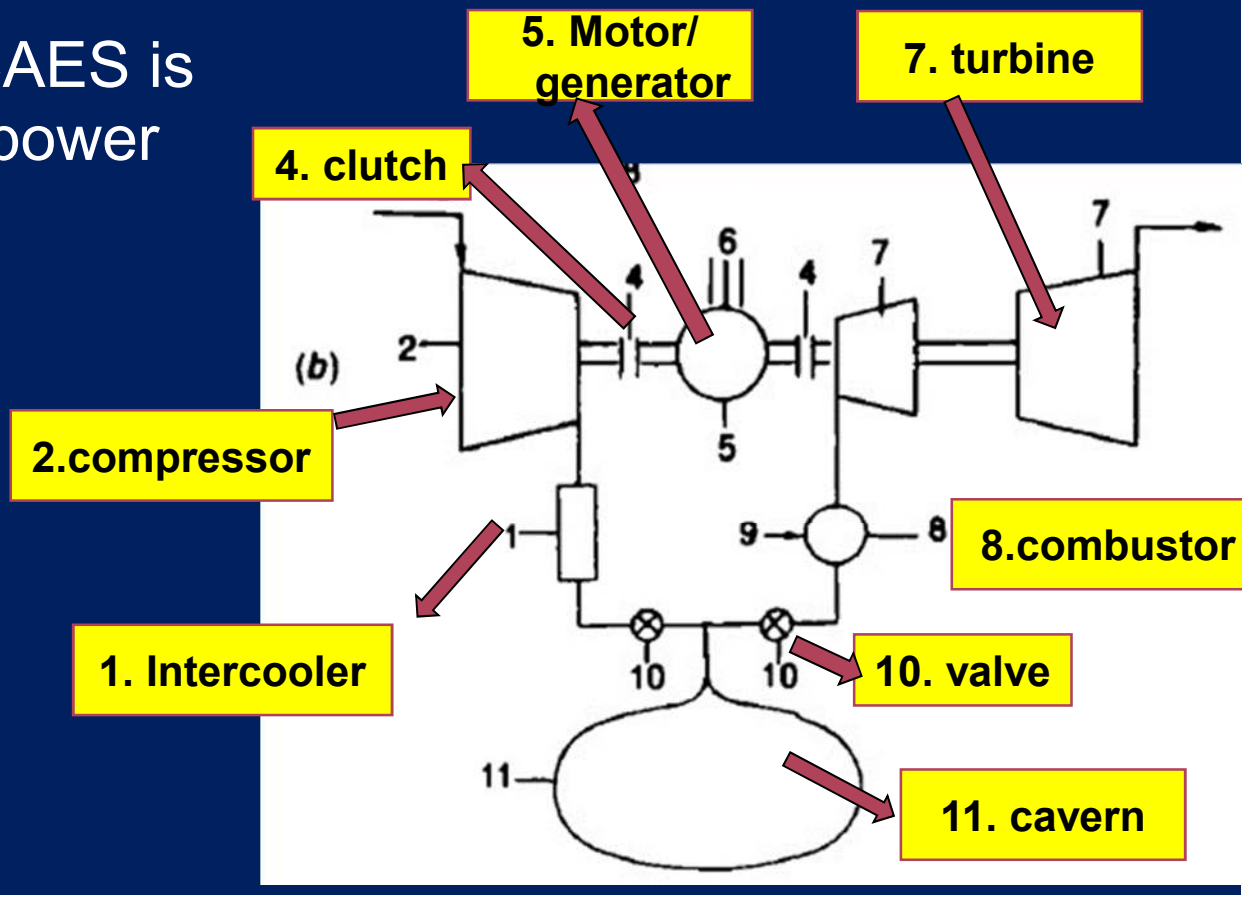
Compressed Air Energy Storage (CAES)

