Re: We can meet all our needs through space development

Source: http://sci.tech−archive.net/Archive/sci.space.policy/2008−03/msg00119.html

- *From*: Einar <einarbb@xxxxxxxxx>
- *Date*: Mon, 3 Mar 2008 18:36:25 −0800 (PST)

Excuse the extreme long time between replies. It was due to a crisis which came somewhat abruptly at work. I left your message actually only half read through on my computer for days.

Some background is necessary. The crisis I´m talking about was an one I had been expecting for some time. I had though been talking to deaf ears. The feeling I was a lone voice in a desert had apparently left me a bit cranky.

But now I am feeling a bit better, seeing things in a bit more positive light again, after having participated in alleviating that crisis, withnessing some of my earlier made proposals put into effect.

That is though only a drop in the ocean, so to speak. I have now decided to generally accept many of your arguments, not all. I still have reservations about your extremelly challenging timeframe.

On Jan 31, 4:01 am, Willie.Moo...@xxxxxxxxx wrote:

> On Jan 30, 9:11 pm, Einar <eina...@xxxxxxxxx> wrote:
>
> > On Jan 30, 2:44 pm, Willie.Moo...@xxxxxxxxx wrote:
> >
> > > On Jan 29, 10:52 pm, Einar <eina...@xxxxxxxxx> wrote:
> > >
> > > > like
> > > > expectations of 13% efficiency not 40% as
> > > > you appear to assume with
> > > > solar energy. A large difference.

> > While 13% was the norm in the 1980s for silicon wafers and
> > one can
> > actually point to them, they are not the norm for
> > multi−specral
> > wafers.
> >
> > http://en.wikipedia.org/wiki/Spectrolab
> >
> > NREL has already demonstrated that multi−spectral cells
> > exceed 40%
> > efficiency.

> But they´re far more expensive and moreover the 40% efficiency you
> were using existe only in laboratory, like I think I pointed out to
> you earlier.

At high concentrations,the critical cost of dollars per watt is actually better with these systems, which is why my company is using them. Expense is something I've been working on for 14 years now. Spectrolab has done studies to show they can increase production levels to support 1.4 TW per year required to compete head to head against conventional energy sources without government subsidy.

> You should work with what is commonly available.

That's like saying 19th century man should build SSTs out of steamships. What is commonly available today does not predict what will be available in 5 or 10 years. That's why you need to go to the lab and think about things based on first principle and deep understanding − not make gratuitous statements from your gut.

> I have posted this to you before, but these people have an idea of
> replasing much of the fossil fule use in USA.

I gave them that idea in 1994.

"A Solar Grand Plan
By 2050 solar power could end U.S. dependence on foreign oil and slash greenhouse gas emissions"http://www.sciam.com/article.cfm?id=a−solar−grand−plan

They intend to only use cheap 13% efficiency wafers, and have made a plan which sounds very doable within theyr stated timeframe, i.e. to 2050.

Presently 30% of all silicon produced goes into manufacturing solar panels.
Presently solar 400 megawatts per year of solar panels are produced.
Presently humanity consumes energy at a rate of 15,000,000 MW
Presently energy use grows at 4% per annum − that's 600,000 MW

To meet all future energy needs with solar sources using conventional solar panels within the next 15 years requires that 2,000,000 MW per year be produced.

To meet all future energy needs with solar sources using my CPV solar panels operating at 18% efficiency within the next 15 years,requires that 1,400,000 MW per year be produced.

At 1x solar intensity we must produce solar panels at 5,000 times the rate they are currently produced and produce silicon 1,500x greater volume.

At 2000x solar intensity (using my system) wemust produce solar panels 3,500 times the rate they are currently produced and produce silicon 1.5x the rate it is being produced today.

I´ll accept your apparent expertice on solar energy solutions. The solar panels you are developing appear to be really what the world is waiting for. Think about it, allmost every country around the world has got the message that something needs to be done to reduce the ever increasing rate of greenhouse gas outputs.

Current efforts are though only good for slowing the rate of increase. It has though been widelly appreciated that more, much more, needs to be done. People have really begun to look for solutions. Many different research plans are in progress, however none I´ve heard about offer this much promise, given that your promises and projections are going to be correct.

You haven´t really said when you think your firm can make them available in quantity, but if you can do so within few years, and moreover can demonstrate theyr effectiveness say in a pilot solar plant within that timeframe, and in addition mass production will make them as cost effective for electricity production as you claim,,,then I think now you´ll find your firm in a similar position as when Bill Gates found his own firm once windows became a success. Now, allmost everibody uses windows, 15 years from now it micht be equally true that allmost everibody uses your solar panels.

