



# Advanced Clean Energy Storage

Jim Greer – Project Director

Crisis in Power Engineering Education:

A National Security Concern – **Challenges & Solutions**

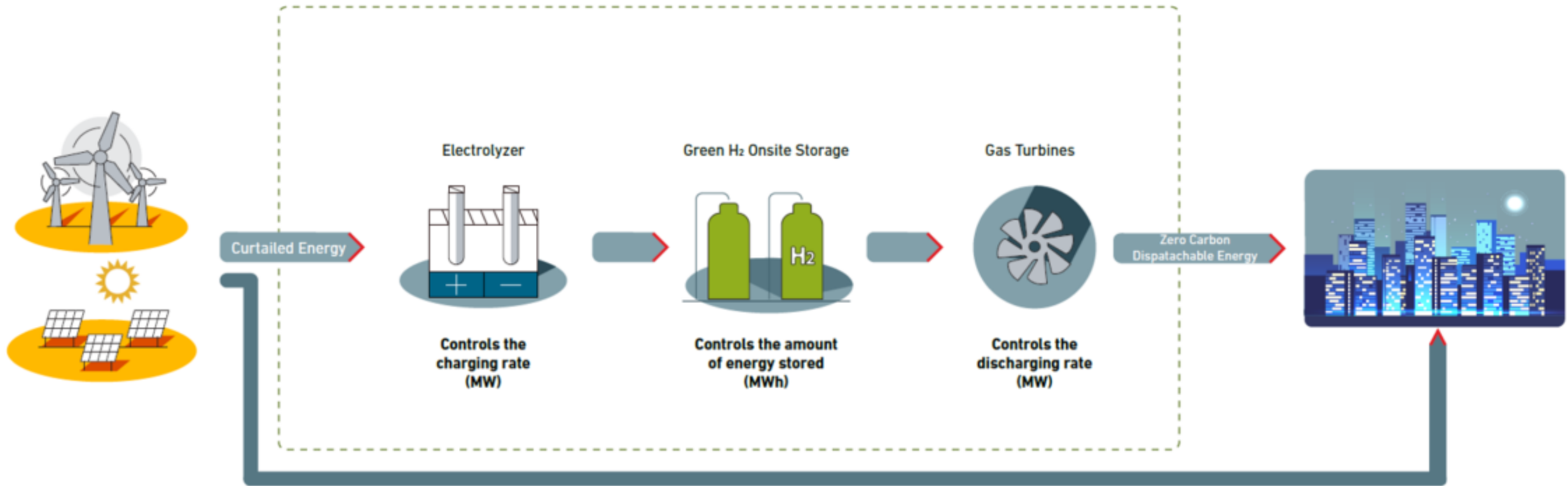
October 21, 2022

# The World's First and Largest Renewable Energy Storage Hub in Utah



- The world is on a mission to become carbon-neutral.
- Enabling previously unattainable utility and industrial scale storage of renewable energy.
- Transforming intermittent renewables into reliable, safe, and affordable energy.
- With ACES Delta the clean energy possibilities are limitless.

# What is ACES Delta?



**Advanced Clean Energy Storage: The conversion of renewable energy into hydrogen for long term storage before dispatching back to the grid at utility scale.**

- **Reached 20% renewable target beginning in 2010**
- **Achieved 37% in 2020**
- **Targeting 80% renewable by 2030**

