CAVERN ENERGY STORAGE

Making Renewables Reliable
With Underground Energy Storage.

The Team

William Taggart – Founder/CEO

- Over 35 years in Engineering/Project Management
- Registered professional engineer in Texas & Louisiana
- Graduated cum laude from Tulane University in Mechanical Engineering - 1988

The Advisory Board

Beth Garza

- Over 35 years in Electricity Market
- ERCOT Independent Market Monitor 2014 to 2019

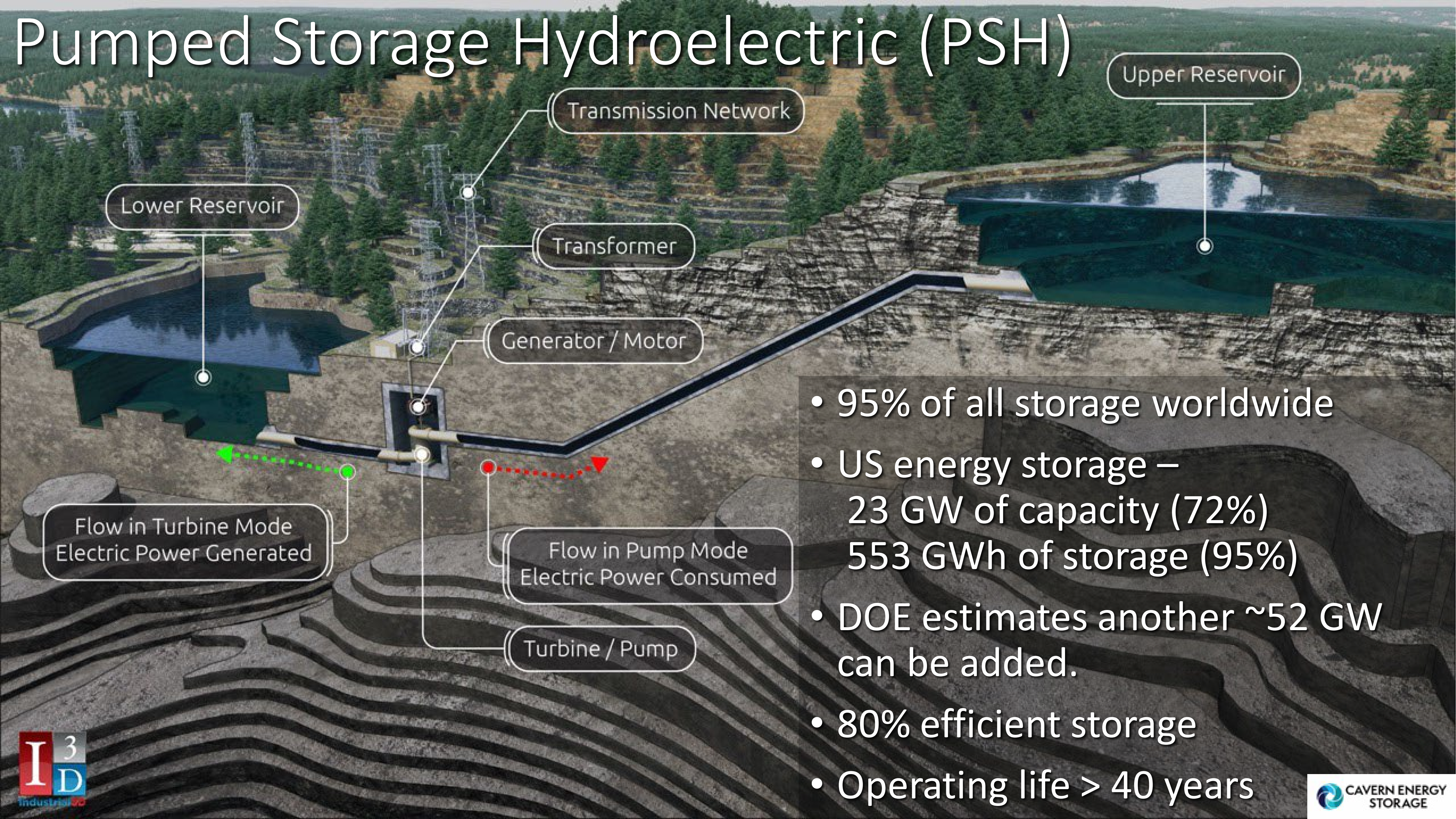
Brian Kling

- Experienced IT professional
- Director of IT for Oil/Gas Firm

Stephen Gerard

- Over 30 years CPA with focus on valuing companies
- 20 years as partner at PwC

Pumped Storage Hydroelectric (PSH)



- 95% of all storage worldwide
- US energy storage –
  23 GW of capacity (72%)
  553 GWh of storage (95%)
- DOE estimates another ~52 GW can be added.
- 80% efficient storage
- Operating life > 40 years

