

John W. Freeman⁺, Don Hervey*, and Peter Glaser^o⁺Rice University, *Brown and Root Development Inc., and ^oArthur D. Little, Inc.

Rice University with subcontracts to Brown and Root Development Inc. and Arthur D. Little Inc. has performed a preliminary study of the feasibility and cost of an offshore rectenna to serve the upper metropolitan east coast. The study proceeded by first locating a candidate site at which to build a 5 GW rectenna. The site was selected on the basis of proximity to load centers, avoidance of shipping lanes, sea floor terrain and conditions, etc. Several types of support structures were selected for study based initially on the reference system rectenna concept of a wire mesh ground screen and dipoles each with its own rectifier and filter circuits. The study also looked at possible secondary uses of an offshore rectenna.

The principal results of this study are as follows:

1. Suitable candidate sites exist off the northeast coast and probably all along the east coast and Gulf of Mexico.
2. Hurricane and winter storm conditions were examined for this area and a set of environmental criteria were established.
3. The winter storm criteria plus tests done at Rice University under icing conditions lead to the conclusion that a protective radome will be required over the active elements of the rectenna including a portion of the ground plane. This conclusion probably also holds for land rectennas located everywhere except perhaps in the desert southwest.
4. For the reference system rectenna (using a wire mesh ground plane and individual dipoles), a double pendulum, two level rectenna panel, which can swing freely is suitable (see figure 1).
5. Approximately 25,000 support towers would be required for a 5 GW antenna using the above reference system rectenna.
6. Four different types of support tower structures were studied and costed. The least expensive of these was the piled guyed tower.
7. For the 49.4m (162 ft) water depth site examined the total cost of a 5 GW rectenna using the piled guyed tower and reference rectenna panel is estimated at \$36 billion. This is considered too expensive for serious consideration. The reference system is not suitable for offshore use.
8. The water depth, wind loading and soil condition cost sensitivities were examined. None of these factors could be altered sufficiently to significantly reduce the cost.
9. Based on the foregoing, the only substantial way to reduce the cost of the offshore rectenna is to reduce the number of support towers or go to a fully surface floating system. Reducing the number of support towers requires a change in the type and mass of the rectenna panels.
10. The number of support towers can be reduced from 25,000 to 3,000 by eliminating the ground screen and adopting an image dipole reflector antenna (figure 2) where each of the dipole plus reflector elements are supported individually by cables which also carry the power from the dipoles. This is called the clothesline concept. Each dipole plus reflector is individually encapsulated to protect it from the weather.
11. The cost of this clothesline concept for the 49.4 m water depth site is estimated at \$5.7 billion.

12. This demonstrates the cost reduction potential possible with new rectenna concepts. The clothesline concept is only one of several possible concepts. Time and fiscal constraints have prevented us from examining a surface floating rectenna, however, Peter Collins in England has estimated the cost of a North Sea floating rectenna at about \$6 billion.

13. Secondary uses, in particular mariculture, mineral extraction and hydrogen generation appear as promising adjuncts to the offshore rectenna. The possibility of wave energy extraction has also been examined briefly. Such secondary uses do not appear to constrain the basic rectenna design significantly.

14. A major problem identified with the reference rectenna offshore version is the sea birds which will be attracted to the vicinity of the rectenna and will land and roost on it. This requires further study, but it appears that the more open structure of the clothesline concept will reduce the bird problem somewhat.

In Summary

We have demonstrated that an offshore rectenna near east coast load centers is feasible. We have not yet demonstrated the practicality of such a system, nor has the design been optimized for cost, efficiency or minimal harmonic reradiation. The secondary and fuel generation uses remain to be fully explored.

Even at this early stage we believe that the offshore rectenna feasibility has been demonstrated and that with the significant advantages of no land requirements and removal of the radiation from populated areas which may offset any additional costs, further investigation of the offshore rectenna should be vigorously pursued.

