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Abstract

Solar Power Satellite (SPS) research and development has received little funding over the 40 years since the concept was first introduced. The U.S. Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) have each hosted and then cancelled space solar power programs because they didn't fit their mandates. It is time to broaden our search for agencies to fund SPS R&D, to find an agency that deals with both space and energy. Another problem faced by space-based solar power advocates is that launch costs are too high for SPS to be affordable. The launch market is currently too small to justify the major investment needed to reduce launch costs. The launch requirements of SPS will force a significant expansion of global launch capability. The way out of this dilemma is for the government to subsidize the launch of the first few full-scale solar power satellites.

Problem

Space solar power technology is still in its infancy because of the lack of R&D funding and the absence of agency leadership. Since Dr. Peter E. Glaser came up with the idea for solar power satellites in 1968, this important solution to our global energy crisis has received only an estimated $80 million[1] in research funding. Both NASA and the DOE have had space solar power research programs but these have all been disbanded. How can agency interest in and funding for SSP be increased and sustained? How can launch costs be reduced sufficiently to make space solar power self-supporting so that agency support is no longer needed?

Historical Perspective

Over 40 years ago, Dr. Glaser of Arthur D. Little Company first proposed the concept of placing satellites in geosynchronous orbit to collect energy from the Sun for the purpose of transmitting the energy back to the earth. Possible implementation of Dr. Glaser's idea was studied by DOE and NASA during the 1970's. In 1975, the Goldstone Deep Space Communications Complex did experiments in wireless power transmission. In 1999, NASA undertook further review of space solar power. In 2007, the Pentagon's National Security Space Office issued a report on space based solar power that included a discussion of its use to power forward military bases. In 2008, the Discovery Channel aired a television documentary featuring John Mankins and his Japanese colleagues testing wireless power transmission between two Hawaiian Islands, a key space

solar power technology. In 2009, Pacific Gas and Electric (PG&E) announced an agreement to buy 2000 MW of space solar power starting in 2016.[4] Also in 2009, the Japanese made SSP a national priority and indicated they may spend $21 billion to build a space solar power satellite over the next 30 years.[5]

The United States is estimated to have invested $80 Million (adjusted for inflation) studying SPS since the idea was first proposed. This includes funding from DOE and NASA for 3 years during the 1970's[2] and the NASA funding in 1999 and 2000.[3] As a comparison, DOE is estimated to have invested $21 Billion in fusion energy research since the 1950s.[1]

Space Solar Power has suffered from a policy dilemma. The Department of Defense (DOD) wants to use solar power satellites (SPS) to deliver electrical power to its forward military bases but that agency cannot build them, since SPS is clearly not in its mission. The DOD is developing lasers and microwave beams for offensive military purposes, but taking a lead in using lasers and microwaves for the beaming of electrical power would be politically unacceptable. The DOD is very interested in being an SSP customer because this satellite energy application would dramatically improve efficiency and reduce costs of supplying power to its troops in the field. Another consideration is in reducing costs in lives, as the generator fuel trucks are easy targets.

Space solar power has been studied by both NASA and the DOE. Unfortunately, NASA considers SSP to be an energy issue and the DOE considers it to be a space issue. Neither is currently funding SSP research. Added to this, NASA is in crisis with the retirement of the Space Shuttle, while trying to operate the International Space Station and return to the Moon with a launch system that is behind schedule, over budget and losing capability. The 2009 Augustine Committee called for a $3 billion increase in the NASA budget just to keep up with its current commitments. NASA clearly cannot take the lead in SPS research and development.

In the past, DOE has been interested in nuclear technology because of its connection to defense and DOE was interested in distributed systems for renewable energy. Now the DOE is putting emphasis on clean coal and biofuels. DOE has not shown any renewed interest in Solar Power Satellites. The DOE thinks launch costs are too high to ever be profitable, and space solar power is unproven both in terms of commercial viability and safety. To confirm safety and commercial viability requires funding. Many groups are working on reducing launch costs. SSP development should be funded in anticipation of launch cost reductions.

Current Situation

The timing would seem ideal for securing SPS development funding in today's world situation. Energy prices are rising at the same time that the demand for

energy is increasing. Public and scientific concerns about climate change are growing based on current levels of carbon dioxide, accelerating in the burning of fossil fuels to meet energy requirements. Cap and Trade legislation and renewable energy mandates are being proposed. Also to be mentioned is the Japanese plan to spend $21 Billion on space solar power development and the Solaren contract in California with the utility Pacific Gas and Electric to deliver 200 megawatts of electrical energy from space starting in 2016.

