Ocean Thermal Energy: Conversion (OTEC)

Learning objectives:

1) To describe the principle behind OTEC operation
2) To indicate challenges with OTEC
3) To state the limitations of OTEC

Principle of OTEC:

- Temperature difference between warm water at the surface and colder water approximately 1km below the surface is used to run a heat engine and energy is extracted from the same

- Temperature difference can be of the order of 15 ^{o}C to 25 ^{o}C

Thermal profile of sea water

First 20 m absorbs sunlight. Surface freezing at poles to 36 ^{o}C in the Persian Gulf

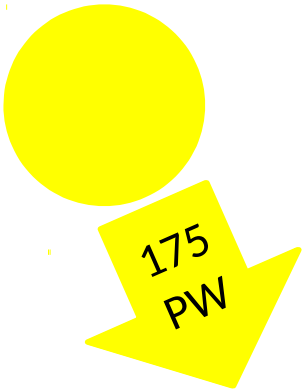
Water turbulent and mixed for a few hundred meters

Boundary of a few hundred meters between mixed layer and undisturbed water below. Called Thermocline

90% of sea water below thermocline, temperature around 3 ^{o}C

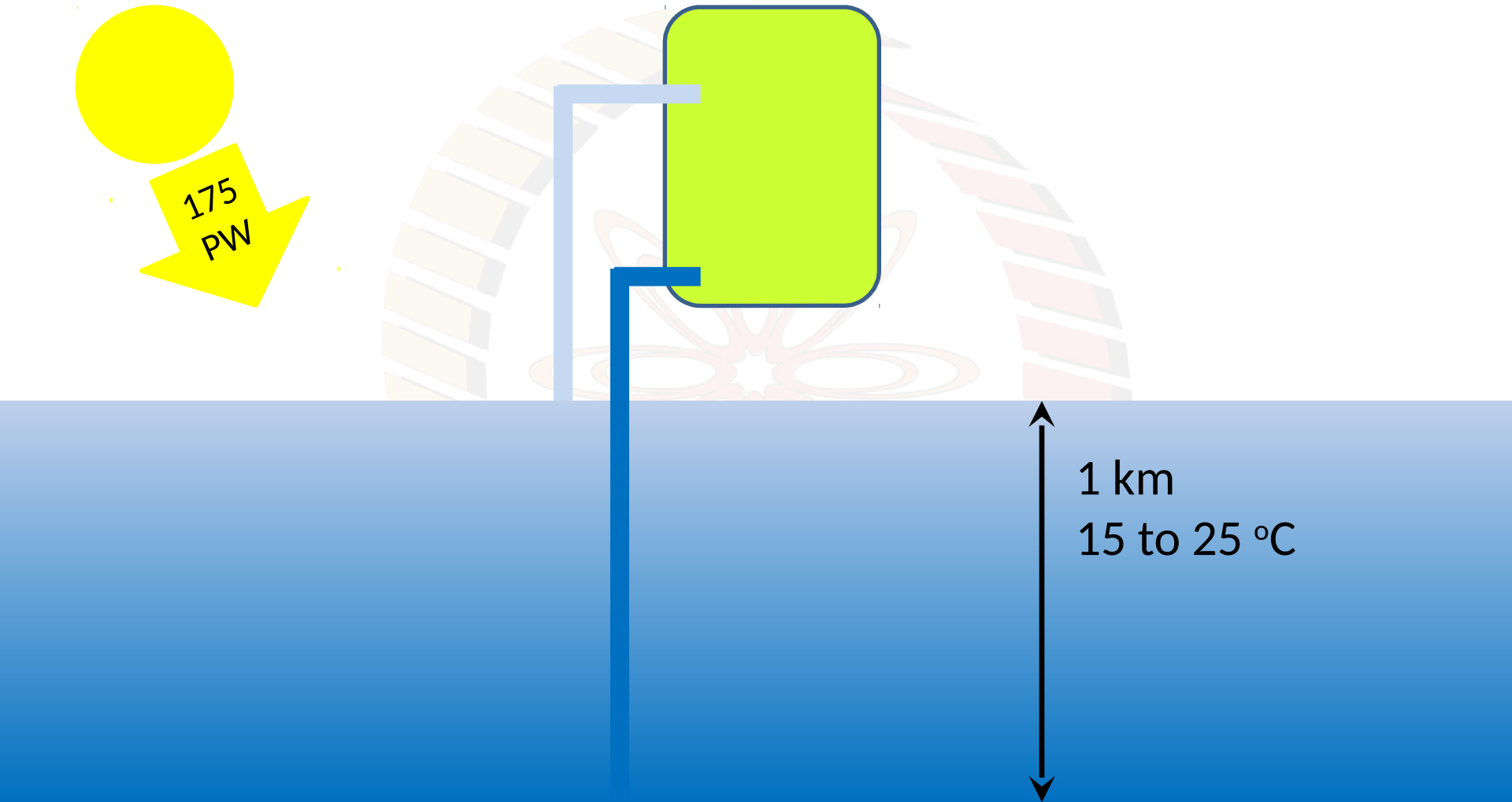
Challenges working under sea:

