

# **Abandoned coal mines are suitable for compressed air energy storage**

Can abandoned coal mines be used as energy storage systems?

The existence of large cavities and the reduced environmental impact make underground coal mines exceptionally suitable for CAES projects. This paper analyzes the potential of abandoned coal mines as energy storage systems and lists the benefits of these projects in the depressed mining areas by the closure of the mines.

Is air storage possible in isolated workings of closed coal mines?

The concept of air storage in isolated workings of closed coal mine is presented taking into account availability of such places in the Silesian Coal Basin of southern Poland. The article also discusses major challenges of such concept such as insulation of underground workings, geomechanical stability of workings and site availability.

Which type of air storage configuration is used in closed coal mines?

Typical CAES configurations such as Adiabatic CAES and Diabatic CAES are described. The concept of air storage in isolated workings of closed coal mine is presented taking into account availability of such places in the Silesian Coal Basin of southern Poland.

Can compressed air energy storage be used in coal mines?

However, the key issues, such as the uneven heat transfer of the system and the corrosion and scaling of the heat transfer medium, need to continue to be addressed. (3) The potential for compressed air energy storage in coal mines' underground spaces is enormous, and it can be used with less costly excavation.

What are the patterns of energy storage in abandoned mines?

The patterns of energy storage in underground space of abandoned mines include mainly pumped hydro storage (PHS) and compressed air energy storage (CAES)[,,].

Can a closed coal mine be used for energy storage?

CAES is the most commonly used form of the utilization of abandoned coal mine space for energy storage. Schmidt et al. investigated the technical feasibility of CAES in a closed coal mine and analyzed the effects of air pressure and temperature on sealing layer, concrete lining and rock mass.

Underground energy storage reservoirs can be classified into salt caverns, aquifers, depleted oil and gas fields, abandoned coal mines, and caverns.

A large number of voids from closed mines are proposed as pressurized air reservoirs for energy storage systems. A network of tunnels from an underground coal mine in northern Spain at 450 m depth has been selected as a case study to investigate the technical feasibility of adiabatic compressed air energy storage (A-CAES) systems.

## Abandoned coal mines are suitable for compressed air energy storage

The number of abandoned coal mines will reach 15000 by 2030 in China, and the corresponding volume of abandoned underground space will be 9 billion m<sup>3</sup>, which can offer a good choice of energy storage with large capacity and low cost for renewable energy generation [22,23]. WP and SP can be installed at abandoned mining fields due to having large occupied ...

The advantages of CAES include 1) large-scale storage capacity, suitable for daily energy storage needs of wind and solar power; 2) environmentally friendly, uses natural air as the working fluid, ensuring safety and sustainability; 3) low cost, utilizes existing or abandoned underground caverns and mines for air storage, reducing construction ...

Overview of current compressed air energy storage projects and analysis of the potential underground storage capacity in India and the UK ... the reuse of disused mines has been considered for use within CAES systems and natural gas storage [70]. Many depleted coal mines possess large pre-excavated volumes therefore has the potential to ...

We have explored multifaceted considerations surrounding the repurposing of abandoned mines for energy storage, with a focus on Underground Pumped Storage Power (UPSH), Compressed Air Energy Storage (CAES), heat storage, and geothermal applications.

A key parameter study was conducted to define the dimensions necessary to transform underground coal mines into an underground energy storage: t&#250;nel-compressed air energy ...

Compressed air energy storage (CAES) technology is a known utility-scale storage technology able to store excess and low value off-peak power from baseload generation capacities and sell this power during peak demand periods. ... Geologies suitable for CAES storage reservoirs are salt, hard rock and porous rock [6]. The total surface area that ...

An abandoned coal mine after long-term service may have a much larger damage zone than those in hard rock caverns and salt caverns [29]. ... This numerical simulation model for the compressed air energy storage in abandoned mines is verified by the simulation results of the Korean CAES pilot test project where Kim et al. [38] considered EDZ and ...

The use of abandoned underground mines as facilities for storing energy in form of compressed air has been investigated by Lutynski et al. [18] and Ishitata et al. [20] pared to underground storage caverns, CAES reservoirs are subjected to relatively high-frequency load cycles on a daily or even hourly basis.

The technology has relatively low energy density, but has advantages including a power capacity decoupled from its energy capacity, no cycle-limit and the potential to be combined with compressed air energy storage. It is currently being trialled in the United Kingdom, targeting abandoned coal mines.

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The challenges associated with employing abandoned mines as lower reservoirs are multifaceted. The foremost challenge stems from limited knowledge about the current state of the mines due to post-mining processes, such as weathering, dissolution, hydration, leaching, swelling, slacking, subsidence, creeping along faults, gas migration, and precipitation, along ...

