

# Two Global Values (U) for SSP

**Goal: 10% market share @  $\leq 10\text{¢}/\text{kwh}$**

- Still crucial to economically sustainable **human economic growth in space**: large exports, multiplier effects ([werbos.com/space.htm](http://werbos.com/space.htm))
- **New UN/MP global effort on “existential threats”**: for Japan and Korea, especially, reducing fossil fuel crucial BOTH for climate goals (in an area of limit sun, land) and for energy security. Like EU without Spain or Greece.
- Huge Spinoffs: Geoengineering, Brayton space to earth

# How much does electricity cost?

Average national electricity prices in US cents/kWh (2011)



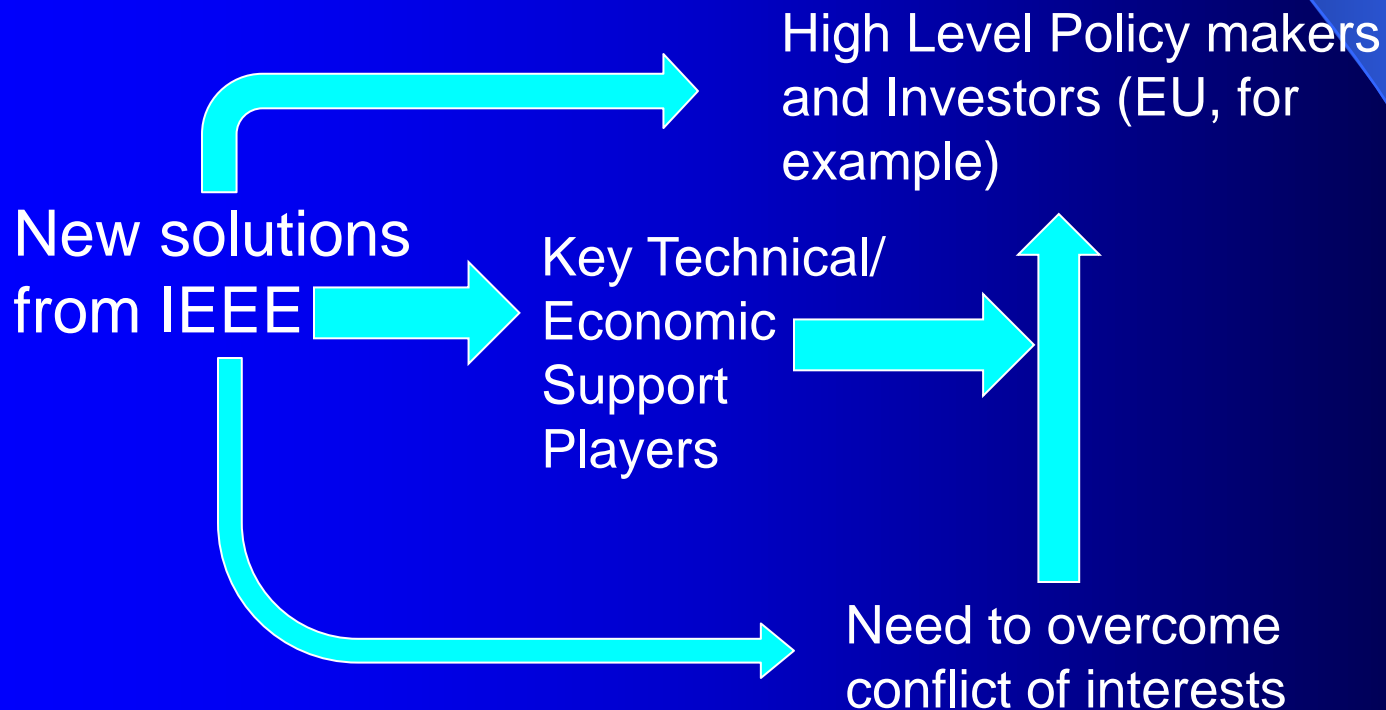
Data: average prices from 2011 converted at mean exchange rate for that year

Sources: IEA, EIA, national electricity boards, OANDA [shrinkthatfootprint.com](http://shrinkthatfootprint.com)

- US and EU are already above 10 cents per kWh. China is less, but heavily subsidized, encountering shortages and price rises with coal (not counting CO<sub>2</sub>)
- OECD/IEA: world uses 20 terawatt hours per year (2008). At 10 cents per kWh, that is worth **\$2 trillion per year**. With wind or solar supplying all, that would double or more. (Storage needs, backup, regulation.)