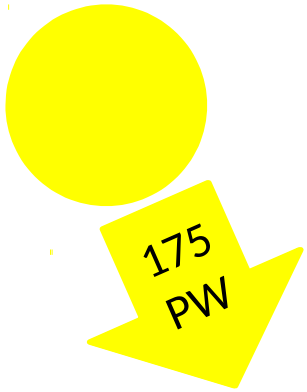
1) Marina Trench, 11 km deep, visited by 3 people
2) Moon, nearly 384,400 km, visited by 12 people



1 km

15 to 25 °C

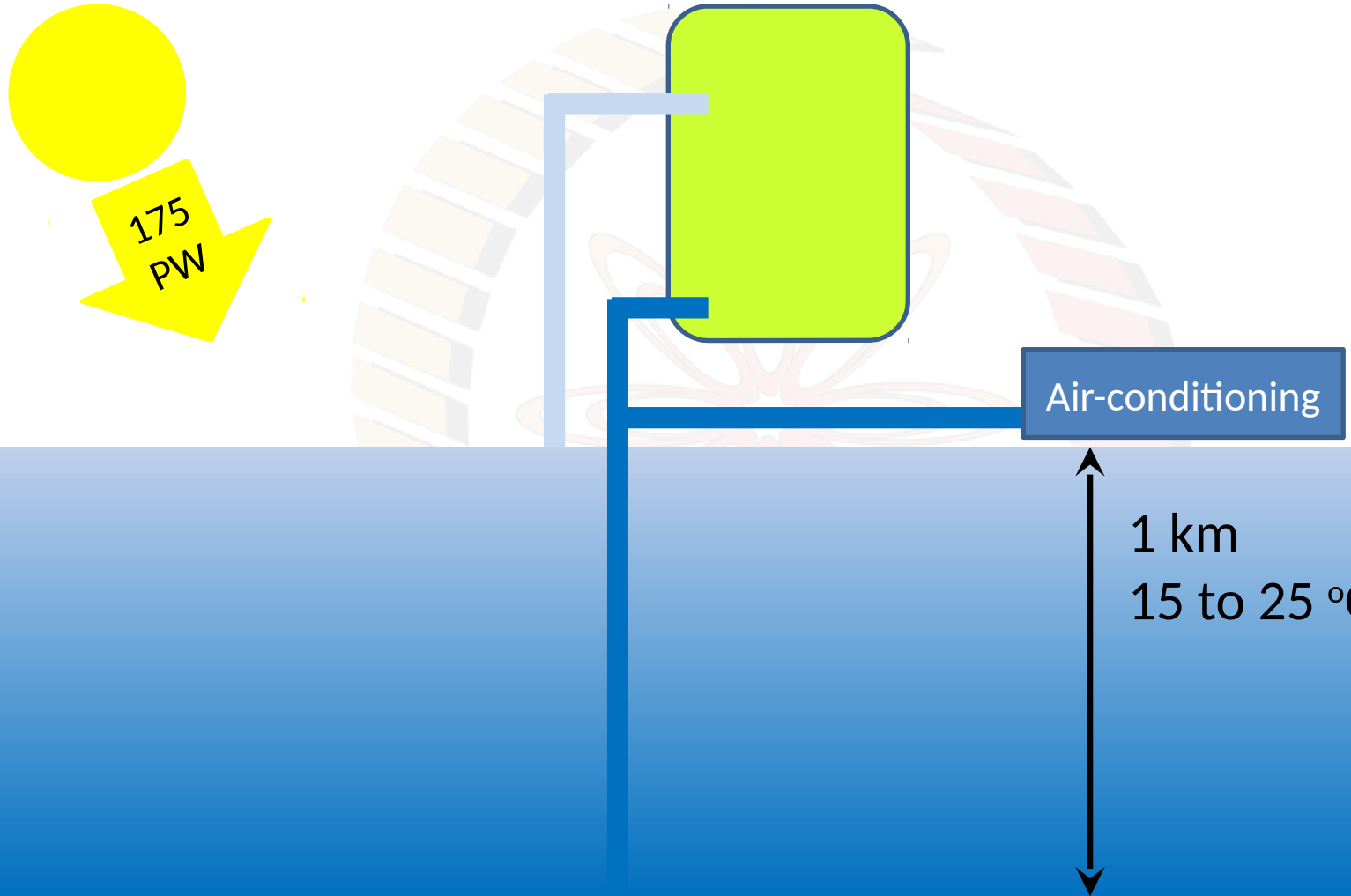

175
PW
1 km
15 to 25 °C

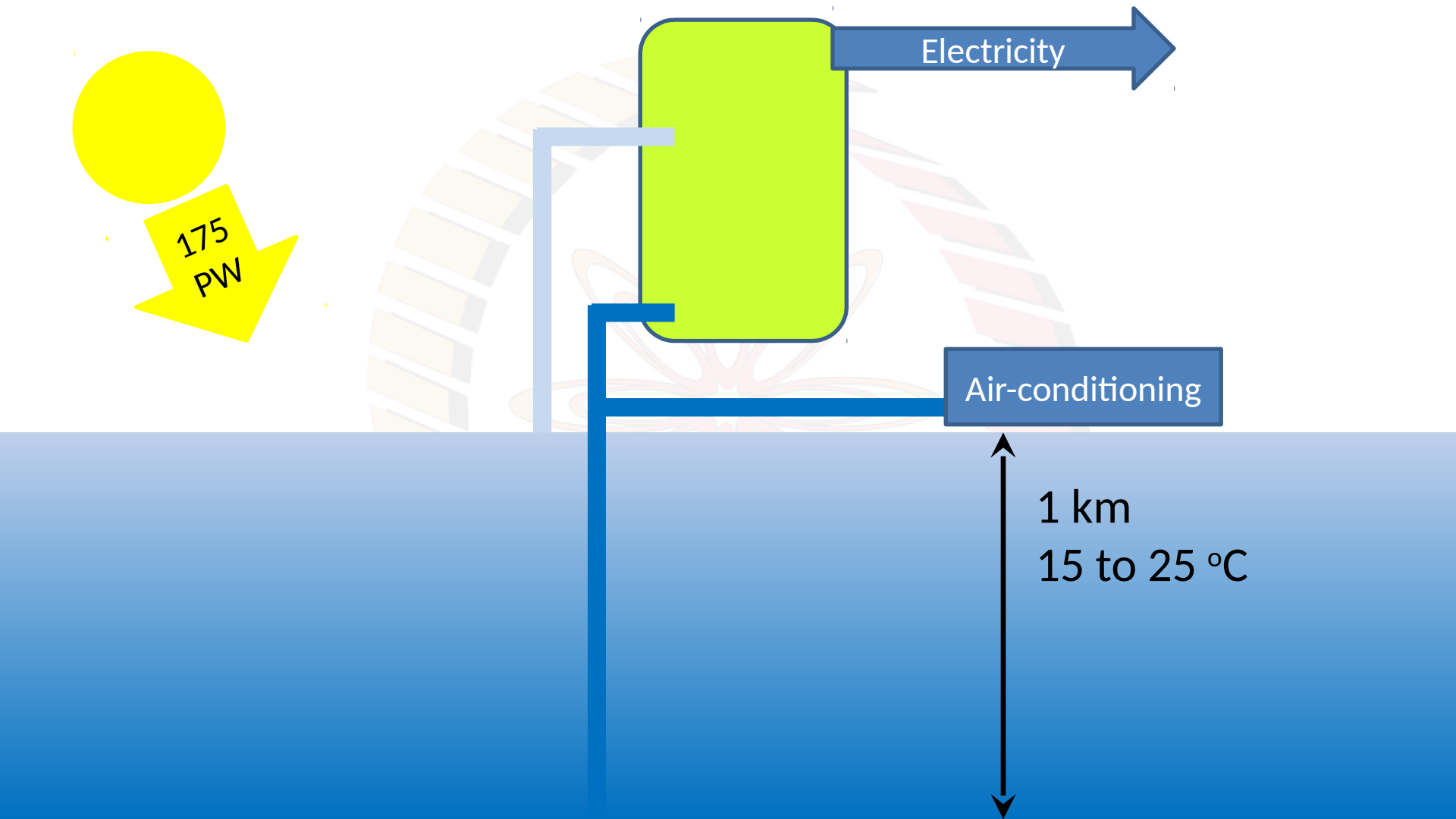


