

Hydrogen Storage in Salt and Hard Rock Caverns

PREPARED BY:

LANE POWER & ENERGY SOLUTIONS, INC

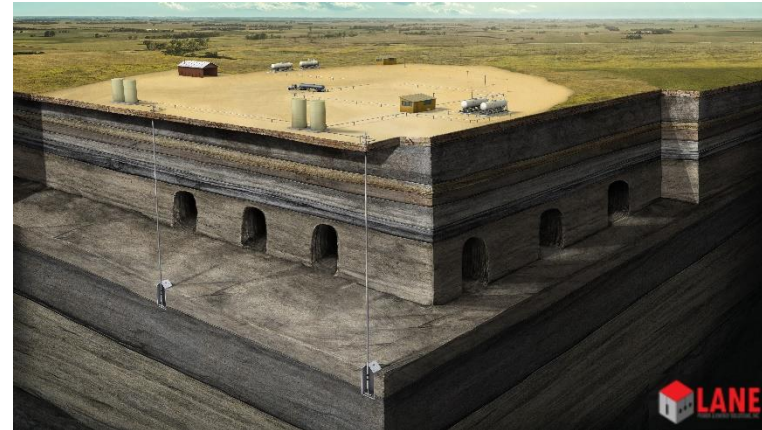
Caverns are Our Core EPC Business

- ✓ Team Experience
- ✓ Hard Rock Caverns
 - 13.5 million Bbl in nine caverns
 - Delivered the only hard rock caverns constructed in US in the last 35 years
 - Reactivated two abandoned caverns for NGL service
 - Converted 73 million Bbl mine to crude oil storage
- ✓ Salt Caverns
 - 100+ salt cavern projects
 - 25+ leach plants
 - *One Hydrogen cavern (2015)*
- ✓ National Energy Security
 - Strategic Petroleum Reserve
 - Waste Isolation Pilot Plant – nuclear waste



Storage Caverns Overview

- ☑ Products stored
 - Gas & liquid hydrocarbons
 - Compressed air
 - Hydrogen
 - Ammonia
 - Helium
- ☑ Solution mined salt caverns
 - 60+ year operational history
 - 2000+ caverns worldwide
 - Several in H₂ service
- ☑ Hard rock caverns
 - 60+ year operational history
 - 200+ caverns worldwide
 - Demonstrated performance to 800 psi (@ 1800' depth)
 - None presently in H₂ service