# New Technology & Market Design to Prevent Climate Extinction:

**Problem: New Science Shows Serious Threat of Human Extinction Due to New Climate Changes**



# New Technology & Market Design to Prevent Climate Extinction:

## ● Findings From IEEE PES Book Effort\*

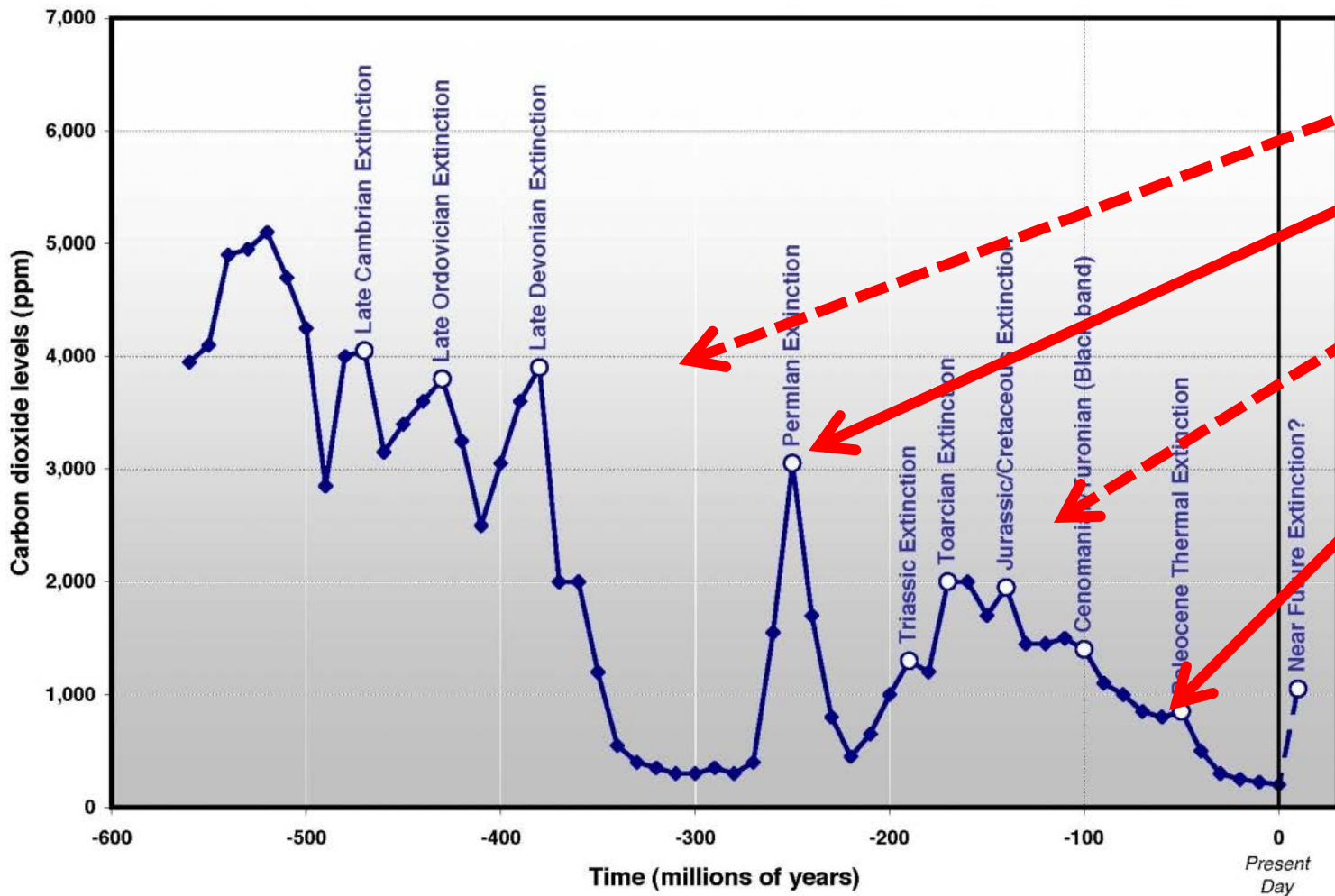
- New data shows we are closer to extinctions than anyone serious believed a year ago. (**Preface by Ward, Wadhams, Werbos\***)
- IEEE options from US and Chile offer solutions to policy & investors (New types of solar farm, **Brayton + AGI** + heat storage).
- The major obstacle for implementation is conflict of interests
- The problem is further complicated by other existential risks and yet there is hope