**100% carbon free energy by 2035**

# Our Innovative & Pioneering Customer

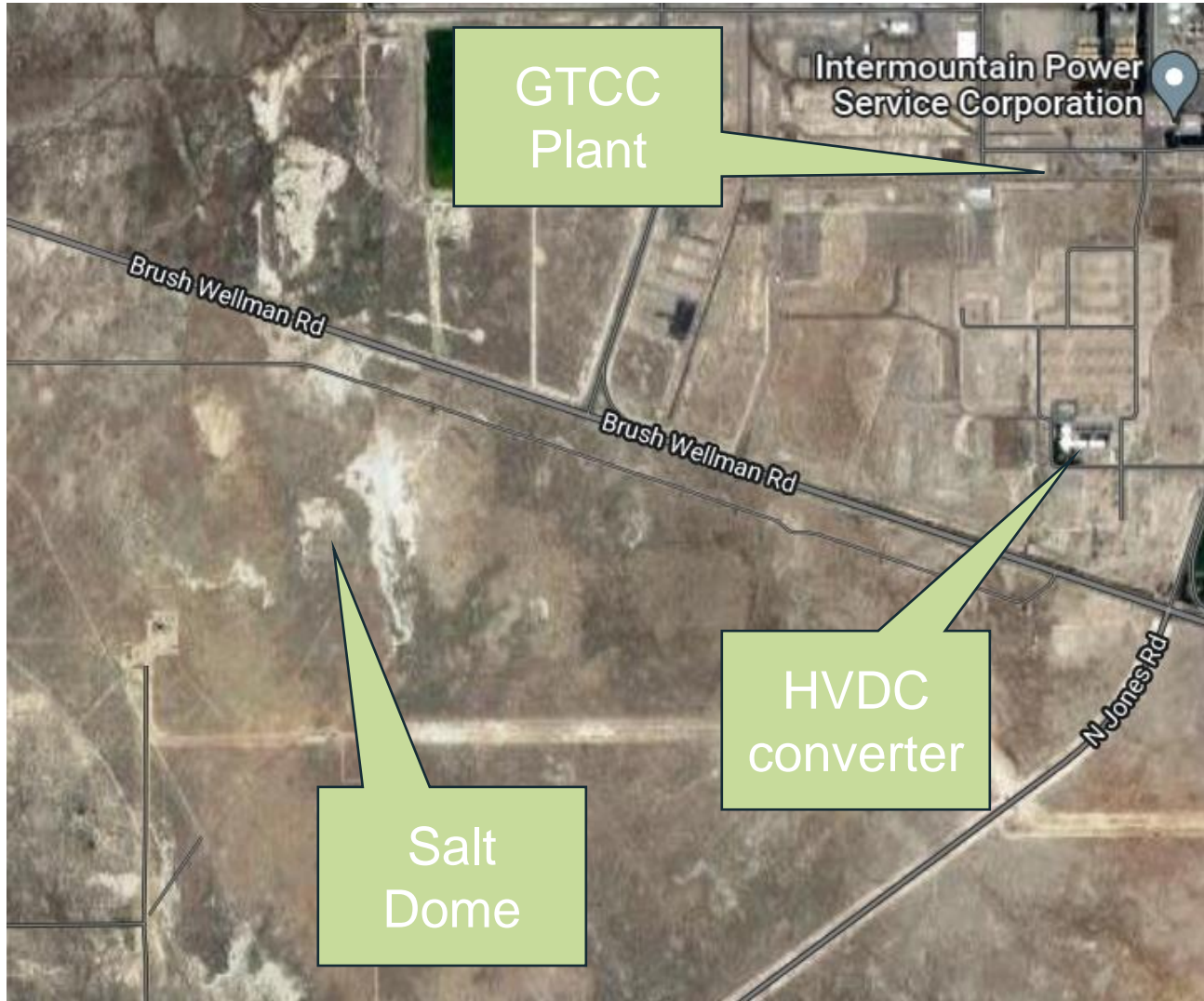


**Figure 1 LADWP's External System**

- Intermountain Power Project was built in the early 1980's to deliver power from a 1600 MW coal fired power plant near Delta, Utah to LA.
- LADWP is the largest municipal utility in the U.S. serving over 4 million residents with electricity and water.
- \$4 Billion operating revenue.
- System peak demand ~ 6,200 MW in summer; 2X winter demand.
- Southern Transmission System consists of a 488-mile 500kV HVDC overhead bipole line connecting Utah to southern California load centers.



