Biomass
a new source of energy

- ***What is biomass energy?***
- ***Which biomass energy source are the most famous for using and under research?***
- ***How does it work?***
- ***What is the advantages and the disadvantages of biomass energy?***
- ***What is the limitations of biomass energy?***
- ***How is it affecting the environment negatively?***

What is the use of biomass energy?

- *For producing heat energy*
- Anything from the nature which can burn to heat.
- E.g. charcoal, wood, Mustard oil

- *For producing electricity*
- Using method is same as oil. Burn it and get energy either for a state or a house.
- E.g. wood, crop residues, Mustard oil

The various and famous examples for biomass

- ***Crop residues :*** burn it in incinerator to produce energy.
- ***Burning woods :*** burning woods in order to produce electricity or heat energy.
- ***Mustard oil :*** used like oil for electricity or diesel

How does it work? (1)

- *CROP RESIDUES* -burn in the incinerator and produce electricity.
- It produces 10% of electricity of Hawaii and Brazil.
- *WOOD* - burn as feul to either produce energy or heat.
- Wood-fired power plants provide 23% of the electricity used in Maine.

How does it work? (2)

- *MUSTARD OIL* - burn in the engine as diesel for vehicle or in power plant to produce electricity.
- It is under research.

The advantages for biomass energy

- Most of them are renewable, e.g., wood, mustard oil and crop residues.
- Solve energy crisis in the future.
- Some of them are re-using the waste, e.g.,crop residues, sewage.
- High energy efficiency.
- Generally it does not polluted the atmosphere as much as oil and coal.

The disadvantages of the using of biomass energy (1)

- More serious air pollution was found when burning plants matters, e.g., CO2, CO, solid particulate matter.
- Emission more carcinogens into the air.
- Emission some toxic gases and ash.

The disadvantages of the using of biomas energy (2)

- It takes too much energy to collect, dry and transport the residues to power plants.
- Reduce soil nutrient replenishment.
- The source of biomass can use fertilize soil, e.g., crop residues and animal manure. Cutting too many woods is a kind of deforestation can cause, soil erosion and natural disasters

The disadvantages of the using of biomas energy (3)

- Raising the price of food, wood and wood products indirectly.
- May cause accident.
- It uses large area to grow biomass.

The limitations for using biomass energy

- Either high technological level or catalytic combustion is needed.
- Large area is needed to grow plants for biomass energy use.
- When producing biomass fuel, large amount of waste will also produced.

The environmental problems are caused by biomass energy (1)

- It will intensify air pollution.
- It may cause saltilization and decrease to total size of the arable land.

The environmental problems are caused by biomass energy (2)

- The source of biomass can use fertilize soil, e.g., crop residues and animal manure.
- Cutting too many woods is a kind of deforestation can cause, soil erosion and natural disasters

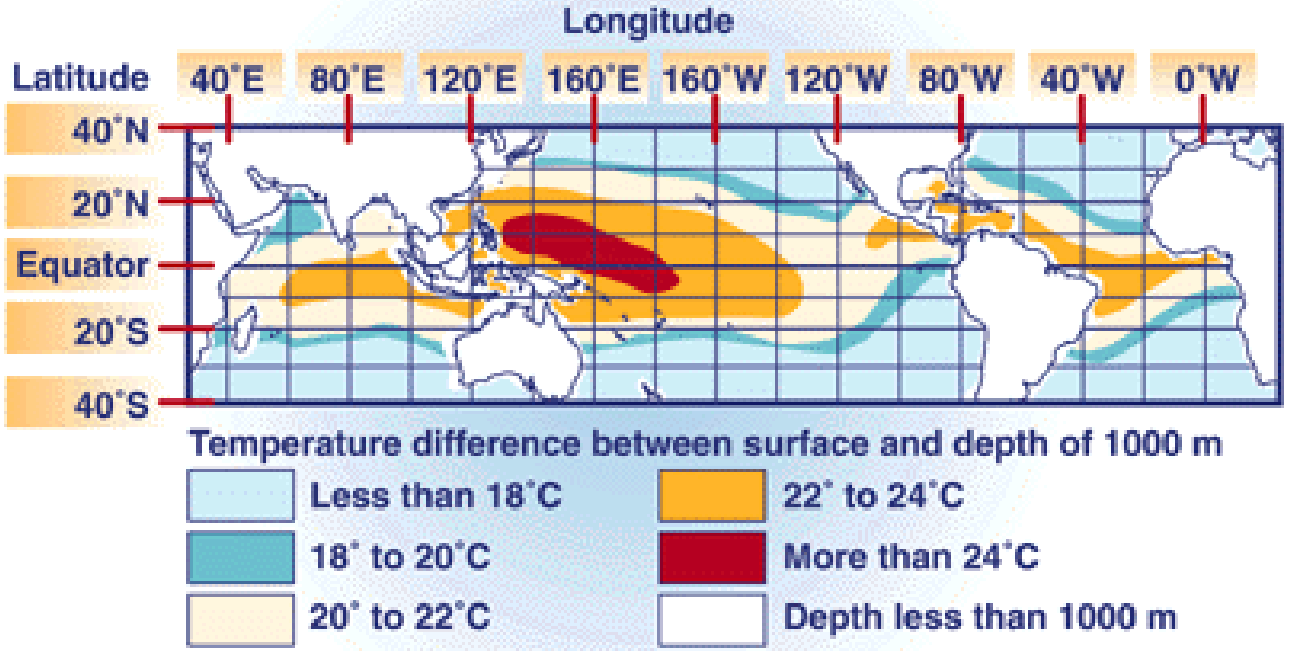
Ocean Power

What is OTEC

- OTEC, or Ocean Thermal Energy Conversion, is an energy technology that converts solar radiation to electric power.
- OTEC systems use the ocean's natural thermal gradient—the fact that the ocean's layers of water have different temperatures—to drive a power-producing cycle.

How Does it Work

- Carnot Efficiency $(T_1-T_2)/T_1$: in transferring heat to do work, the greater the spread in temperature between the heat source and the heat sink, the greater the efficiency of the energy conversion.
- As long as the temperature between the warm surface water and the cold deep water differs by about 20°C (36°F), an OTEC system can produce a significant amount of power with a maximum Carnot Efficiency of about 6.7%



- Half of the earths incoming solar energy is absorbed between the tropic of Capricorn and the Tropic of Cancer.

