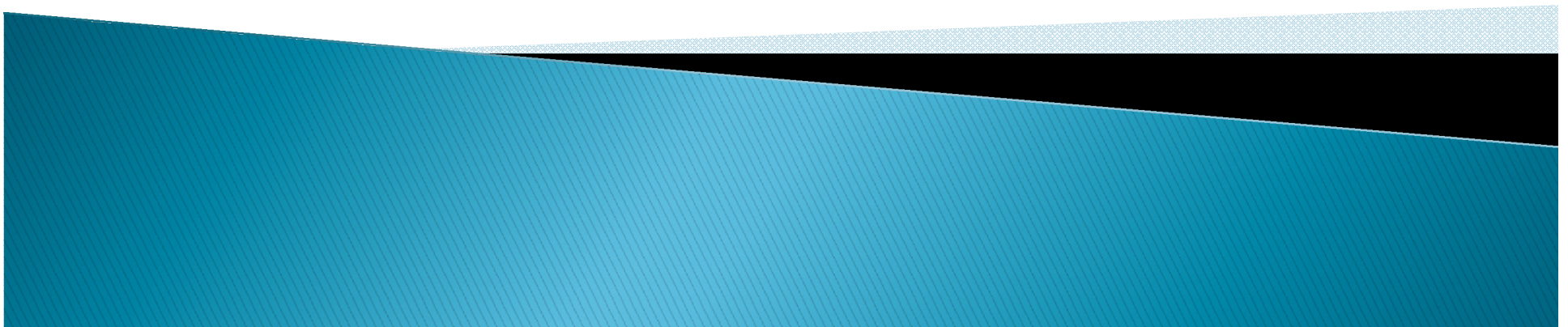
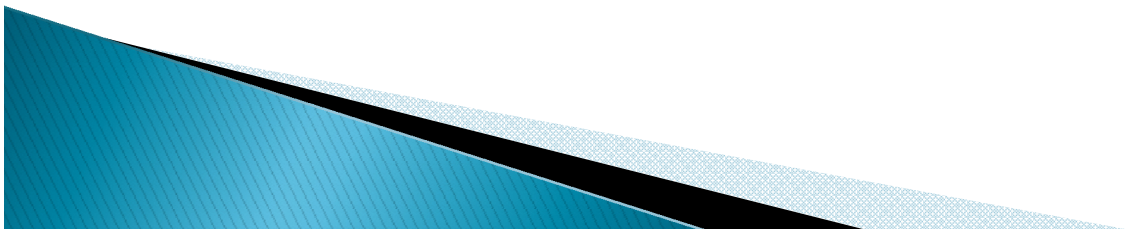


# Ocean Thermal Energy Conversion (OTEC)



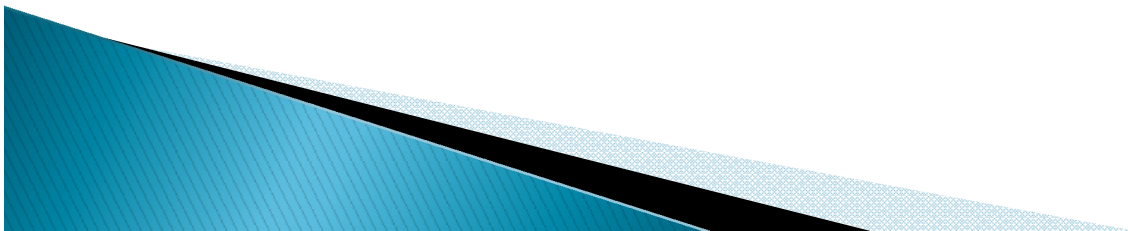
# Introduction

- ▶ Oceans cover more than 70% of Earth's surface, making them the world's largest solar collectors.
- ▶ OTEC is a renewable energy technology that converts solar radiation into electric power by use of world oceans.
- ▶ OTEC Process uses temperature difference between cold deep water (5 °C) & warm surface water (27 °C) to power a turbine to generate electricity.