That I think will be your main market, i.e. the solar panels. In other words your chief cash cow.

In short if you can manage like Henry Ford did to keep lovering the costs while producing ever more, you may be able to maintain an cost/ effectiveness edge over all of your potential competitors. Basigly, what I think may happen is that like with Microsoft and windows you may end up owning allmost the entire world market...and that will make your firm probably the most valuable firm in the world by far. Hmm, it might even create the most valuable firm the world has ever seen.

That is how much potential I think your panels may have, given that your firm really can come through on them.

In fact in that case I think they´ll become so much of a success that you´ll struggle to have eny energy remaining beside producing ever more of them.

What I´m saying is that your solar panels may safe the world. I´m talking about on the surface use.

> > However, the what I keep repeating to you is that, while I think your ideas are potentially workable, the timeframe you have thrown at us is clearly unrealistic.

> Where have you done the work to support your statements?

> > 2100 sounds like a workable timeframe for such extensice ideas.

> I think starting today with an appropriate level of investment, 2035 to 2045 is a good time to complete the program I've outlined here.
>
> Consider that this is 27 to 37 years
>
> From 1903 to 1927 − from the first powered flight of the Wright Brothers to Lindberg crossing the Atlantic was 24 years
>
> From 1927 to 1947 − from Lindberg to Yeager breaking the sound barrier − 20 years

From 1927 to 1957 − from Yeager to the first satellite Sputnik − 10 years

From 1957 to 1969 − from Sputnik to Armstrong/Aldrin − 12 years

In 1967 − the Russian space program was in tatters, it was obvious that the US was going to make it to the moon, and LBJ cut back severely investments in space, following up the cutbacks he made in the 1965 and 1966 budgets − which stopped the increase in expenditures (December 21, 1963 less than one month after Kennedy's assasination Johnson and McNamara cut back the nuclear rocket and other nuclear propulsion programs) − so after this period, humanity exited the fast track to the stars while a two generations of rocket folk have become used to slow and steady and diminishing expectations −

In an emergency the US, and other industrial nations have shown a remarkable capacity to increase the production of things that seemed impossible to build just a few years earlier. Consider the production of war materiel during world war two.

http://en.wikipedia.org/wiki/Military_production_during_World_War_II

Following the attack on Pearl Harbor America shifted into high gear and produced massive amounts of war goods. Most impressive to me is the production of 141 merchant aircraft carriers in an 18 month period.

Similar transformations can be wrought less dramatically by industry in short periods of time.

For example in 1910 International Business Machines sold its first computer to the US Census Bureau and predicted at that time every industrial nation may have need of one. By 1950 IBM felt that the Fortune 500 might have need of their powerful mainframe computers. By 1960 that was expanded to maybe 10,000 machines. Famously their mathematical experts felt that there would always be an economy of scale to make large−scale computing more favored over smaller computers. Even as late as 1967 IBM still maintained that only major corporations with annual sales over $5 million could make use of a computer.

Actual computer now in use exceeded 1 billion by 2007 − and will likely exceed the human population within the next 10 years. Depending on how you define computers. Digital processors of the type found on every remote control − exceed the capacity of early computing platforms − and they exceeded the human population 10 years ago.

From 1967 where expert opinion could argue convincingly that fewer than 50,000 machines would be sold worldwide − to 2007 where 500 million machines will be sold in12 months − a factor of 10,000 − in 40 years.

> Why not do it here? What does it take? Appropriate levels of investment in appropriate goals.

You make some interesting comparisons. On the one hand, computers have become much more sophisticated and much less expensive at the same time. However the vice versa is true about flight. Today only to firms are able to develope and effectivelly market large airliners in the whole world. In the 60s there were many more manufacturers.

It´s interesting also to note that while several countries independently developed flight and then later established domestic manufactured and developed planes, only three have now developed human spaceflight.

It appears that as the technological hurdle gets higher, costs increase dramaticly and as a result the numbers of competitors decrease. In fact this is true in computing as well, though it depends a bit where one looks. There are great many assebelers of computers, but today very few developers and producers of high end chips.

Now, while spaceflight still is at a relativelly primitive stage, the costs of entry are so high that few can afford to join. It´s IMO among others the share numbers of entrants during the earlier decates of flight which drew technological development.

It was cheap to develope your own plane, you could do it in your own garage in the 20s. Then you could fly the thing and be competitive in the air races. Spaceflight is lacking this driver due to the share cost of entry.

Entrants need loads of cash, which means they either have to be rich or have got a convinching business plan. Today the only market which attracts business customers is the satellite launch business. Now, there are some who believe that passenger flight into space is about to happen, however It´s yet to become a proven business.