# Why was ACES first?



- IPA was committed to keeping this power plant viable for decades longer
- ACES Delta consortium partners foresaw the value of the salt dome for energy storage
- Mitsubishi Power moved proactively in determining the place of gas turbines in a decarbonized world
- Magnum Energy pioneered the Western U.S. salt dome energy hub.
- “Trust, Transparency, and Collaboration” were the tenants everyone lived by

**Opportunity + Determination = Success**

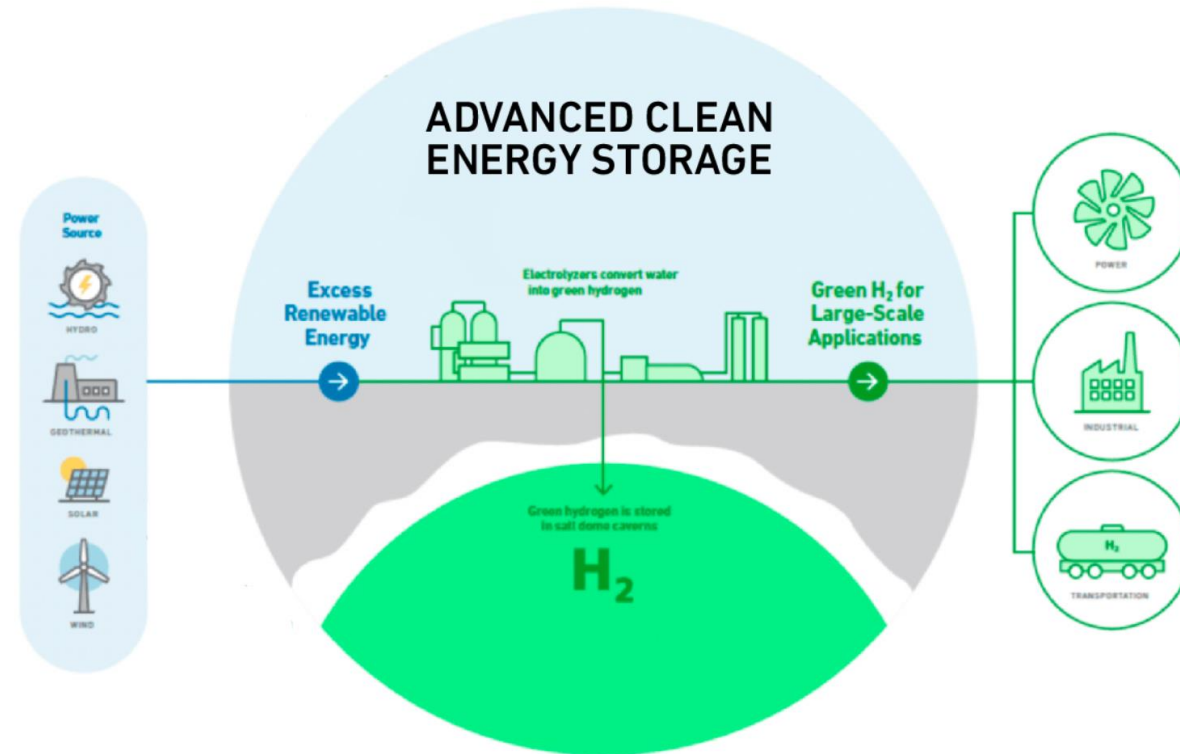
- June 2022 – Financial closing of \$504 million loan guarantee from the U.S. Department of Energy Loan Program Office to ACES plus private equity to develop the world’s largest green hydrogen facility in central Utah.
- Hub will supply IPP Renewed, a new 840 MW hydrogen capable gas turbine combined cycle power plant. The plant will initially run on a blend of 30% hydrogen and 70% natural gas starting in 2025 and ramp up to full hydrogen.
- The Hub will produce up to 100 metric tons per day of green hydrogen using electrolysis and stored in two massive underground salt caverns.
- Total energy storage capacity in the two caverns is **300 gigawatt hours**.
- “This project sets the industry gold standard for hydrogen deployment, helping to combat the impacts of climate change and advance human prosperity”.