Poland has had a total of 70 mines, but now more than half of them is out of operation. This mining closure raises with respect to the environment and unemployment. Innovative technology is needed to overcome the problems ...

In the context of sustainable development, revitalising the coal sector is a key challenge. This article examines how five innovative technologies can transform abandoned or in-use coal mines into sustainable energy ...

As the address types of underground gas storage, the existing compressed air energy storage projects or future ideas can be divided into the following four types: rock salt caves [15], artificially excavated hard rock caverns [16], abandoned mines and roadways [17], and aquifers [18]. Table 1 shows the underground energy storage projects in operation or planned ...

Closed mines can be used for underground energy storage and geothermal generation. Underground closed mines can be used as lower water reservoir for UPHES. ...

The energy transition towards a sustainable model committed by the Organization for Economic Co-operation and Development (OECD) that ratified the Paris Agreement [1] should bring environmental benefits. The universal agreement's main aim is to keep a global temperature rise this century well below 2 °C and to drive efforts to limit the temperature increase even ...

Abandoned coal mines have many underground space resources, such as roadways, shafts, and gobs. Among them, abandoned roadways are the best gas storage space for underground compressed air energy storage (CAES). However, CAES caverns have high air pressure and strict sealing requirements. Therefore, the stability and sealing of abandoned ...

The required roadways of abandoned coal mine cannot be less than 35,960 km, equivalent to 10,273 coal mines, by 2030. The present number of abandoned coal mines is still enough for the medium-term plan (2030). However, the abandoned coal mines are obviously insufficient for the long-term plan of wind-solar power (2050).

Decarbonization of the electric power sector is essential for sustainable development. Low-carbon generation technologies, such as solar and wind energy, can replace the CO<sub>2</sub>-emitting energy sources (coal and natural gas plants). As a sustainable engineering practice, long-duration energy storage technologies must be employed to manage imbalances ...

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Renewable energy (wind and solar power, etc.) are developing rapidly around the world. However, compared to traditional power (coal or hydro), renewable energy has the drawbacks of intermittence and instability. Energy ...

Coupled thermodynamic and thermomechanical modelling was implemented for compressed air energy storage (CAES) in mine tunnels using the technique of lined rock cavern (LRC). ... abandoned mines for CAES application is inspiring. Qin and Loth (2021) 17 indicated that, economically, CAES with abandoned oil/gas wells or coal mines can be a strong ...

This paper deals with underground storage part in CAES concept and lists benefits related to the storage of air in abandoned coal mines. Examples of natural gas storage in ...

The compressed air energy storage in abandoned mines is considered one of the most promising large-scale energy storage technologies, through which the existing underground resources can be not ...

There is another alternative very similar, CAES - Compressed Air Energy Storage, a technology where vast amounts of air can be compressed and stored under pressure in ...

This study focuses on the renovation and construction of compressed air energy storage chambers within abandoned coal mine roadways. The transient mechanical responses of underground gas storage chambers ...

According to statistics, 7100 outdated coal mines have been eliminated across China, with an outdated production capacity of 550 million tons/a, of which 320 million tons/a was phased out during the 12th five-year plan (FYP) period; during the 13th FYP period, about 500 million tons of coal production will cease and 500 million tons of coal will be reduced and ...

A spectrum of repositories, depicted in Fig. 1, is viable for hydrogen storage rface storage options, such as storing hydrogen in its liquid state at sub-zero temperatures, have limited capacity and high costs and are more suitable for small-scale energy storage with short charging and discharging times [[20], [21], [22]].As the production of ...

For example, Huntorf CAES in Germany and McIntosh CAES in USA [3,4]. The problem is the efficiency of these systems, which is why hybrid type of the HCAES (Hybrid Compressed Air Energy Storage) [2 ...

In Germany, a patent for the storage of electrical energy via compressed air was issued in 1956 whereby "energy is used for the isothermal compression of air; the compressed air is stored and transmitted long distances to generate mechanical energy at remote locations by converting heat energy into mechanical energy." [5].The patent holder, Bozidar Djordjevitch, is ...

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The concept of air storage in isolated workings of closed coal mine is presented taking into account availability of such places in the Silesian Coal Basin of southern Poland. ...

Similarly, a coal mine may be abandoned when it is no longer profitable to continue mining. While they may have a variety of geologies, some may be suitable for compressed air energy storage. However, a key to the present concept is the correlation of these underground resources with wind energy resources. An example of this is shown for the US ...

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