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Disruptive Technology: A Space-Based Solar Power Industry Forecast

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Abstract

Space-based solar power (SBSP) is an emerging industry whose objective is to relieve the world of its crippling dependence on fossil fuels. However, beyond energy and climate change, this business is rarely considered for its potentially positive impact on future society. Large-scale efforts at commercialization of innovations have long been dependent on collaborations between government and private sectors, addressing public need. What the Transcontinental Railroad did for the American economy in the 1800's is an example: this technological breakthrough spawned the Industrial Revolution. In the 2000's, space technologies and their industries have demonstrated the potential for a similar revolutionary influence. As the globe continues to face political, commodity and economic strife, technologies such as SBSP will introduce unforeseen solutions that will help to sustain global peace, improve quality of life and create important new breakthroughs of the future. Presuming SBSP becomes a viable industry, future generations can look forward to greater global collaboration leading to more efficient access to space, space commercialization and careers beyond our horizon, the result of the disruptive solar power satellite.

Lessons from History

Beyond the first decade of the 21st century, nations of the world now face escalating pressures in international political affairs, economic instability and resource scarcity compounded by early stage effects of climate change. Though not all civilians are directly affected, rising fuel costs combined with the virtual collapse of the stock market and the job market have left many wondering when and how things will get better. Those most affected by this turbulence include young adults entering college who look forward to entering the workforce. For them, it seems harder to plan for the career of tomorrow and know how to leverage their skills, education and passion into meaningful employment.

The reassuring message of this paper is that there is a world of perpetual opportunity ahead. This is not the first time in history that sobering events have presented themselves to individuals and to nations, nor will it be the last. Were our combined governments and space-oriented industries to draw on the lessons from history, and agree to develop, launch and commercialize the technology of solar power satellite, for example, a fully realized space industry could change the nature of education, jobs and resources available.

Disruptive Technologies

A first step is to define and illustrate the potential significance of space-based solar power for the future evolution of civilization. Using historical precedence is one way to make the argument for solar power satellites in terms of types of government support and private industry initiatives and investment needed. For example, the indirect benefits of SBSP can be presented in the context of future population growth, increasing requirements for electrical power, declining natural resources and heightened environmental and other risks.

Advancements in human civilization can be marked by the appearance of disruptive technologies, those unanticipated innovations that rapidly surpassed current state-of-the-art and dramatically improved quality of life. Development of the printing press illustrated this principle as the rapid reproduction of books enabled public literacy and the invention of steam engines for trains and ships enabled faster travel and quicker distribution of information. Advancements associated with transporting commodities launched revolutions that forever changed society.

When the United States of America was in its infancy, and its populations were clustered predominantly on its eastern Atlantic coast, the development of a Transcontinental Railroad enabled the import and export of goods to and from its western Pacific Coast. Instead of waiting for ships to sail around the tip of South America, goods were loaded onto the railroads and shipped across the continent. What is important to remember about this example is that the construction of the Transcontinental Railroad was backed by the government, but operated as a commercial enterprise initiated by the private sector.[1]

With the comparatively quicker exchange of commodities between the east and west coasts, entrepreneurs found themselves with increased access to the materials needed to achieve their vision. The completion of the Transcontinental Railroad sped along the American industrial ascendancy. The rail innovation encouraged the manufacturing of products for distant markets, prompting mass production. The development of new water, coal and oil powered machines helped to fabricate the items that made life seem more civilized. From the mid-1800's to the turn of the century, the mass-production of goods - ranging from hairpins to horseless carriages - and the introduction of new technologies affecting the lifestyle of average citizens marked a time when there was a significant leap in socioeconomic well being.

Space Technologies

A more recent analogy is the attention given to space. With the development of the National Aeronautics and Space Administration (NASA) of the U.S. government, the country in the1960's established its first space faring agenda. Over five short decades, the USA and other nations have seen space technologies

evolve from small probes to the launch and assembly of an International Space Station in low earth orbit (LEO).[2] Much like the Transcontinental Railroad, the development of operational infrastructures in space was initially backed by the government.

In the early 1980's, Society Expeditions, a travel company known for its exotic cruises and eco tours, commissioned the Phoenix Reusable Launch Vehicle (RLV) to take tourists to space beginning in 1992. But, the Challenger shuttle explosion in 1986 made the government and the commercial markets more cautious, causing a delay in the progress of tourism services in the private sector.[3] In 1994, a visionary named Peter Diamandis created the X-Prize Foundation on the premise that it should not cost millions to travel to space. The best known of these prizes, dubbed the Ansari X-Prize, was for the development of an RLV that could launch, fly to sub-orbital space and return to land on the same runway from which it took off, and repeat the trip within two weeks. These were thought to be the tough but necessary criteria for a sustainable private spaceflight industry. That prize was claimed by Burt Rutan of Scaled Composites a full decade later.[4]

Satellite technologies, successfully leveraged by entertainment, telecommunication, defense and other terrestrial enterprises, have proven to be disruptive in the way earth-bound businesses broadcast programming, acquire and manage information and maintain surveillance of earth and sky. We can barely conjure memories of life before high definition TV, satellite weather reports, cars with geopositioning systems, cell phones and wireless Internet.