--- Bill Newsom, President and CEO of Mitsubishi Power Americas



- A new combined cycle power plant located at the existing IPP site near Delta, Utah operational by 2025 to replace the existing coal generators.
- Will initially run on a 30/70% hydrogen and natural gas blend ramping up to full hydrogen by 2045 in support of California targets.
- \$2 Billion investment.
- 2 Mitsubishi M501JAC power blocks.
- Extra capacity on transmission grid still available for more interconnected renewable power.





**The Advanced Clean Energy Storage hub provides a complete end-to-end solution for Power, Industrial, and Transportation users representing spokes of the hub**

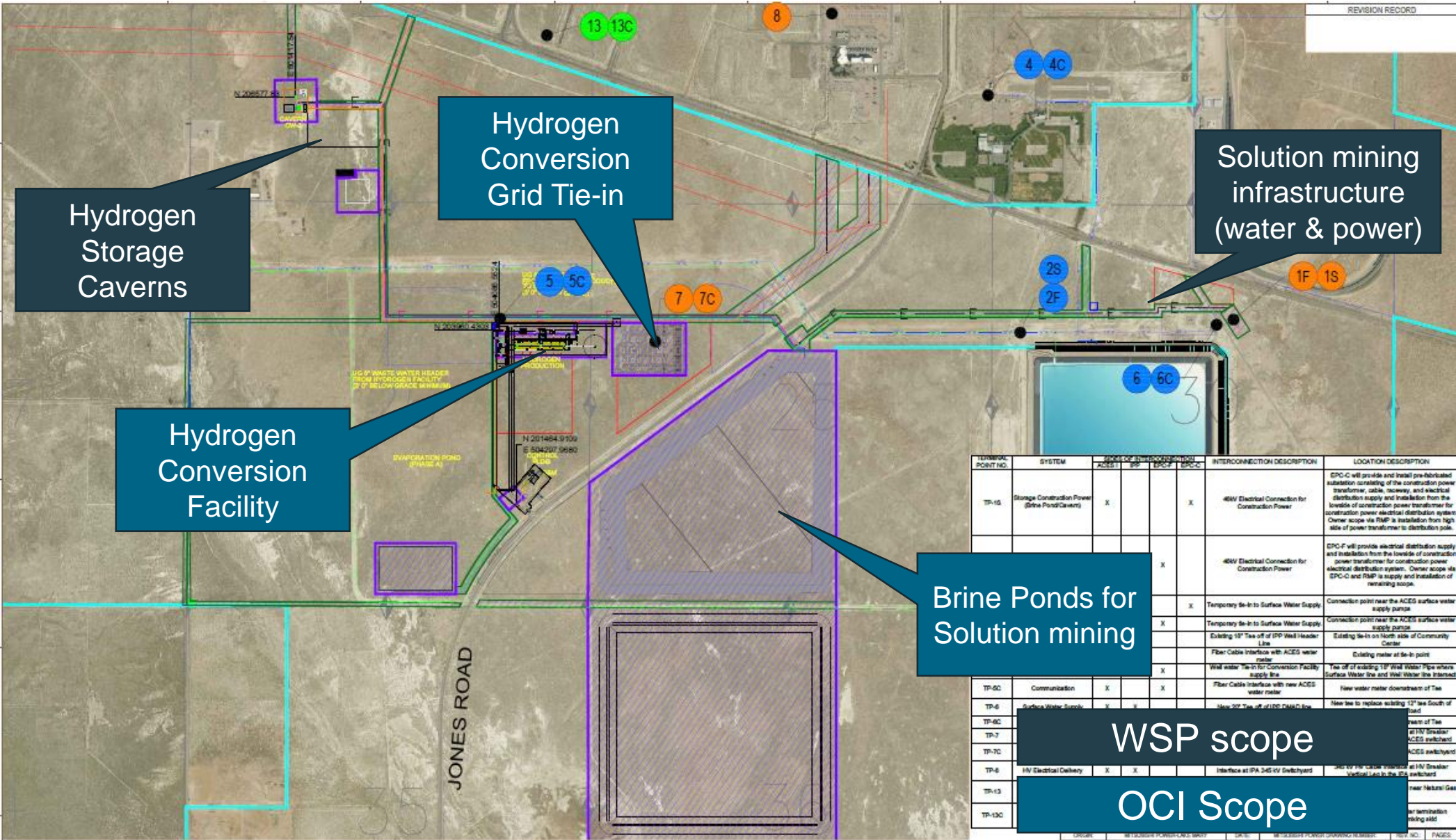
# Safety Moment – Hydrogen Basics

- Hydrogen is the lightest molecule in the universe and is a gas at ambient conditions
- It is 14 times lighter than air so it rises ~22 m/sec and disperses rapidly
- It is colorless, odorless, tasteless, and undetectable by human senses
- It is non-toxic and non-poisonous but can be an asphyxiant at high concentrations