The questions now about SPS are mainly not if but specifically who, what, when, where and how best? For example, is solar voltaic or solar thermal the most efficient approach? Which are the best types of solar collectors to use? Which types of solar cells best balance cost, mass and durability issues? Which is the best wireless transmission method: lasers or microwaves? Where and how do we best build the receiving stations? What manufacturing techniques are most scalable? Which frequency is best for power beaming considering size, electronics, atmospheric and International Telecommunications Union issues? What safety precautions need to be taken with SPS? How can we transmit the power from place to place safely, efficiently and economically? When in this century will the cost of energy rise high enough and Moore's law reduce the cost of the technology sufficiently for space solar power to be profitable? Who will control the SPS market? In 2050, will the U.S. be buying power from space from the Japanese or selling it to Saudi Arabia? Which U.S. agency, if any, will take charge of this issue and invest in space solar power?

Proposed Solution

Since neither the DOE nor NASA considers space solar power to be in its mandate and each refuses to fund its development, maybe it is time for Americans to consider whether there are other U.S. government agencies that might see these developments within their mandate.

The Department of Commerce is an agency that deals with space and is concerned about the nation's energy future. The Commerce Department currently hosts the National Oceanic and Atmospheric Administration (NOAA), one of the world's largest civilian space agencies. Commerce is concerned with all aspects of the U.S. economy and energy definitely affects the US economy.

The Department of Commerce is the perfect agency to take the lead on space solar power. From its Web site, one can see that Commerce's mission includes "promoting the Nation's economic and technological advancement," "strengthening the international economic position of the United States," "improving comprehension and uses of the physical environment," and "ensuring effective use and growth of the Nation's scientific and technical resources." Space solar power development will be key to U.S. future economic and technological development. SPS is an excellent example of a way to help strengthen our international economic position, to improve use of our physical environment and

effectively exploit our scientific and technical resources. Space solar power is clearly within the mandate of the Department of Commerce.

Secretary of Commerce Gary Locke is in a good position from which to champion space solar power development. He was the two-time governor of the State of Washington; thus is very aware of the importance of aerospace to the U.S. economy since Boeing is a pillar of the state's economy. He has strong leadership skills. The Commerce Department currently hosts the Office of Space Commercialization, National Oceanic & Atmospheric Administration (NOAA), National Institute of Standards & Technology, National Telecommunications & Information Administration, National Technical Information Service and Economic Development Administration. All of these can be expected to contribute to and benefit from the effort to develop a system of Solar Power Satellites. The Office of Space Commercialization is presently the only civilian government group interested in space solar power.

The Department of Commerce has a history of cooperation with both DOE and NASA. Today, NOAA works closely with NASA on its weather satellite launches. Gary Locke and Dr. Steven Chu, Secretary of the Department of Energy, work together well, making many joint appearances.

If Commerce will fund SSP development, the issue of launch costs will still need to be addressed. Launching satellites and related materials into space has remained extremely expensive for decades because the current market isn't big enough to justify the major investment required to develop new technology. Given the potential size of this new energy source, it would make sense for the US government to put money into R&D. It would also help if the government subsidized launch costs for the first four full scale solar power satellites in return for a percent of the power produced for the life of the satellite. This could help to get the energy market moving in the direction of space. It may also help to address some of the power needs of our Department of Defense.

To meet the demands of launching the components of four solar power satellites into geosynchronous orbit, the launch industry would have to rapidly up-size. Putting the power of the government behind this effort would assure development of improved facilities and technologies. Four satellites would allow the SSP technology to go through several generations of improvement while the market was being established. Once their capabilities are proven, with four electricity generating satellites in orbit, the industry will have a track record on which to secure investment capital for additional launches. It is hoped that because of the investment and new technologies applied launch costs will have been lowered.

Significance

Space solar power is stuck because of two dilemmas, the difficulty of finding an agency to fund space solar power and high launch costs. NASA considers space

solar power to be energy and the Department of Energy considers space solar power to be space. Space solar power has such huge launch demands that present launch costs make it unaffordable. Part of the reason that launch costs are so high is that the launch market is small. Since the market for solar energy from space is huge, the U.S. government should subsidize the launch of the initial four solar power satellites to drive the launch industry to a new level of capability. The Department of Commerce should be given authority to take the lead in space solar power development.

Space solar power has no serious technical issues standing in its way, but it is facing crippling policy dilemmas. By taking a new policy approach, we may be able to get out of a decades-long quagmire. Energy and space are within the mandate of the Department of Commerce. Help with the deployment of four full scale space solar power satellites will incentivize the launch industry to develop new technologies and more efficient techniques and facilities.

The time is now for the development of space solar power. If the U.S. government commits to it as a matter of public policy, a new SPS industry will emerge, repaying the public investment many times over. If the U.S. does not do so, Japan, China, India or Russia will take the lead in space solar power development and the U.S. will continue to send billions of dollars a year abroad to insure that our energy needs are met.

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