1. Technology

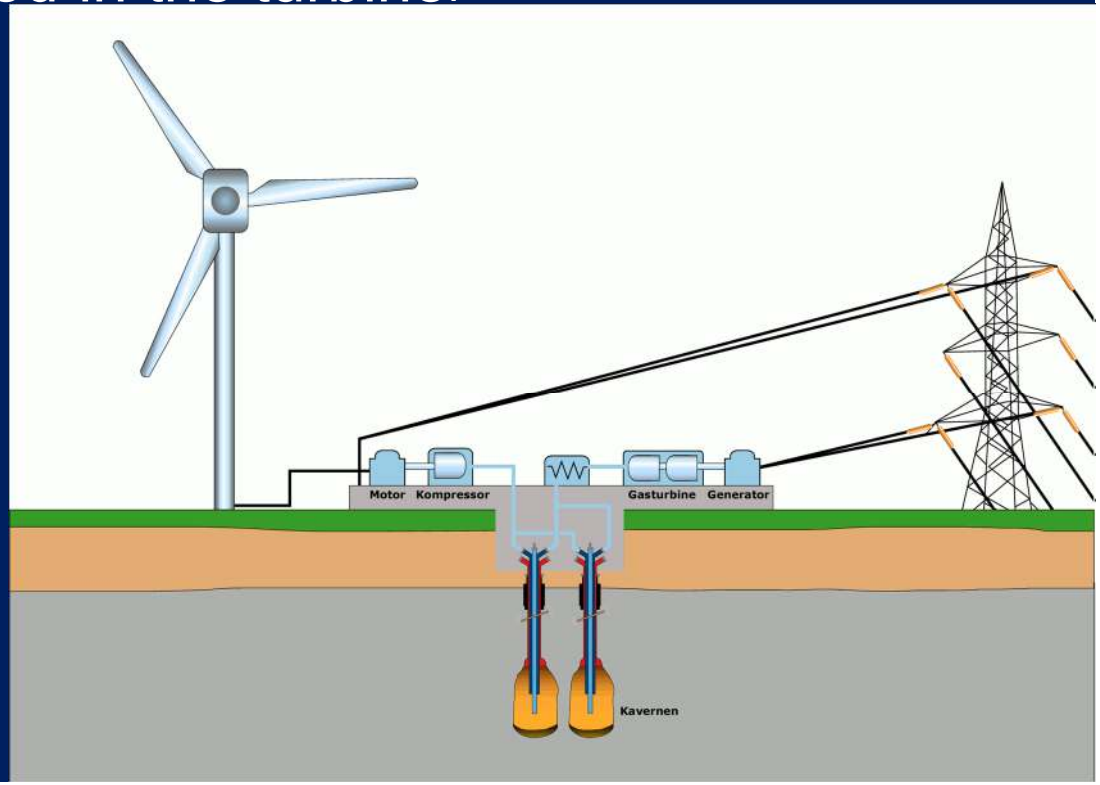
1.1. Basic Principle

- The components of CAES is similar to gas turbine power plant.

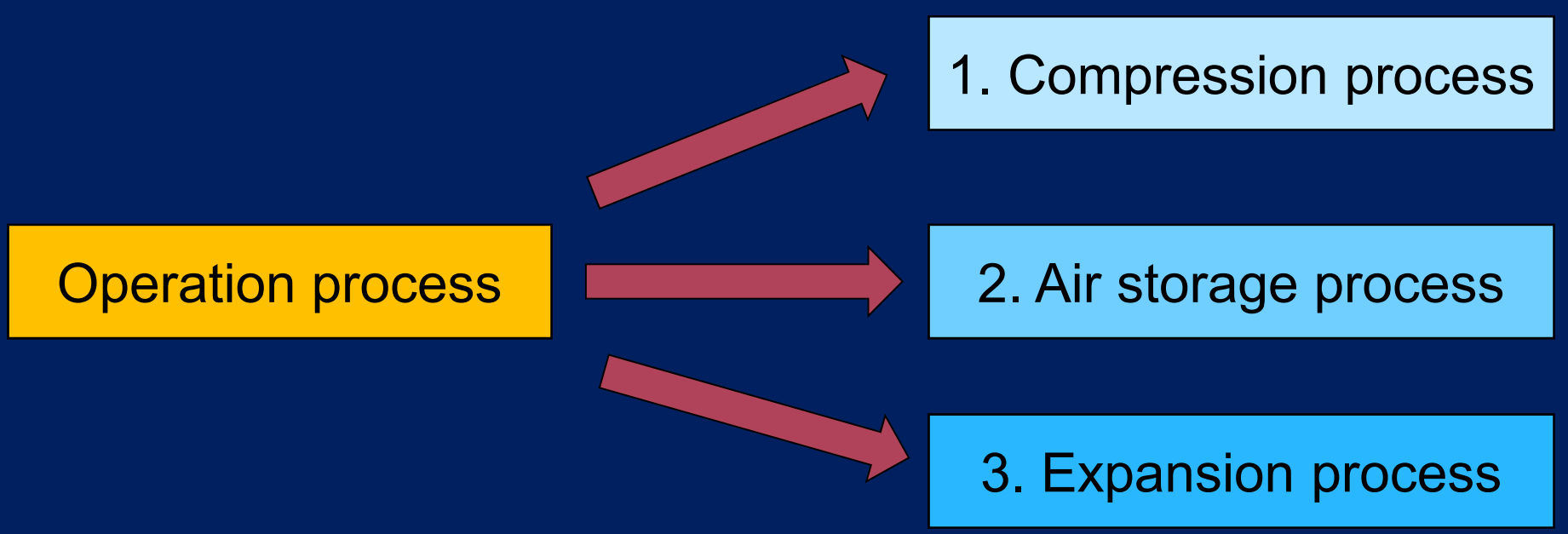


1. Technology

- CAES process works by pumping air into a vessel or cavern when off peak demand or low-cost electricity is available.
- When energy is needed, the pressurized air is released from the cavern and expanded in the turbine.