History

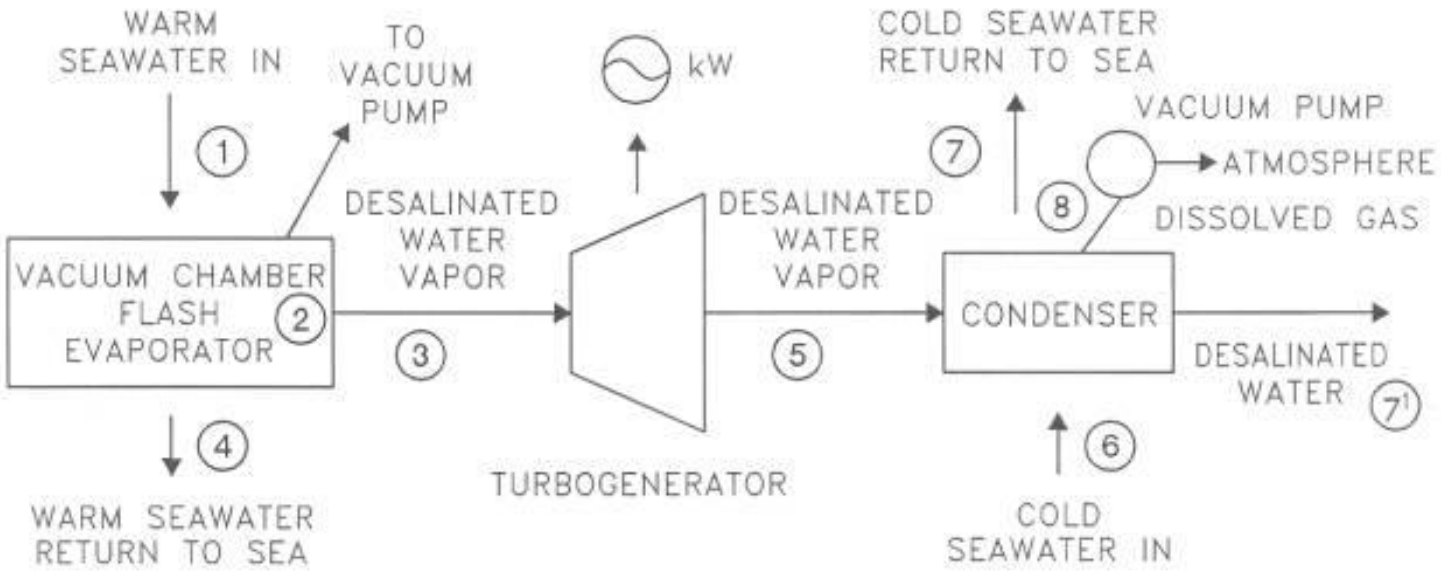
- 1881: Jacques Arsene d'Arsonval, a French physicist, was the first to propose tapping the thermal energy of the ocean. Georges Claude, a student of d'Arsonval's, built an experimental open-cycle OTEC system at Matanzas Bay, Cuba, in 1930. The system produced 22 kilowatts (kW) of electricity by using a low-pressure turbine. In 1935, Claude constructed another open-cycle plant, this time aboard a 10,000-ton cargo vessel moored off the coast of Brazil. But both plants were destroyed by weather and waves, and Claude never achieved his goal of producing net power (the remainder after subtracting power needed to run the system) from an open-cycle OTEC system.
- 1956: French researchers designed a 3-megawatt (electric) (MWe) open-cycle plant for Abidjan on Africa's west coast. But the plant was never completed because of competition with inexpensive hydroelectric power.

History Cont’d

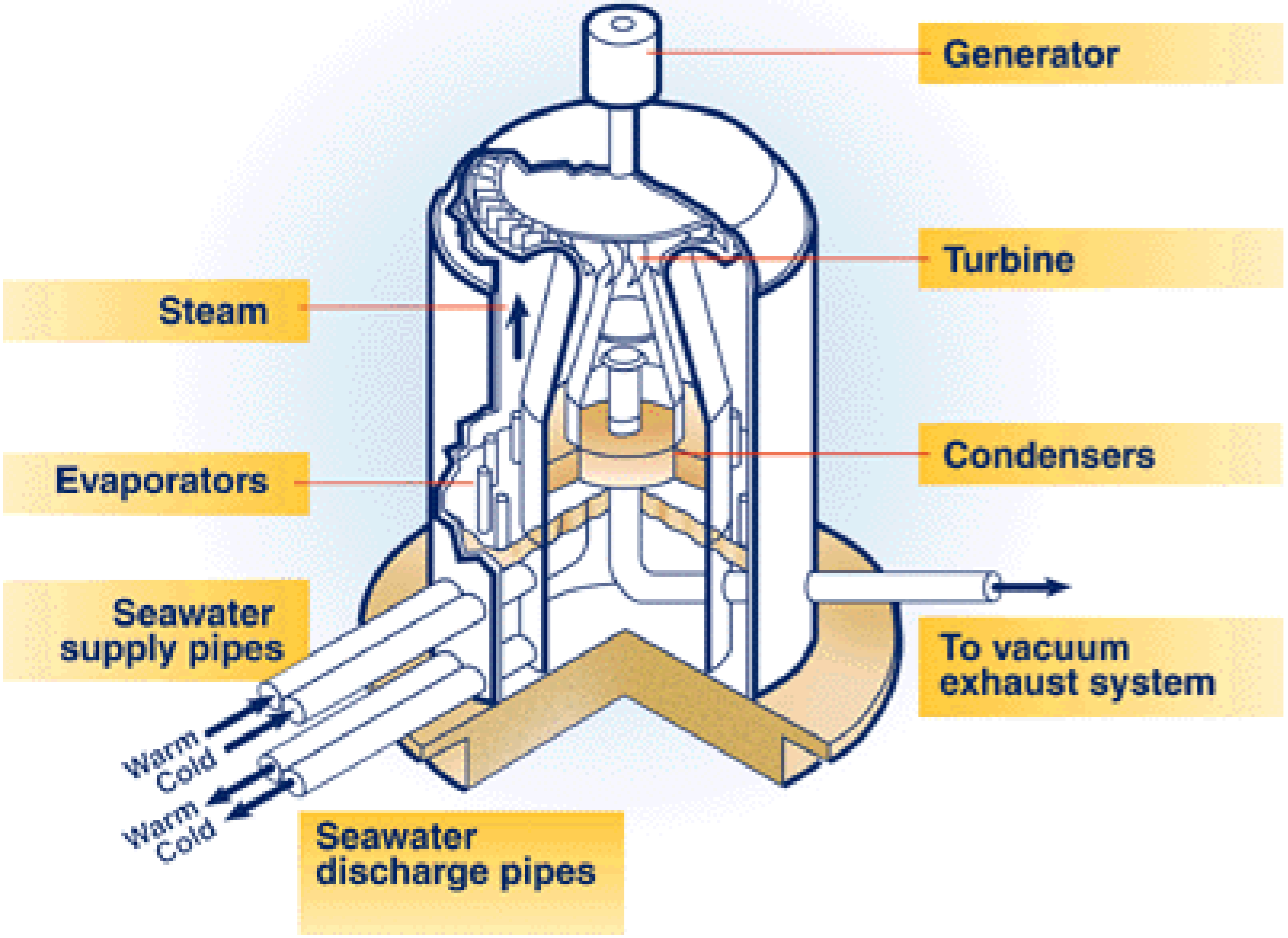
- 1979: The first 50-kilowatt ((kWe) closed-cycle OTEC demonstration plant went up at NELHA.
- Known as "Mini-OTEC," the plant was mounted on a converted U.S. Navy barge moored approximately 2 kilometers off Keahole Point. The plant used a cold-water pipe to produce 52 kWe of gross power and 15 kWe net power.