Today, there are some interesting folks trying to develope better launchers. I have been following theyr efforts with interest, like the folks at Kistler. Theyr K1 veicle will use off the shelf engines, but is intended to prove the viability of reusability.

We´ve had here some discussion of reusability vs. nonreusability, and there were some different opinions. Even those saying that trhow−away would in fact be shown to be cheaper.

Now, the Shuttle probably has not been a very good case of reusability. Newer designs probably can do much better. Still, it remains to be proven how severe f.e. will be fatigue problems, after all the structure will be repeatedly launching and only experience over time can demonstrate what really works and what does not.

The question being how many uses will they really get from each booster? That will be critical in deciding how economical it really will be.

> Anyow,
> by 2050 we will probably be ready to expand solar energy production into space.

Dude, we needed solar energy production in space in 1970... my reasoning below.

Have you looked at the price of oil recently? In December 2004 when I was interviewed at the White House by OSTP about energy policy, oil was $22 per barrel, and the Saudis had announced privately they were going off the $22 price cap. What could America do? I said fill the Strategic Petroleum Reserve with US made synfuel from coal at $25 per barrel − using not only my process, but the dozen other processes that are struggling out there. This will send a signal to Wall Street and the Saudis that if prices stay over $25 per barrel America has an alternative. They didn't like this idea. Instead the opted for Regime Change in Iraq promising in part to pay for it with low price oil that people would gladly sell us at $12 per barrel.

Actually if you adjust things for inflation, you will see that ever since oil was discovered in Titusville Pa, and ever since Rockerfellar started refining it after the Civil War − first for lamp oil, later for gasoline − the price of energy in the industrial world − expressed in $ per barrel has dropped from 1860 to 1960 from $100 per barrel to $2 per barrel. In 1940s King Hubbert, a Geophysicist that worked for the Feds to estimate energy reserves of Germany in world war 2 − indicated that by 1970 the US would peak in oil output and enter secondary production, and that by 2010 the world would peak in oil output and enter secondary production. In the 1950s expert opinion was that nuclear power would displace chemical power by 1970 so we didn't have to worry about it. The US entered secondary production in 1970 which produced an oil crisis and gave OPEC − which had existed powerless in the 1940s and 50s − emerged as the arbiter of oil pricing in the world. From 1970 through 2000 the largest most massive transfer of wealth in the history of mankind has occurred as the US European and Japanese populations have paid increasing amount of their productive output for the oil needed to run their industrial plants.
In the 1970s we became the worlds largest importer. In the 1990s we became the world's largest creditor. In 2001 we were attacked by spoiled brats turned zealots who were spoiled by the tremendous wealth their families earned at our expense.

> Prices have risen steadily from $2 per barrel in 1960s to $100 per barrel again. As a result, capital formation rates, industrial productivity and industrial growth has been severely restricted − and far lower than it might have been. Many of the rosy scenarios of the 1960s were predicated on a continuing 3.9% drop per year in energy prices − with a continuing 8% growth in industrial output. What has happened there has been a steady 8% rise in oil prices,while there has been zero net growth in real terms − despite massive increases in automation and computing capacity.
>
> What makes you think we can wait until 2050?

You have really convinched me that your solar panels work, or rather I think I´m going to trust you on that.

However, that means there will be a demand for them, incredibly rapacious demand, for theyr use on ground. Today the negotiations on Kyoto phase 2 are set to begin soon. Countries around the world will be scouring for something to use to shrink theyr CO2 budget. My friend, if you can deliver your panels in quantity within few years you will be the richest man the Earth has ever seen, possibly...given that you can manage to stay ahead of your competitors. Everyone will want your panels, everyone around the world which lives where theyr use can make economic sence.

> If over the past 50 years (1960 to 2010) we had seen a continuation of the 3.9% drop per year in energy prices, and a continuation of the real 8% per year growth in industrial output − we would be at $211,000 per person per year GDP (instead of $45,000 per capita per year) and the price of a barrel of oil would be $0.30 − THAT'S THIRTY CENTS A BARREL!!! Our energy use would be 100 million barrels per day − just for the US.
>
> > I´ll expect that before then there will be a time of experimentation,
>
> Yes. That's what we're doing now.
>
> > i.e. small scale experiments with small solar powerstations,
>
> Yes, we're experimenting with power beaming even as we speak.

Have heard about some such experiments, but do you have a link on something recent?

> experiments with beemed power, etc.

Yep,.

> That´s what is allways lacking in your suggestions,,,

?

> the inevitable
> experimental phase.

We've been doing experiments since 2003 on this topic ... I have a very clear program of R&D mapped out. I have funds budgeted. I have a road map. What is your rationale to say that a 37 year program won't see as much progress as we have seen in say − personal computing?

