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Space: The Environmental Frontier

By Trevor Brown

The medium of space is set to become a major component of global power in the 21st century. It is already a vital theater of national security operations, as space-based assets such as the Global Positioning System are crucial for an information oriented military and for the national life of a digital society. However, in addition to traditional security issues, the medium of space is becoming increasingly important for its relevance to environmental security issues. There are many untapped natural resources in space that could theoretically contribute to clean energy production, which could protect the environment and in turn enhance U.S. power. Environmental technology and national security are thus closely linked, and if the United States is to thrive in the 21st century it is worth exploring creative options for energy production. One of the most interesting options is in space.

The United States' reliance on oil makes its ability to respond to global hot spots difficult, as protecting petroleum supplies is strategically perilous and enormously costly.¹ At the same time, global warming could lead to resource wars, environmental refugees, and failed states in already vulnerable regions such as Asia, Africa, and the Middle East. As global warming intensifies there will be heightened energy insecurity, water and food shortages, and climate-driven social instability around the world. What is more, by burning ever-increasing amounts of oil, the United States is not only adding greenhouse gases to the atmosphere but also providing financial gain for antagonistic states such as Iran.² These strategic realities suggest that the United States should be creative in considering alternatives to a hydrocarbon based economy. Fortunately, the medium of space offers a wealth of resources which could ameliorate the impending energy and environmental crises.

Despite this, the Obama administration is steadily reducing the scope of both NASA and the Pentagon's missions in space, and relying increasingly on the private sector for its national space effort. Examples include the administration's preference for private sector transportation to the

1 Bryan Walsh. "Does Global Warming Compromise National Security?," *Time*, 17 April 2008, http://www.time.com/time/specials/2007/article/0,28804,1730759_1731383_1731632,00.html (accessed 24 September 2010).

2 Ibid.

International Space Station, as opposed to undertaking the development of a NASA crew vehicle, and its belief that private sector actors should lead the way in removing orbital debris.³ The administration is also considering outsourcing Earth monitoring applications and crucial sensory capabilities for critical satellite systems. Adequate plans have not been forthcoming to replace important systems cut during the Bush administration.⁴

Encouraging the private sector to play a greater role in space is a prudent policy, as true space power must be more than a mere institution, it must be based upon the character and pursuits of a people and run to the core of their national life. Nevertheless, a centralized space effort, including both NASA and the Pentagon, is necessary in order to develop the capabilities to support future generations of space platforms—including environmental applications. However, for the Obama administration, stewardship of the national space program may be less a question of political philosophy than it is a question of resources. Given the severe economic challenges facing the United States, other national economic programs have a higher priority than the space program.

It is crucial that the United States seize the initiative in securing the environment and finding alternatives to rapidly depleting and polluting fossil fuels. Space power is a means to recover the dynamism with which to power the economy and further technological development. At the outset of the 21st century, environmental technology is one of the most promising fields of scientific development, and linkages are increasingly apparent among the environment, national security, and the economy. The United States must consider creative options for energy production if it is to secure its energy supplies and reduce carbon emissions.

As it happens, carbon neutral energy is found in great abundance in Earth orbit, where the solar flux of the Sun is massive outside the Earth's atmosphere. Space solar power (SSP)—the process of collecting solar energy on orbit and transmitting it to the Earth—has great potential as an environmental concept at the intersection of the United States' most pressing national security and economic needs. The SSP concept has been around for decades, but the technology to create large surface areas in space for the requisite energy collection has been unavailable for both technical and financial reasons. A critically sought after breakthrough may not be in space construction techniques or in photovoltaic performance, but rather in the nature of the physical composition of photovoltaic cells. If photovoltaic cells were produced with elastic properties that permit them to expand, a significant opportunity would arise for a novel new architecture for SSP: an inflatable sphere.⁵

Once in a geosynchronous Earth orbit (GEO), a photovoltaic sphere 10 miles in diameter could theoretically transmit in excess of 5 gigawatts of carbon neutral energy to the Earth via

3 Irene Klotz. "Obama Plans Boost Foreign, Private Space Projects," *Reuters*, 28 June 2010, <http://www.reuters.com/article/idUSTRE65R64920100628> (accessed 20 September 2010).

4 Alexis Madrigal. "U.S. Climate Satellite Capabilities in Jeopardy," *Wired*, 2 June 2010, <http://www.wired.com/wiredscience/2010/06/us-climate-sats/> (accessed 8 October 2010).

5 Trevor Brown. "SSP: A Spherical Architecture," *The Space Review*, 1 June 2009, <http://www.thespacereview.com/article/1383/1> (accessed 21 July 2010).

microwaves or other means such as infrared lasers. This amount would be significantly more than the output of most nuclear power plants. Furthermore, it would be far easier to establish these inflatable structures in space than it would be to construct an equivalent number of nuclear power plants and manage the resulting nuclear waste. In any event, a dozen or so of these solar power satellites could alleviate much of the energy needs of the American Midwest in an environmentally friendly fashion.

If this is successful, there could be a vast increase in the scale of such satellites. Extraordinarily large photovoltaic spheres could theoretically deliver the optimum energy output for the entire American economy. For instance, a photovoltaic sphere 200 miles in diameter in medium Earth orbit (MEO) could generate in excess of 25 terawatts in space. There are, of course, many issues to be thought through. These include the method of safe transmission of power to the surface and the environmental/visual impact of such large satellites. Significant opposition to these should be expected, as is currently the case with respect to wind farms.

The cost of these giant photovoltaic balloons would be very high. Once in orbit, however, the cost would be significantly less. Who would operate the satellites (the Air Force comes to mind) and what the charge for the energy they produce would be are details yet to be worked out. Still, the technology is sufficiently promising that it should be explored.

Both the economic and military implications of relatively inexpensive and carbon neutral energy availability would be profound. These include a smaller carbon footprint for all users of energy. The transition from fossil fuels will not be without trauma and dislocation however. It is arguable that the resulting economic transformation would create a multitude of cutting edge green technologies and have a positive effect on employment. It might also unleash a wave of innovation to complement the new energy technology.

The linkage between space and the environment is thus critically important and is emerging as a vital issue of national security. Innovative space-based technology such as *photovoltaic moons* would allow the United States to secure its energy supplies and possibly generate a significant economic expansion. It is time to consider creative alternatives as we develop our environmental and national security policies.

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