- 1993: An open-cycle OTEC plant at Keahole Point, Hawaii, produced 50,000 watts of electricity during a net power-producing experiment.
- This broke the record of 40,000 watts set by a Japanese system in 1982.
- Today, scientists are developing new, cost-effective, state-of-the-art turbines for open-cycle OTEC systems, experimenting with anti corroding Titanium and plastics as rotor material.
- The new designs for OTEC are still mostly experimental. Only small-scale versions have been made. The largest so far is near Japan, and it can create 100 kilowatts of electricity.

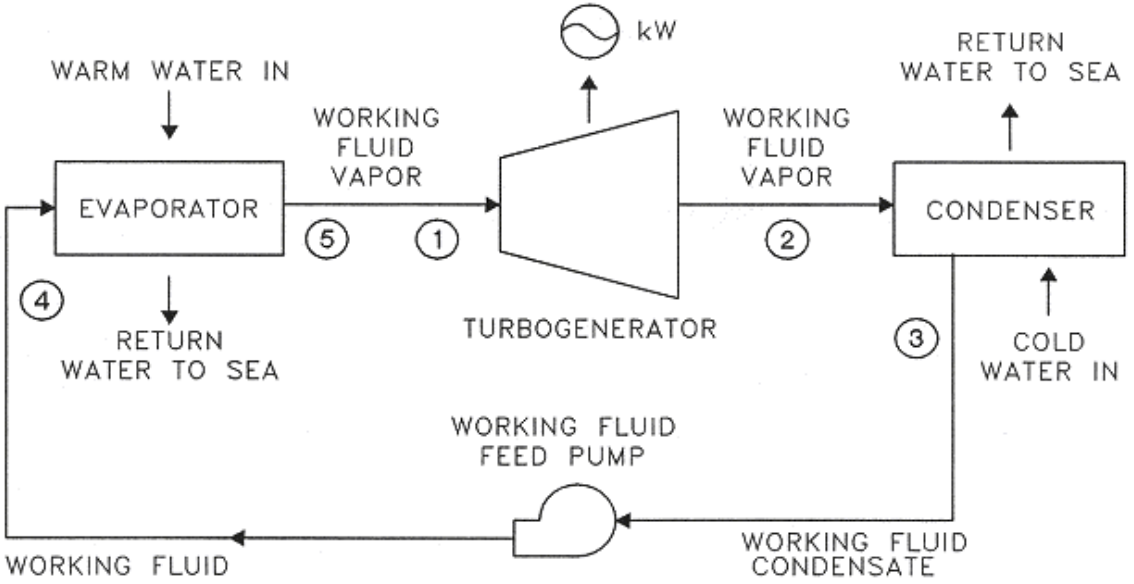
Open-Cycle



- Open-cycle OTEC uses the tropical oceans' warm surface water to make electricity. When warm seawater is placed in a low-pressure container, it boils. The expanding steam drives a low-pressure turbine attached to an electrical generator. The steam, which has left its salt behind in the low-pressure container, is almost pure fresh water. It is condensed back into a liquid by exposure to cold temperatures from deep-ocean water.

