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Solar Power Satellites Research in China

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Abstract

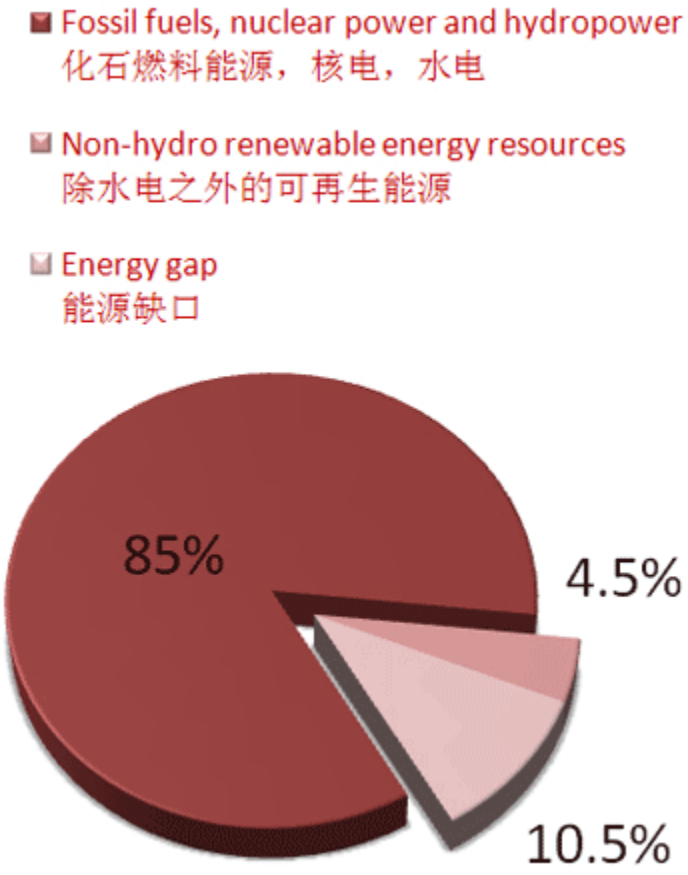
In its long-term vision, the responsibility for ensuring China's food safety for its huge population, meeting its international obligations for environmental protection and providing the structure for its energy needs have determined that the direction of future development of low-carbon energy sources cannot be to sacrifice the "inner" earth. Thus, the state has decided that power coming from outside of the earth, such as solar power and development of other space energy resources, is to be China's future direction.

Space based solar power (SBSP), and the development of solar power satellites (SPS) to facilitate renewable energy production, is one of the "outside" approaches currently under development in China. Based on China's future vision for energy development, this paper will present why SPS development is important for China. A brief introduction to China's SPS project is given.

Energy Status and Future in China

According to a report released by China's National Bureau of Statistics (NBS) in February 2009, in 2008 China's total energy consumption reached 2.85 billion tons of standard coal, while its electricity consumption reached 3.45 trillion KWh, a recorded 5.6% increase over the previous year. The annual report on China' Energy Development, pointing to the prospect for future energy demand, shows that in 2020, 2030 and 2050, China's total energy consumption of standard coal will climb to 3.5 billion, 4.2 billion and 5.0 billion tons respectively. In 2050, about 85% of the growth in energy demand can feed from fossil fuels, from

nuclear power, and from hydropower. Only 30% of the remaining 15% of that growth in energy demand can be met the energy by non-hydro renewable energy resources, such as wind power, bio-energy, terrestrial solar power and tidal energy. That means that by 2050, despite China's continuing growth in energy production based on traditional energy areas, there is a considerable energy gap (approx. 10.5%), for which the state must look to such newer energy producing approaches as fusion and space power stations.



Source: Annual Report on China's Energy Development

The Chinese Academy of Engineering's cautionary report has shown that the fossil energy reserves in China, such as oil, coal and natural gas, will be exhausted in the next 15 years, 82 years and 46 years correspondingly. How to fix the perceived loss of traditional energy resources has become an important problem for China's government. The CAE report also raises the question of growing public concerns over higher fossil fuel prices. More recently, in a 2009 global environmental summit in Copenhagen, the Chinese government promised that by 2020 China's greenhouse gas emissions will be reduced to 40% compared with 2005. It suggests that the government believes that continuing to develop energy resources and environment protection are not internally inconsistent, and that low-carbon energy has a promising future in China.