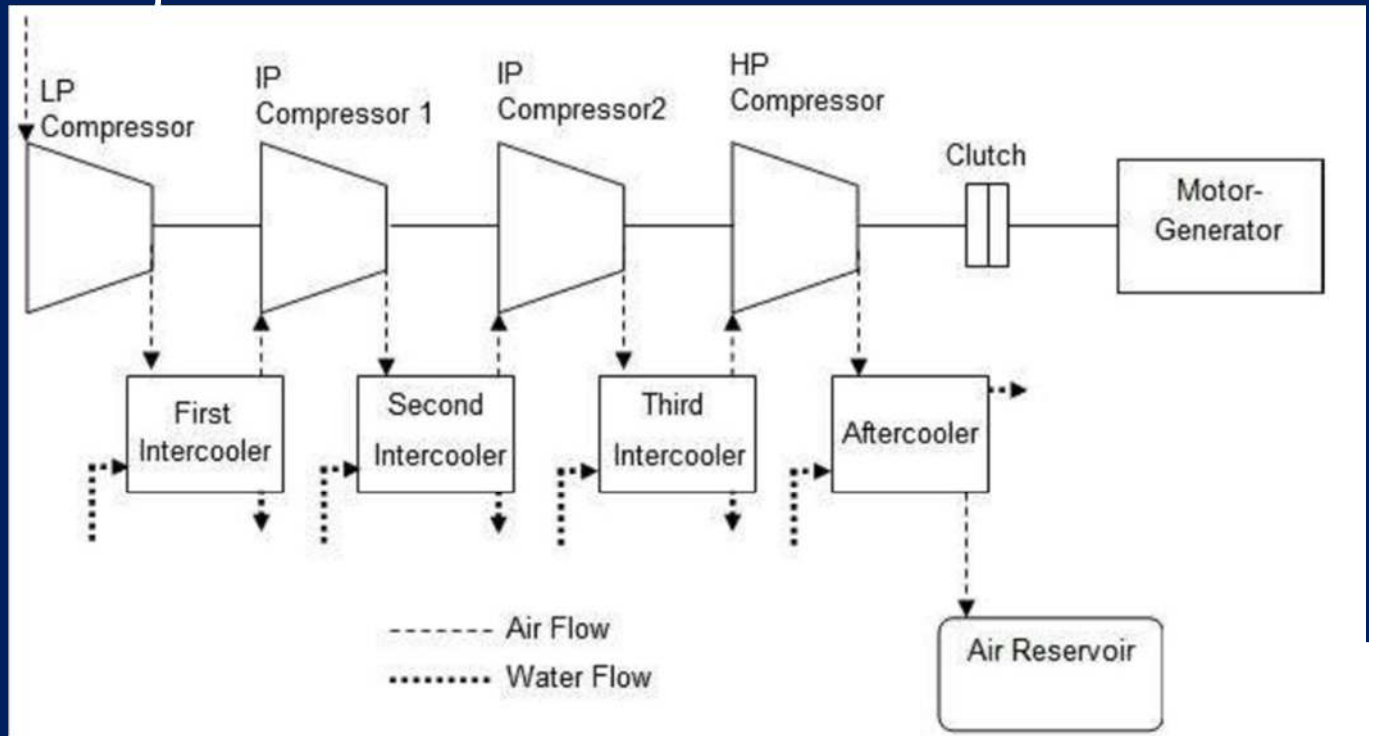
1.1. Operation process



1.1. Operation process

1.1.1. Compression process

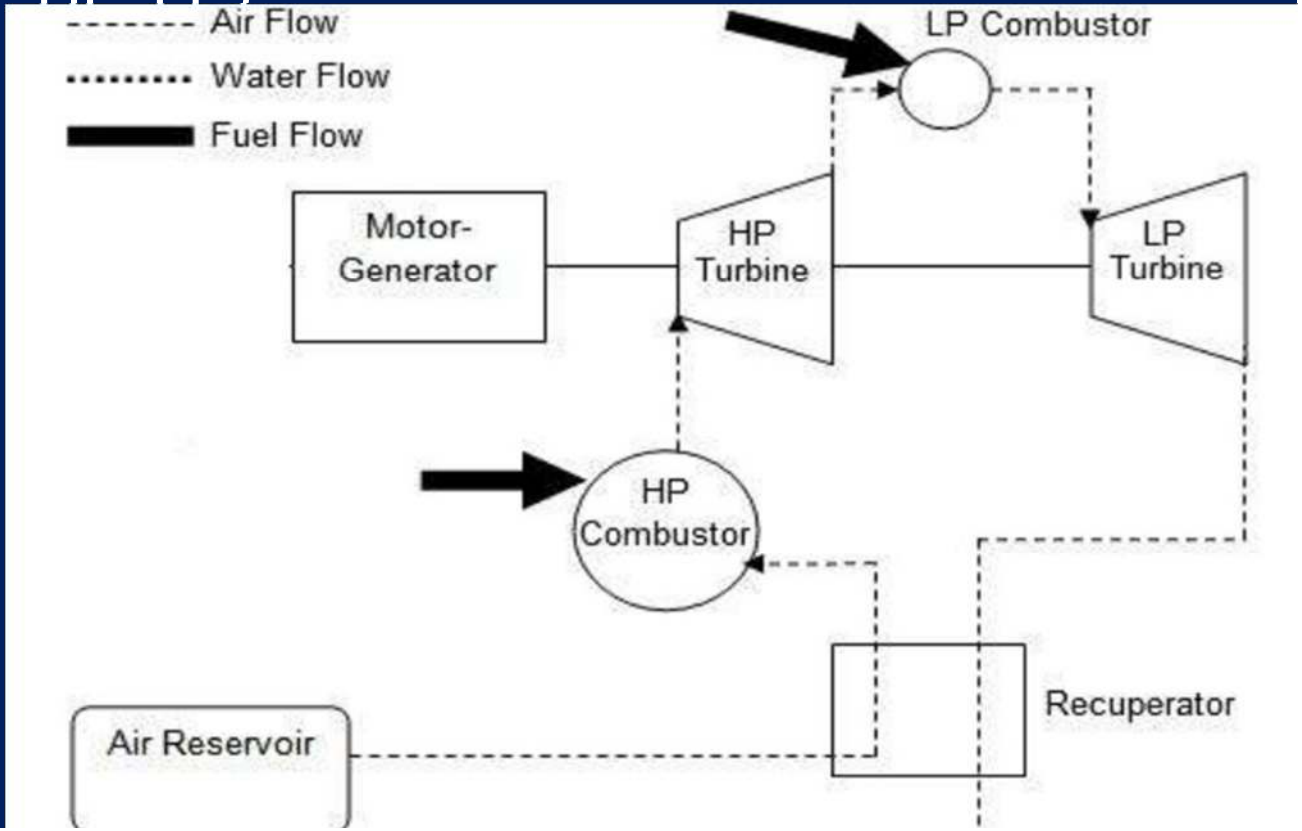
- Electricity is used to run a chain of compressors that inject air into the reservoir.
- Compression chain use of intercoolers for reducing the temperature of the injected air.