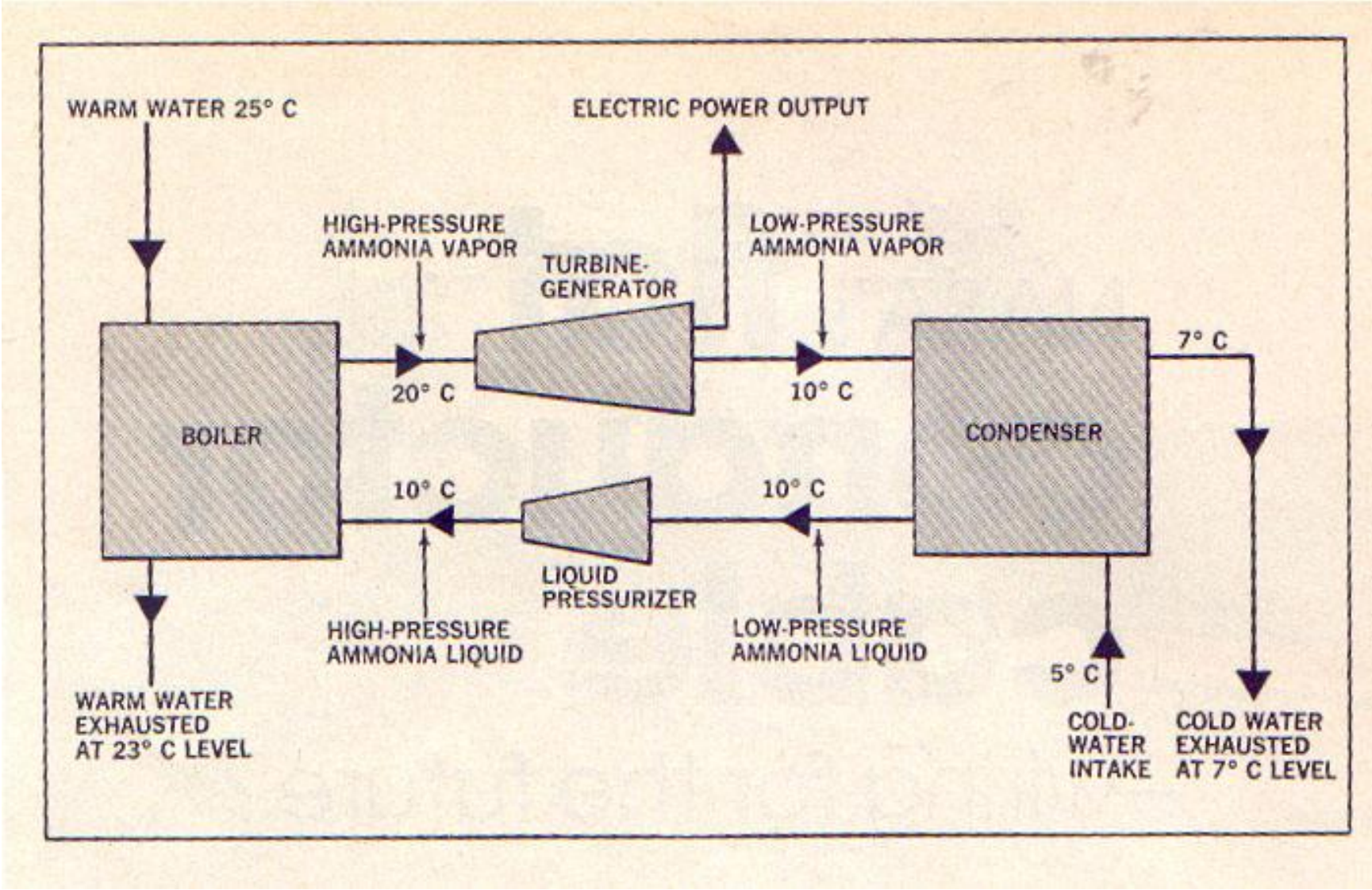

Generator
Turbine
Steam
Condensers
Evaporators
Seawater supply pipes
To vacuum exhaust system
Warm
Cold
Warm
Cold
Seawater discharge pipes

Closed-Cycle (Rankine)



- Closed-cycle systems use fluid with a low-boiling point, such as ammonia, to rotate a turbine to generate electricity. Here's how it works. Warm surface seawater is pumped through a heat exchanger where the low-boiling-point fluid is vaporized. The expanding vapor turns the turbo-generator. Then, cold, deep seawater—pumped through a second heat exchanger—condenses the vapor back into a liquid, which is then recycled through the system.

Closed Loop


WARM WATER 25° C
ELECTRIC POWER OUTPUT
HIGH-PRESSURE AMMONIA VAPOR
TURBINE-GENERATOR
LOW-PRESSURE AMMONIA VAPOR
7° C
20° C
10° C
BOILER
CONDENSER
10° C
10° C
LIQUID PRESSURIZER
HIGH-PRESSURE AMMONIA LIQUID
LOW-PRESSURE AMMONIA LIQUID
5° C
WARM WATER EXHAUSTED AT 23° C LEVEL
COLD-WATER INTAKE
COLD WATER EXHAUSTED AT 7° C LEVEL

Hybrid System

Hybrid systems combine the features of both the closed-cycle and open-cycle systems. In a hybrid system, warm seawater enters a vacuum chamber where it is flash-evaporated into steam, similar to the open-cycle evaporation process. The steam vaporizes a low-boiling-point fluid (in a closed-cycle loop) that drives a turbine to produces electricity.

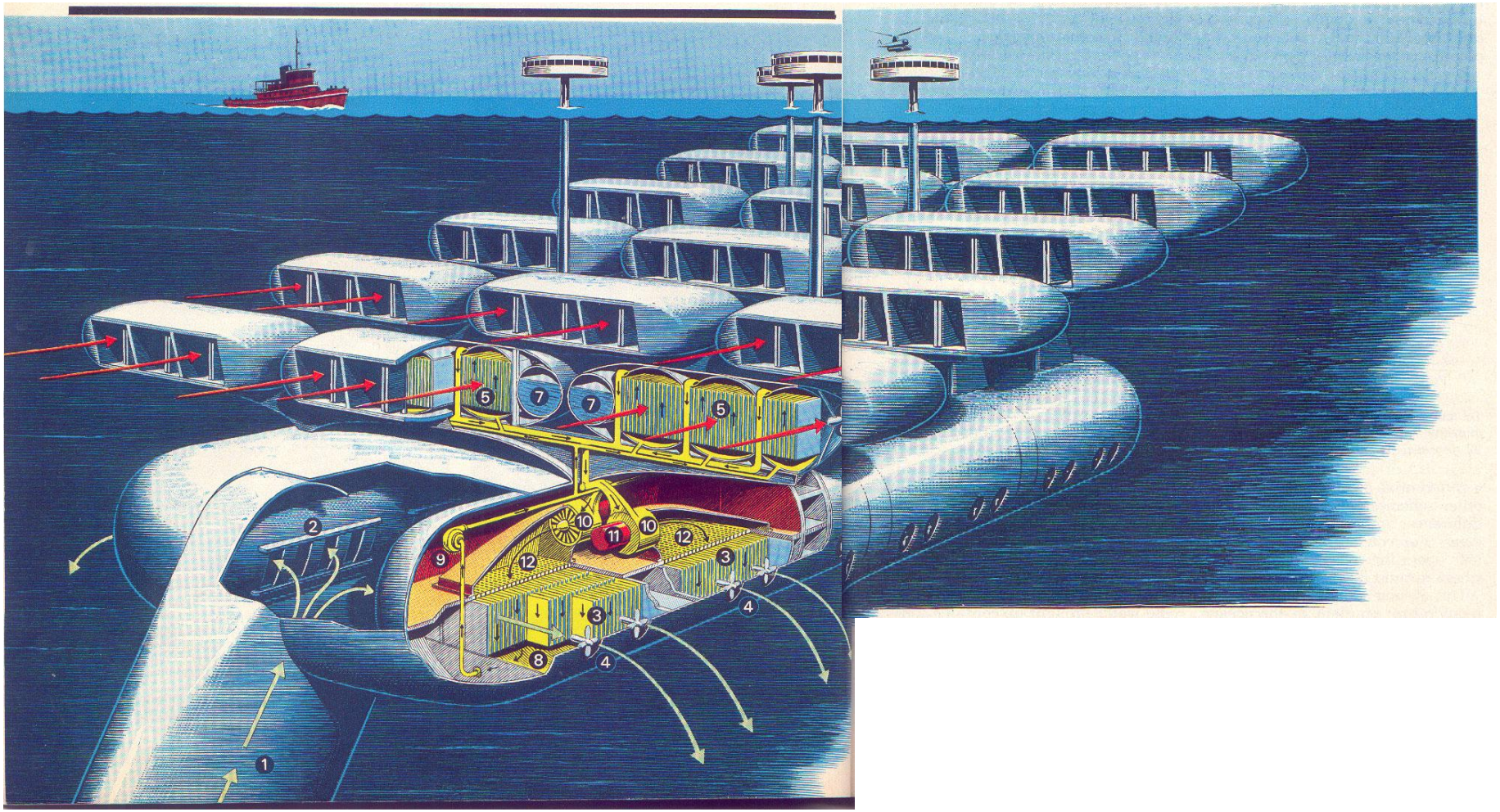
Advantages

- **Low Environmental Impact**
- The distinctive feature of OTEC energy systems is that the end products include not only energy in the form of electricity, but several other synergistic products.
- **Fresh Water**
  The first by-product is fresh water. A small 1 MW OTEC is capable of producing some 4,500 cubic meters of fresh water per day, enough to supply a population of 20,000 with fresh water.
- **Food**
  A further by-product is nutrient rich cold water from the deep ocean. The cold "waste" water from the OTEC is utilised in two ways. Primarily the cold water is discharged into large contained ponds, near shore or on land, where the water can be used for multi-species mariculture (shellfish and shrimp) producing harvest yields which far surpass naturally occurring cold water upwelling zones, just like agriculture on land.

