OPTIONS FOR 21ST CENTURY POWER PROSPERITY

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ABSTRACT

The 17th World Energy Congress challenged "all decision makers in all countries," in effect, to provide 10 billion people by 2050 with the equivalent of ~70 TWt (terawatts thermal) of low cost and clean commercial power [1]. By 2050 ~20–30 TWe of electric power will provide the equivalent economic output. The sun is the only reasonable power source. Unlike Earth, the surface of the Moon dependably intercepts 13,000 TWs of solar power. A Lunar Solar Power (LSP) System, built on the Moon from lunar materials, can dependably beam 20–30 TWe of this power, as microwaves with <20% the intensity of sunlight, to commercial receivers on Earth [2, 3, 4].

POWER CHALLENGES

A power rich world society will require ≥7,000 TWt-y per century of sustainable primary thermal energy. Twenty-three options have been examined [3]. Existing large non-renewable power systems cannot safely and cost-effectively provide the power and energy for more than a century. Nuclear fission requires breeder reactors. Due to technical challenges, large-scale commercial fusion reactors are extremely unlikely by 2050. Strong political forces oppose these nuclear options. Hydroelectric, wave, tide, ocean thermal, geothermal, and bio-resources sources are limited by cost, total available power, and environmental disruptions. Approximately 30% of the low-level wind power over the continents must be captured to provide 20–30 TWe. Both wind and terrestrial solar power systems require huge areas and costly back-up power systems, such as coal, scaled to provide most of the primary power.

SPACE AND LUNAR SOLAR POWER SYSTEMS

Solar power must be dependably accessed by huge facilities in space and transferred to Earth by beams of photons that can dependably pass through the atmosphere. There are three general options. Facilities can be deployed to space from Earth. Also, facilities can be built in space primarily from lunar and/or asteroid materials [3, 5]. Both options are unlikely before 2050 due to high launch cost and major technical and operational challenges [3, 6]. It is reasonable to construct the power facilities on the Moon from lunar materials. Detailed engineering and cost models, based on prior studies of space solar power systems and analogous terrestrial manufacturing, predict that the LSP System can deliver the needed electric power to Earth at a cost that is less than 0.01 $/kWe-h. The world has the aerospace capabilities to implement the LSP System. A workshop hosted by the United States National Science Foundation and the National Aeronautics and Space Administration recommended consideration of the LSP System [7].

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