I3D Industrial3D

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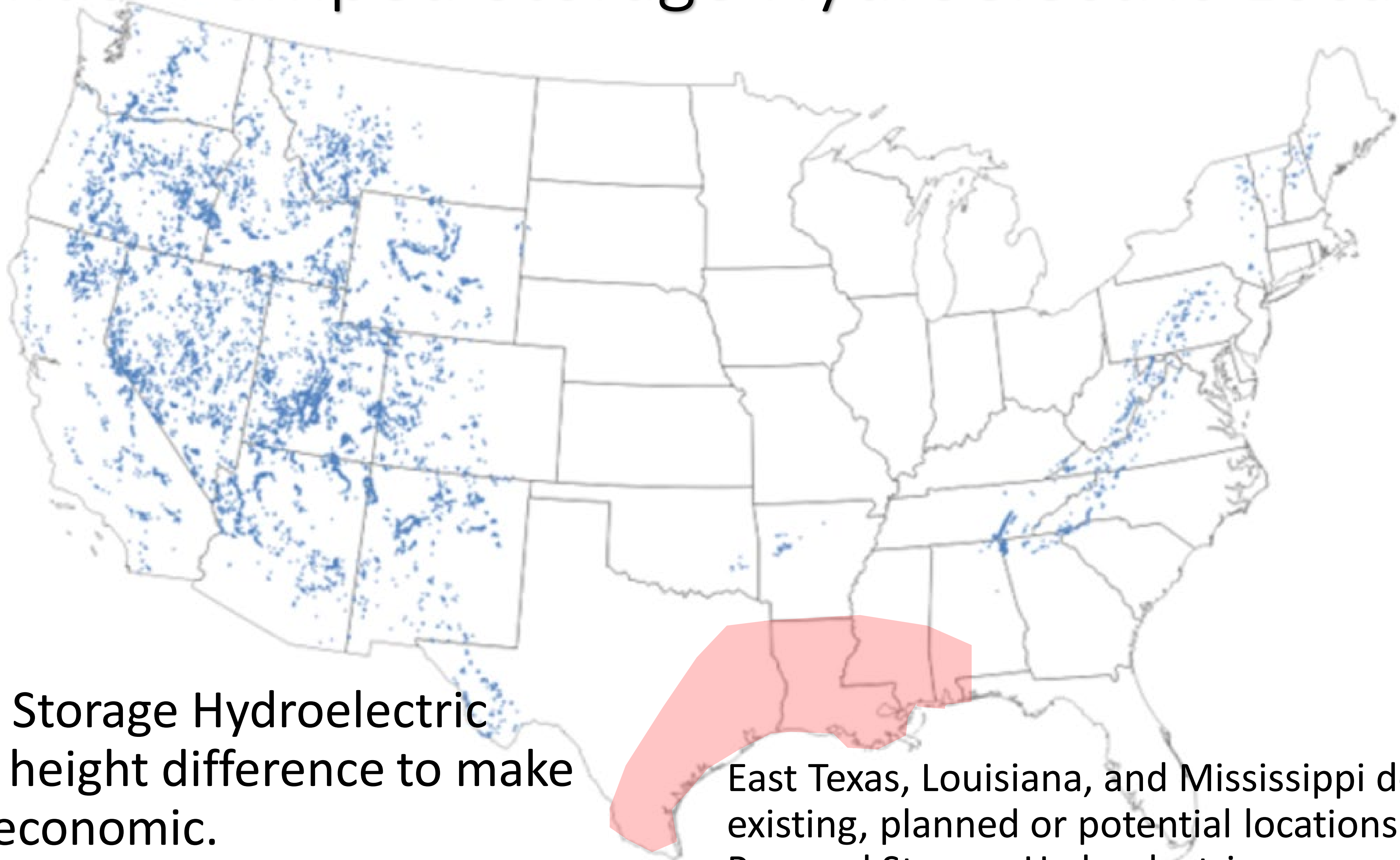
Potential Pumped Storage Hydroelectric Locations



Pumped Storage Hydroelectric requires height difference to make storage economic.

East Texas, Louisiana, and Mississippi do not have existing, planned or potential locations for Pumped Storage Hydroelectric

Spatial distribution of potential PSH sites in the contiguous United States. Image courtesy of NREL.

