Storing Hydrogen in the Subsurface: Opportunities and Challenges for Low-Carbon Energy

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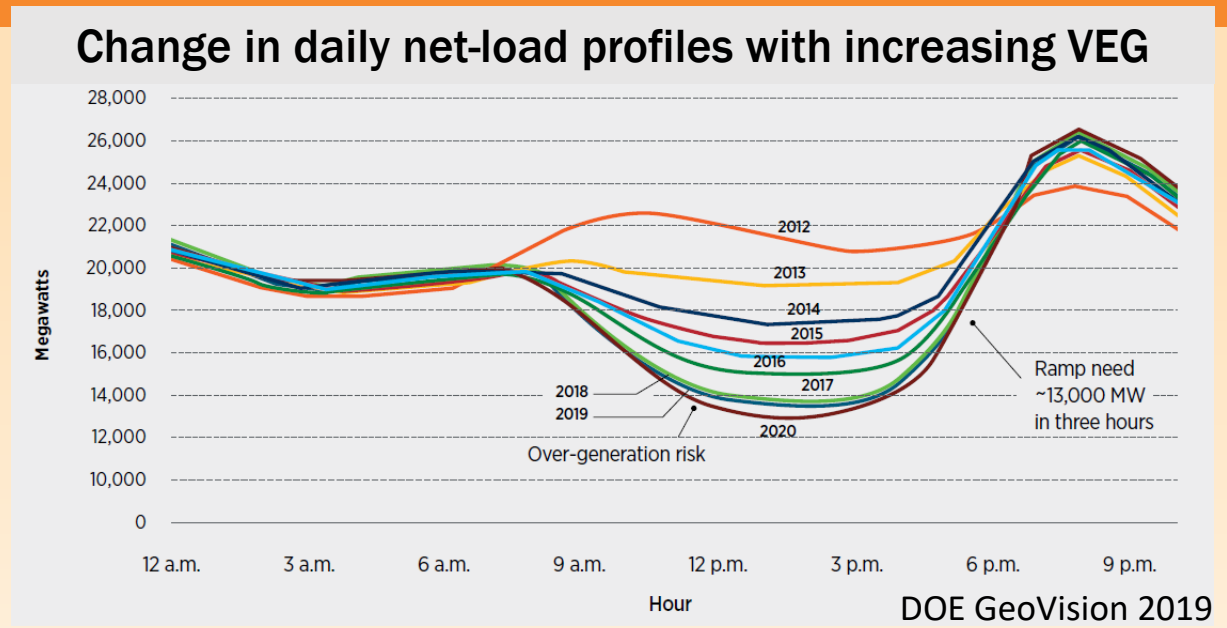
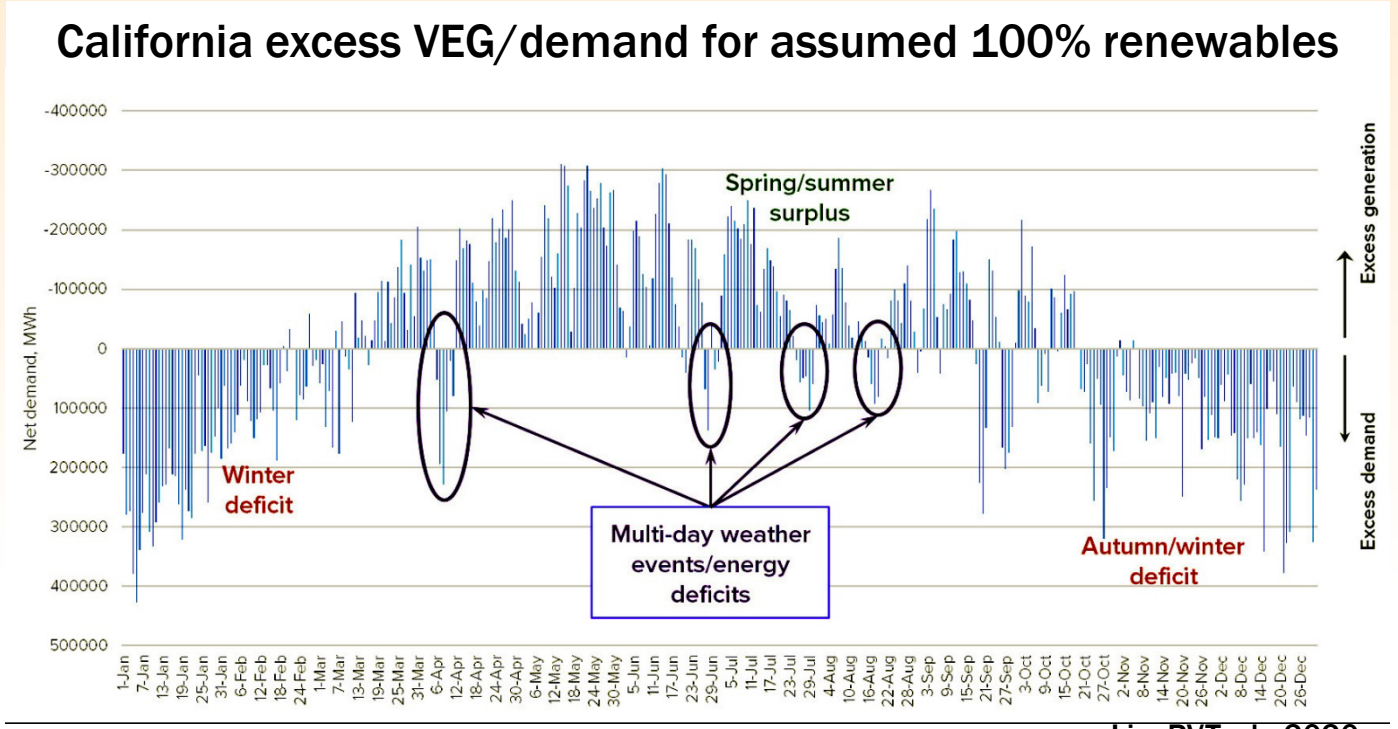
Why energy storage?