1.1. Operation process

1.1.2. Expansion process

- The air is released from the cavern and then is combusted with fuel in combustion chamber for rotating the turbine(normally two stage HP, LP)



1.1. Operation process

1.1.3. Air Storage

- CAES can use both above and underground storage, but above never use because of high capital cost.
- Underground CAES can utilize a variety of geological formations :

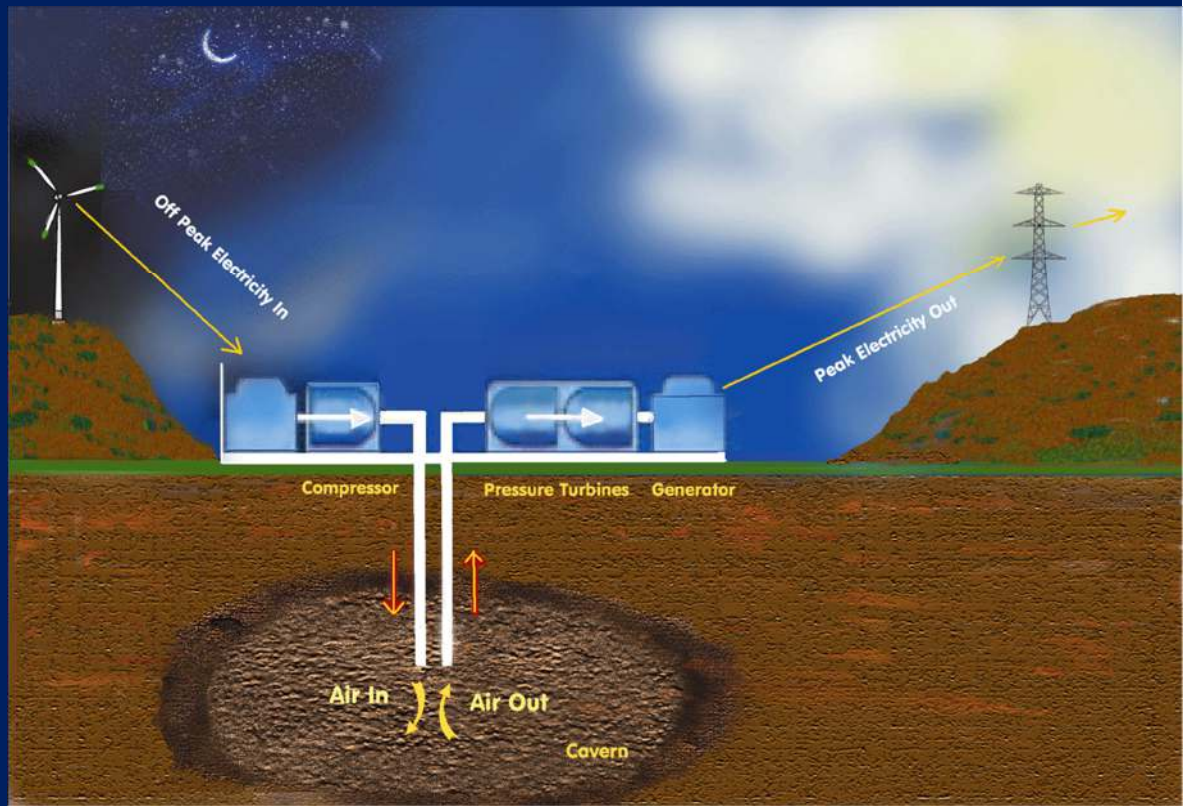
1.Salt cavern

2.Depleted Natural

Gas Caverns

1.Hard Rock

2.Porous Rock



1.1.3. Air Storage

1.1.3.1. Above the ground

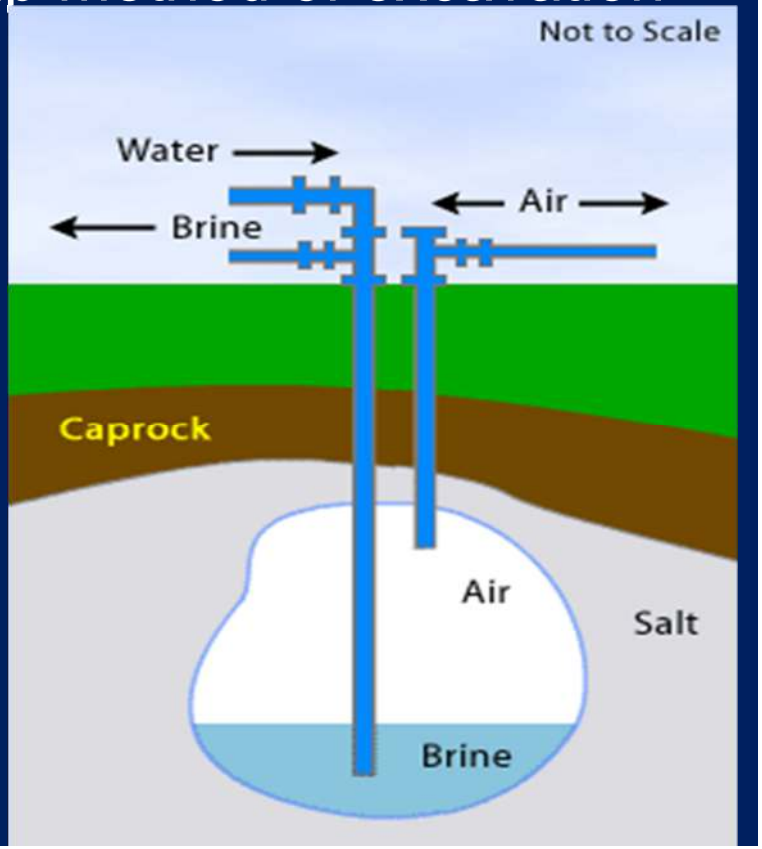
- Compressed air can be stored in above-ground or near-surface pressurized air pipelines.