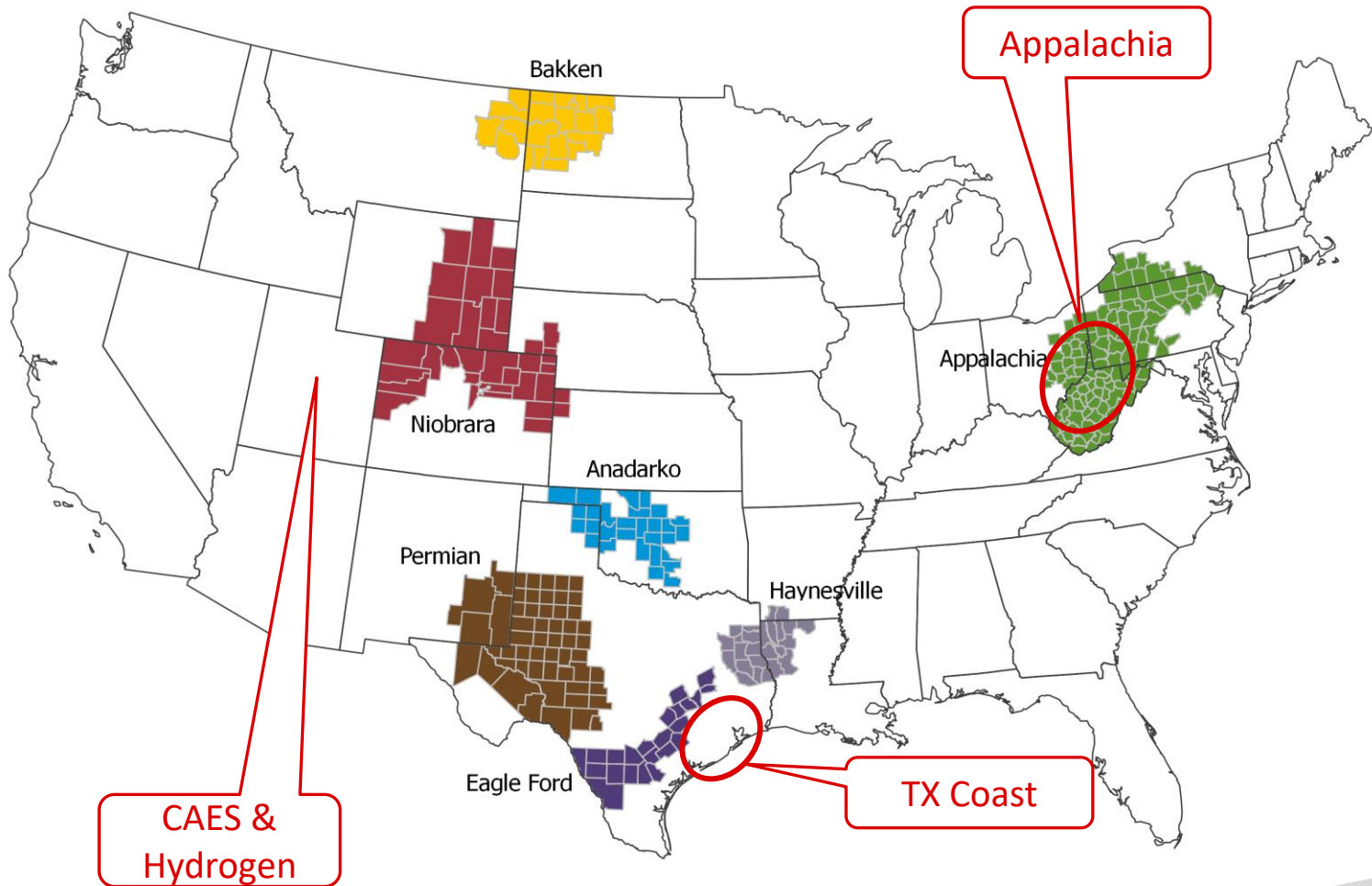


Hydrogen Storage Caverns

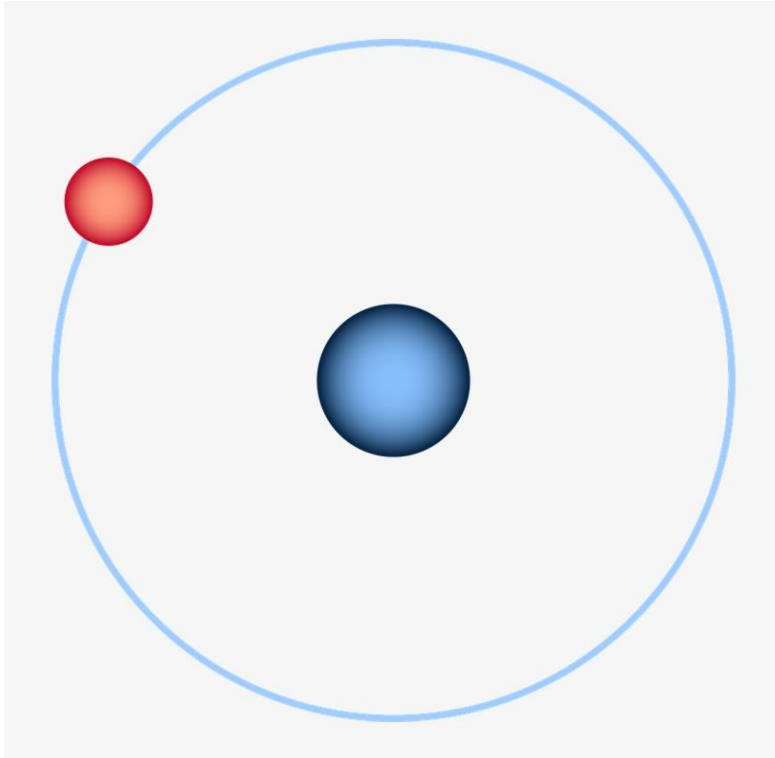
- ✓ Global interest in hydrogen.
- ✓ Design and operation similar to gas storage caverns.
- ✓ Special treatment of production casings.
- ✓ Very large volume.
- ✓ Presently (3) caverns in the US, (3) caverns in UK.
- ✓ Much attention to new development throughout Europe.



Where is the Current US Interest?



Existing H₂ Caverns/Conversion Potential



- ☑ Existing H₂ caverns
 - Teeside, UK. (3) - brine compensated salt caverns
 - Texas. (3) - domal salt caverns
- ☑ Convert existing caverns?
 - Well casings not suitable
 - Requires installing well liner

Key Takeaways

1. Hydrogen is forecast to become a \$130 - \$170 billion US industry by 2050. *(Forbes, Oct 7, 2019)*
2. Biden's Infrastructure plan allocates \$73bn for clean energy, transition and H₂
3. DOE H₂ "Earthshot" - \$1 / kg by 2030
4. Hydrogen can be stored in salt and hard rock caverns.
5. Caverns are far less costly than large volume pressure vessels.
6. Green Ammonia NH₃ will be part of the energy mix
7. Caverns take a long time to construct - *Let's start early!*



Image by Big Guns Energy Services

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