

What is underground thermal energy storage?

Part of the book series: Green Energy and Technology (GREEN) Underground thermal energy storage (UTES) provide us with a flexible tool to combat global warming through conserving energy while utilizing natural renewable energy resources. Primarily, they act as a buffer to balance fluctuations in supply and demand of low temperature thermal energy.

What are the five underground large-scale energy storage technologies?

In this work, the characteristics, key scientific problems and engineering challenges of five underground large-scale energy storage technologies are discussed and summarized, including underground oil and gas storage, compressed air storage, hydrogen storage, carbon storage, and pumped storage.

Why is deep underground energy storage important?

It is an effective way to implement SPRs, natural gas peak shaving, a sustainable supply of renewable energy, and the large-scale and efficient utilization of hydrogen. The development of deep underground energy storage is a key issue in achieving carbon neutrality and upgrading China's energy structure.

Why is the underground a good place to store thermal energy?

The underground is suitable for thermal energy storage because it has high thermal inertia, i.e. if undisturbed below 10-15 m depth, the ground temperature is weakly affected by local above ground climate variations and maintains a stable temperature [76,77,78].

What are geotechnical criteria for underground energy storage?

4.1.6. Geotechnical criteria Geotechnical criteria are related to the construction phase of underground energy storage and include thermal and mechanical rock properties, usually requiring in situ tests to assess the cavern stability.

What is Utes (underground thermal energy storage)?

There are also combinations in which the storage is used for both short-term and seasonal storage. There are a number of such technologies summarized by the acronym UTES (Underground Thermal Energy Storage). 30 years within the framework of IEA (International Energy Agency).

ENABLING SUSTAINABILITY PRINCIPLES IN RESOURCE MANAGEMENT. RESOURCE MANAGEMENT WEEK 2021 | ENABLING SUSTAINABILITY PRINCIPLES IN RESOURCE MANAGEMENT | 26-30 April 2021 | Geneva ... CSA Geological Services for Europe & EU database and atlas for underground storage (CCS/Heat/Energy) Underground Hydrogen ...

Aquifer thermal energy storage (ATES) is a large-capacity thermal energy storage method [8]. It uses natural underground saturated aquifers as an energy storage medium that ...

Underground thermal energy storage, derived from indigenous sources within the earth, is a clean, renewable energy source. Compared with wind energy, solar battery energy and other renewable energy sources, the ...

The 12th International Conference on Energy Storage 1 INNO-XX-YYY Underground Thermal Energy Storage (UTES) Bo Nordell Div. Architecture and Water, Luleå; University of Technology, SE-97187 Luleå, Sweden, ... theoretical explanation came long after the invention itself and the heat pump principle was not scientifically explained until 1870.

By comparing different possible technologies for energy storage, Compressed Air Energy Storage (CAES) is recognized as one of the most effective and economical technologies to conduct long-term, large-scale energy storage. In terms of choosing underground ...

Rock and Soil Mechanics >> 2025, Vol. 46 >> Issue (1): 1-25. doi: 10.16285/j.rsm.2024.0705 o Rock and Soil Mechanics Excellence Forum o Next Articles Research progress on basic principles and analysis methods of lined rock caverns for compressed air energy storage station

Several techniques exist to store H₂ at higher energy densities, which sometimes necessitate energy inputs in the form of heat or work, or the incorporation of H₂ binding materials. Among several H₂ storage options, underground H₂ storage emerges as a large-scale and seasonal storage alternative. Cushion gas (e.g., N₂, CH₄, CO₂, etc.) is needed to ...

The storage of hydrogen is the key for establishing a hydrogen value chain and large volume storage in underground can be a promising option. However, selecting an appropriate underground storage facility is a complex task, subject to the thermomechanical behavior of the host rock, as well as of the stored gas under high pressure and temperature.

This review briefly discusses the current need and state of renewable energy production, the fundamental principles behind the VRFB, how it works and the technology restraints. ... Compressed Air Energy Storage in Underground Formations. Storing Energy, 2016, pp. 113-133. Sabine Donadei, Gregor-Sönke Schneider.

Deep underground energy storage is the use of deep underground spaces for large-scale energy storage, which is an important way to provide a stable supply of clean energy, ...