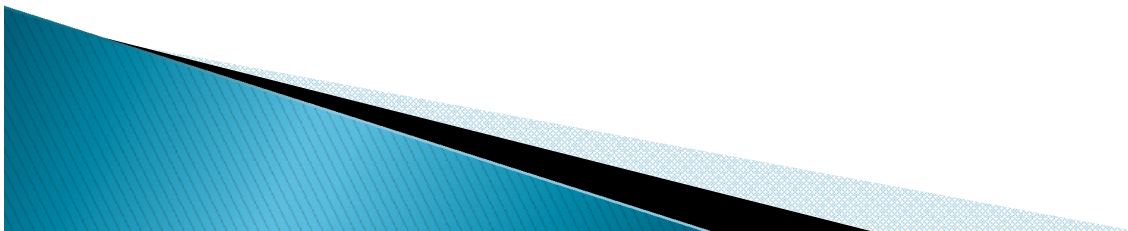
# OTEC Working Principle

- ▶ This plant works on the principle of a closed Rankine Cycle.
- ▶ Warm Water is used to evaporate working fluid like Ammonia or halocarbon Refrigerant.
- ▶ Evaporated Fluid expands in a low pressure turbine, which is coupled with a turbo alternator to produce electricity.



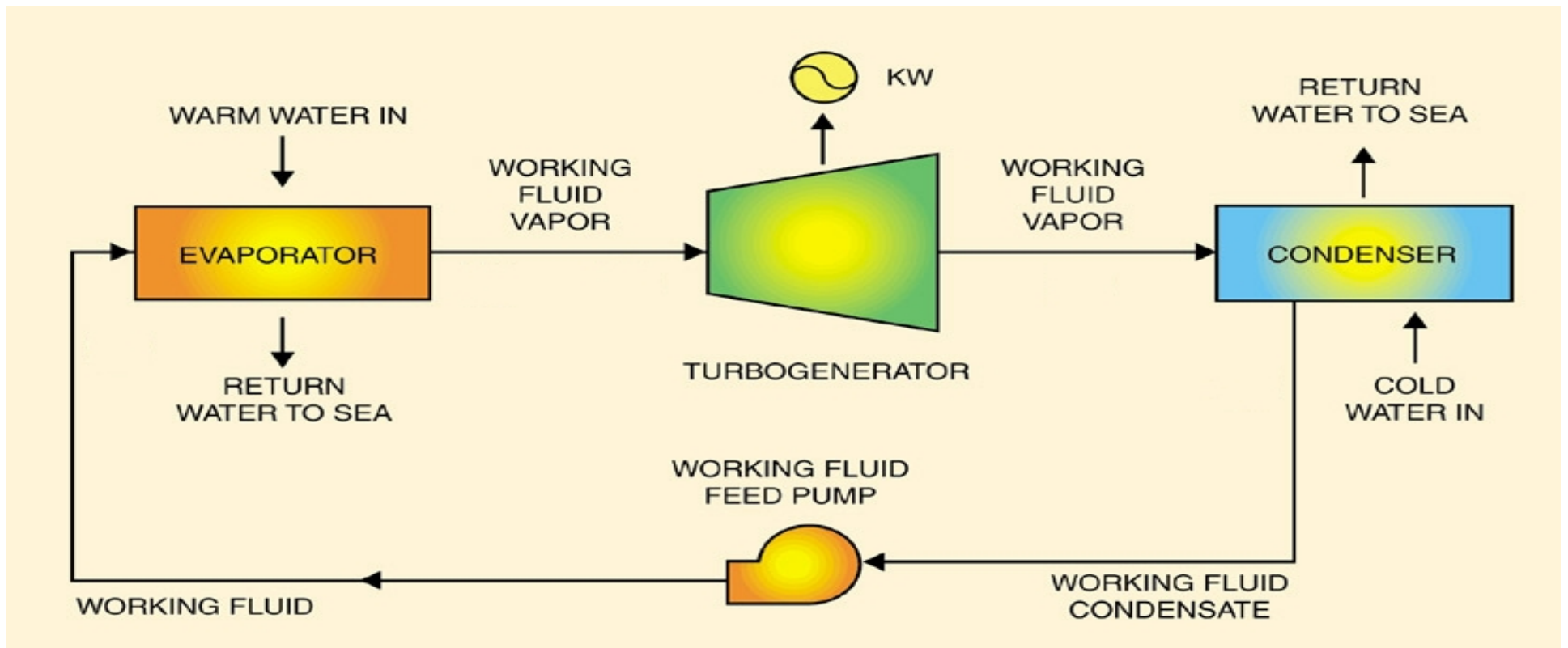
# OTEC Systems

- ▶ There are three types of electricity conversion systems:
  - I. The Closed or Anderson, OTEC Cycle Power Plant
