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Testimony
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Tides, Currents and Waves
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Introduction

The earth's oceans offer infinitely renewable resources for mankind's energy requirements. The daily variations in tidal amplitudes and currents, the ocean winds and the waves they create across the surface, and the temperature (density) differences from the surface to the depths all offer unlimited potential for conversion to electrical power. In some parts of the world, these alternatives for energy from the ocean are already at work. In the future, they will also become competitive with fossel fuel energy in the United States.

Terminology

These renewable, ocean energy alternatives listed above are herein called *oceanpower* to distinguish then from hydropower generated from rainfall stored behind dams on land and the fossel fuel energy from oil and gas.

Development of Oceanpower Alternatives

The following are my concerns for the future development of our oceanpower resources. They are listed in no particular order of importance.

1. All alternatives must be designed to withstand the ocean's harsh environment (wave forces, salt water corrosion, inaccessible locations, etc.). But a wealth of experience exits from the oil and gas industry. For example, in the North Sea, rigs must withstand 100ft high wave forces (10 story building).

2. All alternatives are best suited for development at specified sites, i.e. not all work at all sites. Therefore, all options should be pursued for future development. For example, wave climates vary considerably around the nation's coasts from the northwest on the Pacific Ocean to the Gulf of Mexico shorelines.

3. All alternatives must be connected to land by cables to transmit the power generated at sea. Therefore, all must cross dynamic, coastal boundaries where waves break to create moving currents, sand transport,

and coastal erosion. For example, ocean outfall pipelines must be positioned well below the active beach elevations above and below water levels at the coast. The shoreline is a critical link in the power transmission system.

4. All alternatives interact with the national environment to some degree. Environmental impact concerns are much different than with hydrocarbon extraction and transport. For example, wind mills (turbines) sited near the Danish coastline have been studied to determine what happens to the altered winds in the lee of the turbine farm to alter the water waves that create sand movements and shoreline locations. Coastal erosion may be created.

5. All alternatives will be located near coasts to minimize power transmission losses and costs. Multiple uses and activities currently take place in the coastal zone. Conflicts exist in coastal zone management. For example, in the Gulf of Mexico near coastal Louisiana, the many oil and gas pipelines from the rigs prevent the mining of the sand resources beneath the pipelines for use to rebuild the barrier islands protecting the coast. Clearly, here the energy and mineral resources are in conflict for development.

6. All alternatives require considerable maintenance costs over their design lifetimes. Since downtime converts *immediately* to power loss in the system, considerable overdesign, backup systems, repair part inventories, etc. are required for maintenance. Total, life-cycle costs (initial construction costs plus present worth of annual maintenance costs) must be considered when estimating costs per kilowatt-hour for each alternative. There is no “low cost” alternative for oceanpower.

7. All alternatives are relatively “clean” when things go wrong. Since oceanpower is from kinetic energy (winds and currents), potential energy (tidal elevations), combinations of kinetic and potential energy (water waves) and thermal energy (temperatures), no “spills” can take place.

8. Many professional disciples (engineers, geologists, oceanographers, economists, etc.) are involved in the feasibility studies, planning, siting, design, construction, and management of oceanpower systems. All must be involved in research and development.

9. All alternatives need considerable research and development to reach their potential.

10. The Energy Bill, which was signed into law on August 8, 2005, provides a funding mechanism for oceanpower research and development. As you know, funds from federal oil and gas revenues generated on the Outer Continental Shelf (OCS) are now distributed to coastal, energy-producing states. The list of authorized uses of these funds should be expanded to include research and development of alternatives for oceanpower.

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