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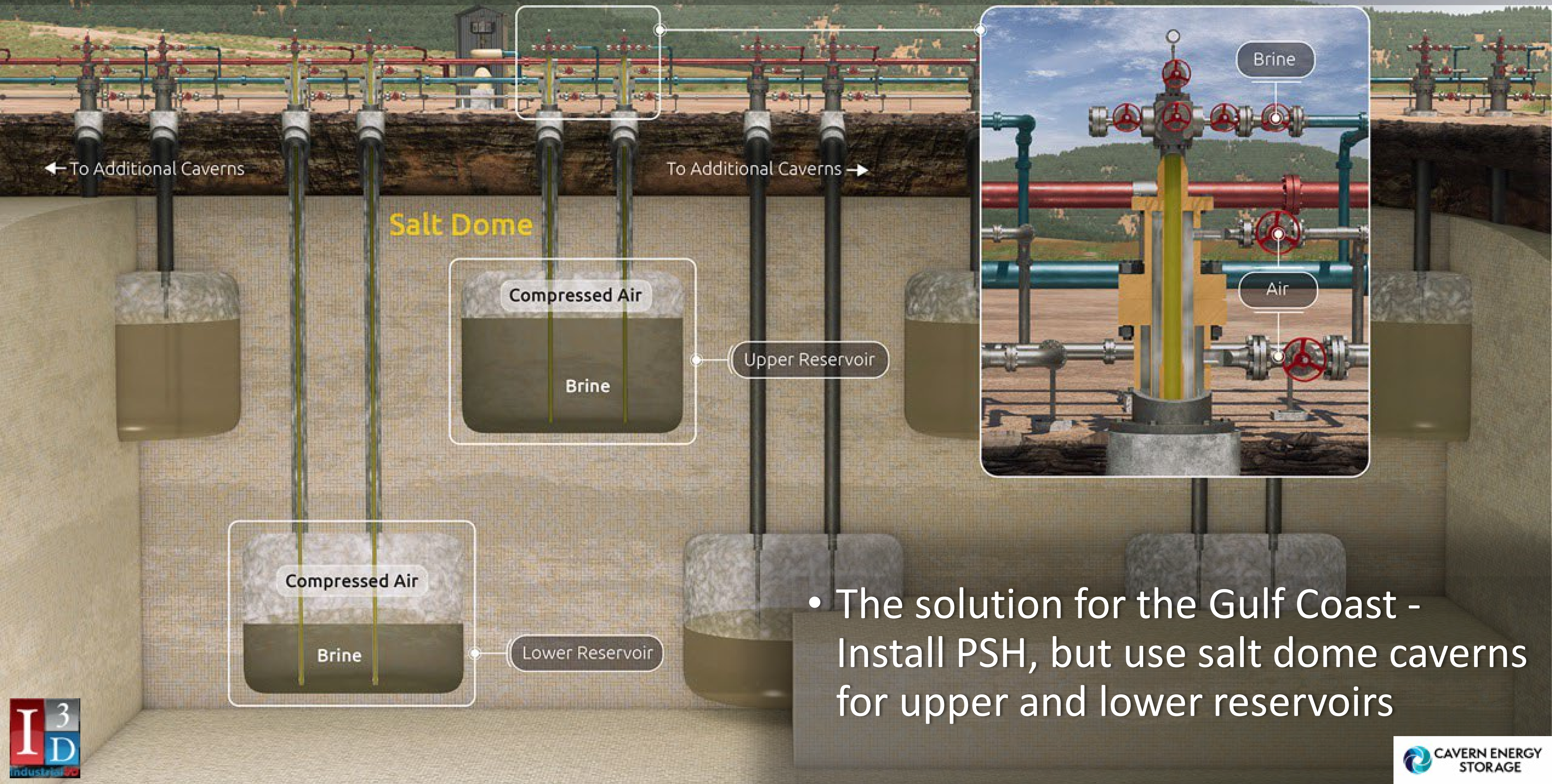
Underground Pumped Storage Hydroelectric (UPSH)



- The solution for the Gulf Coast - Install PSH, but use salt dome caverns for upper and lower reservoirs

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The Gulf Coast has salt domes

- Since the 1940s, companies have used caverns created in salt domes to store oil and natural gas.
- The Department of Energy's Strategic Petroleum Reserve uses 60 underground salt dome caverns to store oil.
- Caverns are being built right now. Construction and regulatory requirements are well understood.

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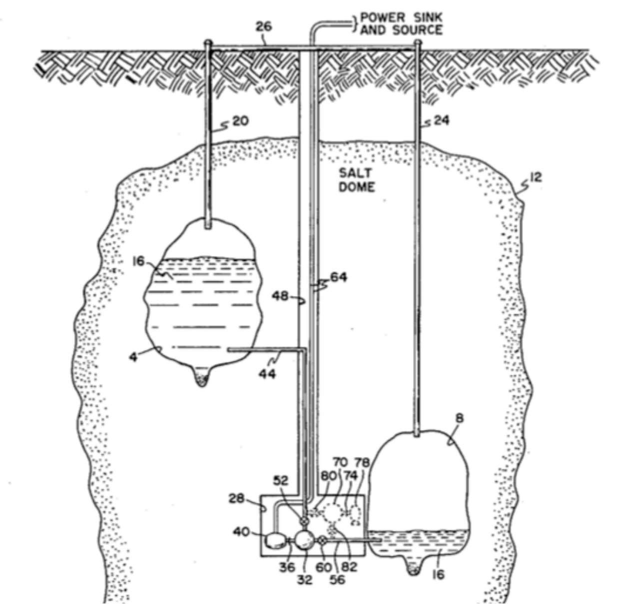
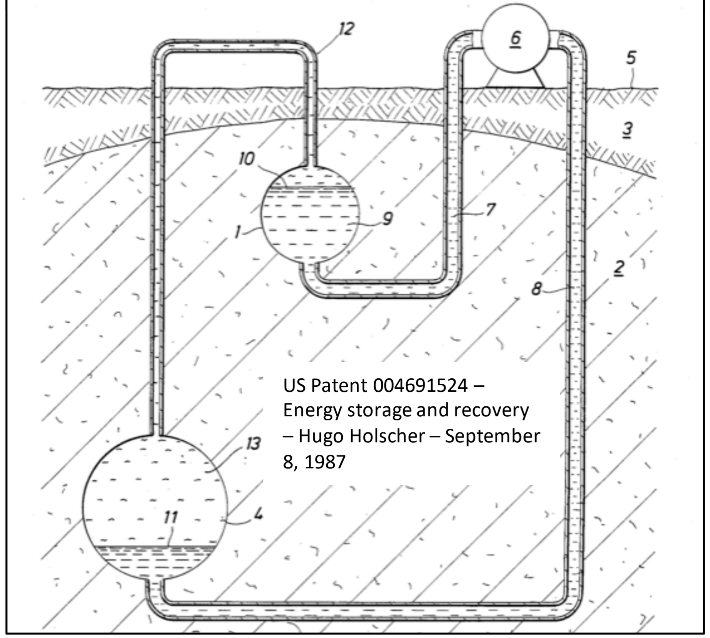
This is not a new idea

- Patents from 1970's showed underground pumped storage hydroelectric in salt domes.
- Some located the powerhouse underground and did not pressurize the caverns, incurring the risk of collapse and increased creep.
- Others used different fluids, oils and other fluids.
- Some used massive shafts to connect chambers
- None were ever built



US Patent 004182128 - Underground pumped liquid energy storage system and method – James H Gardner – December 1, 1977



US Patent 004691524 – Energy storage and recovery – Hugo Holscher – September 8, 1987

Cavern Energy Storage has been awarded a patent

- Our patent is approved by the US Patent Office.
- Patent addresses constructability issues that have prevented UPSH from being deployed.