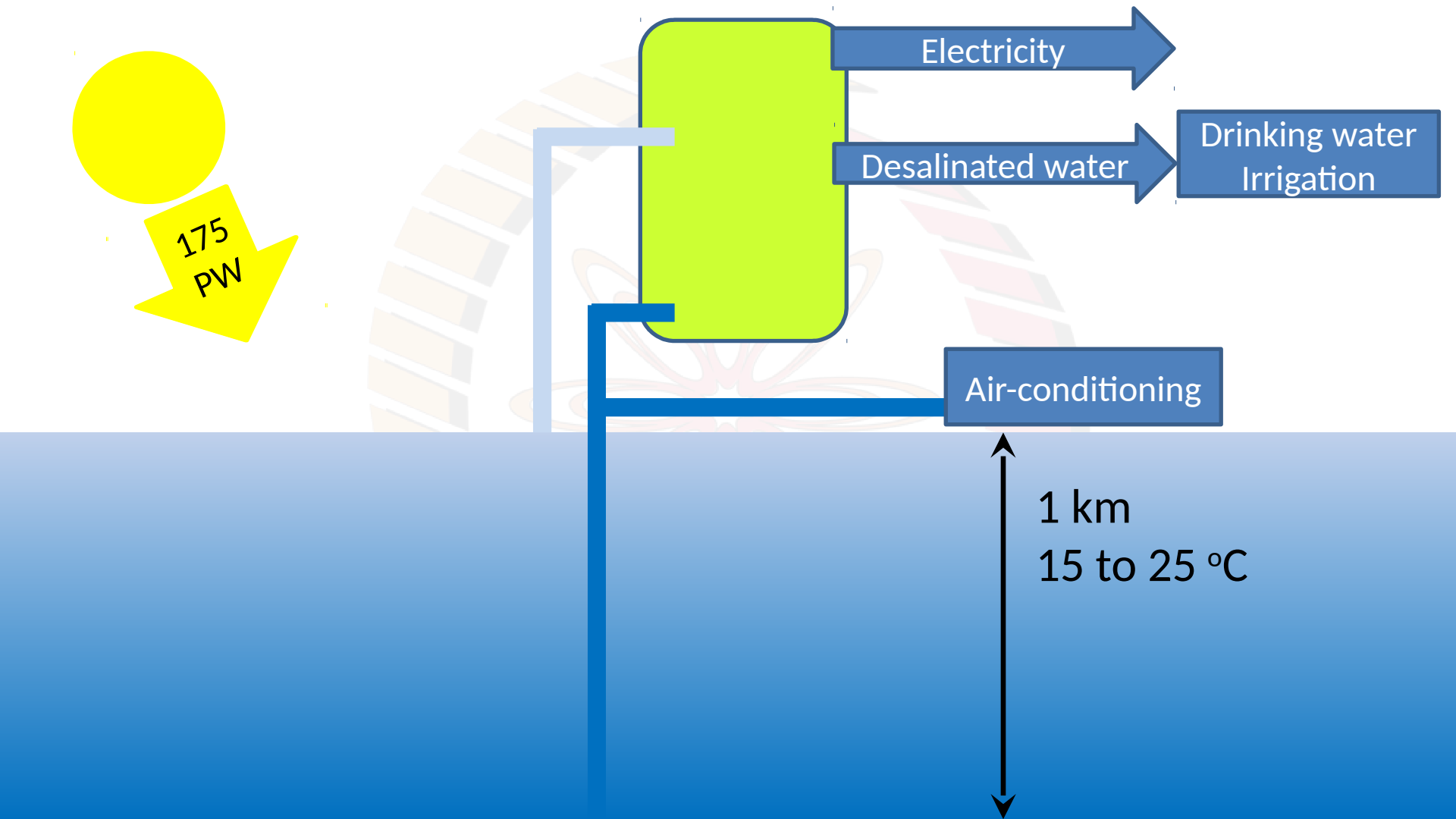
$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{273 + 5}{273 + 25}$$