Expenses of the technology. Computers on the one hand have become very inexpensive, yet highend chips are very expensive to develope hence producers and developers few. Many countries made combat planes during the 20s and the 30s. Many fewere today are competitive in that field today.

If the price of entry is very high, you will get few participants and hence slow development. Today combat planes have become so expensive to develope that it take USA now about 20 years to get them from the concept phase over to production status. After that they intend to use them for some 50 or so years.

Naturally, if were in a World War situation, this would happen more rapidly. Even so, during the early Cold War years USA developed a large numbers of military jets. Today, that would be unthinkable.

During the Cold War France and UK independently developed Mac 2 military jets, today it´s become clear that the Rafale will be the last big budget military jet France will develope in its lonesome. Such was the expense that it´s clear that the Eurofighter Typoon is the future, i.e. shared development costs and risks Europe wide.

Russia is yet to be able to afford to replase any of its Cold War warryors since the end of the Cold War. Today the only country which is developing military jets except Europe in common and USA, is China. Admittedly India has just developed the light combat plane, but that one isn´t really comparable.

So, development of new military jets has slowed down dramaticly, not just because of the low threat environment but also due to the dramatic increase of cost of developing the ever more sophisticated and hence expensive planes.

So that is my reply to your question, i.e. the share rarified costs environment of spaceflight making entrants very few indeed and also making them want to get a long use of each new technology before getting around to develope the next more advanced and hence more expensive thing. Spaceflight is naturally even more expensive than military jet flight, hence more rarified as a result.

> > By 2050 the experimental phase might be over

> When do you imagine it starts?

> > and
> > we may be ready to begin your project of building them on a significant scale − the way you suggest.

> When do you imagine experiments will start? Why do you think Spectrolab is saying what they're saying? Why do you think we're shooting for 60% conversion efficiencies today with 6 junction cells? Why do you think we're shooting for 85% efficiencies with diode and free electron lasers today? lol. Why do you think we're working with large aperture optics today?

> > > Now, when silicon is exposed to light, what happens is
> > > determined by
> > > the colors of the light striking it. In the case of the sun, this is
> > > given by the planck curve of a black body radiator operating
> > > at 5800K
> > > − through an atmosphere that absorbs some of the energy −
> > > principally
> > > hydrogen...

> > > http://en.wikipedia.org/wiki/Black_bodyhttp://en.wikipedia.org/wiki/S....

> > > So photons that are longer or redder than 1,108 nm − don't
> > > operate the
> > > silicon cell. They merely heat it.

And, photons that are shorter or bluer than 1,108 nm − contribute only
the bandgap energy to the circuit. (if its properly balanced with a
load)

What happens to the extra energy? Well, it shows up as ballistic
energy in the photons in the conduction band − yep − heating the
photocell again.

Then there's the recombination of electrons that get formed but not
picked up − this depends on temperature.

And that's not the only source of loss − there are junction losses −
resistances in the cell itself that cause current squared times
resistance (i−squared r) losses − which also causes heating.

The I−squared r losses can be reduced by reducing junction resistance
− in cells like those designed by Bob Swanson at Sunpower − or by
reducing current for a given power by increasing number of junctions
in series − in cells like those designed by Bernie Sater at Photovolt
− or by combining the two together like I do with my cells at Mok
Industries.

Keeping the silicon cool is how to reduce dark current losses.

This leaves you with ineffective photons. The long−wave photons that

don't contribute to the cells operation − and the short wave photons
that contribute onlty the bandgap energy.

Since the planck curve graphs in the references I gave are energy per
wavelength versus wavelength − the area under the curve.

For each wavelength, take a ratio of the wavelength and the bandgap
wavelength in the case of silicon 1,108 nm − and multiply the solar
output by that ratio. So, for example, the energy in a photon with a
wavelength of 554 nm (green) contributes only half its energy to the
operation of the circuit. 277 nm (Violet) contributes only one−
quarter its energy to the operation of the circuit. Do this across the
entire planck curve (its called convolving the silicon response curve
and the solar black body curve) − and you get what each color
contributes to the operation of the silicon cell. Now integrate the
convolved curves to get the area. Then, finally, divide the smaller
area of the convolved curve with the larger area of the planck aka
blackbody curve − and you get a number − around 23% − with small
junction losses and temperature losses.

Now what Spectrolab did − is they combined photocells of different
wavelengths and arranged to have bandgap matched light fall on each
type − and use the output of all of them. NREL has shown that they
operate at 40.7% efficiency with 3 bandgaps. We are discussing
building 6 bandgap system (GaAs can be doped to change its bandgap
energy) − that is expected to have efficiencies exceeding

60% − the
practical limit seems to be 20 bandgaps − with 80%
efficiencies

So, 40% has been achieved

60% is a reasonable near term research target (and the focus
of
current research, visit my web site, fill out a contact form,and
I
will send you a white paper)

80% is a plausible long term achievement

I quoted 40% overall...