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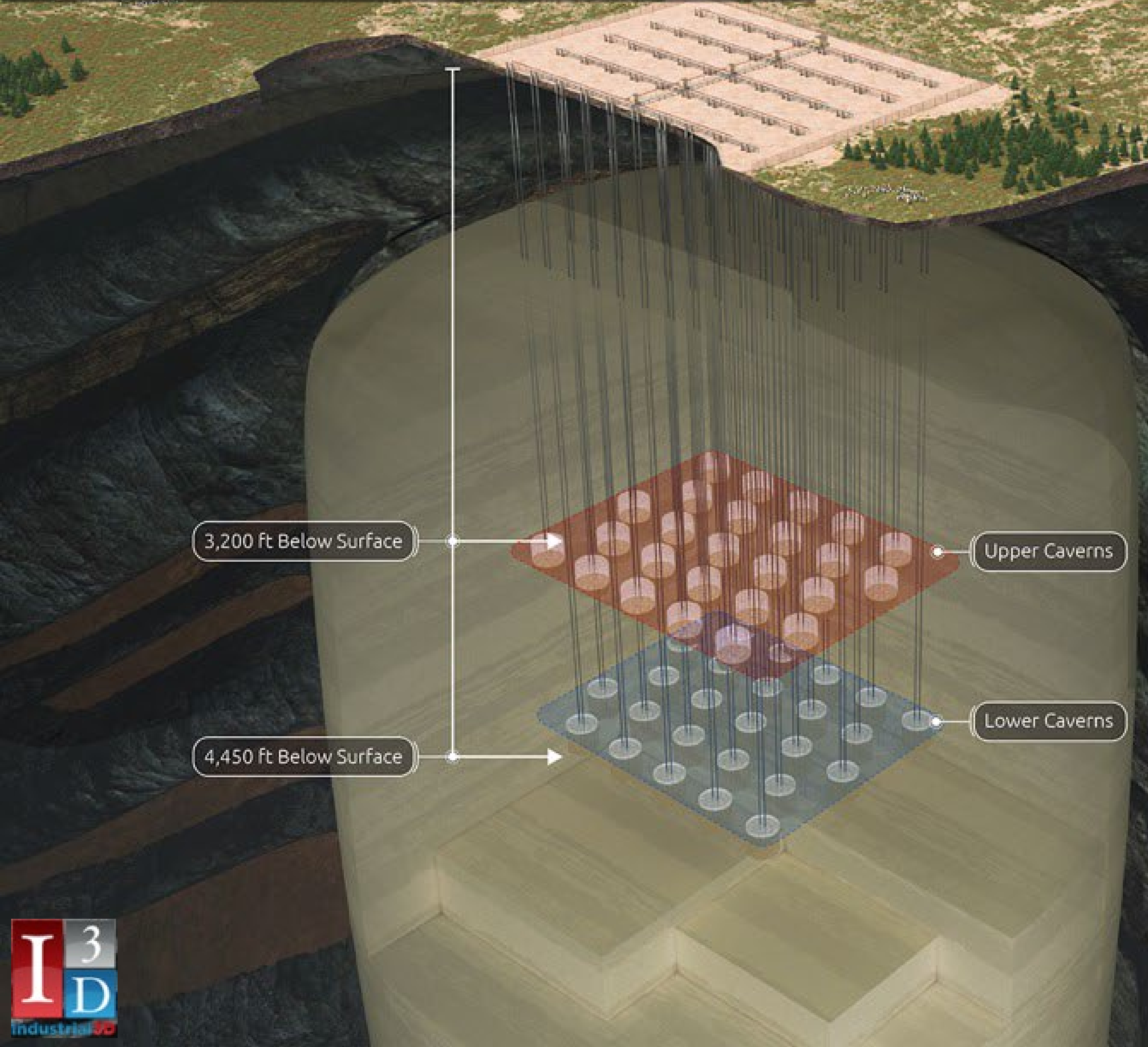
Salt Dome Locations

- 25 Million people live within the region of salt domes, with a need for energy storage.
- We estimate that easily accessible unused salt domes can supply 50 GW of 20-hour storage (1,000 GWh) for the region.

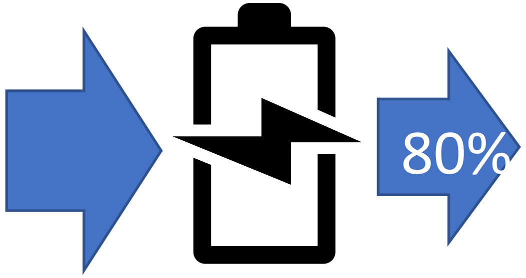
125 MW / 2,500 MWh Small Commercial Unit



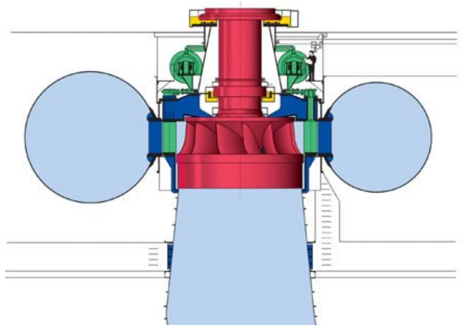
- Modular design with five 25 MW turbines – 125 MW capacity and 20 hours of storage
- Requires 90 acres of salt dome
- Less than 10% of surface area used.
  Can support other activities (grazing/solar panels/wind turbines).

