the possibility of blackmail, coercion, or worse. **The United States should instead adopt an active defensive posture, beginning by expanding and invigorating the research and technical base needed to defend or replenish space assets**. In the absence of defensive systems, the United States government would do well to invest in small satellite development and rapid launch capabilities. The combination of the two, once achieved, changes the strategic calculations of prospec tive adversaries. Instead of achieving strategic surprise by decapitating America’s critical space-enabled weapons, an adversary would only have attained a momentary advantage. Unfortunately, the Air Force and Department of Defense budgets show little intention of investing in these areas.

**It is possible to deploy space weapons – our evidence answers their warrants.**

**Dolman, 5**—Professor of Comparative Military Studies at the US Air Force’s School of Advanced Air and Space Studies

(Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, http://www.e-parl.net/pages/space\_hearing\_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf)

Space Weapons Are Possible Arguments in the first category spill the most ink in opposition, but are relatively easy to dispose of, especially the more radical variants. History is littered with prophesies of technical and scientific inadequacy, such as Lord Kelvin’s famous retort, ‘Heavier-thanair flying machines are impossible.’ Kelvin, a leading physicist and then president of the Royal Society, made this boast in 1895, and no less an inventor than Thomas Edison concurred. The possibility of spaceflight prompted even more gloomy pessimism. A New York Times editorial in 1921 (an opinion it has since retracted), excoriated Robert Goddard for his silly notions of rocket-propelled space exploration. ‘Goddard does not know the relation between action and reaction and the need to have something better than a vacuum against which to react. He seems to lack the basic knowledge ladled out daily in high schools.’ Compounding its error in judgment, in 1936, the Times stated flatly, “A rocket will never be able to leave the Earth’s atmosphere.”We have learned much, it would seem, or else bluntly negative scientific opinion on space weapons has been weeded out over time. Less encompassing arguments are now the rule. As the debate moved completely away from the impossibility of weapons and wars in space to more subtle and scientifically sustainable arguments that a particular space weapon is not feasible, mountains of mathematical formulae are piled high in an effort, one by one, simply to bury the concept. But these limitations on specific systems are less due to theoretical analysis than to assumptions about future funding and available technology. The real objection, too often hidden from view, is that a particular weapons system or capability cannot be developed and deployed within the planned budget, or within narrowly specified means. When one relaxes those assumptions, opposition on technical grounds falls away. The devil may very well be in the details, but if one’s stance opposing an entire class of weapons is premised upon analyses that show particular weapons will not work … what happens when a fresh concept or new technology cannot be disproved? If one bases policy decisions on discrediting the particulars of proposed operations, what happens when technology X, the unexpected (perhaps unforeseeable) scientific breakthrough that changes all notions of current capabilities, inevitably arrives? Have we thought out the details enough we can say categorically that no technology will allow for a viable space weapons capability? If so, then the argument is pat; no counter is possible. But, if there are technologies or conditions that could allow for the successful weaponization of space, then ought we not argue the policy details first, lest we be swept away by a course of action that merely chases the technology wherever it may go?

**Space weapons should be deployed – it would prevent challengers.**

**Dolman, 5**—Professor of Comparative Military Studies at the US Air Force’s School of Advanced Air and Space Studies

(Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, <http://www.e-parl.net/pages/space_hearing_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf>)

The opponents of space weapons on technical or budgetary grounds are not advocating space weapons in the event their current assumptions or analyses are swept aside. Because a thing can be done does not mean it ought to be. Of course, prescience is imperfect. Technologies will be found that were not or could not be foretold, and the foolish policymaker eschews adapting to it until its utility is beyond a doubt. Indeed, it is concern for the unanticipated arrival of technology X that initially motivates my own preference for a policy advocating immediate deployment of space weapons. So long as America is the state most likely to acquire a breakthrough technology in this area, my concern is limited to the problem of letting technology take us where it will. But what if an enemy of democratic liberalism should suddenly acquire the means to place quickly and cheaply multiple weapons into orbit? The advantages gained from controlling the high ground of space would accrue to it as surely as to any liberal state, and the concomitant loss of military power from the denial of space to our already-dependent military force could cause the immediate demise of the extant international system. The longer the US dithers on its responsibilities, the more likely a potential opponent could seize low-earth orbit before America could respond. And America would respond … finally. But would another state? If America were to weaponize space today, it is unlikely that any other state or group of states would find it rational to counter in kind. The entry cost to provide the infrastructure necessary is too high; hundreds of billions of dollars, at minimum. The years of investment it would take to achieve a minimal counter-force capability—essentially from scratch—would provide more than ample time for the US to entrench itself in space, and readily counter preliminary efforts to displace it. The tremendous effort in time and resources would be worse than wasted. Most states, if not all, would opt not to counter US deployments in kind. They might oppose US interests with asymmetric balancing, depending on how aggressively America uses its new power, but the likelihood of a hemorrhaging arms racein space should the US deploy weapons there—at least for the next few years—is extremely remote.