That sounds truly like an excellent technology, but how expensive would such cells be when compaired to those that already are in mass production?

I answer the cost questions below. At $12 per square inch its 40x more expensive than polycrystalline cells. Because they're able to operate at 5,000x solar intensity − the cost per watt− which is the central figure here to keep in mind − is less than a penny a watt. Now, also at 5,000x solar intensity − modest production scales translate to massive power levels. Furthermore, the scale at which Spectralab can produce today is sufficient to meet my immediate terrestrial needs. The scale it can produce at given sufficient investment capital − appropriate to the value created − it can meet the needs I outlined above.

How quickly can the price be reduced through economies of scale?

They already produce at a price and in a volume that meets my needs − and they can exceed expectations going forward.

> > Do they contain very expensive materials that will result in them staying expensive no matter what?

> You have missed a central point. My patened concentrating technologies reduce the importance of material costs. At 5,000x solar intensity − used in space applications − these systems are less than a penny a watt −

OK.

> > These are worthy considerations. Remember you intend to use these on a very large scale, presumably first in groundstations.

> Depends on the details of the application. 5,000x solar intensity is difficult to achieve optically with systems that are cheaply put on the ground. 1,000x concentration − no problem − so we're sticking with silicon for ground applications − float silicon at $1 per square inch − yet the PV costs are on the order of a penny a watt.

Is there anything about your panels which makes on ground use difficult?

> > The people with
> > the abow mentioned plan intend to make do with less sophisticated technology, and still think that it will be possible to significantly reduce the use of imported oil over the period to 2050.

> I will make America an energy exporter again before we reach the peak in global output..

There are many countries around the world that would be very happy to make use of your panels in ground stations, if they really are as cost/effective for electricity production as you claim. China comes to mind. While theyr wet coastal regions probably are unsuitable China has got some dry steppes far in−land, say Innter Mongolia and Synkiang. The Chinese economy has now got incredibly rapacious appetide for electricity production.

I think China would be very willing to purchase solar panels on a massive scale, after all the leadership has recently declaired air pollution to be the greatest challenge China is facing. Today they have got a real lot of money. They´d though probably want them on a very gigantic scale indeed, once they get the appetite.

> > > The program I find believable assumed that
> > > it will take some years to
> > > achieve that 13% efficiency,

> > 40% has already been achieved, I'm funding research to see if we can
> > achieve 60% by doubling the number of junctions, and qualified
> > researchers feel that by increasing the number of junctions further
> > using MEMs technology − it may be possible to get to 80% ...

> MEMs are a most important innovation. Clever use of manufacturing techniques originally used in manufacture of chips, is how most of them are made. The airbag of my car probably is activated by such a MEM.

It is definitely activated by a MEM. MEMs has proven very important in handling heat loads efficiently as well as managing optical properties.

> The question will the bee weather the trick of the chip makers can be repeated, i.e. to make enough of them to shrink the prices down to reasonable levels.

The consumer electronics industry advances a generation every 18 months. Solar applications do not need the same type of improvements. So, the 15% of productive capacity per year that gets tossed aside as new plants are built, are available for solar panel producers. Someone like myself who has sponsored half a dozen substantial solar energy projects around the world, find themselves flush with cash to buy a handful o fthese facilities and outfit them for production of 100 BILLION watts of panels per year − 14 plants like these are needed to meet the need for solar panels on a scale required to make a significant difference in the energy picture of this planet.

Success with these early projects will translate into being a dominant player in the world's $4 trillion annual energy market − and with 80%

margins − (I sell fuels not hardware or technology) − I will have adequate resources to expand my base.

14 plants producing 17 sq km of solar panels a day will require 2,647 days (7 yrs 3 mos) to cover 45,000 sq km of the 100,000 sq km of land I have optioned across the US. This is sufficient to supply 287 million tons of hydrogen each year from solar sources using my 18% efficient solar panels. 177 million tons of hydrogen displaces 1.1 billion tons of coal in the nation's power plants − and an additional 110 million tons of hydrogen are combined by direct hydrogenation − no burning of coal − no production of CO2 − to produce 7.7 billion barrels of liquid fuels. This permits the US a surplus of 1.2 billion barrels a year − which may be exported. AT $80 per barrel margin this generates $616 billion per year. About 15% of the world's market for energy. Microsoft rose in 15 years from nothing to challenge IBM as the leader in computer technology, and now owns 98% of the operating system market worldwide. These are achievable goals, given that I have spent the past 14 years laying the ground work for the next 16.

