Tactical Solar Power Systems

- Types of electrical power sources
- What’s wrong with what we have now?
- If we had our druthers
- What’s deliverable TODAY
TACTICAL ENERGY SOURCES

- Generators
- Batteries
- Fuel Cells
- Solar
Why bother with renewable energy?

COST OF FUEL IN FORWARD AREAS

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation</td>
<td>$1.5M</td>
<td>8%</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$1.5M</td>
<td>8%</td>
</tr>
<tr>
<td>Fuel</td>
<td>$7.9M</td>
<td>43%</td>
</tr>
<tr>
<td>Support personnel</td>
<td>$6.3M</td>
<td>35%</td>
</tr>
<tr>
<td>Transport on battlefield</td>
<td>$0.1M</td>
<td></td>
</tr>
<tr>
<td>Transport to battlefield</td>
<td>$0.8M</td>
<td></td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>$18.1M</td>
<td></td>
</tr>
</tbody>
</table>

Total KWH capacity: 6,031,200 KWH (5600 hrs x 1077KW)

Cost delivered in forward areas: $3.00/KWH
“State of the Art”

Currently, there is no clean, quiet, and “fuel-less” solution for supporting large electrical loads with highly portable units.
• **Sustain 3kw load continuously for 12 hours without harvesting or generation**

• **Support a 3kw load continuously for 15 days without intervention or refueling**

• **Towable on an LTTHC trailer behind a HMMWV over any terrain**

• **Ready for real-world deployment ASAP**
Raven LTSU
Lightweight Towable Solar Unit

- Hybrid design uses onboard automatic genset
- Uses much less fuel than genset alone
- Easy to set up
- Immediate electrical power
- At Technology Readiness Level 6 now

Reduces fuel usage by nearly half
## Raven LTSU

**Lightweight Towable Solar Unit**

### LTSU vs genset-only, 15 day mission

#### Solar Gain and Fuel Consumption

<table>
<thead>
<tr>
<th></th>
<th>GENSET ONLY</th>
<th>4.8 kw LTSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous load</td>
<td>3.0 kw</td>
<td>3.0 kw</td>
</tr>
<tr>
<td>Total kwh/day</td>
<td>72.0 kwh</td>
<td>72.0 kwh</td>
</tr>
<tr>
<td>Total kwh 15 days</td>
<td>1080.0 kwh</td>
<td>1080.0 kwh</td>
</tr>
<tr>
<td>Insolation factor</td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>Solar collection</td>
<td></td>
<td>4.8 kw</td>
</tr>
<tr>
<td>Solar gain / day</td>
<td></td>
<td>28.8 kwh</td>
</tr>
<tr>
<td>Solar gain 15 days</td>
<td></td>
<td>432.0 kwh</td>
</tr>
<tr>
<td>% of load by solar</td>
<td>0%</td>
<td>40%</td>
</tr>
<tr>
<td>Accumulated kwh deficit</td>
<td>1080.0 kwh</td>
<td>648.0 kwh</td>
</tr>
<tr>
<td>Less stored energy</td>
<td></td>
<td>40.0 kwh</td>
</tr>
<tr>
<td>Genset size</td>
<td>3.0 kw</td>
<td>3.0 kw</td>
</tr>
<tr>
<td>Genset fuel usage</td>
<td>0.33 hr</td>
<td>0.33 hr</td>
</tr>
<tr>
<td>Genset run time</td>
<td>360.0 hrs</td>
<td>202.7 hrs</td>
</tr>
<tr>
<td>Fuel used 15 days</td>
<td>118.8 gal</td>
<td>66.9 gal</td>
</tr>
<tr>
<td>Weight of jp8 / lb</td>
<td>6.42</td>
<td>6.42</td>
</tr>
<tr>
<td>Weight of fuel</td>
<td>762.7 lbs</td>
<td>429.4 lbs</td>
</tr>
<tr>
<td>Weight of genset</td>
<td>326.0 lbs</td>
<td>326.0 lbs</td>
</tr>
</tbody>
</table>