  - II. The Open or Claude OTEC Cycle Power Plant
  - III. Hybrid Cycle OTEC Power Plant.



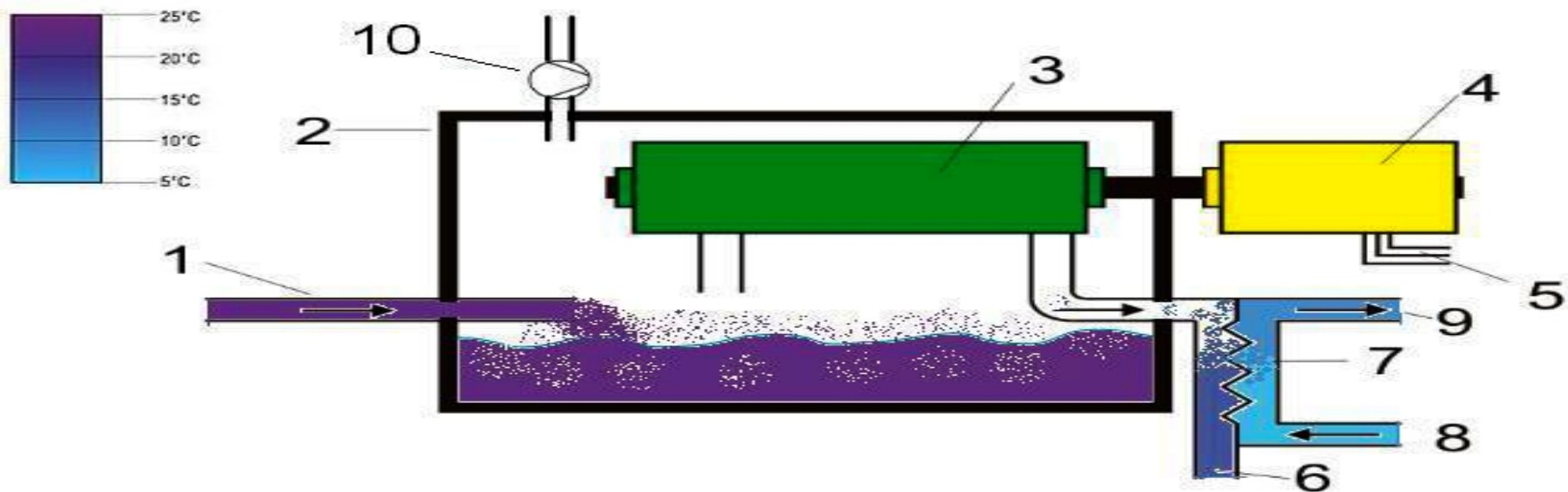
# Closed-loop OTEC

- Closed cycle system use fluid with a low boiling point, such as ammonia to power a turbine to generate electricity.



# Open-loop OTEC cycle

- Georges Claude Constructed first OTEC plant in 1929 in Cuba.
- The Claude Plant used an open cycle in which seawater itself plays the multiple role of heat source, working fluid, coolant, & heat sink.