- Above ground air storage plants can only store about 2 to 4 hours.
- It requires the use of more expensive stainless steel tanks or pipes for storage.

1.1.3. Air Storage

1.1.3.2. Underground

i. Salt Cavern

- The technology of 'solution mining' of salt cavities can control shape well and provides a very cheap method of excavation for large storage volumes.
- CAES plant at Huntorf, Albama used salt cavern.



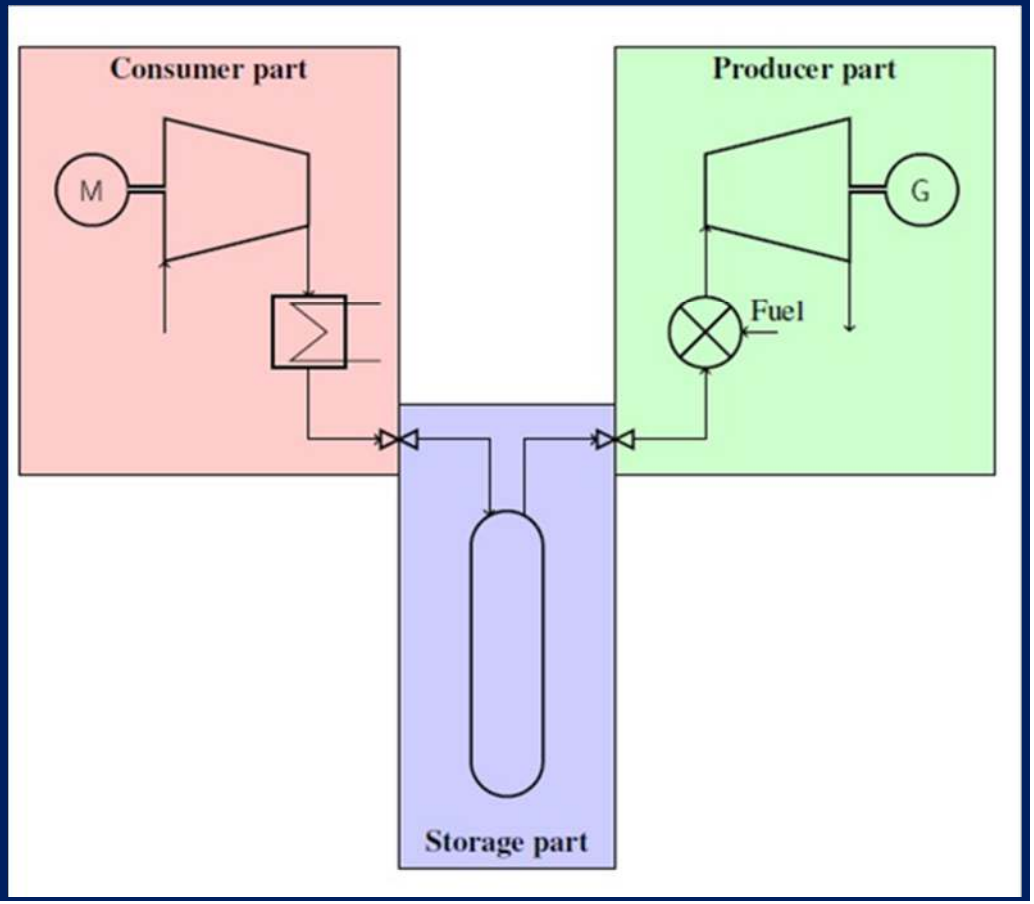
1.3. Type of CAES system

1.3.1. Diabatic system

- When the air is compressed, the heat is released into surrounding by multi-stages of intercooler before the air is compressed in salt cavern.