- It is flammable and explosive over a wide range of concentrations
- It has a very low ignition energy and can be easily ignited by a small spark
- It is non-corrosive but can embrittle some metals; material compatibility is key





# Utah Hydrogen Hub Site Layout



# Types of Electrolyzer Technology

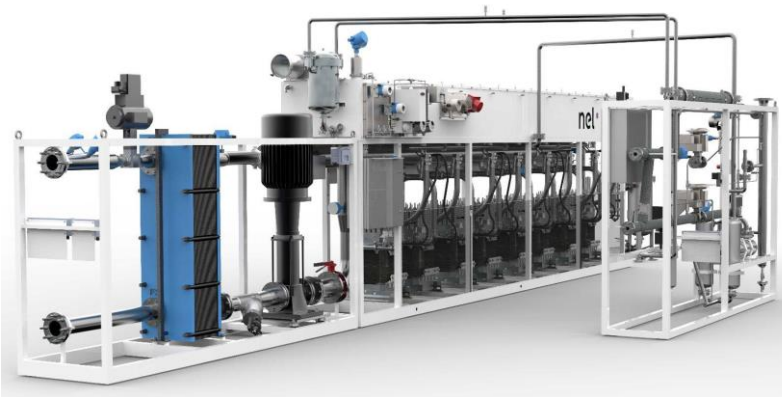
	Alkaline	PEM	Solid Oxide
Chemistry			
Cell Temperature, °C	60 – 90	50 - 80	700 - 1000
Critical Material for Electrodes	Nickel, iron	Platinum, iridium	Nickel on ceramic
Working fluid	KOH solution	DI water	Steam
Relative Capex	Base	Higher	Likely higher
Efficiency	Base	Slightly lower	Highest
Footprint	Base	More compact	Likely more compact
Minimum load,%	20 – 40 per cell stack	5 – 10 per cell stack	TBD
Startup Time	Hot – Base Standby - Base	Hot – Similar Standby – Faster	TBD
Maturity at MW Scale	Fully commercial	Newly commercial	Still developing

## Alkaline:

- Fully mature, commercially available technology in MW-scale sizes
- Multi-MW scale electrolyzers have been operating since 1920's
- Atmospheric or pressurized systems available
- Common Electrode Materials – Nickel and Iron