Advantage over other storage options

Off-the-Shelf



Round-Trip-Efficiency



Inertia to support frequency

Greater than 40 years

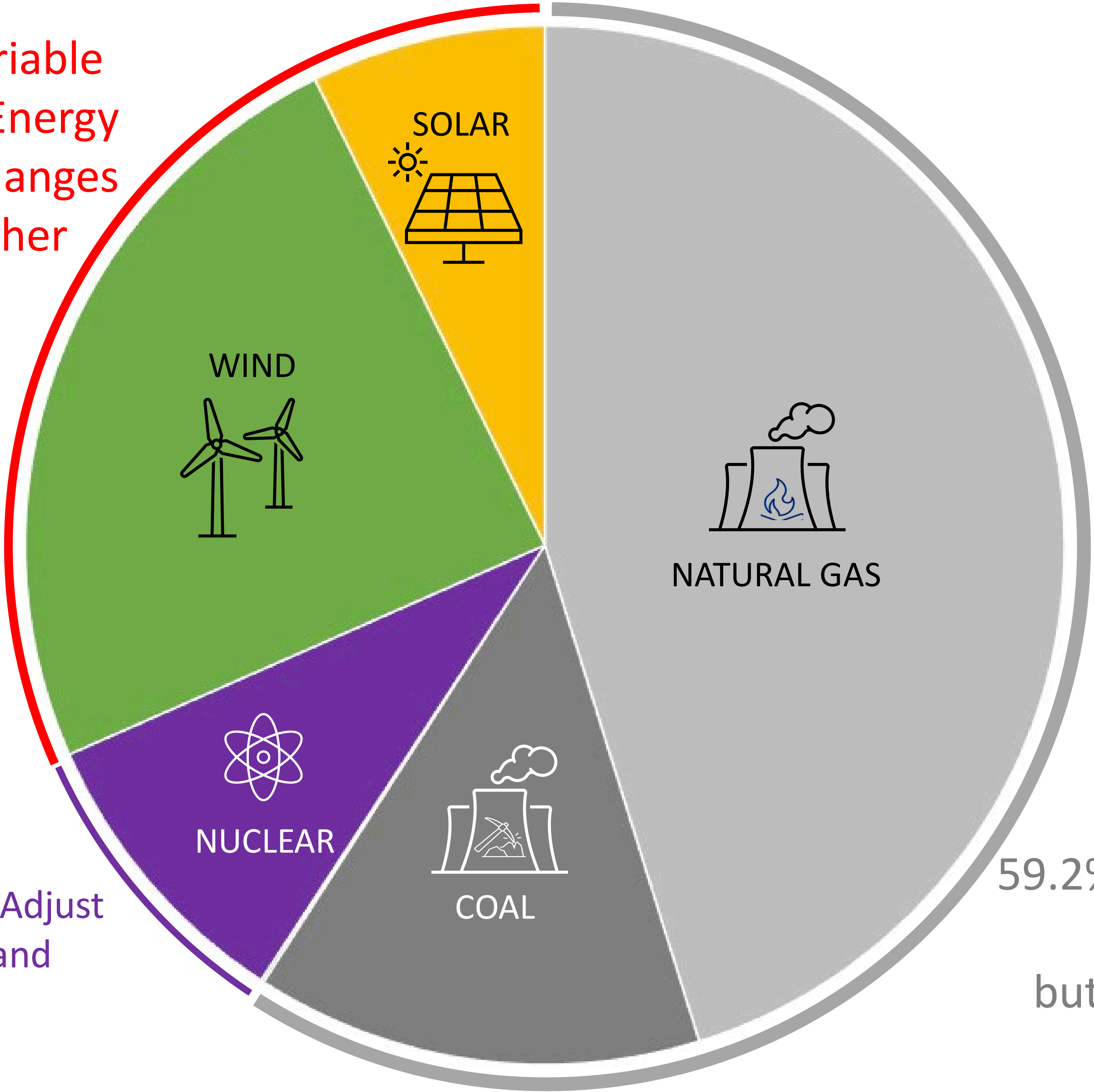
Operating Life

	Storage Duration	Round-Trip Efficiency	Operating Life	Levelized Cost of Storage ($/MWh)	Acres/MWh
Cavern Energy Storage	20 hours	80%	> 40 years	$50 - $70	Medium/Low
Lithium-Ion Batteries	1-4 hours	90% but degrades	5-15 years	$170 - $296	High
Compressed Air Energy	50+ hours	50%	> 40 years	$80 - $150	Low
Hydrogen	50+ hours	35%	> 40 years	$200 - $400	Low
Iron-Air Batteries	100 hours	40%	???	???	High
Quidnet Energy	6 hours	< 60%	???	???	High

Texas needs long duration energy storage

ERCOT 2023 Fuel Mix

31.6% Is Variable Renewable Energy (VRE) and changes with weather



9.2% Can't Adjust to Demand

Increasing Wind and Solar adds volatility to the grid.

59.2% Can Adjust to Demand due to fuel storage but emits carbon dioxide.