- When it discharges the air is reheated by natural gas and burn in combustion chamber in order to get high heated pressure air for rotating the turbine.

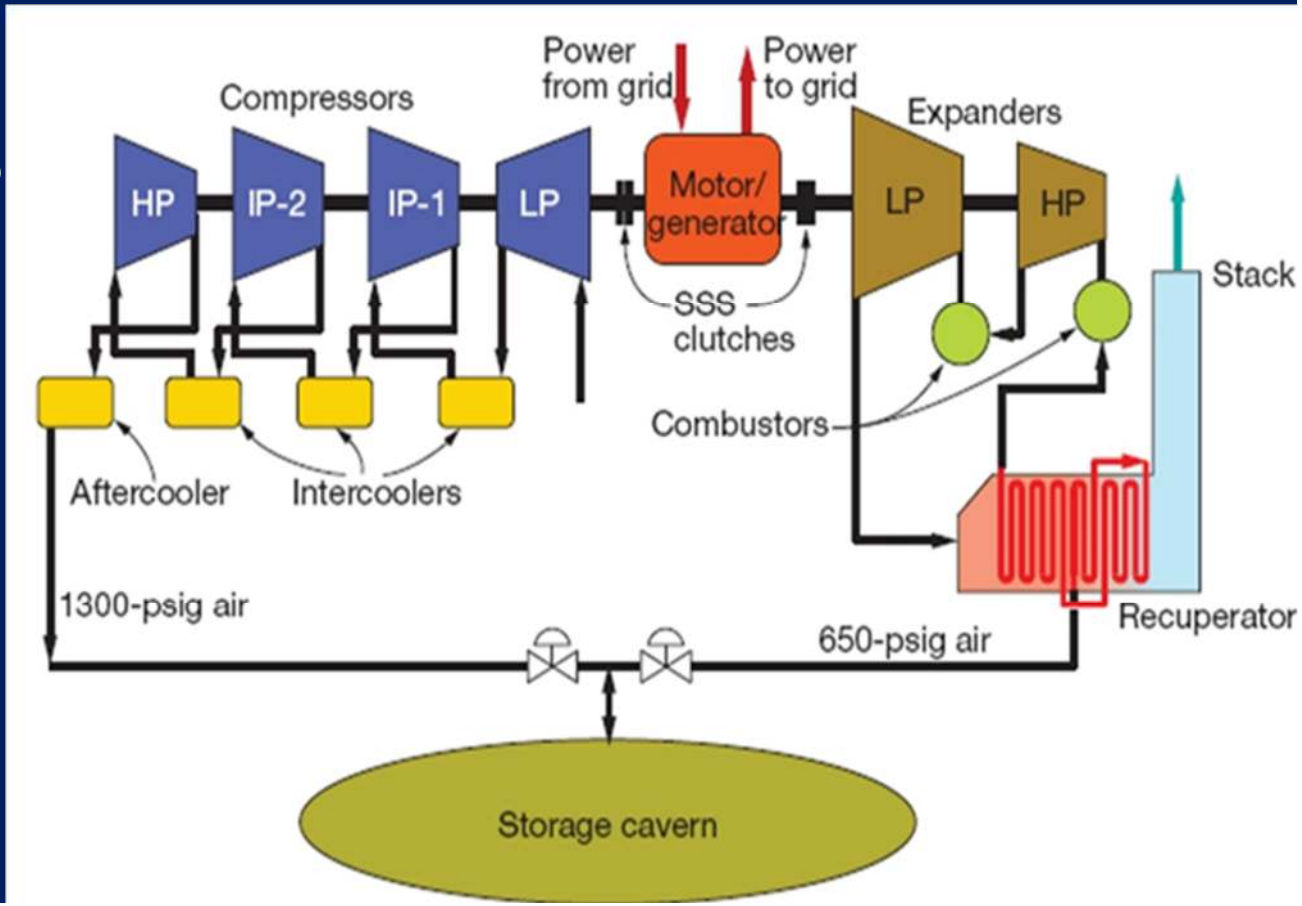
Ex. Huntorf CAES plant.