- Storage evens out variations and differences in supply and demand

- Increases resilience in energy supply
- Currently: natural gas storage & line pack, pumped hydro, peaker plants, voluntary demand reduction, batteries…
- Increasing variation in load demand on grid with increasing variable energy generation (VEG: solar, wind) limits further deployment without storage
- Energy storage of increasing importance





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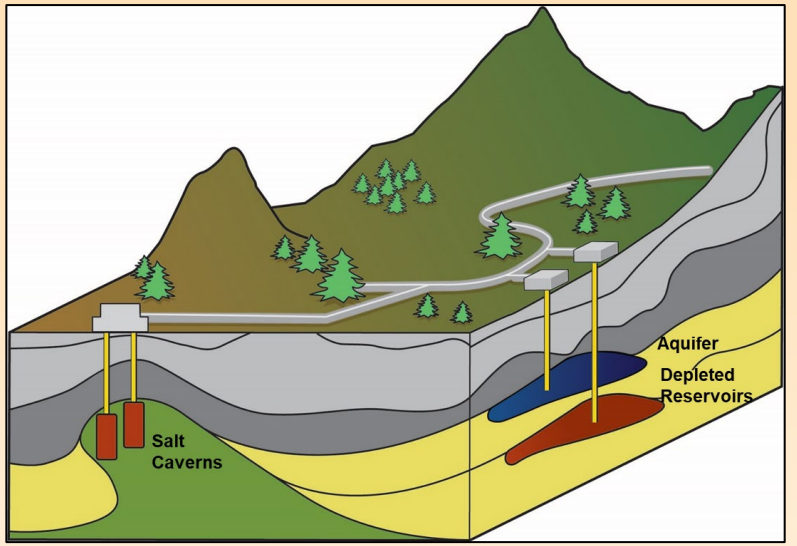
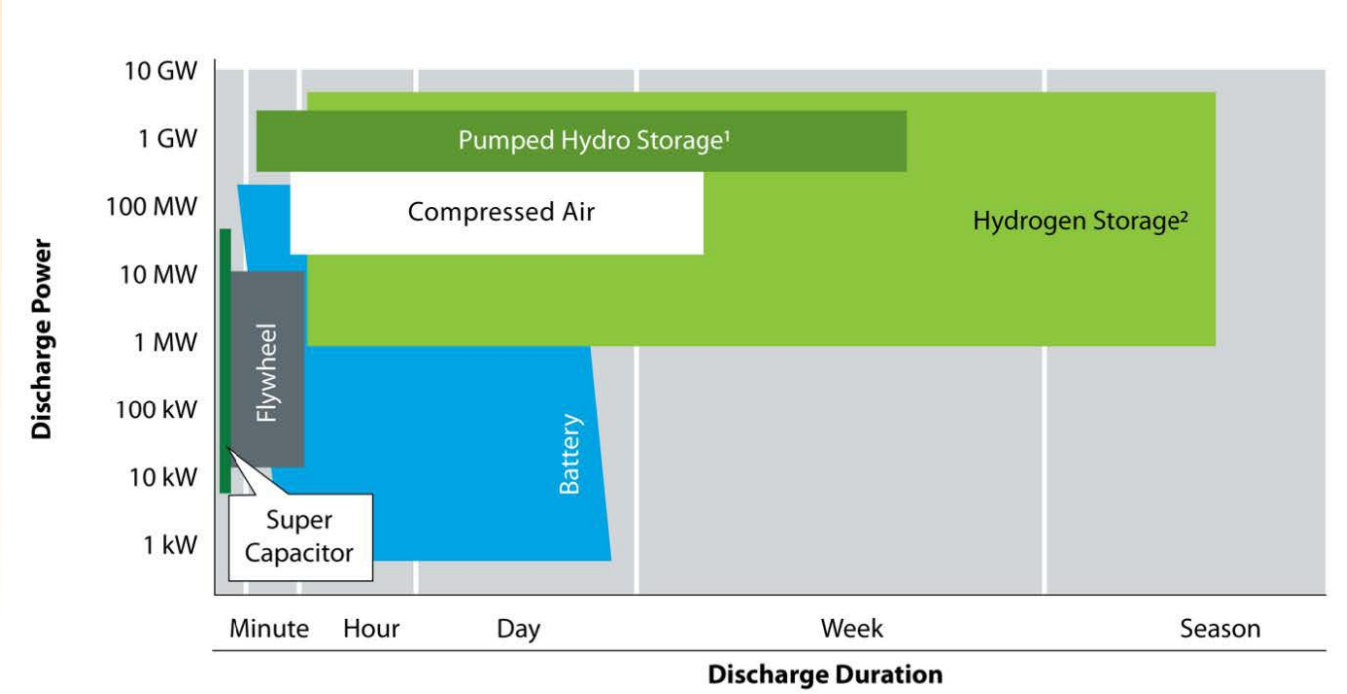
Opportunities for geological hydrogen storage

- Large storage capacity for long duration at low cost



- Hydrogen for intermediate to seasonal storage
- Complementary to other storage options
- H_2 can be stored in tanks and in the subsurface similar to natural gas
- H_2 can be transported in pipelines
- Geological storage: less surface impact than tanks with the same capacity
- Expected to be safer than surface storage
- Can draw from abundant experience with storing NG
- Conversion of existing NG storage sites