**\* See Drafts and Details in active links at [build-a-world.org](http://build-a-world.org), including talks**

US Senate skeptics 2009: “CO2 was >2000 ppm for millions of years in earlier earth. Didn't life just go on as usual? How bad could it be?”



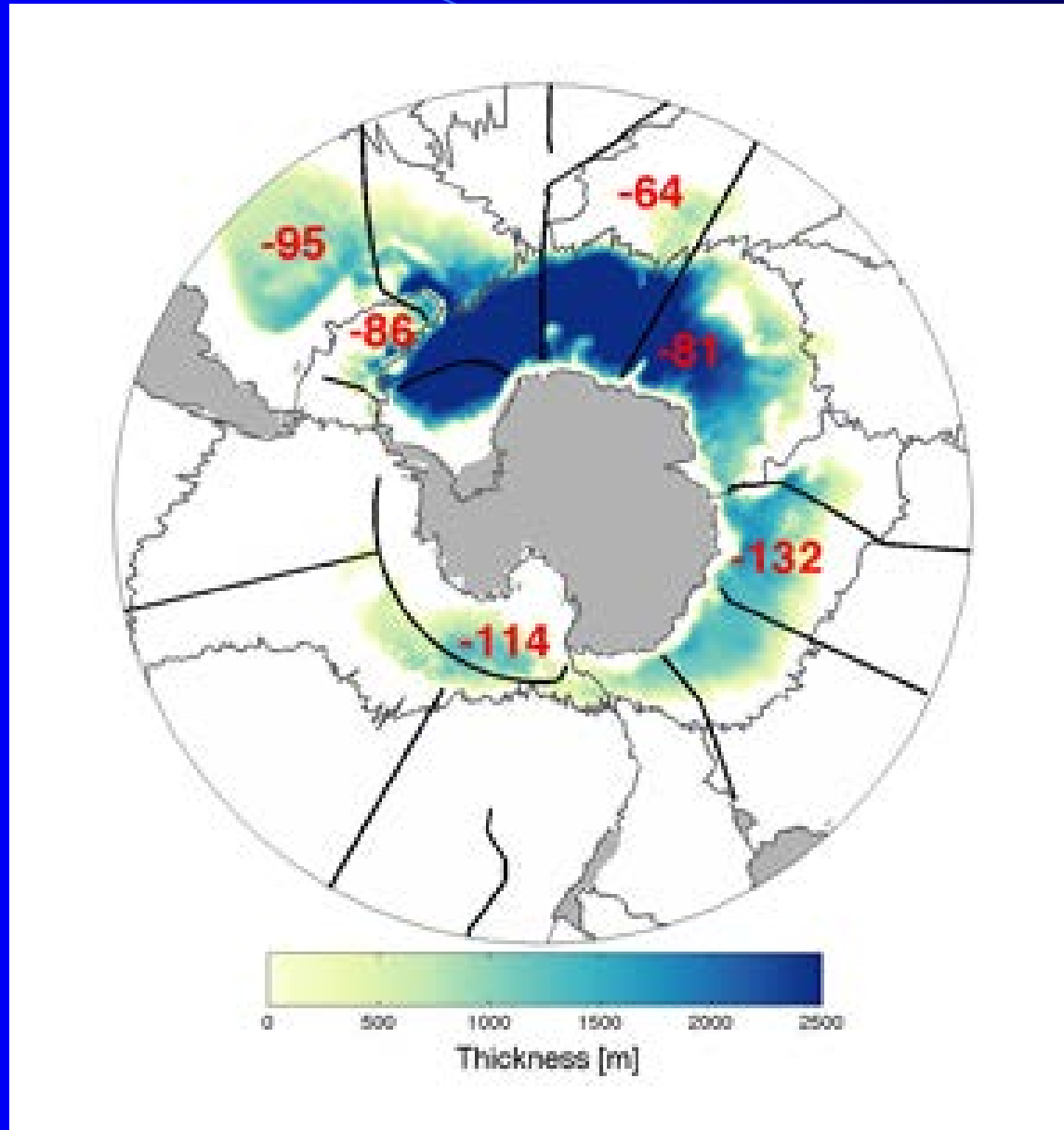
No one in the room knew,  
but I decided to find out