1.3. Type of CAES system

1.3.1. Diabatic system

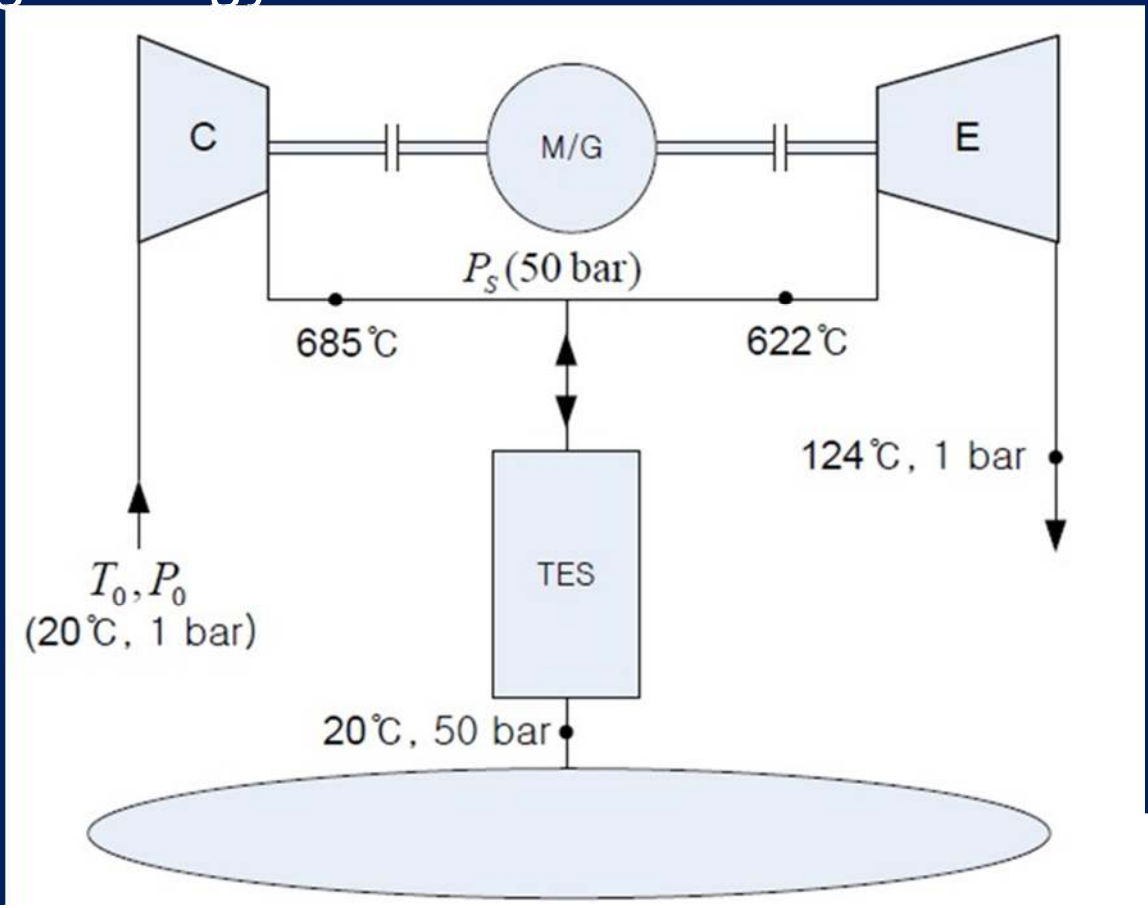
- "Recuperator" is used to recovery the waste heat from LP to heat the compressed air with fuel in combustion chamber.
- It reduce fuel Consumption by 25%
- Ex. McIntosh CAES Plant.



1.3. Type of CAES system

1.3.2. Adiabatic system

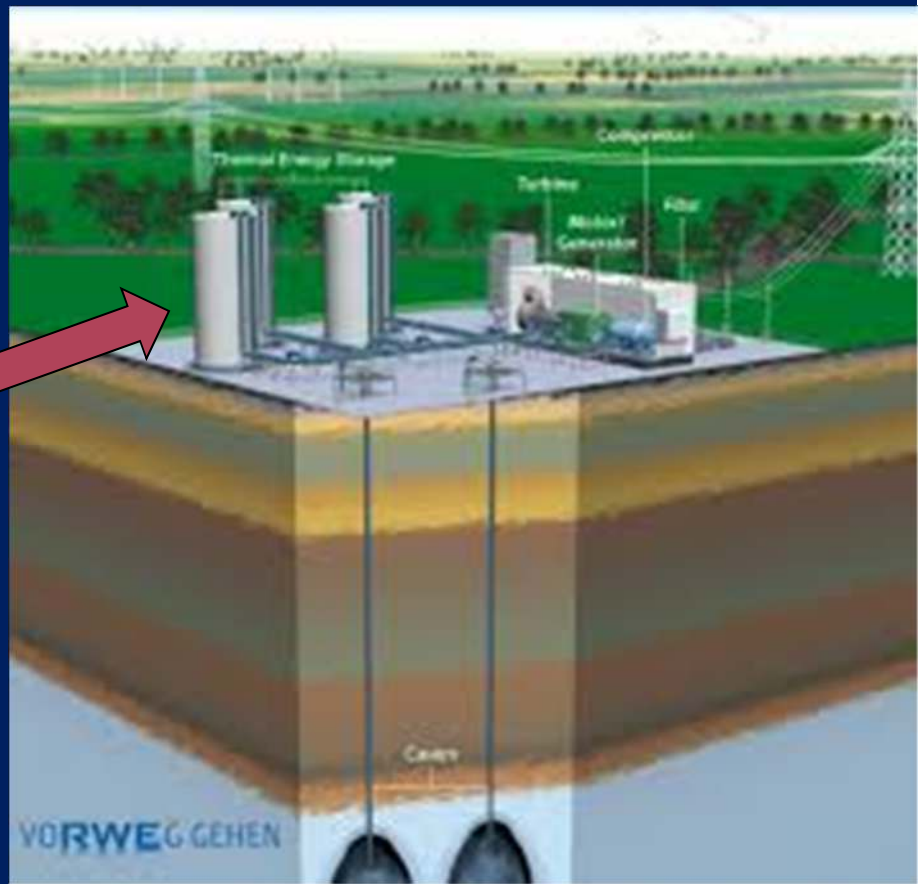
- Heat is not released into the surroundings when compressed
- up to 80% of the charge energy would be recovered without any additional fuel.