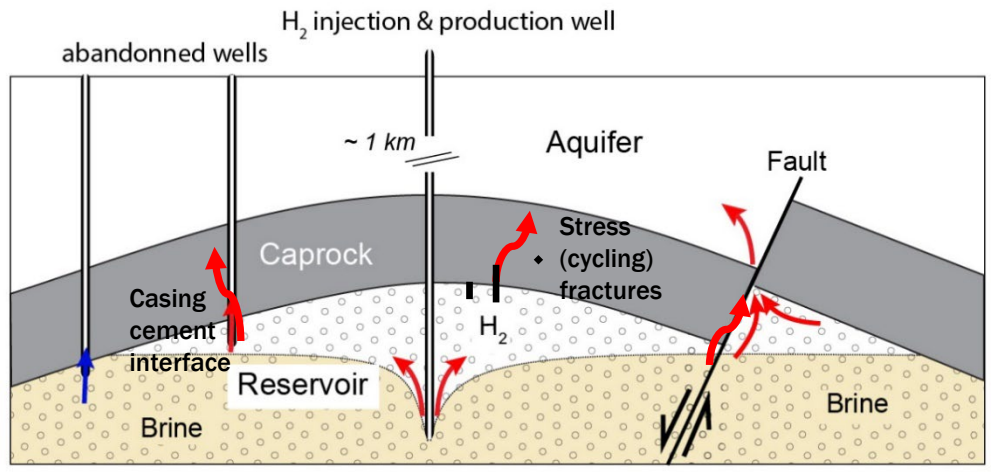
¹ Pumped hydro capacity is limited due to geographic constraints. Estimated maximum potential is <1% of U.S. electrical energy demand
² As hydrogen, ammonia, or synthetic natural gas

NREL 2020

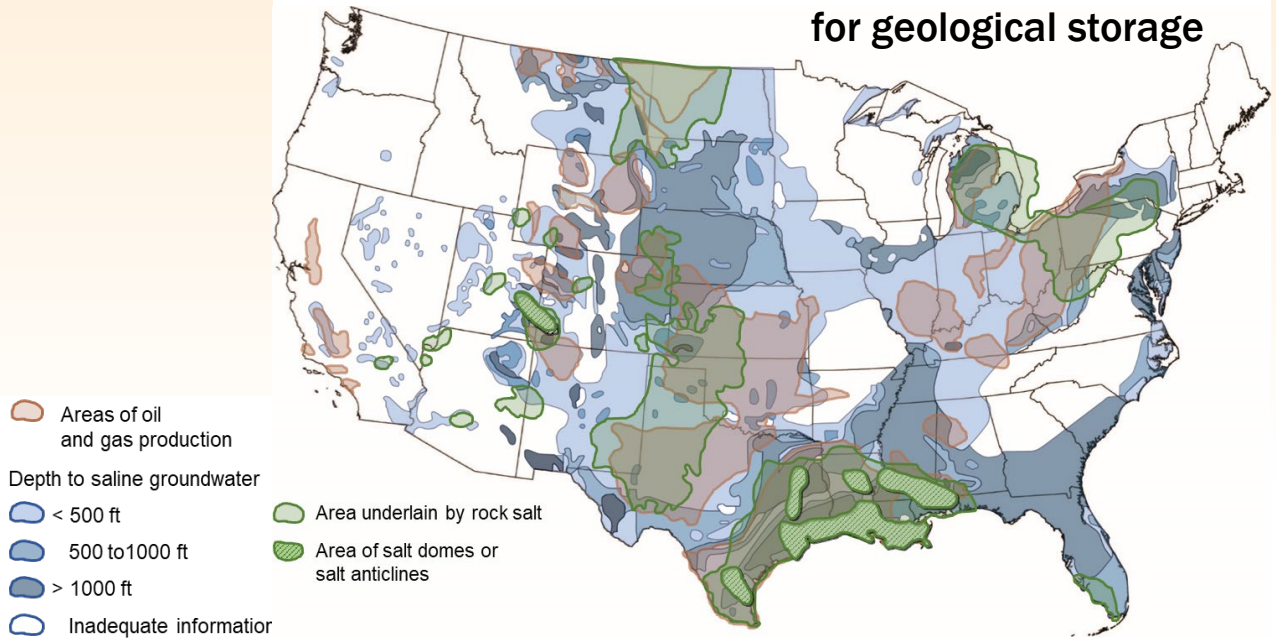
Challenges of geological hydrogen storage

- Location controlled by subsurface geology, not viable everywhere
- Reduced working capacity, H_2 loss by migration within reservoir
- Potential for contamination by chemical & biological reactions
- Leakage through loss in caprock integrity, abandoned wells in depleted O&G fields
- Investment risk—how much H_2 will be needed?
- Competition with NG storage @ lower cost

Leakage risk



Geographic distribution of suitable rock formation for geological storage



Alley, 2003; Johnson and Gonzales, 1978, Lord et al, 2014

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