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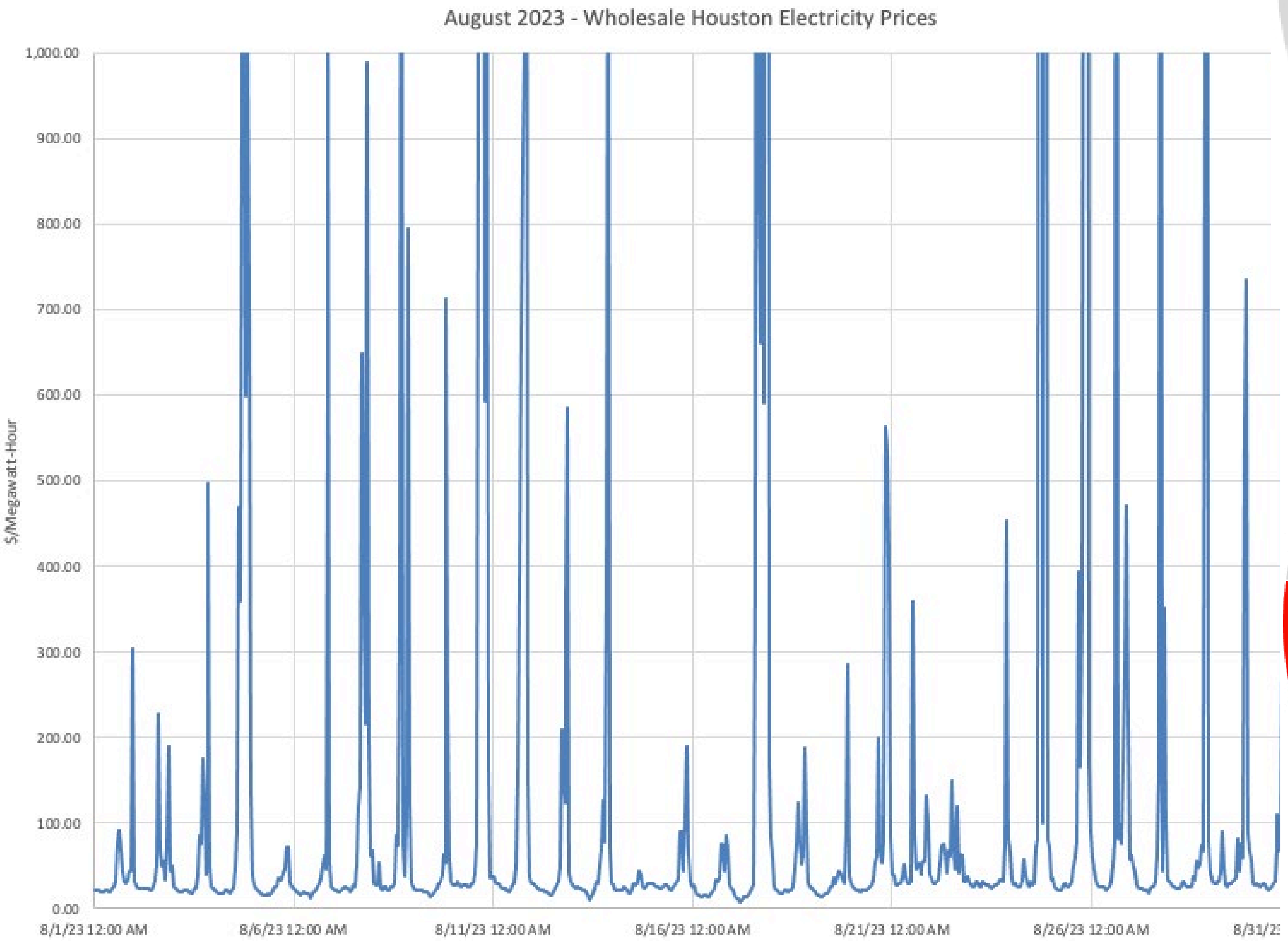
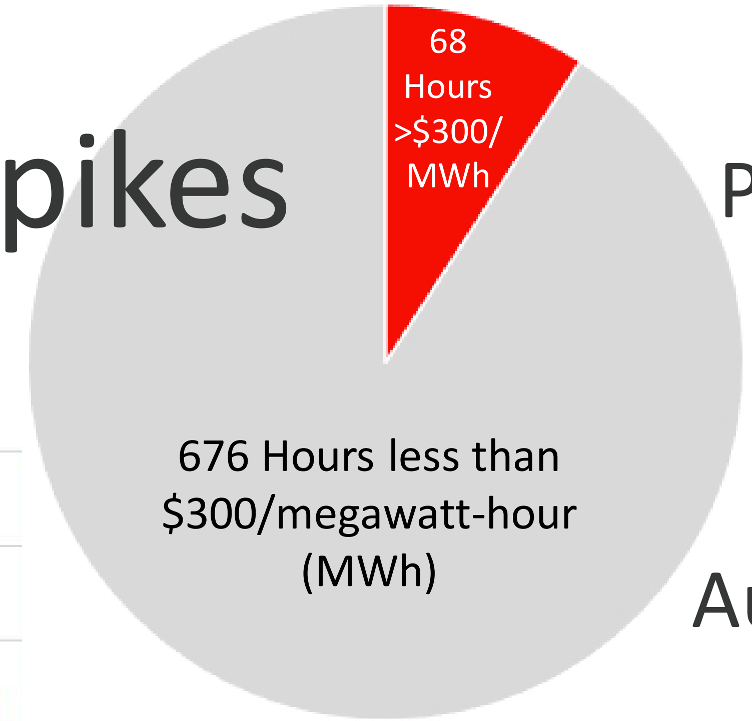
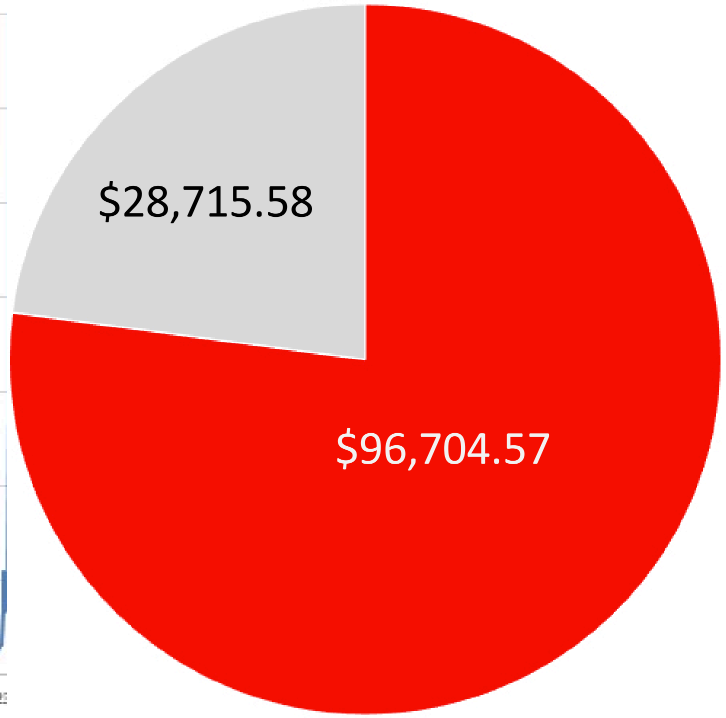
Volatility causes price spikes