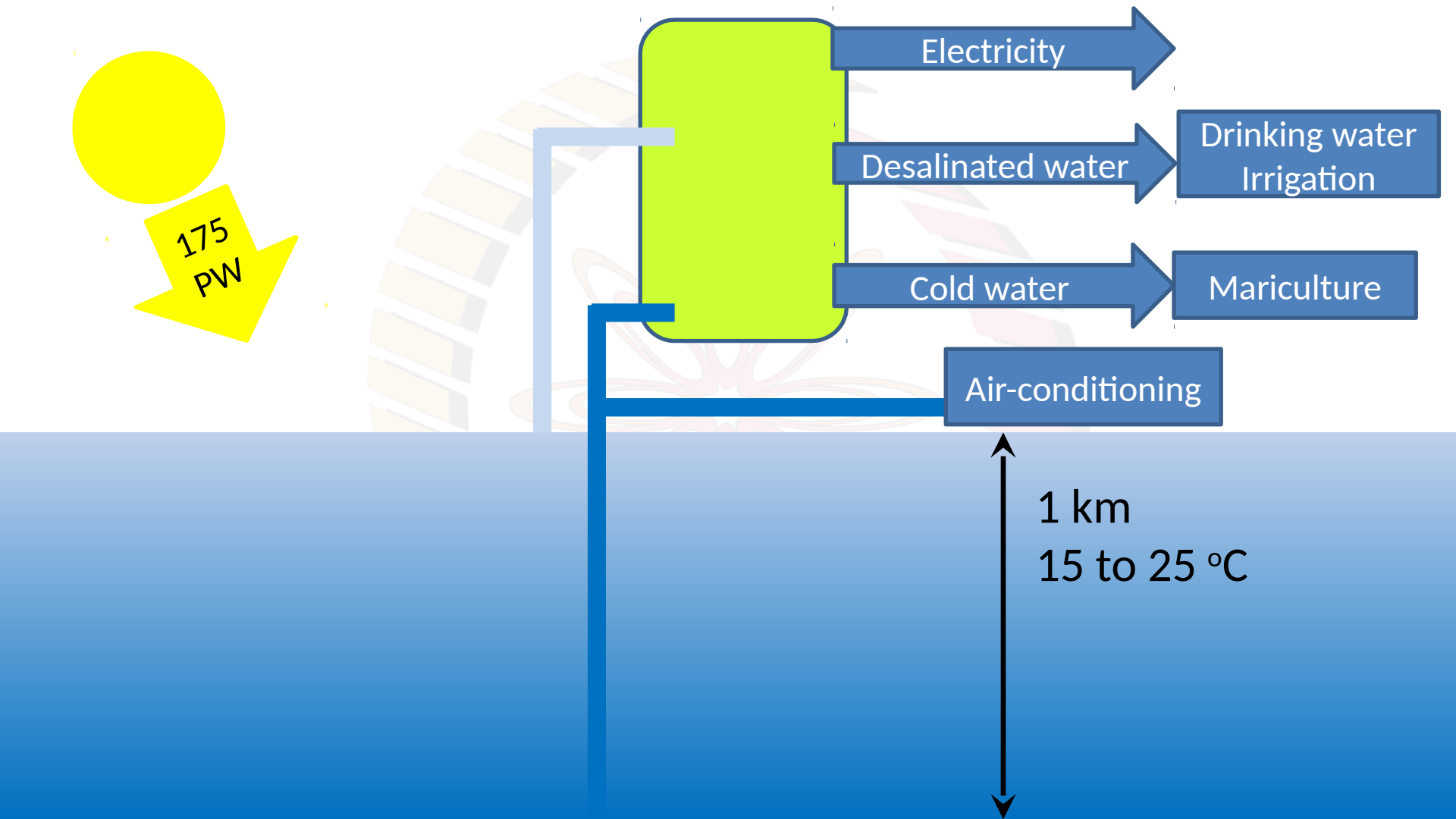
$$\eta = 6.7\%$$

1 km
15 to 25 °C


175
PW
Air-conditioning
1 km
15 to 25 °C


175
PW
Electricity
Air-conditioning
1 km
15 to 25 °C


175
PW
Electricity
Desalinated water
Drinking water
Irrigation
Air-conditioning
1 km
15 to 25 °C


175
PW
Electricity
Desalinated water
Drinking water
Irrigation
Cold water
Mariculture
Air-conditioning
1 km
15 to 25 °C

Open Cycle: Warm sea water evaporates at low pressure, runs turbine, condensed by cold sea water. Desalinated water becomes available

Closed cycle: Low boiling point liquid, ammonia, -33^{o}C. Warm water makes it evaporate and run turbine, cold water condenses it afterwards

Conclusions:

1) OTEC is available to tap in almost all coastal regions
2) Can be setup off-shore as well
3) Efficiencies are low
4) Stability of structures in the presence of water currents is a factor to address