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A PRELIMINARY COST BENEFIT ANALYSIS OF SPACE COLONIZATION: ABSTRACT

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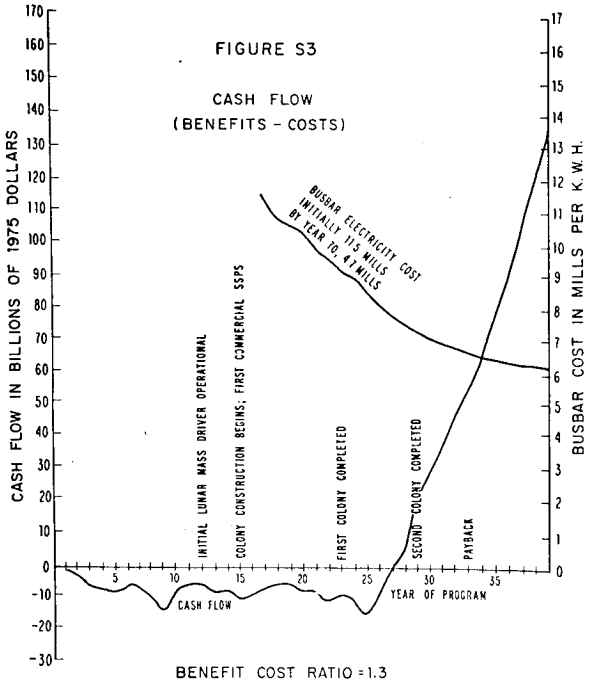
This abstract summarizes the first draft of a paper entitled, "A Preliminary Cost Benefit Analysis of Space Colonization" (1). The paper has been submitted to the Federal Energy Administration for checking. It is available from the author. The data upon which it is based were primarily obtained from the NASA-Stanford 1975 Summer Study of Space Colonization (2).

The economic aspects of the Space Colonization program are summarized by the cash flow diagram given in Figure S3. All costs in this abstract are in terms of 1975 dollars. During years 1 through 12 of the program the major costs are related to the establishment of facilities on the moon and at L-5 (the fifth librational point of the earth moon system). Mass drivers are the major component of the lunar facilities; their operation begins in year 12. These drivers consist of long tracks upon which buckets containing pellets of lunar material are accelerated by electrical power. When the pellets reach the end of a track they are slung into space while the buckets remain behind to be re-used. The lunar materials thus obtained are taken to L-5 where they are processed and fabricated into useful materials by a labor force which is initially housed in a construction shack. For the next 3 years these materials are used to build additional construction shacks and a SSPS (Satellite Solar Power Station) which will be used to provide power needed for expansion of the system. Only a small part of the mass for these items must be brought from earth. In year 15 the first commercial SSPS is built and within a year transported to geosyncronous orbit where it begins to transmit power to the earth. Construction of the first colony, a permanent habitat for 10,000 space workers and their dependents, also begins then. After year 12 costs are dominated by the building of SSPS's.



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The program is set up so that from the first year in which commercial SSPS's are produced, their level of output is always set equal to the demand for them. The U. S. market was assumed to be equal to the market for new plants. This market comes about because of growth and because existing plants eventually wear out. The foreign market for our exports in the case of nuclear plants has been about one-half the size of the U. S. market. It was assumed that this would likewise be the case for space colonization power. Because of the risk inherent in new technology, the demand in a given year is not initially equal to what was called the market size in the above. Rather the market must be penetrated over a period of time; in our case, we have estimated 10 years. After this time, demand is equal to the sum of the U. S. and foreign markets. The market size was assumed to grow at 5 percent per year. This is consistent with the 5.7 percent rate of the Energy Research and Development Administration's intensive electrification scenario. Colonists start to arrive in year 20, and have all arrived at the colony by year 23. By this time costs have become roughly proportional to the number of new SSPS's produced in a year, while benefits are roughly proportional to the total number of SSPS's that have been built. SSPS's are assumed to have a lifetime of 30 years. As a result, benefits rapidly climb with respect to costs.

Benefits were taken to consist of the revenue obtained from sale of electricity plus the benefit obtained by U. S. consumers due to lower electricity prices. Other benefits, although likely to be substantial, were ignored. It was assumed that electricity must be sold at 14.1 mills per kilowatt-hour or less to be competitive. (In 1974 electricity from nuclear plants was 15 mills and from coal-fired plants, 17 mills.) The value of 14.1 was set by an optimistic projection that the cheapest alternative source of electricity, nuclear, would be 14.1 mills during the period of interest. The savings to consumers was calculated subject to the conservative assumption that demand for electricity, if available at 14.1 mills, would not increase if the price were lower.

The total cost of the program through completion of the first colony is $111.5 billion. This figure excludes the costs of commercial SSPS's and latter colonies. Payback of costs occurs 18 years after the first commercial SSPS is built. Figure S3 also gives the costs at busbar of producing electricity by the use of commercial SSPS's. They start in year 16 at 11.5 mills and reach 4.7 by year 70. These costs cover everything except research and development costs which are taken to be the $111.5 billion mentioned above. The analysis employs a 10 percent real discount rate. Loosely speaking, this means that the net costs in any given year include intersts on the outstanding debt, at a real rate of 10 percent. This real rate includes the effects of inflation; that is, if the inflation rate in a given year were 8 percent, then the interest would be 18 percent in terms of the manner that interest rates are normally stated. The benefit cost ratio is 1.3. This implies that even if the costs in every year were 1.3 times larger than was estimated, the program would still be worthwhile.

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To conclude, the tentative economic results of this analysis do not mean that several billion dollars should be spent on space colonization next year. They are too uncertain for that. Rather, these results indicate the desirability of further study. If it happens that they are confirmed, then space colonization should be undertaken.

References

1) Hopkins, Mark, "A Preliminary Cost Benefit Analysis of Space Colonization." First Draft, January 1976, Unpublished.

2) NASA/Ames-Stanford ASEE 1975 Summer Study of Space Colonization. Space Colonization: A Design Study (in press)