Minerals

OTEC may one day provide a means to mine ocean water for 57 trace elements. Most economic analyses have suggested that mining the ocean for dissolved substances would be unprofitable because so much energy is required to pump the large volume of water needed and because of the expense involved in separating the minerals from seawater. But with OTEC plants already pumping the water, the only remaining economic challenge is to reduce the cost of the extraction process.

Artists rendition of a 400MW plant back in ‘75




OTEC-1

Recent Advancements

- The development of the Kalina Cycle which is significantly more efficient than the previous closed-cycle system based on straight ammonia.
- http://www.ocees.com/mainpages/qanda.html#faq3
- The discovery that dissolved gases exchange more rapidly from seawater than from fresh water. This allows for more efficiency and lower costs for open-cycle OTEC and for fresh water production from seawater in a hybrid Kalina Cycle configuration as well as fresh water production in general.
- The development of better heat exchangers and heat exchanger operation with respect to bio-fouling control (on the warm water side) and corrosion control.

The Future

- Records available from experimental plants demonstrate technical viability and provide invaluable data on the operation of OTEC plants. The economic evaluation of OTEC plants indicates that their commercial future lies in floating plants of approximately 100 MW capacity for industrialized nations and smaller plants for small-island-developing-states
- Small OC-OTEC plants can be sized to produce from 1 MW to 10 MW of electricity, and at least 1700 m^3 to 3500 m^3 of desalinated water per day.

Resources

- http://www.otecnews.org/
- http://www.hawaii.gov/dbedt/ert/otec/index.html
- http://www.ocees.com/mainpages/qanda.html#faq3

Ocean Waves and Tides

Waves

- A Wave is a rhythmic movement that carries energy through matter or space.
- In oceans, waves move through seawater

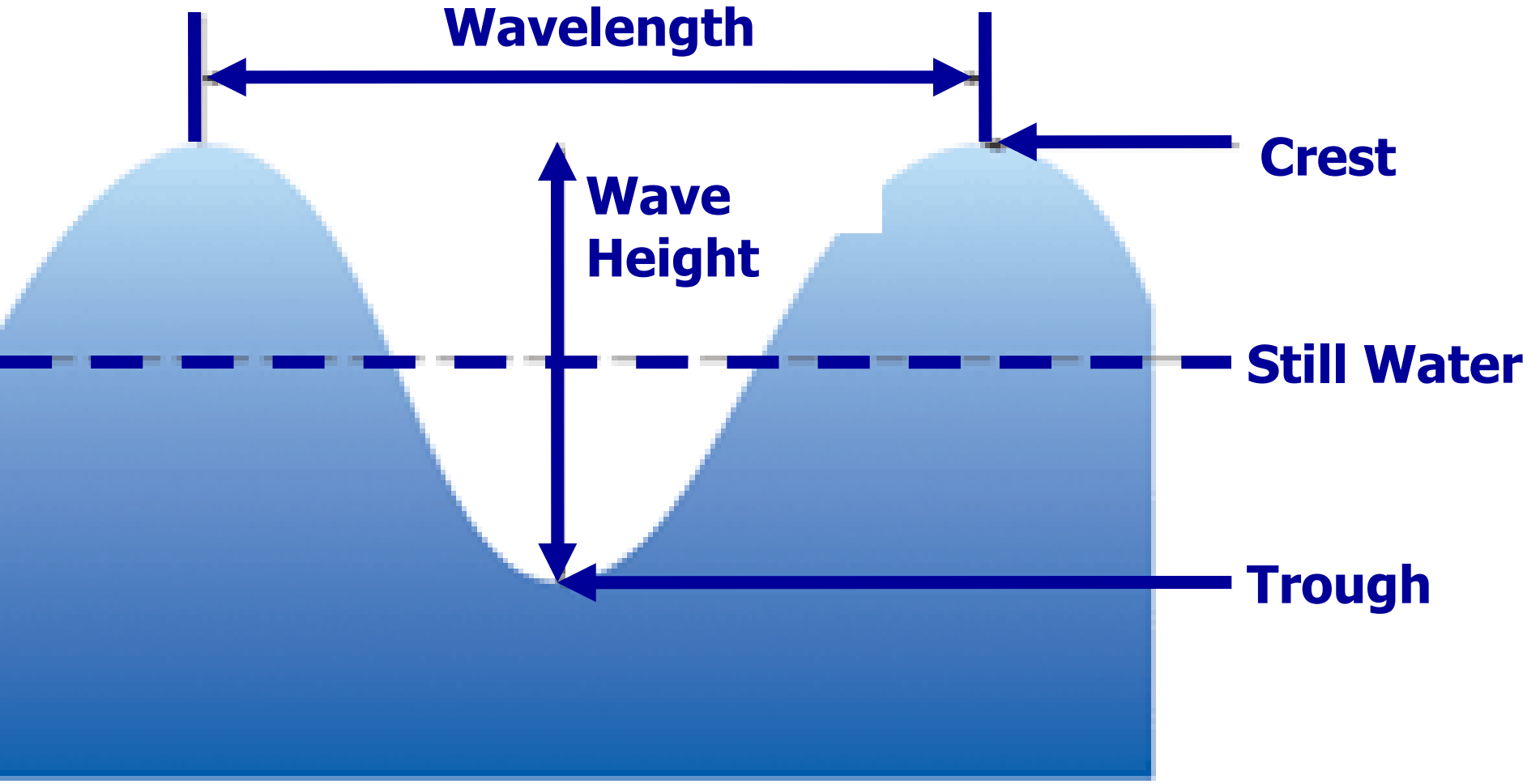
Waves

Caused by:

- Wind
- Earthquakes
- Gravitational force of the Moon and Sun.

