DEPARTMENT OF PLANNING AND NATURAL RESOURCES
VIRGIN ISLANDS ENERGY OFFICE
45 ESTATE MARS HILL
FREDERIKSTED, VIRGIN ISLANDS 00840
TELEPHONE 340 773-1082 STX * FAX 340 772-0063
340 774-3320 STT * FAX 340 714-9531
www.vienergy.org

# OCEAN ENERGY

## INTRODUCTION

Ocean energy draws on the energy of ocean waves, tides, or on the thermal energy (heat) stored in the ocean. The ocean contains two types of energy: *thermal energy* from the sun's heat, and *mechanical energy* from the tides and waves. Oceans cover more than 70% of Earth's surface, making them the world's largest solar collectors. The sun warms the surface water a lot more than the deep ocean water, and this temperature difference stores thermal energy. Thermal energy is used for many applications, including electricity generation. Ocean mechanical energy is quite different from ocean thermal energy. Even though the sun affects all ocean activity, tides are driven primarily by the gravitational pull of the moon, and waves are driven primarily by the winds. A *barrage* (dam) is typically used to convert tidal energy into electricity by forcing the water through turbines, activating a generator.

## OCEAN TECHNOLOGIES

*Wave Energy:* The total power of waves breaking on the world's coastlines is estimated at 2 to 3 million megawatts. In favorable locations, wave energy density can average 65 megawatts per mile of coastline. Three approaches to capturing wave energy are:

*Floats or Pitching Devices:* These devices generate electricity from the bobbing or pitching action of a floating object. The object can be mounted to a floating raft or to a device fixed on the ocean floor.

*Oscillating Water Columns:* These devices generate electricity from the wave-driven rise and fall of water in a cylindrical shaft. The rising and falling water column drives air into and out of the top of the shaft, powering an air-driven turbine.

*Wave Surge or Focusing Devices:* These shoreline devices, also called "tapered channel" or "tapchan" systems, rely on a shore-mounted structure to channel and concentrate the waves, driving them into an elevated reservoir. Water flow out of this reservoir is used to generate electricity, using standard hydropower technologies.

*Tidal Energy:* Tidal energy traditionally involves erecting a dam across the opening to a tidal basin. The dam includes a sluice that is opened to allow the tide to flow into the basin; the sluice is then closed, and as the sea level drops, traditional hydropower technologies can be used to generate electricity from the elevated water in the basin. Some researchers are also trying to extract energy directly from tidal flow streams. The energy potential of tidal basins is large — the largest facility, the La Rance station in France, generates 240 megawatts of power.

*Ocean Thermal Energy Conversion:* A great amount of thermal energy (heat) is stored in the world's oceans. Each day, the oceans absorb enough heat from the sun to equal the thermal energy contained in 250 billion barrels of oil. OTEC systems convert this thermal energy into electricity — often while producing desalinated water. Three types of OTEC systems can be used to generate electricity:

*Closed-cycle plants* circulate a working fluid in a closed system, heating it with warm seawater, flashing it to vapor, routing the vapor through a turbine, and then condensing it with cold seawater.

*Open-cycle plants* flash the warm seawater to steam and route the steam through a turbine.

*Hybrid plants* flash the warm seawater to steam and use that steam to vaporize a working fluid in a closed system.

OTEC systems are also envisioned as being either land-based (or "inshore"), near-shore (mounted on the ocean shelf), or off-shore (floating).

## ADVANTAGES AND DISADVANTAGES

*Advantages:* Ocean Energy uses clean, abundant, renewable, natural resources.

OTEC systems can produce fresh water as well as electricity. This is a significant advantage in the Virgin Islands where fresh water is limited.

There is enough solar energy received and stored in the warm tropical ocean surface layer to provide most, if not all, of present human energy needs.

*Disadvantages:* OTEC-produced electricity at present would cost more than electricity generated from fossil fuels at their current costs.

OTEC plants must be located where a difference of about 40 degrees Fahrenheit occurs year round. Ocean depths must be available fairly close to shore-based facilities for economic operation.

Construction of OTEC plants and laying pipes in coastal waters may cause localized damage to reefs and near-shore marine ecosystems.

## ADDITIONAL RESOURCES

Energy Efficiency and Renewable Energy Network: www.eren.doe.gov/RE/ocean.html

National Renewable Energy Laboratory: www.nrel.gov/otec/

Office of Power Technologies: www.eren.doe.gov