

Analysis of energy storage field in cold regions

How do seasonal thermal storage systems improve intermittency of solar energy?

Seasonal thermal storage systems overcome the drawback on intermittency of solar. Heat pump and solar collectors with low-temperature storage improve the performance. Climate, storage temperature, energy efficiency, and life cycle cost are discussed. A decision support flow chart is presented for selection of system options.

What is seasonal thermal energy storage (STES)?

In the seasonal thermal energy storage (STES) technique, the available solar radiation in summer is harvested by solar thermal collectors and stored in large storage tanks or in the ground to be used during winter. The STES system is one of efficient systems for the heating application in building sector, especially in cold climate zones , .

What are the different types of thermal energy storage systems?

The STES systems are typically categorised in four types; hot-water thermal storage (HWTS), borehole thermal energy storage (BTES), aquifer thermal energy storage (ATES) and water gravel pit storage (WGPS). Among these types, the ATES and BTES are most commonly used due to their cost-effectiveness .

Which thermal energy storage system is best for space heating?

The double U-tube borehole thermal energy storage (BTES) integrated with ground coupled heat pump (GCHP) and evacuated tube solar collector (ETSC) system was found to be most appropriate for space heating in cold climate zones.

Why is a low-temperature STES system more suitable for space heating?

The higher the storage temperature, the heat loss would be greater. Studies suggest, the low-temperature STES system would be more suitable for the cold climate conditions. However, the low grade stored heat cannot be directly used for space heating and a heat pump needs to be coupled to upgrade the temperature of delivered heat.

Do heat pump and solar collectors improve system performance in cold climate zones?

Heat pump and solar collectors with low-temperature storage are the influencing factors to improve the system performance. This paper investigates STES systems integrated with heat pump and solar collectors for heating applications in cold climate zones based on the current available literature.

A larger difference between the surrounding rock temperature and PCM melting temperature is efficient for the cold energy storage of PCM plates, and the cold energy storage time and temperature ...

In the past decade, Chinese urban areas have seen rapid development, and rural areas are becoming the next

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construction hotspot. The development of rural buildings in China has lagged behind urban development, and there is a lack of energy-efficient rural buildings. Rural houses in severe cold regions have the characteristics of large energy exchange, a long ...

The global cold thermal energy storage market is projected to grow from USD 244.7 million in 2021 to USD 616.6 million in 2028 at a CAGR of 14.1% ... Based on our analysis, the global market projected a slow growth of 6.6% in 2020 when compared to the average year-on-year growth during 2017-2019. ... cold thermal energy storage systems are ...

Recently, subways in China's severe cold regions have developed rapidly. Harbin, a typical city in a severe cold region, can reach the lowest outdoor temperature of $-37.7\text{ }^{\circ}\text{C}$ in winter, making the thermal environment of the underground tunnels a huge challenge. Due to the complexity of the subway environment, there are few long-term field measurements, and ...

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Energy Build. (2014) J. Lai et al. A state-of-the-art review of sustainable energy based freeze proof technology for cold-region tunnels in China. *Renew. Sust. Energ.* ... Temperature field analysis of a cold-region railway tunnel considering mechanical and train-induced ventilation effects. *Applied Thermal Engineering*, Volume 100, 2016, pp. 114 ...

Consequently, a GSHPS with heat recovery is a potentially efficient and economical approach for buildings in hot-summer and cold-winter regions. Model of the hybrid ground source heat pump system ...

3 · An analysis of the interactions with the energy network, including the loading and unloading of storage facilities and the dynamics of upstream price zones, shows that it is ...

This study aims to acquire a better understanding of the quantitative relationship between environmental impact factors and heating energy consumption of buildings in severe cold regions. We analyze the effects of five urban morphological parameters (building density, aspect ratio, building height, floor area ratio, and shape factor) and three climatic ...

Climate change and the energy crisis have catalyzed the architectural industry's consideration of green and energy-efficient buildings. With the continuous deepening and expansion of research, people have gradually realized the reference value of the passive design strategies embedded in traditional residential buildings for contemporary architectural design ...

This study conducted monitoring and analysis of the temperature field for large-span concrete box girder bridges in cold regions. The objective is in revealing the temperature response patterns of concrete box girders

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under cold climate and insolation conditions, improving the accuracy of the temperature field model, and realizing accurate temperature distribution ...

In order to prevent freezing damage in cold regions tunnels, tunnel heating system using heat pump was introduced for the first time at Linchang tunnel in Inner Mongolia Autonomous Region of China. The tunnel heating system consists of the heating section, absorbing section, heat pump, collector, and distributor line. This system can be used for heating lining and drainage ...

Concrete materials are widely used in tunnel engineering. In China, the cold regions have gradually become the main area for highway and railway construction. Affected by high altitude, low temperature, turbulent wind, and other conditions, freezing damage, such as tunnel icing, occurs in concrete materials, which seriously affects the quality and operational ...