Parts of a Wave

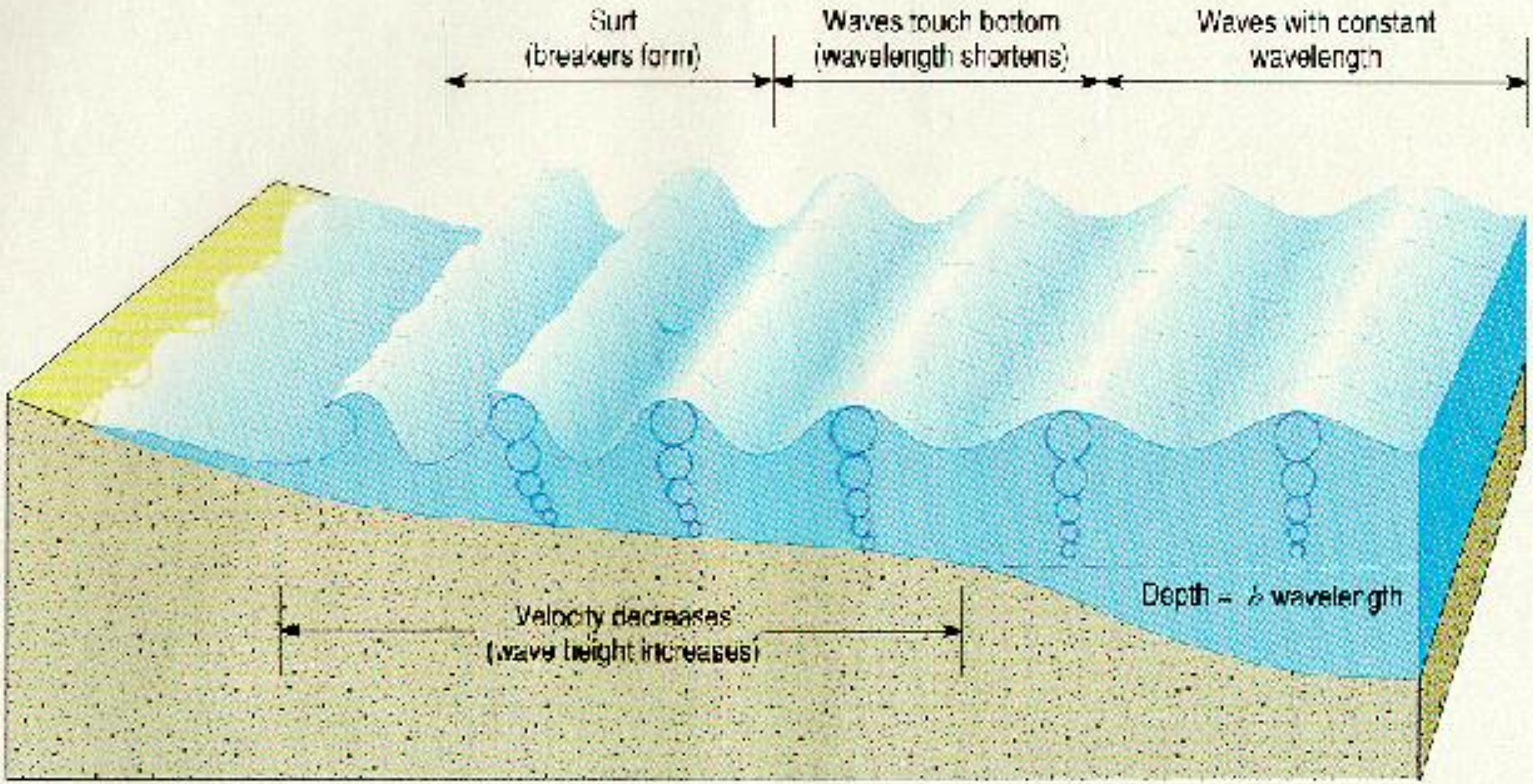
- Crest – highest point of a wave
- Trough – lowest point of a wave
- Wave Height – vertical distance between the crest and the trough
- Wavelength – horizontal distance between two crests or two troughs



Wave Parts

Wave Movement

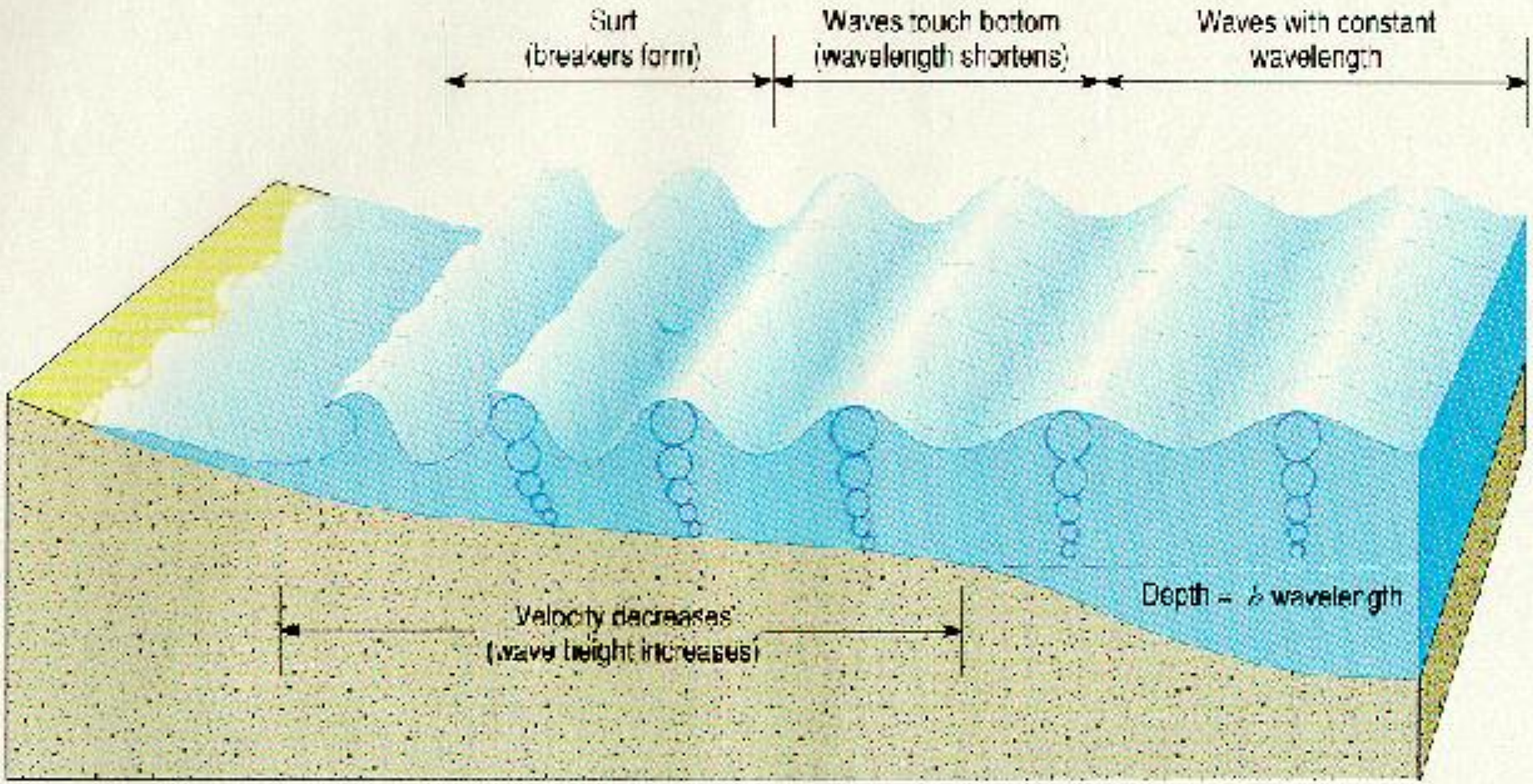
- When a wave passes through the ocean, individual water molecules move up and down but they do not move forward or backward.