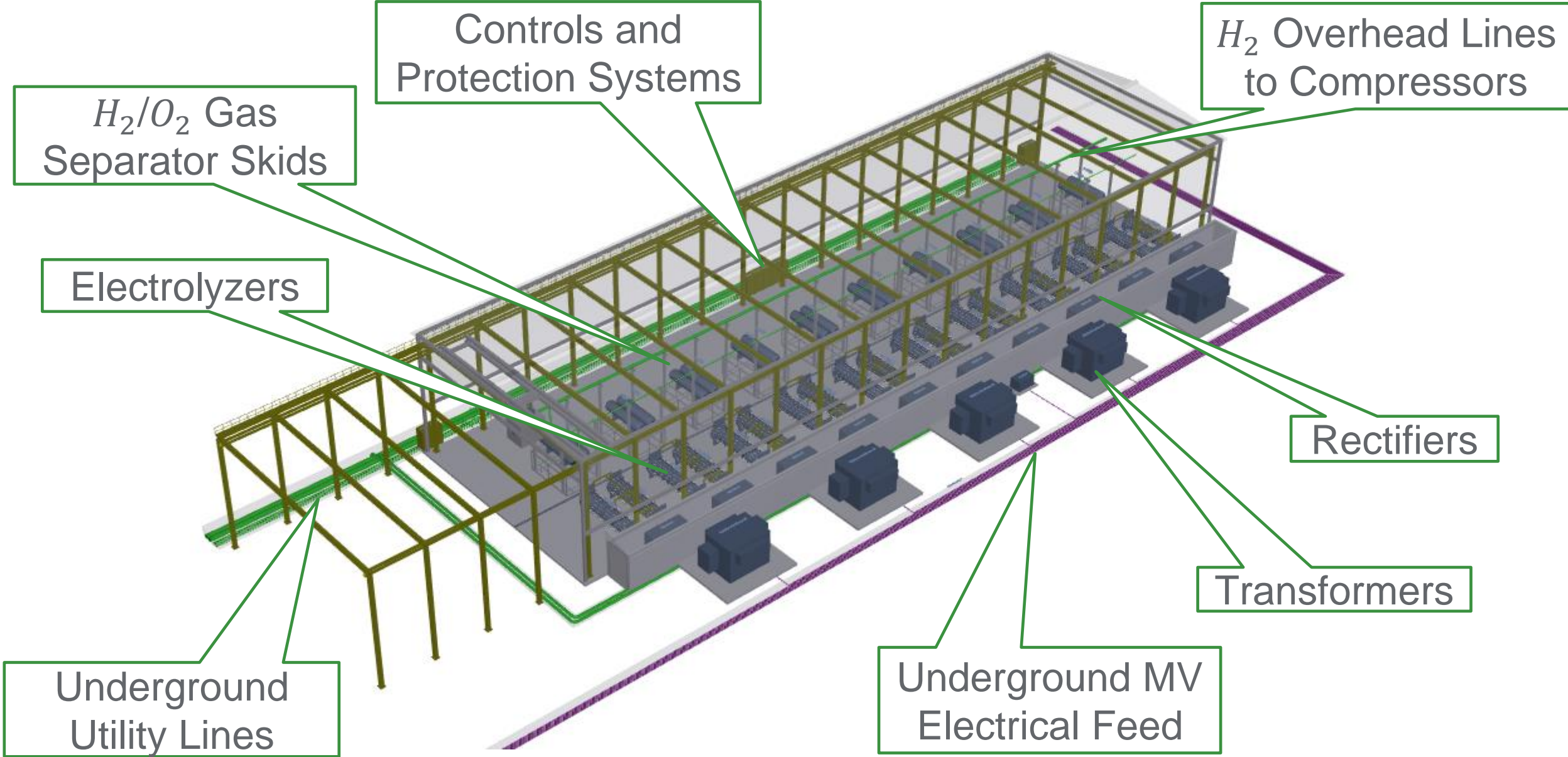
## Proton Exchange Membrane:

- Smaller footprint due to higher current densities
- Enhanced operating capabilities ideal for smaller systems requiring precise load matching
- Shorter installation and operational experience
- Exotic Electrode Materials – Platinum and Iridium