### WEIGHT

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container</td>
<td>700</td>
</tr>
<tr>
<td>Battery pack</td>
<td>890</td>
</tr>
<tr>
<td>Inverter, etc</td>
<td>100</td>
</tr>
<tr>
<td>Rack 3 x 24 foot truss</td>
<td>260</td>
</tr>
<tr>
<td>Panels 24 * 45# ea</td>
<td>1080</td>
</tr>
<tr>
<td>Genset (2kw diesel)</td>
<td>326</td>
</tr>
<tr>
<td>Fuel</td>
<td>429</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3785</strong></td>
</tr>
</tbody>
</table>
Raven LTSU
Lightweight Towable Solar Unit

- Total weight 3800#
- 3kw for 15 days without intervention
- 3kw for 12 hours without generation or harvesting
- Droppable, flyable, etc.
- Literally bulletproof
Large Scale Renewable Energy Production
LARGE SCALE RENEWABLE ENERGY PRODUCTION

NEST Transportable Solar Grid

- Arranged in “clusters” of 10-12 units (100kw+)
- For longer term requirements (6months+)
- All-up cost, less than $1 per KWH in forward area
LARGE SCALE RENEWABLE ENERGY PRODUCTION

NEST Transportable Solar Grid

- Deliverable by air, land and sea
- Clean, quiet power - no fuel required
- Power for force support areas
- Can be combined with genset for HYBRID operation
LARGE SCALE RENEWABLE ENERGY PRODUCTION

NEST Transportable Solar Grid

• Supports reconstruction projects
• Disaster relief shelters/housing
• Military base housing
• Remote, off-grid areas
Technological Advancements
Today and Tomorrow
Innovative aluminum solar truss
Lightweight high-output PV (encapsulated polycrystalline PV)
Computerized power management and monitoring (SOLIS)
High density battery pack (LiFePO4)
Hybrid steel / foam / kevlar enclosure
Portable Renewable Energy Solutions
Near Future (3-5 year) Developments

What’s on tap…

• Solar panels with 40-50% efficiency (2 to 3 times current COTS)
• Solar panel will cost $1.50 per watt instead of $5.00 per watt
• Batteries ten times as weight-efficient as lead-acid
If technology that’s in the laboratory today were available tomorrow…

- We could provide a portable, towable solar unit that would supply 100% of the DREAM energy needs from solar alone. No noise, no fuel, no maintenance.

- We could manufacture large-scale solar systems that could be transported on two medium size trucks and would replace a 100kw generator that burns 200 gallons of fuel per day.
Portable Renewable Energy Solutions
Enabling Technological Advancements

SOLIS™ Energy Management and Security System

- Secure, web-based communications protocol
- Interactive communications between unit & HQ
- Alerts to power fluctuations / intruders
- Optional surveillance / security system
Portable Renewable Energy Solutions
Enabling Technological Advancements

Aluminum truss grid

- Patented “truss-rack” design
- Accelerates deployment of large-scale PV systems
- Support panels at correct angle
- Wind, torsion, shear, load tested
- 2 person set up, no special tools, expertise needed
Portable Renewable Energy Solutions
Enabling Technological Advancements

Hybrid steel / foam / Kevlar shell

- In production
- Strong as reinforced 14g steel shell
- Reduces enclosure weight from 1200# to 360#
- Insulated, bulletproof (Kevlar sandwich)
- EMP protection
Portable Renewable Energy Solutions
Enabling Technological Advancements

Encapsulated polycrystalline PV

- Encapsulation eliminates aluminum frame
- Simplifies assembly process
- U.S.-made
- Highest efficiency possible with COTS product
Portable Renewable Energy Solutions
Enabling Technological Advancements

Lithium Iron Phosphate Energy Storage (LiFePO4)

• Much lighter than lead-acid, NiCad
• Safer than Lithium-polymer
• Faster charge, no heat issues
• Integrated battery charging / power management