Changes when a wave moves onto shore.

Wave Movement

- When a wave breaks against the shore, the crest outruns the trough and the crest collapses.
- Called a breaker.
- In this case, water does move forward and backward.



Changes when a wave moves onto shore.

Waves Caused by Wind

- When wind blows across a body of water, friction causes the water to move along with the wind.
- Wave Height depends on –
  - Wind speed
  - Distance over which the wind blows
  - Length of time the wind blows

Tides

- The rise and fall in sea level is called a tide.
- Caused by a **giant wave**.
- One low-tide/high-tide cycle takes about 12 hrs and 25 min.
- Tidal range is the difference in ocean level between high-tide and low-tide

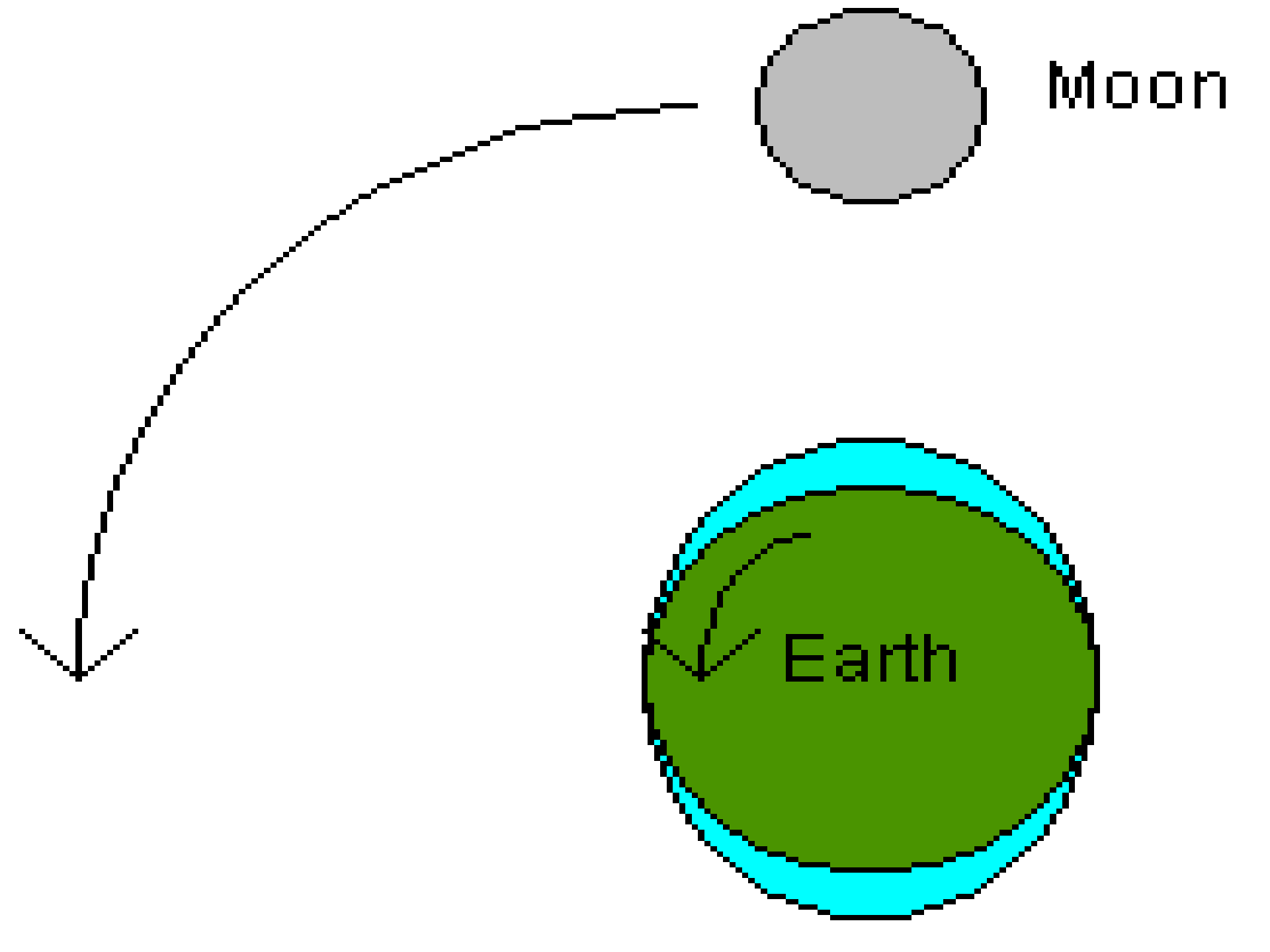
What is the Tidal Range?

