

# RUSSIAN UNDERGROUND ENERGY STORAGE



What is underground energy storage? Underground energy storage represents a complex and widespread field of research in large-scale applications, depending on the geological structure of the site, the nature of the material to be stored and the purpose of storage such as displacement and recovery.



Is underground hydrogen storage a viable solution for large-scale energy storage? This review paper provides a critical examination of underground hydrogen storage (UHS) as a viable solution for large-scale energy storage, surpassing 10 GWh capacities, and contrasts it with aboveground methods.



Does underground energy storage exist in porous media? Compared with caverns (e.g., salt caverns and rock caverns), underground energy storage in porous media occupies much larger market. This paper systematically reviewed the current state of underground energy storage in porous media worldwide, especially the development of UES projects in porous media in China. Some conclusions can be drawn:



How has China improved the underground energy storage system in porous media? China has gradually improved the underground energy storage system in porous media, especially underground gas storage in depleted natural gas reservoirs, and the current working gas volume of UGS projects is more than 16.4 billion m<sup>3</sup>. Thermal energy storage in shallow aquifers is widely developed, and the technology is mature.



What is underground gravity energy storage? A novel technique called Underground Gravity Energy Storage turns decommissioned mines into long-term energy storage solutions, thereby supporting the sustainable energy transition. Renewable energy sources are central to the energy transition toward a more sustainable future.

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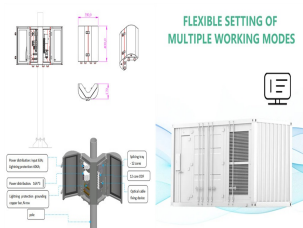
How deep is the underground space for energy storage? The underground space for energy storage mainly includes porous or fractured porous media (e.g., depleted oil and gas reservoirs, aquifers) and caverns (e.g., salt caverns, rock caves, abandoned mines or pits) ( Jannel and Torquet, 2021) ( Fig. 3 ). The depth can range from several hundred meters to several kilometers( Kabuth et al., 2017 ).



Russia's Gazprom has emptied its gas storage facilities in western Europe to unusually low levels ahead of the winter, adding to fears that Moscow has exacerbated a shortage of supplies that



"The new technique called Underground Gravity Energy Storage (UGES) proposes an effective long-term energy storage solution while also making use of now-defunct mining sites, which likely number



In spring 2023, Ukrainian gas storage operator Ukrtransgaz was certified under EU gas storage regulations. These measures have proved somewhat effective, with European traders storing around 10 billion cubic meters of gas in Ukraine's underground facilities in 2020-21. However, this was primarily reverse flow Russian gas passing through Ukraine.

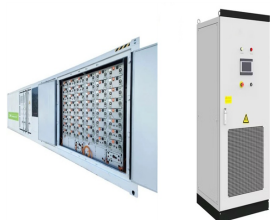


An underground gas storage site in Ukraine was attacked on Sunday in the latest wave of Russian missile strikes on power facilities, while officials restored power in cities, ordered imports and

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Experience to date with hydrogen storage in geological media is limited to four salt-cavern projects at Teesside (UK) and the US Gulf Coast, and to three aquifer storage projects for town gas (50% hydrogen) storage in the 1960s and 1970s (Panfilov 2016). However, there is extensive experience in the storage of other energy and waste fluids (e.g. oil, natural gas, CO ???



Dusan Bajatovic, Director of state-owned gas company Srbijagas, announced that Serbia and Russia have commenced work on expanding the underground gas storage facility in Banatski Dvor. The project will utilize Russian equipment and technologies, benefiting both Serbian consumers and Russian manufacturers.



Table 3 summarizes the general criteria required for UES (Underground Energy Storage) in hydrocarbon reservoirs. As depleted reservoirs have been consistently exploited in UGS, they are thought to be an economically feasible storage option for UHS (Underground Hydrogen Storage) given their already existing infrastructure [82]. To ensure a



hydrogen storage is underground storage in depleted oil and gas fields, the subterranean aquifers, underground reservoirs in salt deposits, permafrost grounds. These methods Russian R&D in Hydrogen Energy. Ministry of Education and Science of Russian Federation, Federal Agency for Science and Innovations, Moscow, 2007.



