

## **Exploring Underground Hydrogen Storage Options in North Dakota: A Review**

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### **Abstract**

As the world shifts towards a low-carbon future, the demand for efficient, safe, and cost-effective energy storage solutions has become increasingly critical. Hydrogen has emerged as a promising energy carrier with numerous advantages, such as high energy density, zero-emission combustion, and versatile applications. Nevertheless, the challenge of effective hydrogen storage remains. This study examines the potential of underground hydrogen storage (UHS) in North Dakota, assessing its opportunities and challenges in supporting the region's renewable energy objectives. North Dakota's unique geological features, abundant renewable energy resources, and growing energy demands make it an ideal location for UHS implementation. This review explores various UHS technologies, including salt caverns, depleted oil and gas reservoirs, and aquifers, emphasizing their technical feasibility, environmental impacts, and economic viability within the North Dakota context. Salt caverns, created in subsurface salt formations, are well-suited for UHS due to their impermeability, structural integrity, and rapid cycling capacity. North Dakota's plentiful salt deposits, especially in the Williston Basin, present significant opportunities for large-scale hydrogen storage. Depleted oil and gas reservoirs offer another feasible option, leveraging existing infrastructure and reservoir knowledge. The state's long history of oil and gas production yields numerous depleted reservoir candidates for potential UHS projects. Aquifers, naturally occurring underground water-bearing formations, constitute a third alternative. Although less investigated than salt caverns and depleted reservoirs, aquifers show promise for UHS in North Dakota due to their extensive distribution and potential for substantial storage capacities. Additionally, we emphasize key economic factors and benefits for the state. In conclusion, this study provides a comprehensive assessment of the opportunities and challenges linked to implementing underground hydrogen storage in North Dakota. By conducting a detailed analysis of the region's geological characteristics, economic factors, and environmental concerns, we aim to offer valuable insights for policymakers, industry stakeholders, and researchers. This information can help inform future UHS projects and support the state's transition towards a sustainable energy future.