With this sort of revenue, what will it take to dominate the field going forward?

There are two approaches −

1) keep doing what works − build more panels and more panel production plants. Increase the number of terrestrial plants to 150 − and blanket 550,000 sq km of Earth to make 3.34 billion tons of hydrogen gas − to displace all current needs. This will be completed in an additional 15 years− and by that time − 25 years from today − energy use will be 266% what it is today − assuming a 4% annual compounded increase in energy use. So, we'll control 37% of the market.

2) do something more efficient − build solar power satellites − allowing me to generate 20x the energy from the same terrestrial installation − by adding 50,000 sq km of solar panels in space − while reducing my cost per watt to less than 1 cent − and pass a portion of that savings on to my customers to promote rapid growth in demand. Here I will have enough power to produce 7 billion tons of hydrogen gas per year, total demand will rise at 7% − total demand in 25 years will be 542% − I will control 40% of the market − and make 3x the profit.

I think I believe that those on ground stations will work. It´s very clear demand, as soon as the technology is proven to work, will be very rapacious. You appear to think you can produce sufficient panels for any conceivable demand, very well.

This would safe the planet, by the way.

> But if expensive materials are used, or materials which supply could cause a bottleneck,

AT 5,000x concentration possible with this technology, the bottleneck is in the silicon operated at 1x concentration − as I showed above.

> then they might stay expensive anyhow.

Yes, they will even get more expensive, but on a dollar per watt basis − they will get less expensive due to clever optical design.

> Moreover,
> many of the chips have become so incredibly complex, so expensive to develope that even though they are mass produced in great numbers, they ´re not especially cheap to purchase.

If you own the process where that is done, you will get them at cost. The cost is on the order of hundreds of millions of dollars. To put up a plant, especially a retooled plant purchased at a discount − costs again hundreds of millions of dollars. The value created is hundreds of billions of dollars. Not a bad deal.

> That is importan, the price.

The dollars per watt and bottlenecks are important. concentrating sunlight with low cost optics is a critical factor here and why that has been a central point of my research.

> If you are to persuate people to use
> them.

I make a commodity − gasoline, diesel fuel and jet fuel − and sell it at market rates. No one needs any persuasion. Getting utilities to buy hydrogen is a different matter. I am working on a program now to buy stranded facilities and undervalued facilities, and coal companies with power plants − to get them off dead center − and begin the transformation to a hydrogen economy with our coal fired plants.

Now, replasing powergeneration alone will be a huge thing. That will go far towards saving the planet. I think now that demand for your solar cells for powergeneration may grow very rapacious very quickly ones proven to work as adverticed.

What is it you have in mind about cars. Cars can burn hydrogen and so can planes, is that what you have in mind? Fuel tanks for hydrogen are though still somewhat inefficient for cars.

There are alternative like hydrogen fuel cells. Those can be put into each home, or much larger ones can power whole cities, or alternativelly much smalle ones can even power individual cell phones.

> > Today, older tech solar cells have become cheap enough that average people can affor to use them on a reasonable scale.

> Conventional solar power made with polysilicon is an energy sink. You need to cheaply concentrate solar energy to reverse that.

> > Solar
> > cells f.e. on the roof of a house can really shrink the electricity bill.

> Not when you count the cost of capital tied up in conventional panels you don't.

> > > > as current mass produced solar cells do not achieve more than 10%,

> > > I am mass producing CPV systems that routinely achieve 18%

> > At what cost when compaired with cheaper cells?

> $0.07 per peak watt including all balance of system costs − when producing hydrogen.

> > > > I can only assume that you are expecting what is now only possible in controlled laboratory settings will become practical mass production,

which by the way is not an obvious
assumption.

Lets do more than quote numbers shall we. Lets look behind the
numbers and then we can come to some logical conclusions.

The number you give is an average based on systems that use amorphous
or polycrystalling construction. Junction losses are extraordinarily
high in these systems. This is deemed acceptable because they can get
their silicon at very low cost compared to pure float silicon that is
a pure crystal.

What you term − experimental or laboratory − systems have far higher
efficiency.because they use float silicon − that costs about $1 per
square inch. This is about 3x higher in price than polysilicon
systems − but the output is less than double (14% versus 23%) −

I use float silicon − but fabricated in a way and cut into dies that
allow me to operate it at 1,000x solar intensity. (see my web
pagehttp://www.usoal.com) − this cuts the PV costs per watt way down, and
lets me operate at higher efficiencies.

Ditto with the UTJ cells from spectrolab. They have a germanium
subtrate − and CVD epitaxially grown − GaAs and InPh layers − whose
thickness allows efficient capture of specific colors of light. These
are $12 per sq inch in quantity.