When Russia launched a major missile attack on a Ukrainian gas storage facility in April it inadvertently highlighted the resilience of Ukraine's underground gas storage system, and bolstered

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Abstract Data on the energy status and activity of pro-/antioxidant metabolism during photomorphogenesis of the rhizome apex of *Achillea millefolium* L. were obtained. At the photophobic stage of development, etiolated rhizome apices were characterized by increased respiration intensity and energy storage rate: the share of energetically efficient cytochrome ???



Within Uniper, all expertise in underground gas storage across Europe is pooled in Uniper Energy Storage GmbH. We operate natural gas storage facilities in Germany, Austria and the UK with a working gas capacity of over 7 billion cubic meters. Our storage facilities ensure the year-round supply of gas for consumers.



He had previously blamed record gas prices on European energy companies not pumping enough gas into underground storage ahead of the winter and denied that Moscow has restricted supplies to Europe.



According to the latest statistics from the International Gas Union (IGU) [], there are a total of 689 underground gas storage facilities around the world at present, with a total working gas volume of  $4165.3 \times 10^8 \text{ m}^3$ , accounting for about 11% of the total global gas consumption ( $35,429 \times 10^8 \text{ m}^3$ ). This is a  $232 \times 10^8 \text{ m}^3$  increase in the working gas volume ???



As highlighted by the International Energy Agency in September 2021, Russia has been reducing its piped gas supplies to the EU market, while it did not fill its storage sites in the EU to adequate levels.. Pipeline deliveries from Russia declined by 25% year-on-year in Q4 2021. This decrease in Russian pipeline supply to the EU became more pronounced in the first seven weeks of ???

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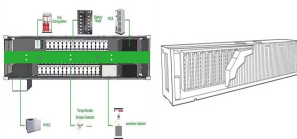
Underground storage of pure hydrogen: The energy cycle including underground storage of pure H<sub>2</sub>. II. They are capable of storing much larger gas volumes than salt caverns (the maximum volume of a Russian aquifer storage, Kasimovskoie, is 18 milliard st-m<sup>3</sup> of gas) and are expected to be technologically and economically feasible because



European traders this summer are using only a fraction of Ukraine's vast natural gas storage, following Russian attacks that drove up risks, depriving the war-torn country of scarce revenues



Active gas volumes in European underground warehouses is at its lowest level in years, according to a statement released by Russia's gas giant Gazprom on Monday.. Per the statistics from Gas Infrastructure Europe as of July 31, the rate of use of European and Ukrainian underground gas storage facilities prior to the last summer month remained exceptionally low, ???



This research investigates the potential of using bedded salt formations for underground hydrogen storage. We present a novel artificial intelligence framework that employs spatial data analysis ???



Russian Missiles Hit Ukraine's Power System, Gas Storages. Russia attacked five regions across Ukraine on Thursday with a barrage of missiles and drones, targeting the nation's energy system and underground gas storage sites.

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Underground energy storage is best for long-term and large-scale usage. Compressed Air Energy Storage (CAES) is a storage method that may be used for short-term (hourly) storage [17]. Germany has a huge number of underground natural gas storage facilities. In Russia, many clean hydrogen storage facilities were built underground to meet the



6 ? October 28, 2021 - Russia's Gazprom has emptied its gas storage facilities in western Europe to unusually low levels ahead of the winter, adding to fears Moscow is using supply shortages to push prices to record levels. infographic in what critics say increasingly points to an attempt to squeeze European energy supplies, according to the



Aquifer thermal energy storage for the Berlin Reichstag building-new seat of the german parliament. In: World Geothermal Congress. Kyushu-Tohoku, Japan: 3611???3615. Kalles?e AJ, Vangkilde-Pedersen T, Guglielmetti L. 2020. HEATSTORE???underground thermal energy storage (UTES)???state of the art, example cases and lessons learned.



Finally, we anticipate the future development of salt caverns for energy storage in China to focus on large-scale, integrated, and intelligent projects, emphasizing their significance in achieving