Price Spikes during just 9% of the hours in August 2023 accounted for 77% of the cost of electricity

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Economics in ERCOT

Main income will be through arbitrage (buy low /sell high)

- Texas ERCOT – average $/MWh income between high/low for 10-hour charge/discharge

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
$/MWh storage income	$15	$20	$11	$14	$20	$22	$27[+]	$16[@]	$32*	$57	$61
% Wind & Solar	10%	11%	12%	15%	18%	19%	21%	25%	28%	31%	32%

- DOE Target Cost for long duration storage is $50/MWh
- Cavern Energy Storage can achieve levelized cost of storage of $50/MWh with two things
    - Reduce drilling costs through repetitive modular design (shale producers have seen large savings in drilling costs using repetitive design).
    - Recover salt during construction and sell for 40% of retail road salt price.

[*] - 2021 was $76.30, but is $32 without February Uri Freeze

[@] - 2020 was COVID and electricity pricing was down 33%.

[+] - 2019 was $39.46, but is $27 without August Heat Wave

What do we need – A Stable Market

Texas ERCOT - Main income through arbitrage (buy low /sell high)

- 2023 – One Megawatt of capacity (10 hour 80% RTE) - $ 225,000 for the year
- 2024 – One Megawatt of capacity (10 hour 80% RTE) - $ 68,625 for first 8 months

Potential Income is down 60% since since last year.

Reasons -

- Summer has been much cooler in Texas and surrounding states.
  EIA reported Heating Degree Days -   2023 – 1870
  2024 – 1653 – down 12%
- An almost tripling of the Lithium-Ion Batteries in ERCOT.
  Battery operators will earn a lot less money this year – down 50+%
- The big competitor for storage is natural gas peaker power plants
  And at $2/mcf natural gas – they make electricity at $18/MWh fuel cost

Long Duration Energy Storage (LDES) addresses the issue of price volatility.

"LDES can provide system flexibility—the ability to absorb and manage fluctuations in demand and supply by storing energy at times of surplus and releasing it when needed. It offers a way of integrating and providing flexibility to the entire energy system..." – McKinsey & Company, November 2021 report on Net Zero Power

- The Department of Energy estimates the US will need 1,000 gigawatt (GW) of electrical energy storage to support a 90% renewable energy system.

- In 2022 the US had only 32 GW of existing storage compared with 1,167 GW of power generation. University of Michigan – Center for Sustainable Systems Sept 2022

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Road Map

Timeline	9 months	12 months	24 months	24 months	24 months
Phase	Pre-SEED ($300k)	SEED ($2M)	Series A ($12M)	Series B ($20M)	Series C ($120M)
Funding Source / Decision Gate	SBIR / STTR Phase 1 and/or 3rd party funding Is Tech Viable?	SBIR/STTR Phase 2 or 3rd party funding Is Alpha Demo Viable?	SBIR / STTR Phase 3 and 3rd party funding Is Alpha Demo a Success?	DOE Funding/Loan and 3rd party funding Is Beta Demo Viable?	DOE Funding/Loan and 3rd party funding Is Beta Demo a Success?
Tasks	• ORNL Technoeconomic Analysis • TAMU Metallurgical Analysis • ORNL/ANL hydraulic/ thermodynamic studies	• Identify and secure existing salt dome caverns for Alpha Demonstration Unit • Scale Model in the lab • Front-End Engineering Design of Alpha Demonstration Unit	• Order pump and hydroelectric turbine • Prepare salt dome caverns • Build / Operate Alpha Demonstration Unit (1 MW /$350k/yr revenue)	• Identify and secure salt dome acreage for Beta Demonstration Unit and Commercial Unit 1 • Front-End Engineering Design of Beta Demonstration Unit	• Order pump and hydroelectric turbine • Drill wellbores and build caverns for Beta Demonstration Unit • Recover and sell salt • Build / Operate Beta Demonstration Unit (5 MW /$1.7M/yr revenue)
TRL Level	4	5	7	7	9
Valuation	$0.5 M	$2.5 M	$15.0 M	$35.0 M	$200.0 M
Employees	1 to 2	2 to 4	4 to 5	6 to 8	8 to 12

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Summary Slide

In a nutshell? - Cavern Energy Storage aims to provide a scalable and cost-effective solution for long-duration energy storage, in regions where traditional pumped hydro is not viable but salt domes exist.