H2S in air  
And  
Radiation  
Enough  
To kill  
All humans

- NSF Geosciences sponsored best data on past:
- Graph from Peter Ward, Under a Green Sky, adapted by Englander. Ward theory half right.

# NOAA data: 40 years for Pacific O<sub>2</sub>?



# Comparing Sources in 2022: Bad News

- MAIN CAUSE OF PAST EXTINCTIONS:
  - low O<sub>2</sub> in deep ocean
  - High fertilization in major sources of ocean currents like Humboldt and Gulf Stream
- Latest data says problems coincide, worst case, soon



# What's Important for CO<sub>2</sub>: Data from DOE/EIA-0573 (2009)

- Total US CO<sub>2</sub> emissions: **5426** million tons (Table 7, page 22)
  - **2160** direct CO<sub>2</sub> from electric utilities
  - **1854** direct from transportation
  - **1412** all other places, including electricity generation by industry and commercial sectors
- 1404 is the total emissions of industry (direct plus indirect)

# 5 Point Plan To Reduce the Worst Climate Risk

1. Sectoral Bill:  
Cut net GHG in  
Electricity Generation

5. New Basic R&D:  
Ocean options,  
Archaea, currents

4. Geoengineering:  
R&D for better  
options from aerosols  
to mirrors to..

2. Sectoral Bill:  
Cut net GHG in  
Cars and Trucks

3. Agriculture:  
Recycle \$20-\$40/ton  
CO2 fee to recycle CO2  
From terra preta to happy cows



$\pi$

# Computational Intelligence for the Smart Grid—History, Challenges and Opportunities



IEEE COMPUTATIONAL INTELLIGENCE MAGAZINE  
AUGUST 2011

Also posted at [www.Werbos.com/energy.htm](http://www.Werbos.com/energy.htm)