ORIGINAL PAGE IS
OF POOR QUALITY

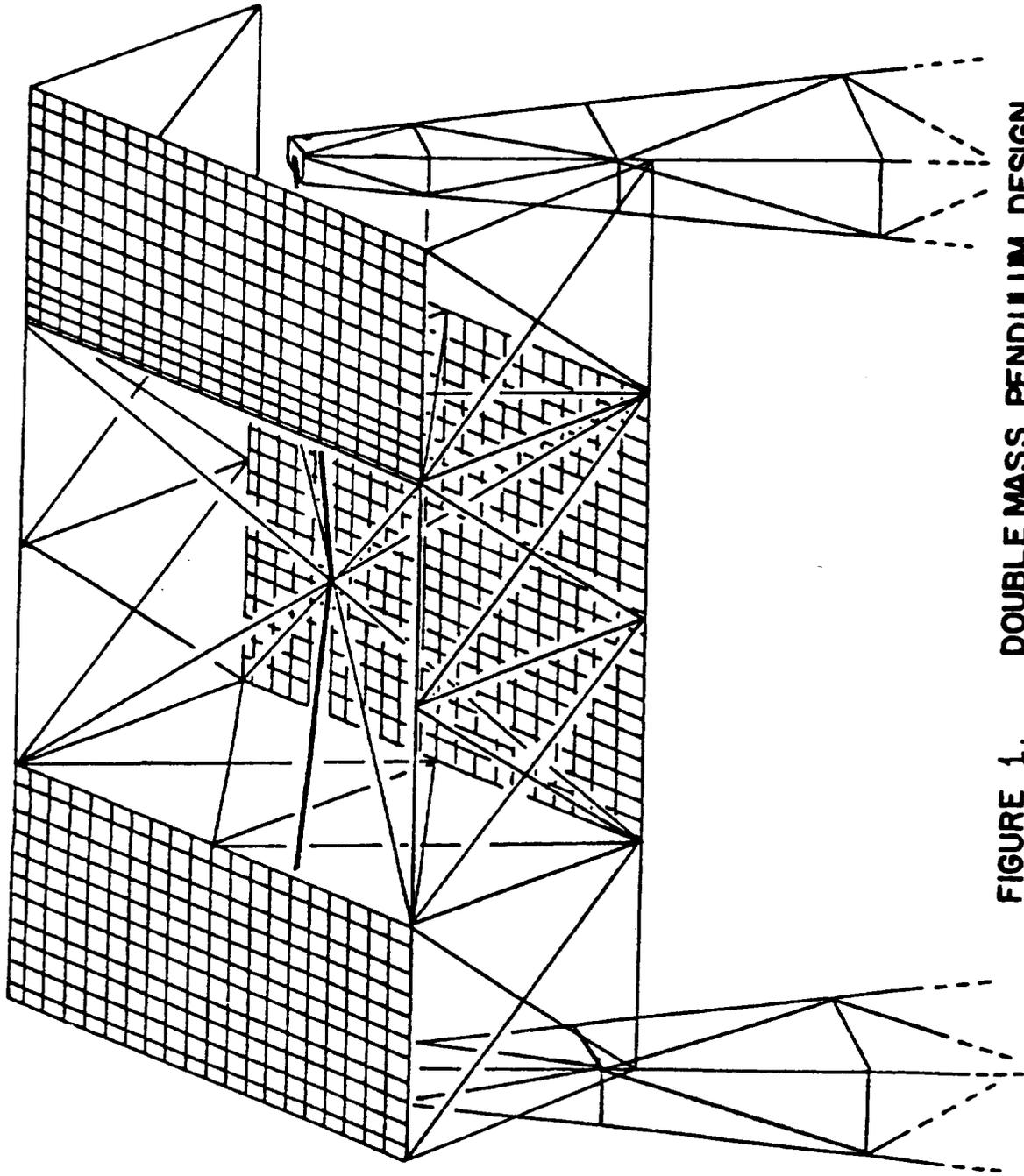


FIGURE 1. DOUBLE MASS PENDULUM DESIGN