A PCM is typically defined as a material that stores energy through a phase change. In this study, they are classified as sensible heat storage, latent heat storage, and thermochemical storage materials based on their heat absorption forms (Fig. 1). Researchers have investigated the energy density and cold-storage efficiency of various PCMs [[1], [2], [3], [4]].

Multi-energy complementary heating (MECH) is the most promising and potential heating technology of the future. However, owing to the increase in energy types, the system is complex, and the operation procedure cumbersome. In addition, due to the uncertainty of climate conditions, it is difficult to develop a general control strategy suitable for all heating ...

Carbon neutrality has become a common goal for all humanity. The total energy consumption of the building sector has grown by an average of 1% per year over the past 10 years, reaching 133 EJ (exajoules) in 2022, accounting for 30% of the world's total energy consumption []. According to the Global Carbon Project platform, China is the world's largest ...

Energy consumption in public and residential buildings worldwide accounts for approximately 20.1% of total energy consumption [1]. According to 2017 data, the energy consumption of the building sector in the US accounts for about 39% of the total primary energy use [2]. In China, the building sector consumed approximately 20% of the primary energy and ...

Lai et al. (1999) carried out nonlinear analyses for the coupled problem of temperature and seepage fields in cold region tunnels by Galerkin's method. Lai et al. (2002) proposed approximate analytical solution for temperature fields in cold regions circular tunnels using dimensionless and perturbative method. However, all these researches are ...

A new sustainable energy based freeze proof method for drainage system in cold-region tunnels: A case study of Tianshan Shengli Tunnel. ... Y. et al. Tunnel temperature fields analysis under the ...

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With the accelerating deployment of renewable energy, photovoltaic (PV) and battery energy storage systems (BESS) have gained increasing research attention in extremely cold regions. However, the extreme low temperatures pose significant challenges to the ...

The cold storage for this field test is located in Xuzhou City, Jiangsu Province. The cold storage has four floors, each of which has four independent rooms (A represents the first floor and D represents the fourth floor), and each room has an area of 1310 m² and volume of 6400 m³. A1-D2 are freezing rooms, and D3 and D4 are chilled rooms that are not running ...

However, theoretical research on the GSHP system in cold regions tunnels is still at an early stage; to make better use of energy-saving and environmentally-friendly technology, research on numerical calculations multi-field on coupling with phase change- temperature-seepage-stress coupling and a heat source should be performed.

Several tunnels have been built in the high latitudes of western and northern China to promote regional development and strengthen economic inter-regional economic ties [1, 2]. Tunnels built in the seasonal cold region are inevitably exposed to diseases such as lining cracking and ice condensation on the road [3, 4] and poor thermal environment comfort [[5], ...

Evaluation of actual zero energy buildings (ZEBs) performance and identification of its regional characteristics are of great significance for similar future projects. Based on more than 400 cases in cold regions, this study compared the post-evaluation and drivers of ZEBs from China, the US and the European Union (EU).

Li et al. [7] reviewed the PCMs and sorption materials for sub-zero thermal energy storage applications from -114 °C to 0 °C. The authors categorized the PCMs into eutectic water-salt solutions and non-eutectic water-salt solutions, discussed the selection criteria of PCMs, analyzed their advantages, disadvantages, and solutions to phase separation, ...

The integrated application of multi-energy coupled technology in nearly zero-energy building (NZEB) is promising from the perspective of low-carbon development to achieve the goal of net zero energy. PVT (photovoltaic/thermal), air, and ground sources were combined organically to establish an experimental platform of a multi-source heat pump (MSHP) system, ...

In a typical cold region, taking a 477 m² residential area of Harbin as the research object, building energy consumption simulation software DeST is used to calculate the building's annual hot and cold load, with the following results: In the heating period, the maximum heat load of the building heating is 92.80 kW, the accumulative total heat ...

Fig. 2 indicates the concept of hybrid compression-assisted sorption thermal battery for seasonal energy storage in severe cold region which aims to reveal vast potential in solar energy utilization. Compared with basic sorption thermal battery, a compressor is integrated between high temperature salt (HTS) and low temperature salt (LTS ...

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High altitude cold regions tunnel construction environment is the key factor of tunnel construction progress, also relates to the technical personnel's health, this paper analyzes several key ...

As the installed capacity of renewable energy such as wind and solar power continues to increase, energy storage technology is becoming increasingly crucial. It could ...

The purpose of this investigation is to provide a detailed review of various parameters (options) of seasonal thermal energy storage (STES) systems such as thermal ...

In this study, on the basis of the temperature data collected at 612 meteorological stations in China from 1961 to 2019, cold regions were defined using three indicators: an average temperature of <-3.0 °C during the coldest month; less than five months with an average temperature of >10 °C; and an annual average temperature of ≤ 5 °C. Spatial interpolation, ...

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