SSP: Hearts and Minds

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IEEE, October 2013

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Three Generations of SSP Conception

1970s-1980s  Clever but not technically feasible

1990s-2000s  Increasingly feasible but not economically viable

Today  Economic non-viability beginning to be seen as diminishing, but...

   ...neither on the “main sequence” of humankind’s quest for renewable energy
   ...nor of our 21st-century space agenda

SO WHAT?!
No development

Stepwise non-USG tech demos (e.g., Japan)

USG tech demos

Private development

DOE

DoD

NASA STMD

No space power for Earth

“Manhattan Project”

Stepwise capability emplacement

Today

Tomorrow
5-Point Framework for Changing the Conversation

1. Know the competition
2. Know the customer
3. Do our homework
4. Learn aikido
5. Start small
Know the competition

• Inertia

• Linear thinking

• Acceptable costs of delivering power

• Alternative visions about renewable energy

• Orthogonal visions about what space is good for

What is SSP really competing against?
### Getting on the space radar

<table>
<thead>
<tr>
<th>Option</th>
<th>Purpose</th>
<th>Myth</th>
<th>Needs (+ $10^{11} over 40 yr)</th>
<th>Yields</th>
<th>2050 Space Population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explore Mars</strong></td>
<td>Extend direct human experience as far as possible</td>
<td>Hero (Lewis and Clark)</td>
<td>Public commitment sustained over several decades</td>
<td>Cultural achievement: setting foot on Mars</td>
<td>Six international civil servants</td>
</tr>
</tbody>
</table>
| **Settle the Moon**          | Establish humanity as a two-planet species                              | Pioneer (Heinlein) | • Routine heavy traffic to lunar surface  
• Use of lunar resources | “Living off the land” in space                                    | 10^3 citizens raising families off-world                    |
| **Accelerate space passenger travel** | Create new travel-related industries                                | Jet set (Branson)   | “Four 9s” reliability launch and entry  
• Highly reliable, reusable space vehicles  
• 1-hr intercontinental travel | 10^3 crew + 10^5 citizens in LEO every year                      |                                                      |
| **Enable space solar power for Earth** | Prepare for post-petroleum age with minimal disruption              | Green              | Public-private and inter-Agency partnerships  
• Energy-abundant future  
• Economical heavy-lift launch | 10^2 skilled workers in GEO                                        |                                                      |

Know the customer

- Those who are used to easy electrical power
- Those who provide it today
- Those who could make a fortune providing it tomorrow
- Those who could change the world – and make a fortune – by using electrical power in new ways

Who should (or will...) care about SSP, and what motivates them?
Do our homework

• Understand the practical alternatives to SSP
  – Advocate them, too

• Acknowledge the enormity of the SSP undertaking
  – Describe it in relatable terms

• Study side-effects of vast quantities of cargo launch
  – Differentially advocate the most sensible option(s)

• Benchmark public and environmental safety
  – Expose, analyze, validate, and become definitive about it

• Know the terrestrial side – land use, regional integration
  – Show people what they will actually see
A simple calculation

World electricity energy usage in 2010\(^1\) = 18.5 (10\(^{12}\)) kWhr

World power average consumption = \(\frac{18.5 (10^{12}) \text{ kWh}}{24 \text{ hr/d} \times 365 \text{ d/yr}}\) = 2.1 (10\(^9\)) kW = 2.1 TW

Assume \(~50\)x today’s power demand: 100 TW
• Neutral demand growth in the west due to conservation
• 3\(^{rd}\) world rises to 1\(^{st}\)-world standards
• Electricity to desalinate sea water for potable supply
• Electricity to crack water for hydrogen mobile fuel

Assume end-to-end SSP efficiency = 1%
• Losses from PV conversion, \(\mu\)wave xmitter, free-air xmission, atmospheric absorption, rectenna spill, inversion, etc.)

GEO collector area = \(\frac{100 \text{ TW}}{1400 \text{ W/m}^2 (0.01)}\) = 7.14 (10\(^{12}\)) m\(^2\) = 7140 km\(^2\)

For comparison: U.S. National Highway System\(^2\) = 259 (10\(^3\)) km long, and cost \(~425\) (10\(^9\)) B\$2006

Assume average paving width \(~10\) m = 10\(^{-2}\) km \(\rightarrow\) Total paved area = 2590 km\(^2\)

\(^1\) U.S. Energy Information Administration
\(^2\) Wikipedia, 21 Sep 2013
Learn aikido

Price at the pump
Balance of trade
Capitalism
Hegemony
Harmony
Energy
Potable water
Environmental stewardship
Path
Morihei Ueshiba

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Start small

- $10^{11}$ infrastructure project
- Creation of a new federal agency
- Fully robotic assembly and maintenance
- ...or, an O’Neill colony of construction families
- ...mining the Moon for construction materials

Some of something is better than all of nothing
“When you come to a fork in the road…”

Commercial Investment

- Space passenger travel
- Orbital resort hotels
- Industrialize GEO
- Demonstrate SSP scale-up
- Demonstrate end-to-end SSP
- Expand HSF into GEO

Government Investment

- Develop space flight
- Demonstrate space habitation
- Explore the solar system
- Settle the Moon

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Our limited world is just a soccer ball held at arms’ length...as viewed from tomorrow’s source of energy