America's Energy Future is at Risk without Space Solar Power

Key U.S. energy policy questions

- How much energy will the U.S. and the world need this century?
- How long could easy energy (oil, coal, and natural gas) last?
- What is the sustainable energy potential of nuclear fission and terrestrial renewables to replace easy energy?
- What is the role of space solar power in meeting U.S. and world energy needs this century?

U.S. and world energy needs will grow dramatically this century

- Driven by population increase, U.S. energy needs will grow by a factor of 1.6X by 2100.
  - U.S. population will grow to 420 million by 2050 and, at the same growth rate, to 560 million by 2100.
  - U.S.'s annual energy needs will increase from 17 billion barrels of oil equivalent (BOE) today to 28 billion BOE by 2100.
    - This 1.6X increase already reflects a 15% decrease in U.S. per capita energy use from the 2001-2007 average due to energy conservation and improved energy use efficiencies.
- World energy needs will grow by a factor of 3.4X by 2100.
  - The world's population will grow from 6.7 billon today to 10 billion before the end of the century.
  - By the end of the century, over 5 billion more people will want modern energy.
    - Today, 2.4 billion people do not have access to modern fuels; 1.6 billion do not have electricity.
    - Population growth will add 3.3 billion more people who will want to use modern energy.
  - On top of population growth, the world's per capita energy use will also see dramatic growth.
    - Developing nations clearly understand that electricity and modern fuels are essential for economic prosperity and political stability.
    - Over the course of this century, per capita energy use should be expected to increase from today's 12 BOE per year to 27 BOE per year.
      - Japan, South Korea, and Western Europe set the standard for per capita energy use that developing nations seek to emulate—27 BOE per year by 2100 (10% less than today).
  - World's annual need for energy will increase from 81 billion BOE today to 280 billion BOE by 2100.

Affordable easy energy will be exhausted by the end of the century

- 6,000 billion BOE: known reserves of easy energy (excluding undersea methane hydrates).
- 12,000 billion BOE: known reserves plus extremely optimistic estimates of additional reserves recoverable (for example, including 3,000 billion barrels of oil from oil shale).
- Easy energy provides 86% of the world's energy needs (85% for the U.S.).
  - 70 billion BOE today; 240 billion BOE needed in 2100 at the same usage percentage.
- Easy energy, without substantial sustainable energy replacement, will run out this century.
  - 2009-2100 average of oil, coal, and natural gas use would be about 155 billion BOE per year.
  - 12,000 billion BOE of reserves ÷ 155 billion BOE per year = 77 years of supply (to year 2086)

Conventional nuclear and terrestrial renewables are only part of the answer

- Sustainable energy planning scenario—assume U.S. undertakes the following:
  - — Builds about 70 new 1-GW_e nuclear power plants to raise output to 175 GW_e.
  - — Adds the equivalent of 15 Hoover Dams (30 GW_e total) to reach the practical maximum of 108 GW_e of hydroelectric generation capacity in the U.S.
  - — Expands geothermal electricity generation by a factor of 50X, from today's 3 GW_e to the Department of Energy's estimate of 150 GW_e available in the western U.S.
  - — Installs over 1 million large land and sea wind turbines covering 150,000 sq. mi. of land and stretching along nearly 5,000 miles of coastline.
  - — Builds nearly 60,000 sq. mi. of commercial ground solar photovoltaic systems in the American Southwest.
  - — Collects and converts to biofuels all 1,300 million dry tons per year of sustainable non-food biomass in U.S. croplands and forestlands.
- In this scenario, sustainable energy will provide the U.S. with *only* about 30% of its needed 2100 dispatchable electrical power generation and 40% of its fuels production.
  - — *In fact, this level of sustainable energy production will not even replace current U.S. oil, coal, and natural gas usage.*
- With proportional sustainable energy development (10X the above), the world will also have dramatically less energy than is needed to meet reasonable expectations.

Space solar power is needed to eliminate the baseload electricity shortfall

- Space solar power (SSP) will place extremely large platforms in geostationary orbit to convert sunlight to electrical energy and transmit this 24/7 to large receiving ground antennas.
- 250 SSP platforms will provide 70% of the U.S.'s electrical power in 2100 to close the gap left by the sustainable energy sources in the above scenario.
  - — Will provide 1,250 GW_e.
  - — Sustainable fuel production (e.g., hydrogen) done in conjunction with the SSP receiving antennas can also provide nearly 25% of the U.S.'s 2100 fuel needs.
- World will require about 2,000 SSP platforms total.

SSP platform transmits energy to ground antenna where it is then provided to electric utilities.

Summary

- Space solar power will be needed—absent a dramatic growth in nuclear energy or the industrial-scale recovery of undersea methane hydrates—to close the gap in dispatchable electrical power generation left by even optimistic terrestrial sustainable energy sources.
- Space solar power should be added to America's arsenal of sustainable energy solutions to replace easy energy and assure today's children the energy they will need.