**Two paths to get to**

**about 10¢/kwh**

– **“A Team”:**

**From NSF/NASA JIETSSP**

**to SPS Alpha (Mankins):**

**(1) Refine New Design for 9¢/kwh**

**(2) cut launch cost to**

**≤\$500/kg-LEO, ≤\$1000/kg-GEO**

– **B Teams”:**

**Solar Thermal with Brayton**

**(the best on earth) or D-D laser fusion in space (Werbos and Fork) . Also depend on launch costs.**

– **DARPA XS-1 Technology could get us to ≤\$500/kg-LEO**

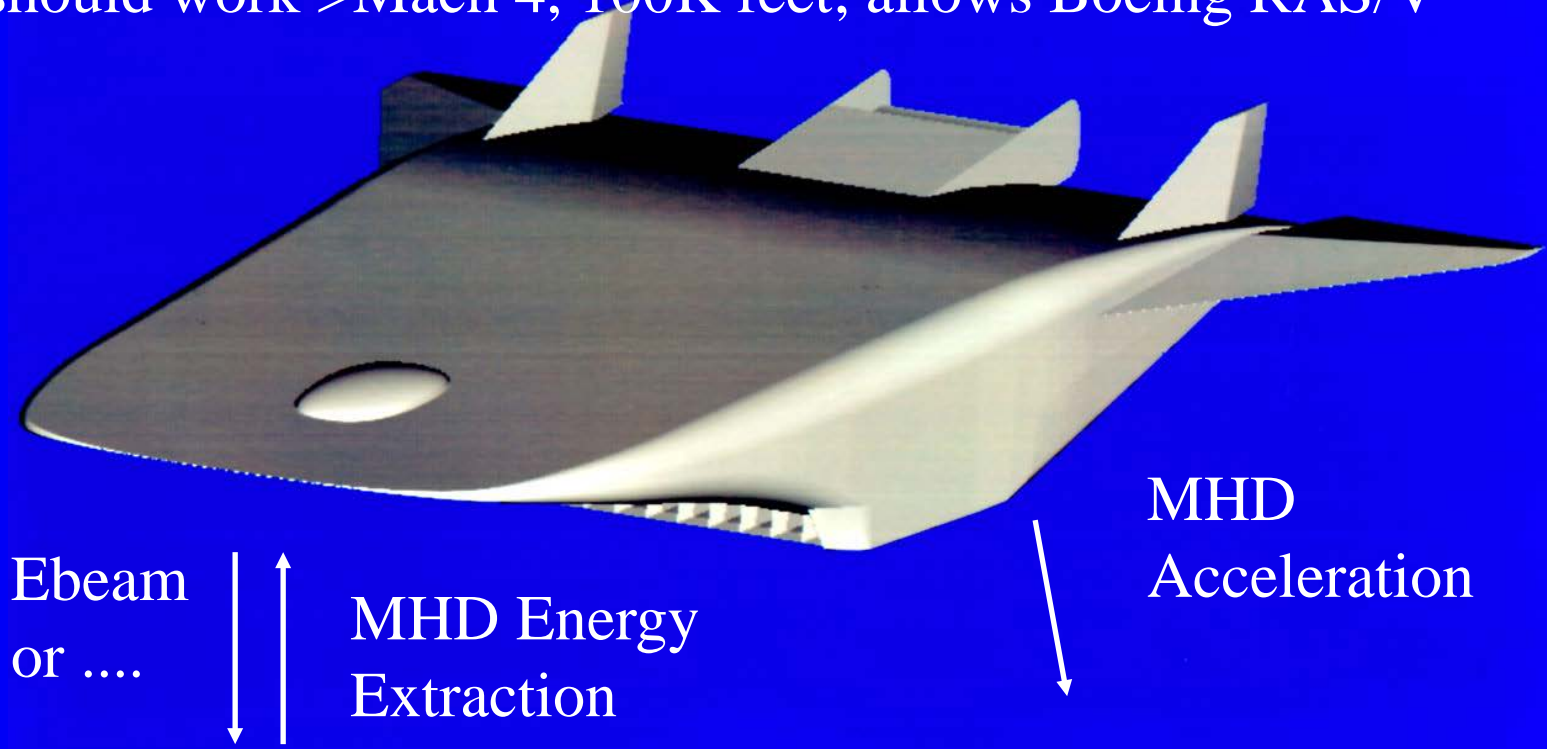
# NASP: An L5 Victory That Wasn't



- L5 discussion with Boeing TAV, Bnai Brith, SDI
- Implementation: Boeing bypassed, TAV ended
- Learned Hard Lessons About TPS = Active fluid cooling

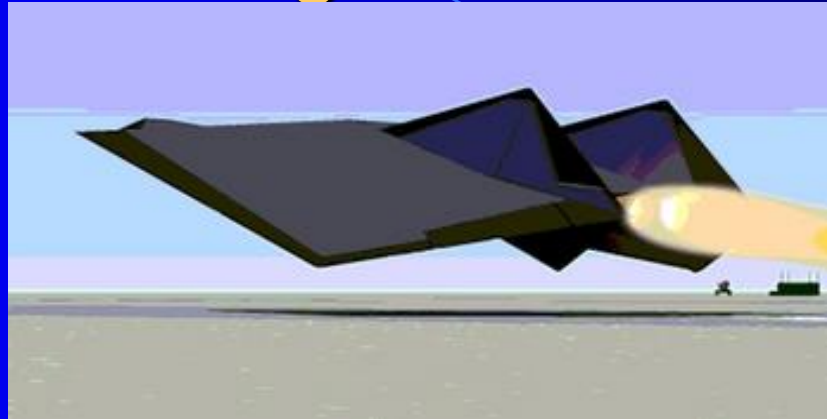
# Plasma Hypersonics: ANSER/Chase NSF\$

REDUCED DRAG: AAC 1st; Ganguly (APS00) shows it should work  $>$ Mach 4, 100K feet; allows Boeing RAS/V



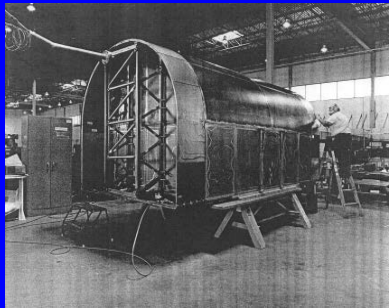
Best plasma theory predicts new Princeton design will allow ramjets to reach Mach 12, scram much more... Ames and Chase (ANSER) whole-system SSTO designs..