So, here's the deal; lets compare the older design, with my
current
design (Patent #7,081,584 − Mook), and whats in the labs
today that
I'm expecting to use on orbit tomorrow;

sunlight − 645 milliwatts per square inch terrestrial clear day
881 milliwatts per square inch space earth orbit

mass produced conventional solar panels
14% efficient
1x concentration
645 milliwatts per square inch solar
90.3 milliwatts electrical per square inch
$0.30 per square inch cost
$3.32 per peak watt (PV cost)

Mok terrestrial PV
18% efficient (filtered)
1000x concentration
645 watts per square inch solar
116 watts electrical per square inch
$1.00 per square inch cost
$0.01 per peak watt (PV Cost)

Spetrolab 6J PV (research)
55% efficient
5,000x concentration
4,405 watts per square inch solar
2,422 watts per square inch electrical
$12.00 per square inch cost
$0.005 per peak watt (PV Cost)

> I simply must disbelieve your figures until
> you can give some idea how
> you are arriving at them.

I have not only given you pointers to research results from
one of my

> vendors independently verified by government laboratories, I
> have
> given you an insight into my current research efforts.

> Thank you for that. But as your figures clearly demonstrate the newer technologies are more expensive per square inc over to far more expensive per square inc.

So? Its dollars per peak watt that is the critical factor. which is why I computed it for you.

> That matters a lot, when you intend to use them on a large scale

No, get your mind around the fact that you don't need as much material when you concentrate. How do you think I got a lower dollar per watt figure with a more expensive material? The supply problems would come if we produced enough solar panels to meet all our needs − with conventional panels. Not when we use concentrator systems.

Lets look at a 100 mm diameterwafer

1x solar intensity − terrestrial 1.1 watt electrical
1000x solar intensity − terrestrial 1,412 watt electrical
.5000x solar intensity − space 27,293 watt electrical

You need thousands of times more wafers to equal the capacity of the concentrator system − so even if you pay 3 to 40 times as much for it − you're still ahead− and your supply problems are non−existent with the concentrator systems.

> However, there is naturally the issue in what setting the planned use is for. I wouldn´t be surpriced, once perfected and shown to be reliable, the high energy per square inch types will dominate installations where cost per square inch is not so great an issue but energy produced per square inch is.

Concentrators cannot increase the intensity of sunlight − however, higher efficiency systems do make for smaller overall systems. The critical factor is DOLLARS PER WATT − and my systems reduce costs to PENNIES PER WATT − so there's really no comparison.

Since you didn't bring it up, I haven't yet addressed the other big
issue − the laser efficiency, and then the efficiency of the conversion on the ground. Free electron lasers have achieved 30%
efficiencies 20 years ago, diode lasers routinely exceed 10% efficiency − yet are less tunable.

http://www.frascati.enea.it/fis/lac/fel/fel2.htmhttp://www.alfalight.....

The military has focused on lightweight compact applications for
years. But both teams believe for sound and valid reasons that 80% to
85% efficiencies are achievable with a dedicated effort over the next
five years.

So, I have used those figures for my estimates here.

sunglight −−−> DC electricity 55% 55%
DC electricity −−−> laser energy 85% 47%
laser energy −−−> DC electricity 85% 40%

That´s a bit of an assumption.

What is?

By the way, the asteroid project you appear to be assuming sounds
really seriously expensive.

Cost is only one aspect, value created is the other. So, it is important to create more value than you spend in order to achieve your
goals.

> Now, this asteroid operation is clearly an operation in which the will inevitably have to be a testing period.

Correct.

> This will necessiate a large trained cadre of astronauts.

Yes.

> This will moreover also necessiate quite bit of EVA training of those astronauts.

Yes

> This will in addition necessiate the development of deepspace vessels,

Yes.

> I´d say preferably nuclear powered.

That is not in my planning. Reusable heavy lift launchers hydrogen/ oxygen powered, reusable heavy kick stages, hydrogen/oxygen powered, Reusable heavy lift launchers − laser powered with hydrogen propellant, reusable heavy kick stages hydrogen propellant laser powered, deep space laser probe/scan, deep space laser power, deep space laser propulsion. This is the development arc. Payloads will be, communication satellites, telerobotics, space tourists, space industry research, power satellites, moon based factories, mars base, asteroidal base, near sun solar power satellite, asteroid movement, asteroid capture, asteroid process research, test run, expansion; raw materials, finished goods, assembled goods, agriculture, forestry, homes.

> Now, I know you have suggested beemed power over the distance from the Sun. But that´s another development project with a testing period all of its own, and expenses, potential bottlenecks,

> etc, etc.

