

THE FOUNDATION
**COMMERCIAL
SPACE REPORT**



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Dear Subscriber:

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Recently I was asked by the newly formed Space Foundation, Inc. of Houston, Texas to write and produce an audio-visual multi-image slide presentation which would be used in the fund-raising efforts of the group. The Space Foundation is a non-profit organization composed of businessmen and technologists from the Houston area and surrounding communities which has as one goal the promotion of a private enterprise oriented future in space. The presentation which is reproduced below in script form was done as both a fund-raising and educational tool, and deals with a pressing national problem: energy.

THE HARVEST

"Harvesting resources from space is certainly one of the next logical steps for man to take now that he has established a foothold in this new frontier. Energy is the most plentiful resource in space and is critically needed here on earth. If we are to have this commodity available, we must begin now to cultivate the capability to gather and deliver it."

It has rarely been fashionable to believe that a single idea or concept could be a panacea for the problems facing mankind. Indeed, in these times it is very popular to claim there are no permanent solutions, no answers, to the steady dwindling of energy, and resources for earth's growing billions. The declines in capital investment, growth opportunities and standard of living seem to be inevitable, the chance for healthy national economies uncertain...unless we change one simple notion which dominates how we plan for the future.

We are not limited to one planet.

Only one hundred miles above our heads is a limitless treasure trove ideally suited for an expanding technological civilization. No scientific questions of any significance presently limit our exploitation of this realm beyond the atmosphere. Limitations are of our own making, not nature's.

Our technological civilization requires cheap energy.

With it, more efficient use can be made of other limited material resources. Without cheap energy...the road we are now taking leads inevitably into the cold, bleak future, and then the Long Night.

But the seeds of a hopeful future were planted more than a decade ago. First came the proof that we could travel, work and live in space. Next came the idea that the resources of space were available to humans on earth. One of the prime resources of space is abundant solar energy.

What is the motivation for going into space to obtain energy we need on earth? Every year the average American consumes the equivalent of six tons of coal to

heat his home, manufacture his products and grow his food. This translates to two kilowatts per person. As material resources become scarce on earth, more energy will be required to maintain and improve the standard of living...and to allow the growth of our industrial society. By the early part of the next century, our children will need fifteen kilowatts or forty-five tons of coal annually per person. Fifteen kilowatts per person means that anywhere on earth has adequate raw materials for an industrial society.

If we capture solar energy in space and deliver it to the ground, a very different picture becomes clear. In the 1980's, one person's share of a space solar collector need be only fifteen feet on a side and would weigh only forty pounds. It could provide that two kilowatts per person.

On the ground, two pounds of sophisticated electronics and another eight hundred pounds of low cost materials like concrete and steel would be needed to capture the electricity and feed it into the national power grid. Once built, such a system would have limited maintenance needs.

And the fuel is free.

The growth possibilities of space power plants are also impressive. As the technology of capturing sunlight and turning it to electricity improves towards the end of this century the same area....fifteen feet on a side in space....will provide the fifteen kilowatts of energy needed by each of our children and their children.

Many different concepts have been proposed to make use of the energy resources in space. At this time, there is no one way to go about the task. But the broad outline of the technology needs are known and can be used for planning.

If there are no major scientific obstacles to the establishment of space power systems, why aren't they already in operation? The reason is one of economics and not technology. To deliver the forty pounds of space power station structure to orbit around the earth would presently cost over \$2000 per pound. This is an intolerable economic burden. Several schemes have been proposed to lower the cost of this transportation. One of them uses enormous heavy lift launch vehicles whose diameter is bigger than the entire length of the Saturn V moon rocket. Several of these vehicles would have to be launched every day with five hundred ton payloads to allow the construction of a few space power systems annually. But there are other ways.

Energy is not the only resource space has to offer. There are material resources as well. One of these resources has the equivalent surface area of the entire United States. We've been there. We've mapped its craters and mountains and hills. We've studied its mineral resources. We've even sent a geologist to it.

The moon.

The moon can be the source of the materials necessary to build a satellite solar power system. Many studies have been conducted over the past decade to explore this possibility: the use of extraterrestrial materials in solar power system construction.

The energy required to lift raw materials from the surface of the moon to the construction site is less than a twentieth of the energy necessary to carry the same materials from the surface of earth to orbit. This means the cost of these

materials can be reduced by at least the same amount. A bootstrapping lunar materials option makes space solar power feasible now.

