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Natural Gas Storage Facility

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Underground storage facility of natural gas in abandoned mine shafts

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BRIEF DESCRIPTION

In the South African Integrated Resource Plan (IRP), the country has indicated the intent to significantly increase the amount of electric power generation to be sourced from renewable resources, particularly wind and solar. Unfortunately, these two resources are variable and must be backed up with dispatchable power to balance demand with supply.

Dispatchable Energy is only used occasionally and when it is used, it must be available in significant volumes. This makes the fuel supply a challenge unless there is a system to provide a buffer storage to provide the large volumes required when needed. For the South African grid, by 2030 it is expected that dispatchable energy must be available to supply up to 10 GW for short durations, but only average less than 200 MW over the year, implying about 2% usage factor.

Abandoned mine shafts can be utilized to provide the required storage volume for natural gas to meet the dispatchable power need.

VALUE PROPOSITION/ BENEFITS

The concept of mine shaft storage provides an economical concept for natural gas storage with sufficient volume and delivery rate to meet the needs for dispatchable power generation in South Africa, utilizing readily available infrastructure.

UNIQUE CHARACTERISTICS

In most of the world, the required gas storage volume is provided with underground storage in depleted oil and gas reservoirs, aquifers or salt domes. For dispatchable power the preferred storage medium is in salt domes to cater to the large offtake rates needed. There are no salt domes in South Africa and no depleted oil and gas reservoirs, so a suitable alternative for dispatchable gas storage is identified.

South Africa has a long history of deep mining operations and many abandoned mines. These can be utilized to provide this required storage volume. One area that has not be considered for storage volumes is the mine shaft that connects the mining horizons to the surface.

TARGET MARKET

The ultimate customer for this service is the electricity grid operator, as this storage system facilitates the supply of dispatchable power needed to maintain the grid. However, it is probable that the actual use will be made by a sub-contracting company to those companies providing the gas fuelled dispatchable power.

TECHNICAL DESCRIPTION

The concept of mine shaft storage is to cement an open bottom steel storage tank inside the mine shaft. There will be a floating bottom seal in the tank separating the stored gas from the surrounding water. The water around the tank will provide a pressure buffer within the gas storage cylinder. Gas inlet and outlet piping will be installed at the top of the tank.

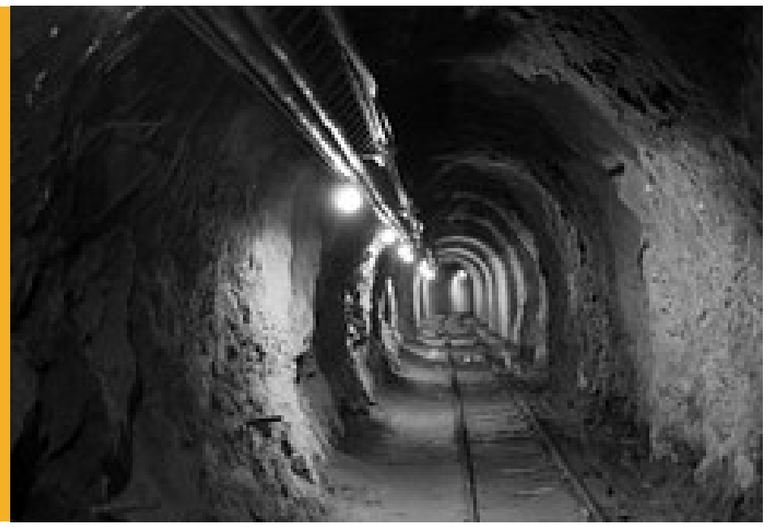
The dimensions of the storage tank will be limited by the dimensions of the chosen mine shafts. It is expected that the tank will have a radius of 5 to 7 meters or dependent on the shaft radius, and a vertical length of up to 1000 metres. The pressure rating of the storage will also be affected by the depth that the tank is situated in the mine. We have assumed that the tank top will be set 1000 metres into the mine shaft. To meet the 10 GW of dispatchable energy needs of South Africa in 2030, it is expected that 3 to 10 of these tanks must be installed depending on tank volumes. To minimize the number of installations that must be constructed, each tank will be built as large as possible, both in diameter and in length.

The pressure on the outside of the tank is provided by the water gradient in the mine shaft and surrounding rock. The pressure on the bottom of the floating floor is provided by the water column in the mine shaft. When the storage tank is full, the pressure at the bottom of the tank is balanced, but there is a pressure differential inside the top of the tank equal to the gas pressure minus the pressure of the outside water. This pressure will be transferred into the surrounding rock. When empty, pressure differences are eliminated. The water pressure on the floating floor ensures maximum delivery of gas as the tank is supplying the stored gas.

INNOVATION STATUS

A provisional patent application (no: 2019/03690) has been filed for this innovation.

A concept for underground natural gas storage in a steel tank in abandoned mine shafts to meet peak demand by dispatchable power generation.



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