**We need space weapons for Heg – and the U.S. is key.**

**Dolman, 5**—Professor of Comparative Military Studies at the US Air Force’s School of Advanced Air and Space Studies

(Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, <http://www.e-parl.net/pages/space_hearing_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf>)

This rationality does not dispute the fact that US deployment of weapons in outer space would represent the addition of a potent new military capacity, one that would assist in extending the current period of American hegemony well into the future. This would clearly be threatening, and America must expect severe condemnation and increased competition in peripheral areas. But such an outcome is less threatening than any other state doing so. Placement of weapons in space by the United States would be perceived correctly as an attempt at continuing American hegemony. Although there is obvious opposition to the current international balance of power, the status quo, there is also a sense that it is at least tolerable to the majority of states. A continuation of it is thus minimally acceptable, even to states working towards its demise. So long as the US does not employ its power arbitrarily, the situation would be bearable initially and grudgingly accepted over time. On the other hand, an attempt by any other state to dominate space would be part of an effort to break the land-sea-air dominance of the United States in preparation for a new international order, with the weaponizing state at the top. The action would be a challenge to the status quo, not a perpetuation of it. Such an event would be disconcerting to nations that accept the current international order (including the venerable institutions of trade, finance, and law that operate within it) and intolerable to the US. As leader of the current system, the US could do no less than engage in a perhaps ruinous space arms race, save graciously decide to step aside.

**Space weaponization key to solve many problems.**

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(Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, <http://www.e-parl.net/pages/space_hearing_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf>)

America will maintain the capacity to influence decisions and events beyond its borders, with military force if necessary. The operational deployment of space weapons would increase that capacity by providing for nearly instantaneous force projection worldwide. This force would be precise, unstoppable, and deadly. At the same time, the US must forego some of its ability to intervene directly in other states because its capacity to do so will have been diminished in the budgetary trade-offs required. Transformation of the American military assures that the intentions of current and future leaders will have but a minor role to play in international affairs. The limited requirement for collateral damage, need for precision to allay the low volume of fire, and tremendous cost of space weapons will guarantee they are used only for high value, time sensitive targets. Whether or not the United States desires to be a good neighbor is not necessary to an opposing state’s calculation of survival. Without sovereignty at risk, fear of a spacedominant American military will subside. The US will maintain its position of hegemony as well as its security, and the world will not be threatened by the specter of a future American empire. Seizing the initiative and securing low-Earth orbit now, while the US is unchallenged in space, would do much to stabilize the international system and prevent an arms race is space. From low-Earth orbit (LEO), the enhanced ability to deny any attempt by another nation to place military assets in space, or to readily engage and destroy terrestrial ASAT capacity, makes the possibility of large scale space war and or military space races less likely, not more. Why would a state expend the effort to compete in space with a superpower that has the extraordinary advantage of holding securely the highest ground at the top of the gravity well? So long as the controlling state demonstrates a capacity and a will to use force to defend its position, in effect expending a small amount of violence as needed to prevent a greater conflagration in the future, the likelihood of a future war in space is remote. Moreover, if the US were willing to deploy and use a military space force that maintained effective control of space, and did so in a way that was perceived as tough, non-arbitrary, and efficient, such an action would serve to discourage competing states from fielding opposing systems. Should the US use its advantage to police the heavens (assuming the entire cost on its own), and allow unhindered peaceful use of space by any and all nations for economic and scientific development, over time its control of LEO could be viewed as a global asset and a public good. Much in the manner that the British maintained control of the high seas, enforcing international norms of innocent passage and property rights , the US could prepare outer space for a long-overdue burst of economic expansion.