Why SPS is important for China

Since 1968, when Dr. Peter Glaser proposed the first SPS scenario, the concept of solar power satellites has been under consideration. During those 40-plus years, the renewable energy requirement for electricity has been continuously going up. As one of the principal economies in the world, China is thirsty for energy to water its blooming industries. SPS is regarded as a reasonable path to energy production. Either from geostationary earth orbit (GEO) or in low earth orbit (LEO), this type of power system will have more direct access to the power of the sun. In analyzing the characteristics of SPS and space solar power applications, the China Academy of Space Technology (CAST) concludes that the advantages of SPS for China can be grouped into three relevant directions: sustainable economic and social development, disaster prevention and mitigation, and the retaining of qualified personnel and the cultivating of innovative talents.

Sustainable development: With its population growth and rapid economic development, over the next 30 years China will become one of the most powerful and influential economies of the world. During this time, energy resources and environmental issues will be serious challenges for China. To avoid the grave consequences and to learn lessons drawn from others' mistakes, a sustainable development strategy will need to be adopted. This strategy can be expected to include renewable energy sources from outside earth to alter the heavily reliance on fossil fuels, a process that will contribute to world energy development and assure environment protection.

The acquisition of space solar power will require development of fundamental new aerospace technologies, such as revolutionary launch approaches, ultra-thin solar arrays, on- orbit manufacture/assembly/integration (MAI), precise attitude control, in-situ resource utilization (ISRU) for deep space exploration and space colonial expansion. Since SPS development will be a huge project, it will be considered the equivalent of an Apollo program for energy. In the last century, America's leading position in science and technology worldwide was inextricably linked with technological advances associated with implementation of the Apollo program. Likewise, as China's current achievements in aerospace technology are built upon with its successive generations of satellite projects in space, China will use its capabilities in space science to assure sustainable development of energy from space.

Disaster prevention and mitigation: In 2005, Hurricane Katrina killed thousands of people in the U.S. Meanwhile, every year several typhoons bother the east coast of China. From preliminary research, it appears that microwave wireless power transmission may heat the top of the clouds, thereby reducing the force of typhoons and hurricanes. In 2008, China's southern region experienced a rare snowstorm; such an extreme weather attack led to a complete paralysis of the entire southern power grid due to the frozen grid. Without wired power supplied, the economy of the Southern provinces suffered heavy losses in the first few

months of 2008. Again, if there had been an operational SPS power system in China, wireless power transmission quite possibly could have unfrozen the grid, and restored power to the region.

In May 2008, in the great Sichuan region, a deadly earthquake measured at 8.0 magnitude killed thousands of lives. The most important steps to be taken in mitigating the effects of that earthquake was to rebuild the human support system and provide an alternative communication system, each of which depended on the reinstatement of power supply systems. As space satellite systems can help to supply prompt restoration of terrestrial communications, and space solar power systems can achieve wireless power transmission via microwave and laser beams, space-based solutions would have been the fastest and most appropriate way to crack those problems.

Retaining and cultivating talent: China understands that having an innovative, qualified and skilled workforce is the basic infrastructure on which national development can proceed. Higher education in China is developing rapidly, but the state lacks talent at both ends of its research lines, that is in advanced concept research and in basic/technical sciences research. Objectively and actually, these are currently greater problems than finding financial sources for research. CAST is of the opinion that in order to attract more outstanding personnel and to generate a magnetic field for attracting more college students into basic sciences and engineering, it is necessary for China to launch an SPS-type Apollo project to increase research and development investment in all corollary fields. This will relate to the country's goal of attaining the leading position in both energy and space technology.

SPS Research in China

China's first SPS research started in the late 20th century. In the new millennium, when the energy issue became a constraint on sustainable development in China, the China Academy of Space Technology submitted to the government a "Necessity and Feasibility Study Report of SPS." Later, an SPS concept design was activated, approved and funded by the Ministry of Industry and Information Technology (MIIT). CAST's present SPS system oriented study is the first to address its key components, and to define a baseline or reference system that will allow a relatively accurate determination of mass and cost in China.

The CAST SPS research team conceives that there are four imperative sections for SPS development: launching approach, in-orbit construction/multi-agents, high efficiency solar conversion and wireless transmission. Except for launch, the other aspects do not seem to be insurmountable issues for China in the upcoming years.

Based on China's SPS scenario, there are 5 steps to achieving the first commercial SPS system. In 2010, CAST will finish the concept design; in 2020, we will finish the industrial level testing of in-orbit construction and wireless transmissions. In 2025, we will complete the first 100kW SPS demonstration at LEO; and in 2035, the 100mW SPS will have electric generating capacity. Finally in 2050, the first commercial level SPS system will be in operation at GEO.

Conclusion

In order to meet China's increasing energy desires, space solar power will be sought after as an inexhaustible energy source. Solar power satellites will play an increasingly significant role in the environment protection associated with the various carbon emission reduction schemes. More and more, sustainable development will be linked to securing sun's energy as the boundless, clean and reusable energy resource of the future.

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