# Unexpected Outcome: Near-Term Design Has Passed Tough Peer Review, Scrutiny

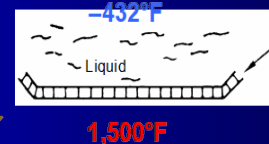
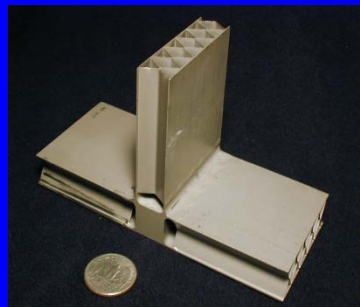
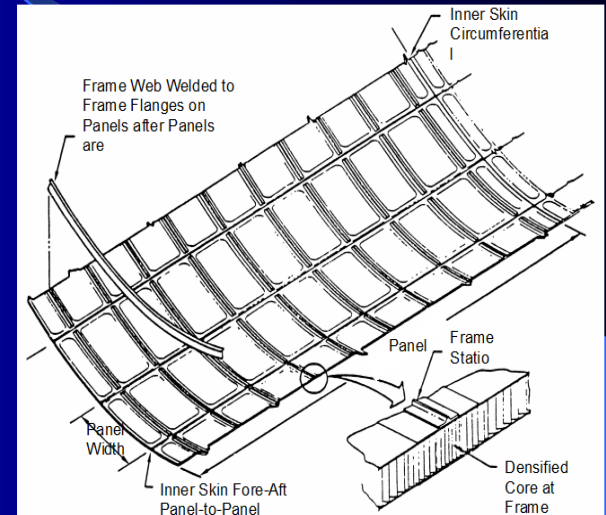
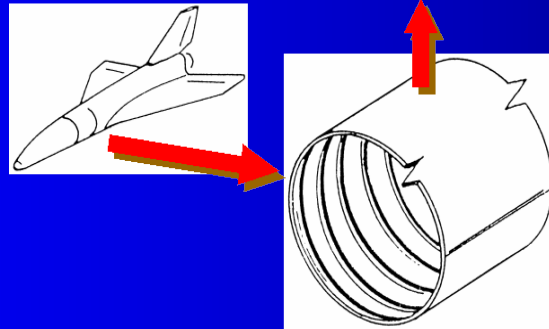
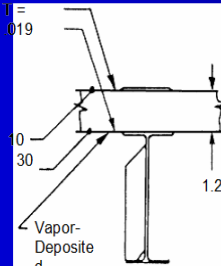


- Advanced RLV designs require use/enhancement of **endangered** off-the-shelf legacy technology
- Need Big vehicle to minimize \$/lb (initial \$200/lb **REAL**)
  - 1.5 million pounds, \$10-15 billion, **not a small business**
- **Horizontal takeoff essential** for aircraft operations (see also Mueller 60's) and for big-wing lower heat load on re-entry
- Design allows use of formerly black **hot structures technology** instead of flaky tiles, ablative structures, hard-to-control slush
- Project chart **4 years**, AF mission model enough for profit

# Validated Hot Structures and Thermal Protection System



Top Panels  
(Titanium)



RENE 41  
Panel

- Existing Material Technology
- Multifunction Metallic Surface

Checked with the unique test lab at WPAFB



# Current Status

- **Hot structure technology is stranded and endangered.** Boeing lost the only test article. This year, TAV team sent to four winds, people and teams still available but barely and not for long.
- NASA has some capability (Glass@Langley) **but not supported**
- **Space Launch System** now required to be useless – but could NSS and our friends upgrade it?
- SpaceX lacks this technology, ablatives won't meet their long-term goals. **Could NASA R&D** help them all?
- X37B and required to use ATK carbon technology which works, but a cost issue... in space.
- DARPA ALASA & WPAFB could have solved the problem, but were scaled back by political folks ... But XS-1 **might** save us!
- China has a NASP program, maybe just a rerun of small hope
- Russia/France – unknown but they seem alert