Diabatic Compressed Air Energy Storage

European Association for Storage of Energy

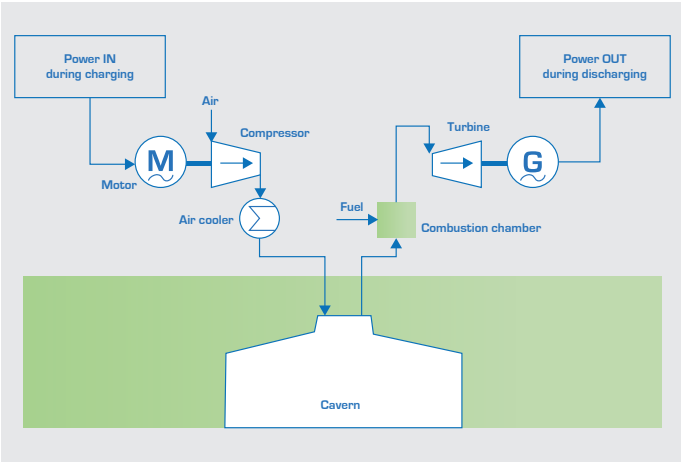
Mechanical Energy Storage

1. Technical description

A. Physical principles

A Diabatic Compressed Air Energy Storage (D-CAES) System is an energy storage system based on the compression of air and storage in geological underground voids (typically salt caverns, however other mediums are under development such as depleted gas fields, aquifers, and hard rock). During operation, the available electricity is used to compress air into a salt cavern at depths of hundreds of meters (typically 500-800m) and at pressures of around 100 bar (depth dependant). When the stored energy is needed, the released air is heated via combustion using natural gas or fuel and is expanded in order to drive a gas turbine to generate electricity. In fact, a D-CAES System is not a pure energy storage system, but a hybrid system composed of a natural gas fired open cycle turbine and an electrical storage system.

Illustration: Charging principle of D-CAES System



B. Important components

The main components are the following:

- Compressor driven by a an electric motor
- Air storage: salt cavern, hard-rock cavern, depleted gas field or an aquifer
- Turbine
- Generator
- A fuel/gas combustion system to preheat the released air

C. Key performance data

Power range	Some 100 MWs
Energy range	100 MWh – 10 GWh
Discharge time	Some h – some 10h
Life duration	> 30 years
Reaction time	Some min
Efficiency	≈ 55 %
CAPEX: energy	50 - 150 €/kWh
CAPEX: power	400 – 1,200 €/kW

D. Design variants (non exhausitive)

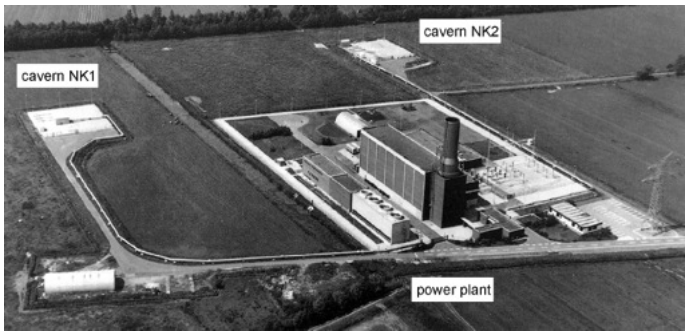
The following design variants are under study or development:

- Adiabatic CAES (A-CAES)
- Hydropneumatic Storage
- CAES + Concentrated Solar Power
- Adsorption-enhanced CAES
- Isothermal CAES (I-CAES)

2. State of the art

Today there are only two CAES plants in operation worldwide. One plant is located in McIntosch, US (110 MW), commissioned in 1991, and one in Huntorf, Germany (320 MW), commissioned in 1978.

The Huntorf plant (see picture) has been successfully operated by E.ON since 1978. These plants operate without heat storage and therefore use natural gas as a heat source for the discharging process. The other plant currently in operation (McIntosh) quotes reliability of 97% generation and close to 100% compression over its life span.



3. Future developments

A form of CAES that does not require the use of natural gas to reheat the air during generation is currently in the research and development phase. This technology is called 'Adiabatic CAES' and it will store the excess heat created during compression above ground. Then it will be reused to heat the air upon expansion. It is likely that this technology will become available on a commercial scale towards the year 2020 or beyond. Additionally, R&D activities and economic valuation works are running to upgrade a diabetic-CAES with a Thermal Energy Storage (TES) device. In this application, the TES delivers only a part of the required heat which can make the deployment achievable within a moderate time frame.

4. Relevance in Europe

The envisaged increase of intermittent renewable energy in the generation mix by 2030 will likely trigger the need for large scale energy storage as well as decentralised small scale generation. D-CAES is the only recognised and proven bulk storage technology aside from Pumped Hydro Storage currently available on commercial scale in Europe. .

5. Applications


Daily/weekly balancing


Arbitrage


Reserve


Demand Services & other standard Ancillary Services

6. Sources of information

- EASE Members
- Gaelectric
- E.ON