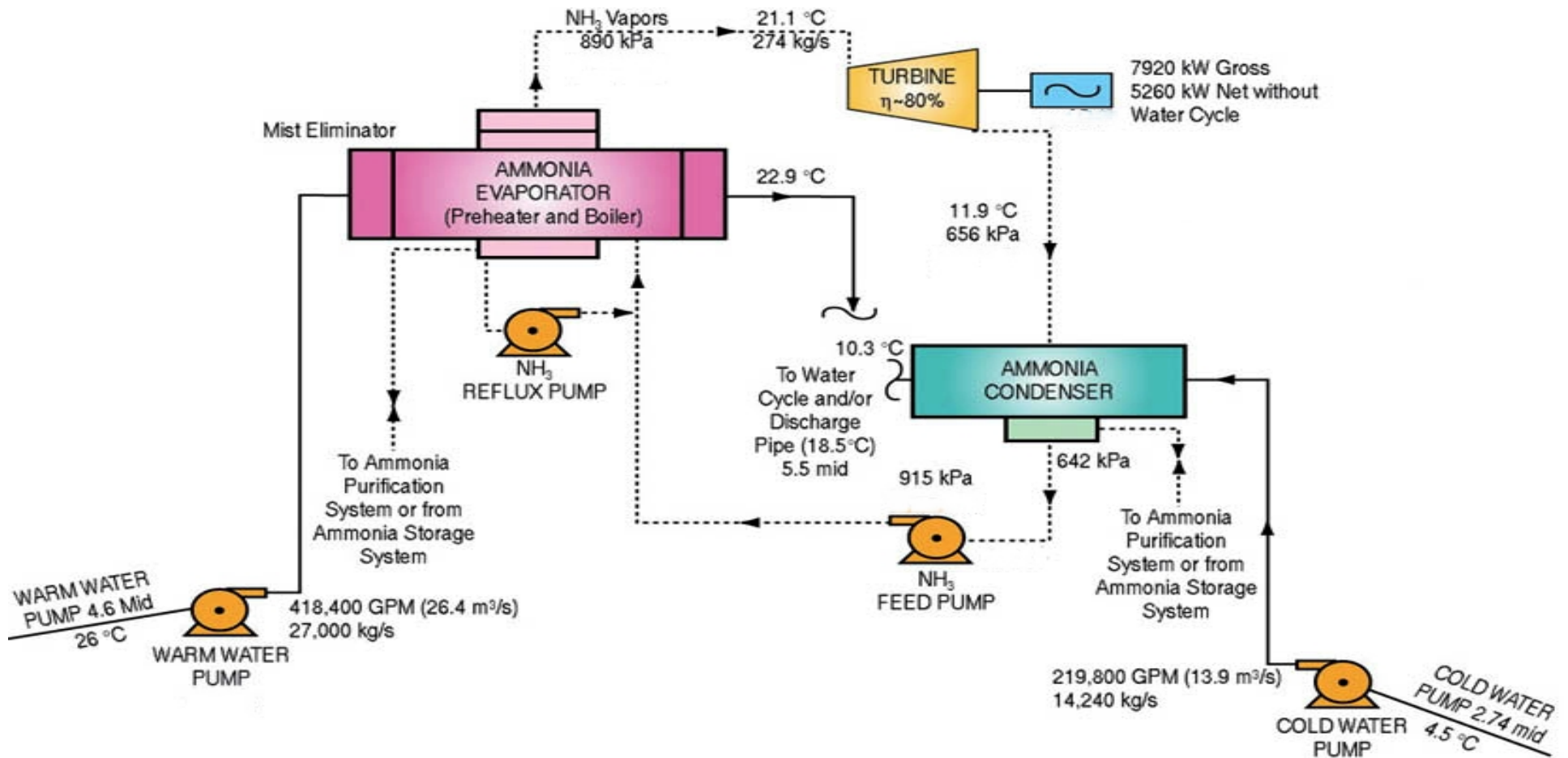


1 Surface water ~ 25°C  
2 Vacuum chamber, 3 % to 1 %  
of atmospheric pressure  
3 Turbine  
4 Generator  
5 Line to the grid

6 Desalinated water ~ 23°C  
7 Condenser  
8 Deep water ~ 5°C  
9 Waste water ~ 7°C  
10 Vacuum pump

# Hybrid OTEC cycle

- A Hybrid cycle combines the features of both the closed & Open Cycle System.