Now, multiple nations are exploring the prospects for launching a new breed of satellites designed to harvest solar power in space, transmitting it from geosynchronous orbit to terrestrial receivers. If these plans turn out, solar power satellites will radically change the ways we harness and distribute energy. Solar power from space is far more efficient than terrestrial capture due to the filtering effects of our atmosphere and the day and night cycles experienced everywhere on earth. Solar power is thought to be our most likely candidate for a clean-base, renewable and dependable source for energy. According to Dr. Feng Hsu, Technical Lead and Manager over Integrated Risk Management at NASA, Goddard, roughly 350,000,000 terawatt hours of energy falls towards earth per year.[5]

SMSP has obvious selling points, but this development presents advantages of a higher order. That is, the implementation of solar power satellites has the prospect of enabling development of other technologies, which can send waves of creative innovation throughout global society. Is it hard to imagine its implications for international peace keeping? Wars are fought over access to energy. Sun's energy is abundant and free, if we can learn how to tap it. Is it hard to imagine that capturing and delivering sun's energy to global users is a global business, and that

thousands of careers and millions of jobs will be created in the process of bringing it to reality?

Already, teams of engineers, economists and business people are figuring out the logistics of launching and assembling massive solar arrays in space. Study teams are seeking to find the least controversial and the most effective means of transmitting wireless power from space to ground and for designing the terrestrial infrastructure needed to distribute that power, potentially to all human civilization.

The Solar Power Satellite Agenda

Despite the high hurdles remaining in making the SBSP an industry in reality, we can look forward to many dialogues among nations. This will be true because energy from space is a logical solution to relieving our civilization's unsustainable dependence on fossil fuels. With enough solar power arrays in space, sufficient storage of power and expanded power distribution channels on the ground, nations will begin to see that it is far more sensible – and possibly more economical - to build and launch solar power satellites into space than to continue digging and burning coal and oil on earth.

Another, less often considered, benefit is that solar power satellites give all nations reasons to protect space as a natural resource for the benefit of all mankind. Space Law is in itself a future career path. As national economies become more space-bound, there will be a need for further resolution and definition of space peace treaties, such as the Commercial Space Act initiated by the United States in 1998, and laws governing the peaceful use of space for commercial development.[6]

Development of a private spaceflight industry will parallel development of solar power satellites, since the cargo-to-space innovations needed to carry out frequent and affordable launches from earth will parallel innovations in human space transport. For example, recreational travel to space can only be developed out of accessible power sources native to space as opposed to today's method of lifting the energy needed to sustain space missions from the launch pad.

Comparatively, today's model is as efficient as the days when pulling loaded wagons on the Oregon Trail during the times of the "American frontier" was necessary because there were no proven sources of food, warmth or shelter along the way. Suborbital power stations coupled with water resources recently found on the moon, with water being the key to propulsion in space, may give rise to virtual intergalactic "gas stops" for future space traffic.[7] More efficient payloads could mean more industries accepting the possibilities of space to develop new technologies, manufacturing techniques and products that improve the quality of life here on earth.

There will always be a need for space research, so a government space agenda will always be needed. But the focus will be on private sector initiatives, as has been true in Research industries in agriculture and transportation, medicine and information technology. The advance guard of space-bound research may be the pharmaceuticals industry because of the possibility of space-based materials being valuable to curing terrestrial diseases and the micro and zero gravity conditions of space being necessary to the growing of larger crystals with which to make medicines.[8] Emerging nanotechnology and biochemistry related research may find increased purpose in space as well. All of these are enabled by a fully realized SBSP infrastructure.v

As more nations ascend into the "first world" and "second world" rankings in a fully realized SBSP economy, their citizens will come to expect higher standards of living in access to housing, commodities, information and healthcare made possible in part by easier access to energy, and more efficient transportation, communications and data networking. A change of perspective is possible. Rather than viewing tomorrow's world population as merely an expanding "grid" of energy users, that population can be viewed as a renewable resource of creative ideas for tackling the world's challenges.

Instead of climate change causing a threat to the survival of life on earth, those additional minds and bodies working collaboratively have the potential to prevent such a fate, especially when these minds and bodies have equal access to resources world-wide. Such a scenario could exist with a fully realized SBSP infrastructure.

Modern civilization has come to depend on energy to support quality of life, maintain global scale economies and sustain research. In the context of compromised fossil fuel reserves and increased demand for renewable resources, we can look to space to meet, hopefully to exceed, our energy demands of the future. With the implementation of SBSP, other industries will find a home in space, delivering a new generation of goods and services that benefit humanity. At the same time, new job and new careers will emerge to support these burgeoning businesses. As we solve our energy needs through SBSP, we can think more confidently about ensuring the sustainability of civilization. We can focus on addressing the important issues of tomorrow with increased global cooperation.

REFERENCES

1. Uschan, Michael. The Transcontinental Railroad. New York: Gale, Cengage Learning, 2009, 14.
2. Bacon, Jack. "ASHRAE: Engineering for Sustainability." Lecture, Coastal Georgia Center, May 2, 2007.

3. Collins, P.Q. and D. M. Ashford. "Potential Economic Implications of the Development of Space Tourism." Ad Astronautica 17, n. 4 1988, 426.
4. Edwards, John S. "RLV Challenges," Aviation Week and Space Technology. 164, n. 3, January 16, 2006, 150.
5. Hsu, Feng. Space Solar Power Track, Presentation, National Space Society, International Space Development Conference, Orlando FL. May 31, 2009.
6. Finch, Edward R. "Commercial Space Development in Millennium 2000," Ad Astra 12, n. 2, March/April 2000, 41.
7. Blacic, J.D. "Nonterrestrial Resources," in Space Manufacturing 6 Nonterrestrial Resources, Biosciences and Space Engineering: Proceedings of the Eighth Princeton/AIAA/SSI Conference, eds. Barbara Faughnan and Gregg Maryniak, American Institute of Aeronautics and Astronautics, Washington D.C., 1987, 20.
8. Barrett, David. Ibid, 18.