Customers / Partners?
The Texas ERCOT market is seen as the beachhead for this technology with customers being operators of power plants or those wishing to enter the ERCOT energy market. Oak Ridge National Laboratory, Argonne National Laboratory, and Texas A&M College of Engineering have partnered with CES to submit pending grants. The technology is seen as advantageous to oil/gas operators due to the strong dependency on drilling and seismic analysis.

Value Proposition?
Cavern Energy Storage's value is providing long-duration energy storage by combining pumped storage hydroelectric technology with salt dome caverns. The approach offers several advantages:

- Scalable, long-duration, inertia-based, and readily dispatchable solution for clean energy storage which is crucial for integrating intermittent renewable energy sources into the grid.
- Provides 12+ hours of energy storage at 80% round-trip efficiency.
- Leverages the abundant salt dome formations in the Gulf Coast region of the United States, where conventional pumped storage is not feasible due to the flat terrain.
- Storage is underground, surface area can be used for other activities like ranching, solar panels, or wind farms.
- Can be built economically and at lower cost than other grid-scale storage systems.

Test Case

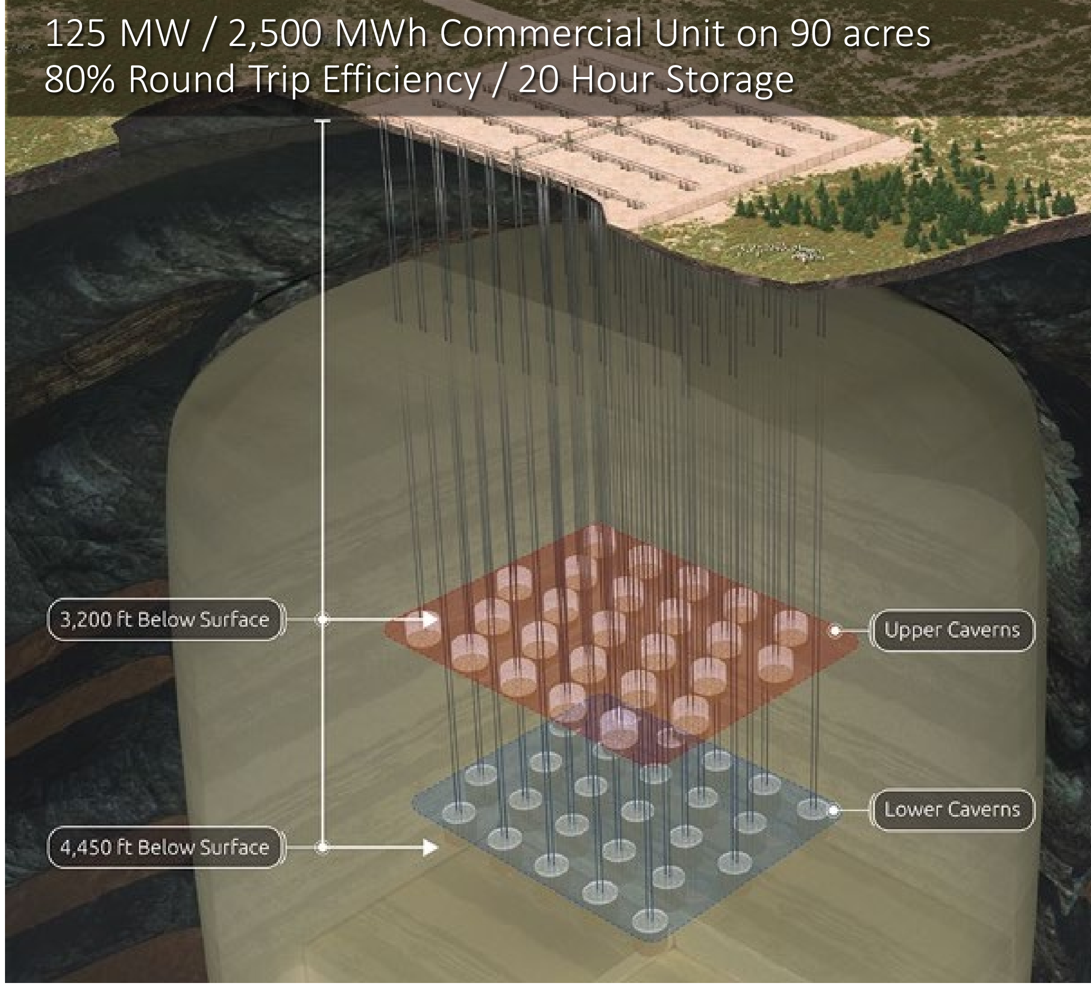
- Pumped Storage Hydroelectric and salt dome caverns are both TRL 9, the combination of Underground pumped storage hydroelectric is TRL 3/4 at the moment. CES is positioning to build a 1-megawatt demonstration unit using existing salt dome caverns in the next two years.

Status

Company Name – Cavern Energy Storage, LLC
Focal Point – William Taggart - william@cavernenergy.com
Website – cavernenergy.com
Maturity – TRL 3
Deployment Status – Pre-Seed Funding

bitly

www.CavernEnergy.com



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