# An OTEC system application

- ▶ **Hydrogen** can be produced via electrolysis using electricity generated by the OTEC process.

- ▶ **Desalination**

It's produced in open & Hybrid cycle.

System analysis indicates that a 2 MW plant can produce 4300 cubic meter desalination water each day.





# An OTEC system application

- **Aquaculture**

It reduces the financial & energy costs of pumping large volumes of water from deep ocean.

Deep ocean water contains high concentration of essential nutrients that are depleted in surface water due to biological consumption.

- **Mineral Extraction**

The ocean contains 57 trace elements in salt dissolved in solution.

The Japanese investigated the possibility of extracting Uranium.



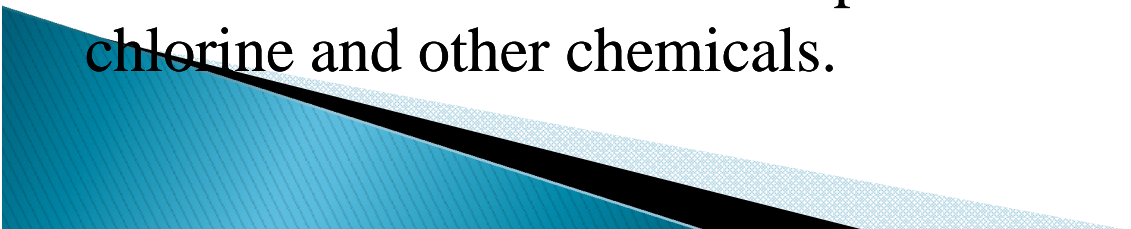
# Advantages of OTEC

Warm surface sea water and cold water from the ocean from the ocean depths replace fossil fuels to produce electricity.

OTEC plants will produce little or no carbon dioxide or other polluting chemicals.

OTEC systems can produce fresh water as well as electricity. A lot of fish & other nutritious sea-food will be collected in outlet flow.

OTEC can also be used to produce ammonia, hydrogen, aluminium, chlorine and other chemicals.

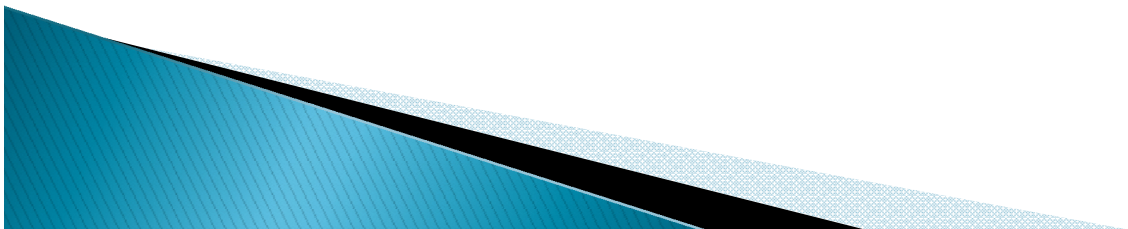


# Disadvantages of OTEC

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

No energy company put money in this project because it only had been tested in a very small scale.

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



## Current operating Plants of OTEC

- In March 2013, Makai installed and operate a 100 kilowatt turbine on the OTEC Heat Exchanger Test Facility, and connect OTEC power to the grid.
  - Okinawa Prefecture announced the start of the OTEC operation testing at Kume Island on April 15, 2013. The plant consists of two units; one includes the 50 kW generator while the second unit is used for component testing and optimization.
  - In July 2014, DCNS group partnered with Akuo Energy announced their NEMO project. If successful, the 16MW gross 10MW net offshore plant will be the largest OTEC facility to date.
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