



# DUPONT SUMMIT 2013

..... Pressing Issues, Economic Realities

December 6, 2013 \* Historic Whittemore House, Washington, DC

The Policy Studies Organization

## **Speaker**

Keith Henson - *Lifeboat Foundation*

### **“Design to Cost Analysis of Space-based Solar Power”**

Keith Henson will present a "design to cost" analysis, based on the assumption that to gain enough market share to be worth doing, the cost of energy from space had to be half the cost of the least expensive fossil energy (as electricity). Electricity from depreciated coal plants is around 4 cents a kWh, so the target is set at 2 cents per kWh.

Based on levelized cost, 20 years and 6.8% discount, a "no fuel" energy project can spend ~80,000 times the cost charged per kWh. For 2 cents per kWh, the owner can spend up to \$1600/kw or \$1.6 B/GW. That's about a fifth of the cost of a 1 GW nuclear plant.

It seems likely that the receiving antenna on the surface of the Earth, can be constructed (in 5 GW blocks) for about \$200 M/GW or \$200/kW. Of the remaining \$1400/kW, the parts and labor should not exceed \$900/kW. The remaining \$500/kW is for shipment to GEO. If the power satellite's mass is 5 kg/kW (a reasonable number) then the shipment cost can't exceed \$100/kg.

That's roughly 100 times less than the current cost to ship communication satellites to GEO, This reduction seems possible.

The proposed first stage for low cost transport is a second generation Skylon (Reaction Engines) that carries no oxygen.

Acceleration to low earth orbit (LEO) above the air-breathing part of the flight is from hydrogen heated to ~7500 m/s by a laser in geosynchronous orbit (GEO). (This takes about 4000 km of acceleration.) Part of the substantial cost reduction comes from the improved payload fraction due to the higher exhaust velocity. The rest of the reduction comes from the high flight rate, 3 per hour at 20 tons delivered to GEO per flight.

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## **" Why the Global Economy Fails to Maximize Innovation and How to Fix it"**

A first-pass business analysis in the JBIS paper put the peak investment at ~\$140 B over about 7 years. The entire investment (in the baseline model) is paid off by year 12 from the start.

This is within the ability of a number of governments to fund. The difficulty with the proposed method is getting the first propulsion laser to GEO. That is a major part of the \$140 B estimated price tag. A suggestion from Steve Nixon leads to the concept of powering the first laser from the ground via a 10-km-sized microwave transmitter and a 1-km high power receiver on the end in GEO. Reciprocity indicates the transmission loss would be the same. It would be much smaller and lighter than a power satellite. An unclassified NASA study from 1987 indicates a 5-GW rectenna in space would mass less than 1,000 tons. Another large advantage over the baseline design is that it could be built and tested in LEO.

With 5 GW available, Hall thruster engines would push the propulsion laser to GEO in about ten days. It could cut the cost by more than half, perhaps to \$55 B and cut years off the time to build the transport infrastructure to build power satellites.



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## **Biography**

**H. Keith Henson** is an American electrical engineer and writer on life extension, cryonics, memetics, and evolutionary psychology. In 1975, he cofounded the L5 Society, which promoted space colonization and which was eventually folded into the National Space Society. More recently, his outspoken criticism of the Church of Scientology and subsequent criminal proceedings has gained him headlines.

Keith received a degree in Electrical Engineering from the University of Arizona. After graduation, he went to work for Burr-Brown Research, now merged into Texas Instruments. While there, he worked on extremely low distortion quadrature oscillators and non-linear function modules — multipliers, vector adders, and root-mean-square modules. His first patent was a design for a 4-quadrant log-antilog multiplier. During this time he became familiar with the System dynamics work of Jay W. Forrester.

After Burr Brown, Keith set up his own company, Analog Precision Inc., producing specialized computer interface equipment and related industrial control devices.

In 1974 or 1975, physicist Dr. Dan Jones, introduced him to the space colonization work of Dr. Gerard K. O'Neill of Princeton University. To promote these ideas, he cofounded the L5 Society in 1975.

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## **Biography (Continued)**

Keith authored *Sex, Drugs, and Cults*. An evolutionary psychology perspective on why and how cult memes get a drug-like hold on people, and what might be done to mitigate the effects, *More on Memes, Memes, L5 and the Religion of the Space Colonies*, *Evolutionary Psychology, Memes and the Origin of War*, *The Guru Trap*, or *What Computer Viruses Can Tell Us About Saddam Hussein*, and *Memetics: The Science of Information Viruses*, and coauthored *Memes, Evolution, and Creationism*, and *Cryonics, Religions and Memetics*.

His patents include *Method of launching payloads*, *Traffic control system*, *Heterodensity heat transfer apparatus and method*, and *Method for processing and fabricating metals in space*.

<http://lifeboat.com/ex/bios.h.keith.henson>