**US weaponization would be for the greater good even if it’s not a perfect strategy.**

**Dolman, 5**—Professor of Comparative Military Studies at the US Air Force’s School of Advanced Air and Space Studies

(Everett C., “U.S. Military Transformation and Weapons in Space,” 9-14-05, <http://www.e-parl.net/pages/space_hearing_images/ConfPaper%20Dolman%20US%20Military%20Transform%20&%20Space.pdf>)

As leader of the international community, the United States finds itself in the unenviable position that it must make decisions for the good of all. On the issue of space weaponization, there appears no one best option. No matter the choice selected, there are those who will benefit and those who will suffer. The tragedy of American power is that it must make a choice, and the worst choice is to do nothing. And yet, in the process of choosing, it has a great advantage—the moral ambiguity of its people regarding the use of power. There is no question that corrupted power is a dangerous thing, but perhaps only Americans are so concerned with the possibility that they themselves will be corrupted. They fear what they could become. No other state has such potential for selfrestraint. It is this introspection, this self-angst that makes America the best choice to lead the world today and tomorrow. It is not perfect, but perhaps it is perfectible.

# Dominance Good

**The number of challengers to US dominance is increasing**

**The Economist, 08**(“Disharmony in the spheres - The militarisation of space”, 1/19, lexis)

**Even those who doubt that America would really go to war against China for the sake of Taiwan worry about the dangers posed by the growing number of countries that have access to outer space. Ten countries (or groups of countries) and two commercial consortia can launch satellites into orbit. A further 18 have ballistic missiles powerful enough to cross space briefly. By the end of 2006, 47 countries and other groups had placed satellites in orbit, either on their own or with help from others. In its crudest form, any object can become a space weapon if directed into the path of a satellite.**

**Domination of space is key to prevent a world war**

**Oppenheimer 3**, (Andy, contributor to lane's Information Group and the Bulletin of the Atomic Scientists, “Arms race in space” Foreign Policy, Issue 138, p. 81, September- October 2003) // CCH

Eight days before Operation Iraqi Freedom began, Maj. Gen. Franklin J. Blaisdell, the U.S. Air Force director of space operations and integration, offered a blunt warning: "We are so dominant in space that I pity a country that would come up against us." In the five weeks that followed, more than 5,500 Joint Direct Attack Munitions pummeled Iraq, guided to within 3 meters of their targets by orbiting Global Positioning System satellites. High-resolution radar satellites peered through clouds and sand-storms, allowing coalition aircraft to pick off former Iraqi President Saddam Hussein's Republican Guard. But despite such military prowess, the U.S. defense establishment is worried. Two years ago commission formerly chaired U.S. Defense Secretary Donald Rumsfeld warned that growing dependence on commercial and military satellites left the United States vulnerable to a possible "space Pearl Harbor." **More recently, national security agencies have been circulating proposals to develop a flotilla of military spacecraft that would deny U.S. enemies (and possibly even U.S. allies) access to Earth’s orbit without U.S. permission.**

**US must prevent other countries from accessing outer space dominance**

**Eisendrath 6**, (Craig, a senior fellow at the Center for International Policy in Washington, D.C., is an adjunct professor of American Studies at Temple University, Philadelphia, “Waging War in the Heavens: Profit and Power Go Hand in Hand as the U.S. Gears Up to Spread Its Military Influence to Vet Another Vast Region-Outer Space” USA Today (Society for the Advancement of Education), Vol. 135, November 2006) // CCH

**Moore wonders what would happen if China or Russia, or even Great Britain or France, had said it planned to dominate outer space militarily within 15 or 20 years? The U.S., he maintains, would demand a change of policy, or call upon the international community to impose sanctions. "But if such measures failed, the world would have a new space race," he says, and that would be "outrageously expensive; it would suck intellectual resources and scarce capital into black holes of mutual suspicion; it would compromise the ability of nations to meet everyday human needs. Worse, it would make fruitful international cooperation on mitigating a host of pressing global problems considerably less likely.** "The United States may have the best of intentions when it speaks of achieving a space-control capability. It may have no notion of ever denying access to space to another country except in extremis. It may have no wish to vaporize the satellites of other nations or to demolish buildings with devices launched from , orbit unless a war were in progress, but what nation could afford to rely on the everlasting good intentions of another nation, even the United States?"