On the other hand, a closed-loop scheme is widely installed as a borehole thermal energy storage (BTES) system, in which the heat is extracted via vertical borehole heat exchangers (BHEs) consisting of plastic pipes, placed in a borehole as U-tubes or coaxial tubes and fixed by filling the borehole with grout material. Already only one BHE is sufficient to ...

The global capacity of energy storage provided by Underground Gas Storage (UGS) facilities in Europe is huge: 1978 TWh i.e. around 180 Bcm (billions of cubic meters of gas in standard conditions) Figure 1: Number and capacity of underground gas storage facilities in Europe (Source: GIE-GSE, 2017) 1 According to GIE 2018 data-base

Large-Scale Underground Energy Storage (LUES) plays a critical role in ensuring the safety of large power grids, facilitating the integration of renewable energy sources, and enhancing overall system performance. To explore the research hotspots and development trends in the LUES field, this paper analyzes the development of LUES research by ...

This definition encompasses all types of energy storage currently available. For the purposes of this paper, a specific definition for thermal energy storage, based on definition of energy storage in the CEP, is proposed: 2. Technology Overview Three different thermal energy storage principles. can be observed: sensible heat storage, latent heat

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The underground energy storage technologies for renewable energy integration addressed in this article are: Compressed Air Energy Storage (CAES); Underground Pumped Hydro Storage (UPHS ...

The need to support the rapid industrialization of the 1970s and the two oil crises stimulated the construction of underground energy storage facilities, such as crude oil and liquefied petroleum gas (LPG) storage caverns, and pumped-storage power plants (Lee, 1996). The principles of rock mechanics have played an important role in site ...

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Such thermal energy storage is mainly for long-term storage or seasonal storage of thermal energy storage. There are also combinations in which the storage is used for both ...

The world is rapidly adopting renewable energy alternatives at a remarkable rate to address the ever-increasing environmental crisis of CO₂ emissions....

underground thermal energy storage (UTES) in the energy system, 2) providing a means to maximise geothermal heat production and optimise the business case of geothermal heat production doublets, 3) addressing technical, economic, environmental, regulatory and policy aspects that are necessary to support

1. Introduction. Electrical Energy Storage (EES) refers to a process of converting electrical energy from a

power network into a form that can be stored for converting back to electrical energy when needed [1-3] ch a ...

Compressed Air Energy Storage Haisheng Chen, Xinjing Zhang, Jinchao Liu and Chunqing Tan ... principle, function and deployments. The chapter is structured in the following manner. ... facilities vary depending on the type of underground storage but are typically in the range from \$400 to \$800 per kW. The typical specific energy density is 3-6 ...

Countries like Denmark have only a few hilly areas suitable or available for PHS systems. This paper presents a novel idea for a PHS system which is based on a storage reservoir, where water is enclosed in a membrane placed underground as shown schematically in Fig. 1 - the energy membrane-underground pumped hydro storage system (EM-UPHS).

Capacity defines the energy stored in the system and depends on the storage process, the medium and the size of the system;. Power defines how fast the energy stored in the system can be discharged (and charged);. Efficiency is the ratio of the energy provided to the user to the energy needed to charge the storage system. It accounts for the energy loss during the ...

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In this work, the characteristics, key scientific problems and engineering challenges of five underground large-scale energy storage technologies are discussed and summarized, ...

This photo shows a view of the surface structure of salt cavern air storage inside the 300 MW compressed air energy storage station in Yingcheng City, central China's Hubei Province, Jan. 9, 2025. ... intermittency and ...

Fig. 1.1 illustrates the potential use of the underground space for energy storage and production as well as extraction of raw materials. Compressed air storage (CAES) as a special form of energy storage in abandoned salt mines is discussed by Hausdorf et al. (2009). Fig. 1.2 and 1.4 illustrate capacity and discharge capabilities of different

Overview of Large-Scale Underground Energy Storage Technologies for Integration of Renewable Energies and Criteria for Reservoir Identification. ... UHS uses the same P2G principle of UGS, but although it is a proven technology using salts caverns as reservoirs, it is only a prospective technology with conceptual designs and pre-commercial ...

An overview of underground energy storage in porous media and development in China. Gas Sci Eng, 117 (2023), p. 205079. [18] M. Budt, D. Wolf, R. Span, J. Yan. A review on compressed air energy storage: basic principles, past milestones and recent, 170 ...

Deep underground energy storage involves complex situations such as multi-field multi-phase coupling and multi ... Fig.4 Working principle of compressed air energy storage power station He ...

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