1.3. Type of CAES system

1.3.2. Adiabatic system

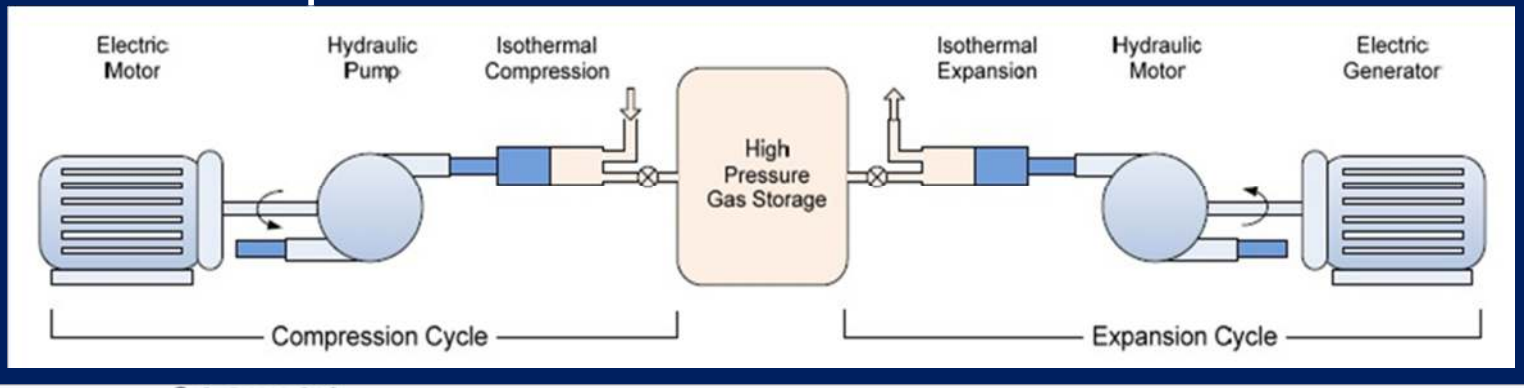
- key to achieving significant reduction in fuel consumption.
- The heat is stored in Thermal Energy Storage(TES).
- TES stores heat during charge, and it reheat air before expansion.

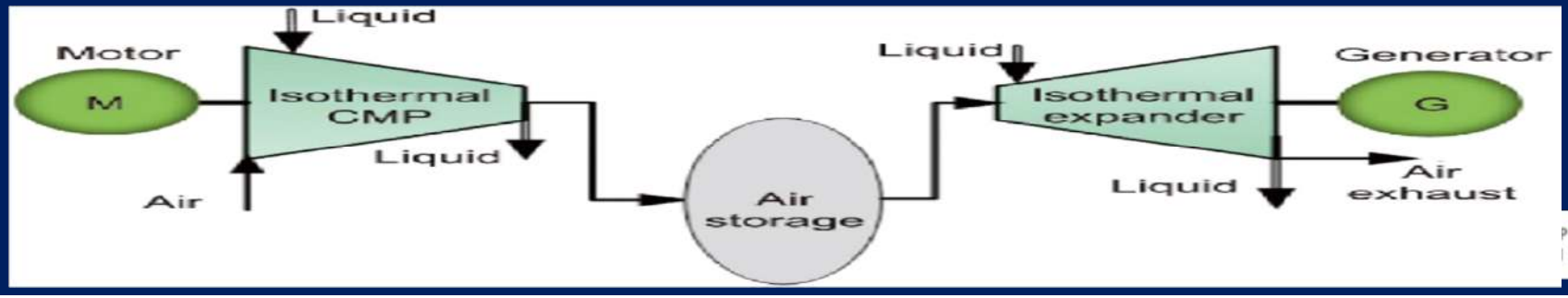


1.3. Type of CAES system

1.3.3. Isothermal system

- CAES system which eliminates the need for fuel and high temperature thermal energy storage.
- Isothermal CAES can minimize the compression work and maximize the expansion work done through isothermal compression/expansion.





2. Environment

2.1. Advantages

1. Reduce CO2 emission
2. No fuel consumption(Adiabatic system)

2.2. Disadvantages

1. Not pure energy storage
2. Contaminate water
3. The salt waste

5. Conclusion

- Although CAES has some problems such as location, not pure energy.
- CAES is still a good choice for storing energy due to its capacity, capital cost, and potential.
- According to new technology (Adiabatic), CAES will not consume fuel any more.