**Space weaponization key to defend America**

**Eisendrath 6**, (Craig, a senior fellow at the Center for International Policy in Washington, D.C., is an adjunct professor of American Studies at Temple University, Philadelphia, “Waging War in the Heavens: Profit and Power Go Hand in Hand as the U.S. Gears Up to Spread Its Military Influence to Vet Another Vast Region-Outer Space” USA Today (Society for the Advancement of Education), Vol. 135, November 2006) // CCH

Moore cites the problem, often raised by critics, that space weaponization is being driven by those corporations, such as Boeing, Lockheed-Martin, and TRW, which benefit from the , tens of billions of dollars of defense contracts. **Although profit is a motive, the overwhelming driver in shaping defense policy is a conviction that space weaponization is the way to defend the U.S. and its vital interests**, argues Gen. Chuck Homer, former commander-in-chief of the U.S. Space Command. "**Space is becoming increasingly important in combat and we must address--and deny the enemy--the use of space and ensure our access to [it].** We did it in Desert Storm by bombing satellite group sites and asking the Russians and the French not to provide overhead imagery to the Iraqis. The idea of keeping the military out of space is a little late. The train has left the station."

**America should rightfully weaponize space as the hegemonic power**

**Eisendrath 6**, (Craig, a senior fellow at the Center for International Policy in Washington, D.C., is an adjunct professor of American Studies at Temple University, Philadelphia, “Waging War in the Heavens: Profit and Power Go Hand in Hand as the U.S. Gears Up to Spread Its Military Influence to Vet Another Vast Region-Outer Space” USA Today (Society for the Advancement of Education), Vol. 135, November 2006) // CCH

Remember, advises Dolman, "The United States relies on space more than anyone else, and the United States has also set up a world international system since 1945 that it dominates. **Any other state claiming to weaponize space would be doing so to overthrow the extant status quo which, though not preferred by many states, is at least tolerated by them**.... The question is... not whether the United States should be the first to weaponize space, or if space weaponization is inevitable; rather the question is: Can the United States afford to be the second state to weaponize space?" Dolman asserts that nations with little or no capacity for space weaponization will vote against it, as they periodically do at the United Nations. Real arms races are among equals. **Yet, if the U.S. is first, why should it cede its position?** Limiting the nuclear arms race is not analogous since those weapons are so much more dangerous. **The U.S. is the hegemonic power, and should act like one.** Keep in mind that, although space weapons are expensive, their funding would not come from welfare or education, claims Dolman, but other military costs, such as ships, tanks, soldiers, and aircraft. The problem with putting all, or most, of America's eggs in this basket is that a space-centered military would be unable to carry out the current tasks the country is undertaking around the world.

**A space war is very unlikely**

**The Economist, 08**(“Disharmony in the spheres - The militarisation of space”, 1/19, lexis)

Other experts, such as Michael Krepon, co-founder of the Henry L. Stimson Centre, a security think-tank, play down the Chinese peril. Mr Krepon says that **though similarly alarming conclusions could have been drawn from American or Soviet military literature in the cold war, a space war never took place. What is more, the greater China's economic reliance on satellites, the keener it will be to protect them.**

**No reason for America to weaponize space right now**

**Eisendrath 6**, (Craig, a senior fellow at the Center for International Policy in Washington, D.C., is an adjunct professor of American Studies at Temple University, Philadelphia, “Waging War in the Heavens: Profit and Power Go Hand in Hand as the U.S. Gears Up to Spread Its Military Influence to Vet Another Vast Region-Outer Space” USA Today (Society for the Advancement of Education), Vol. 135, November 2006) // CCH

**"A nation could not use space-based weapons to deny other countries access to space, although it could make space launch and operation more expensive. No persistent advantage comes with putting weapons into space first. Thus, the United States has time to pursue diplomatic options to address space security concerns."**