- HT = 30 ft, LT = 20 ft
- HT = 20 ft, LT = 12 ft
- HT = 50 ft, LT = 20 ft

Gravitational Effect of the Moon

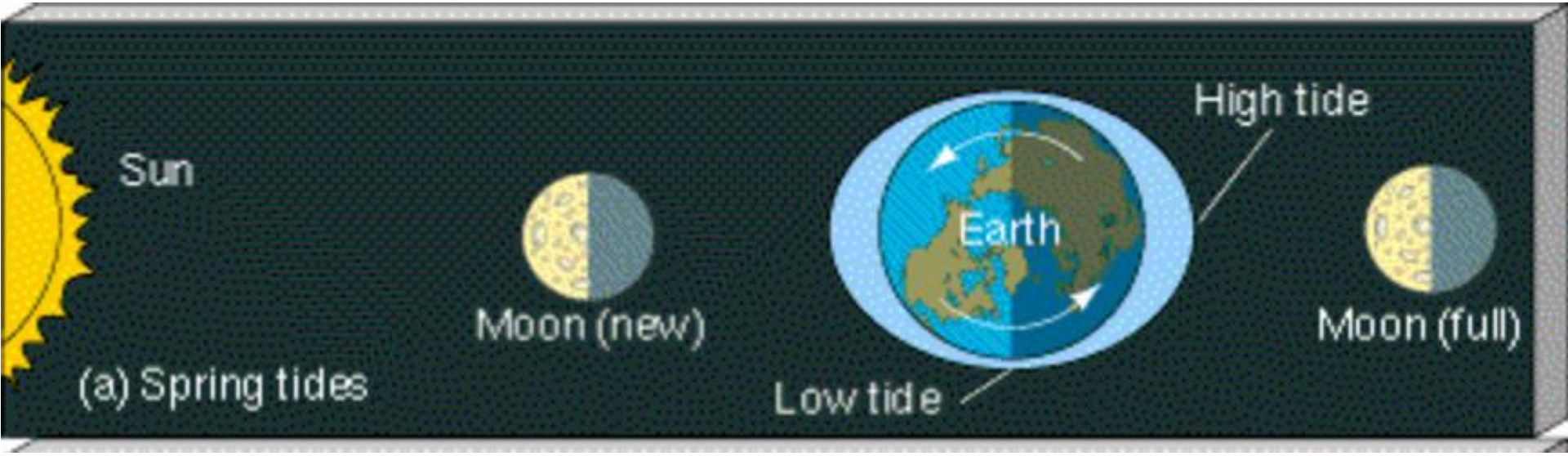
- Two big bulges of water form on the Earth:
  - one directly under the moon
  - another on the exact opposite side

- As the Earth spins, the bulges follow the moon.


Moon
Earth

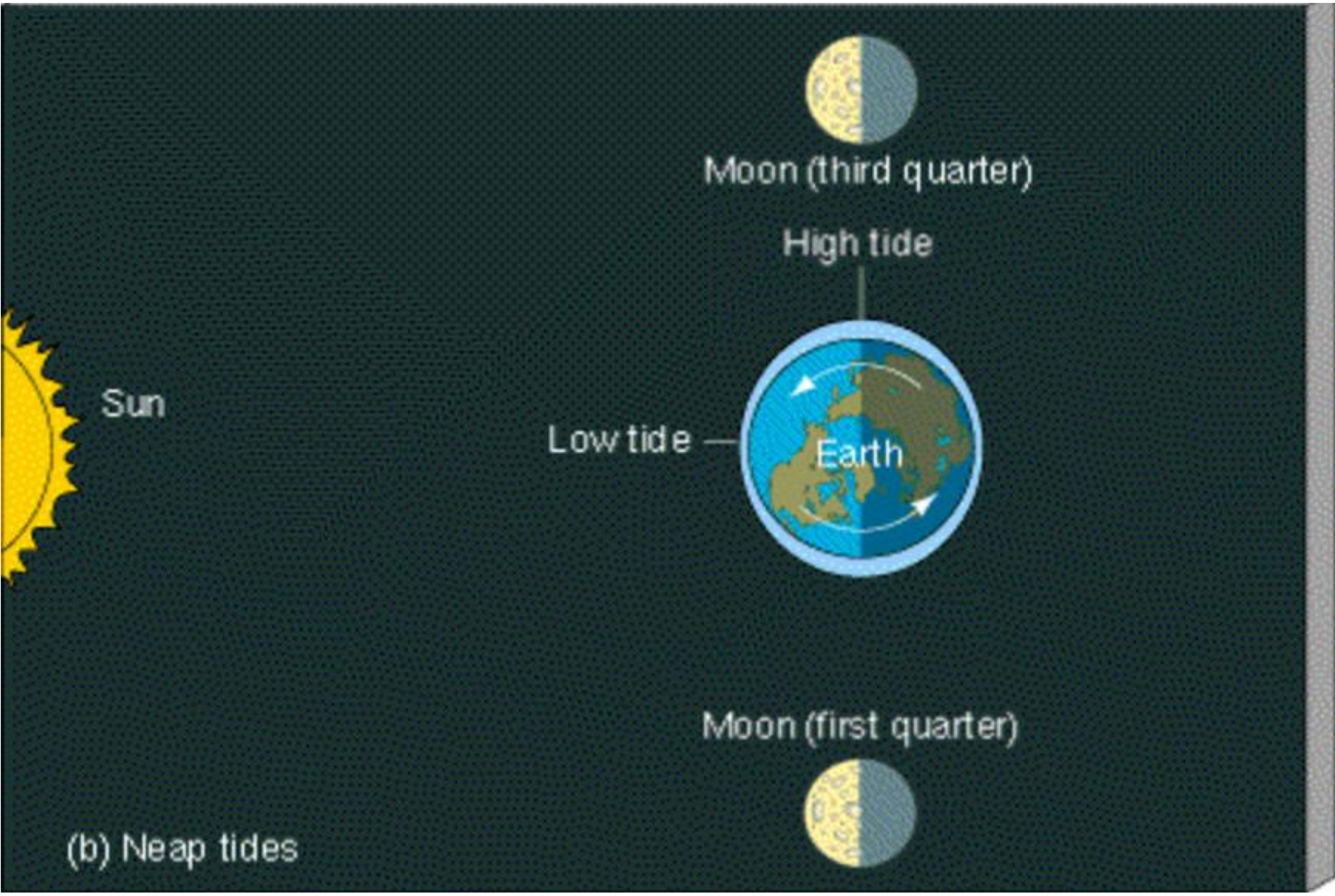
Gravitational Effect of the Sun

- Spring Tides
  - Earth, Moon, and Sun are lined up
  - High Tides are higher and Low Tides are lower than normal


Sun
Moon (new)
Earth
High tide
Moon (full)
Low tide
(a) Spring tides

Gravitational Effect of the Sun

- Neap Tides
  - Earth, Moon, and Sun form right angles
  - High Tides are lower and Low Tides are higher than normal


Moon (third quarter)
High tide
Sun
Low tide
Earth
Moon (first quarter)
(b) Neap tides