> Yes. The communication satellite network will generate a revenue in excess of $80 billion per year − greater than all the budgets of all the space programs of all humanity. This covers launch infrastructure and launch vehicle development. Capturing 15% of a $4 trillion market generates $600 billion per year 12.5% allocated to power satellites doubles the figure above − and develops powersatellite build out infrastructure, and all the processes needed to support it− including ground and flight staff.

Now, I´m wondering about your assumptions regarding those communications sats. I remember the IRIDIUM sats system and the phones. It was intended that by supplying a truly world wide system, phones that could be used truly enywhere on Earth´s surface demand would arise for the said service which would suffice to pay for the development costs as well as proviting prophits for the developers.

Now, as things came to be GSM ground stations proved to be more competitive, as well as GSM phones proved to be more convenient for most users, as well as being cheaper in every way.

Now, already broadband ground stations for the internet are being established in wealthyer countries, somewhat comparable to the network of GSM groundstations though a considerable different technology. Now, I think this may be analogous even though the uses are not the same.

What are your arguments that things will be different with your broadband sats?

> Please note that Mercury 7 astronauts were called for in 1959 and the first astronauts were flying in 1961. In September 1962, nine pilot astronauts were chosen and 14 more were selected in October 1963. This is when Armstrong came aboard. He was on the moon by 1969. 11 scientist astronauts were added to the astronaut program in 1967 and one went to the moon in 1971. I don't see why you think it impossible to train the right people to do the jobs asked of them.

I didn´t strichtly speaking say impossible. I´m simply observing the fact you are planning space construction on much waster scale than ever done before. That will require a much larger cadre of trained astronauts than anyone has ever had before.

I´m wondering about how easy it will be to scale up the operation so massivelly. Undoubtedly new suits will be necessary. This is a new type of operation in fact. Spaceconstructions done so far are so tiny in comparison that your operations will have to find out what works and what does not, the hard way. Nobody knows really how it would be most efficient to have say 100 astronauts working at the same time, in eva, at the same project.

> > Beemed power will require years of testing, first small scale then large scale all of its own.

> That's right and its going on today.

Do you have got recent links?

> > Now, today we may not foresee any great difficulties. But there allmost allways are difficulties, especially when working in an environment humans stichtly speaking still have got very litle experience in working within.

> That's true and I am speaking from experience. What are you speaking from?

There are some examples both of successes and ffield of regard above our heads − what's the smallest spot we can see
1.499 AU away? (Ceres orbit 2.499 AU, Earth orbit 1.000 AU − difference 1.499 AU)

That's 223.85 billion meters −

Ar = lambda / D = 1e−6 / 5000 = 2e−10 radians − 44.77 meters diameter airy disk at 1.499 AU.

OK, did ask around a bit, got some answeres back and have decided to stop arguing with you about optics.

> > What you need to do is to bring the mirrors in closer like can be done with spaceprobes.

> Two satellites similar to hubble connected by an open optical laser link (rather than fibers) can replicate what I describe here in space − without the atmospheric distortion− at about 50x the cost ($3,8 billion) − but we need to do the Atacama tests first. Then after we do the VLBI hubble style tests on orbit − then, we will have the skills and background to take the next step reliably − sending probes to the asteroid belt.

Then you don´t need a very large mirror, only a very
well made one. A superhighgrade camera.

Correct.

Microwaves have far longer wavelengths, but operated at far
larger
distances − vlbi − very long baseline interferometry − can
achieve
remarkable results in the microwave region

http://www.news.cornell.edu/releases/Aug99/AsteroidPix.bpf.html

LOL, and Arecibo is well large.

Arecibo didn't take this picture alone it was constructed by very long
baseline interferometry − which was the point.

You were proposing constructing a
number of observatories.

YEs.

The asteroid in question was only at the
distance of 5,3 million miles.

Yes.

It was therefore very much closer to
the Earth than the asteroids in the asteroid belt.

About 1/50,000th the distance.

"The astronomical unit (AU or au or a.u. or sometimes ua) is a unit of
length approximately equal to the distance from the Earth to the Sun.

> The currently accepted value of the AU is 149,597,870,691 ± 30 metres (nearly 150 million kilometres or 93 million miles)."

Please don't talk down to me − I gave you previously distances to Ceres as a representative of the asteroid belt − in terms of AU − I have computed rayleigh limits of various VLBI systems in the optical range using AU − where do you get off talking to me like this? Obviously you cannot respond usefully to the topic at hand so seek to act as some sort of expert by your tone. How many years have you been in grad school working your ass off as a research associate for an astronomer? I know what the hell I'm talking about − I'm answering your question