Our prospecting on the surface of the moon has uncovered vast resources of titanium, aluminum, silicon, and oxygen. With no redesign satellite power system concepts that are presently being proposed for launch from earth could be adapted to lunar materials. More than 90% of the material in a 100000 ton ten thousand megawatt power station could be derived from the moon rather than from earth. These materials would first be beneficiated on the moon and then processed into final form, either there or in space at the site of the construction station. Some lunar materials, such as titanium, glass fiber and bulk materials, might subsequently be sold in earth markets. Very little lunar material is really necessary to build a space power systems. A pit the size of two football fields laid side by side and only a few feet deep is all that is necessary. This lunar base could be bootstrapped into existence. It is possible that only a thousand tons of cargo might have to be delivered to the moon to start producing space power systems at the the rate of a few per year. Using technology which has been extensively studied and explored, we would be able to process the raw lunar materials into girders, solar cells, reflectors and other components of a solar power satellite. No new scientific insights are necessary to begin this process.

The moon is not the only place where we might go for new material resources in the solar system. It is merely the closest and the easiest to exploit. In the future there are even more opportunities.

One of the most spectacular is represented in the one hundred thousand or more asteroids that cross the orbit of the earth. These asteroids are flying mountains, some of them more than a mile in diameter. Scientists know that these bodies are composed of industrially valuable materials which might be used in space...such as carbon, water, oxygen and metals. A percentage of these asteroids are composed of nearly pure steel, with trace quantities of cobalt and rare strategic metals. A single one hundred yard body of this type, small enough to fit within the Houston Astrodome, represents an economic resource worth more than 5 billion dollars. It contains one years's supply of nickel, and three year's supply of cobalt at the current US rate of consumption. Beyond the asteroids, there are other planets in the solar system: Mercury, Venus, Mars, and the gas giants beyond. The innermost planets are like the earth in a gross sense: small and rocky. We can expect to find concentrations of elements similar to those found on earth in these planets. One of the advantages of going to these planets rather than continuing to mine some minerals on earth is that there will be far less environmental impact...an important consideration in the near future. Farther out, other resources contained in the atmospheres of the giant planets Jupiter and Saturn might become valuable as hydrocarbon feedstocks for space industries of the future. Finally, sometime in the next century, we might even change or "terraform", planets to suit our needs.

But all of these are opportunities for the future. The opportunity now is to use a nearby, well known resource...the moon...and the abundant solar energy available in space...to fill the need for energy on earth. Now.

There are roadblocks to this process. Technical innovations will still be needed, even if the project is scientifically feasible. International legal arrangements will have to be made to allow the use of space and lunar resources. The national political environment must change so that these resources are recognized as valuable, and usable now. Laws must be written which will expedite the exploitation of this new, high frontier.

But the payoffs are staggering. Solar powersats will help promote economic stability in the United States. The country must spend 600 to 800 billions of dollars in the next two decades to pay for energy resources and facilities. Using the enormous technological base developed in the Apollo project, the United States is in an ideal position to spend some of those dollars, perhaps 10%, on an aggressive space power program. This program, operated in the private sector, could create jobs to reduce unemployment, provide energy for export to improve our balance of payments, earn lasting material wealth to reduce inflation, result in new technology for new products and increase industrial productivity. Space solar power systems deliver energy where it is needed. They reduce pollution. They can produce the large amounts of power that the market demands, and provide enough energy for continued economic growth. The systems would be simple, and passive. Space power can come on line in time to make the difference in our energy future. The first units could be working in the 1990's, and by the year 2000, could produce half the of the 1978 US electrical power output. The technology developed to build these systems out of lunar resources will give the United States and the companies that invest in their development a decided competitive advantage in the long term future markets for energy.

No other countries on the planet today have the opportunity to develop these facilities. We have pioneered the way into space. We can again lead the world. But the knowledge we have gained is available to all the world, and if we hesitate, we will lose the technological lead.

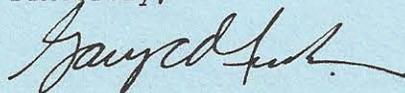
The role of the Space Foundation is to promote and direct that technological superiority, to bring the benefits of the 100 billion dollars already spent on space in the last two decades home...to America.

One of the Foundation goals will be to change the legal and political context of space in the country today, for example, to allow the operation of private launch vehicles. Another will be to improve the focus of government funding of research in the field. We will keep the pressure on to use the accomplishments of the past years for the future commercial exploitation of space resources. Another Foundation goal will be to open debates and discussion in government, industry, non-profit organizations and among the public about the use of these opportunities in space.

Space power systems, manufactured by the use of extraterrestrial materials from the moon, will help our nation maintain a leading role in new technology development in the world. It will improve productivity by supplying cheap energy and new material resources to the ground. It will give use the opportunity for unlimited non-competitive growth, a new business lead in global markets. It will improve our national security posture by giving us back control of our energy resources in a place that is secure and inaccessible to those who might wish to jeopardize our industrial future.

Only the United States has the 10 to 15 year head start whereby it can immediately embark on these projects. We must reap the harvest of our vast investment in space now...or we will lose it. As Arthur C. Clarke said nearly twenty years ago: "In this inconceivably enormous universe we can never run out of energy or matter, but we can all too easily run out of brains".

Sincerely,



Gary C. Hudson