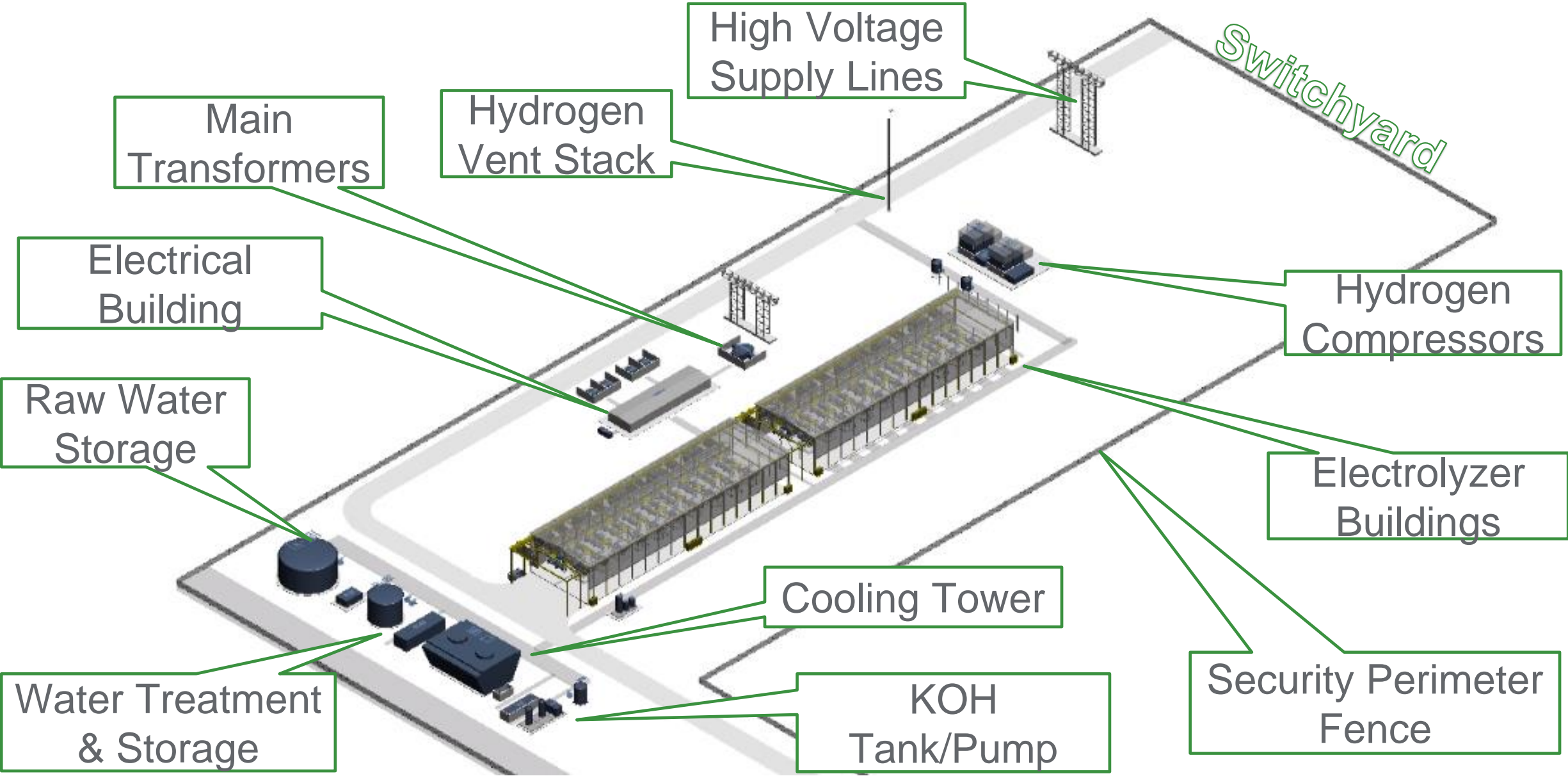


# Hydrogen Facility: Building Overview (2 TPH / 110 MW)



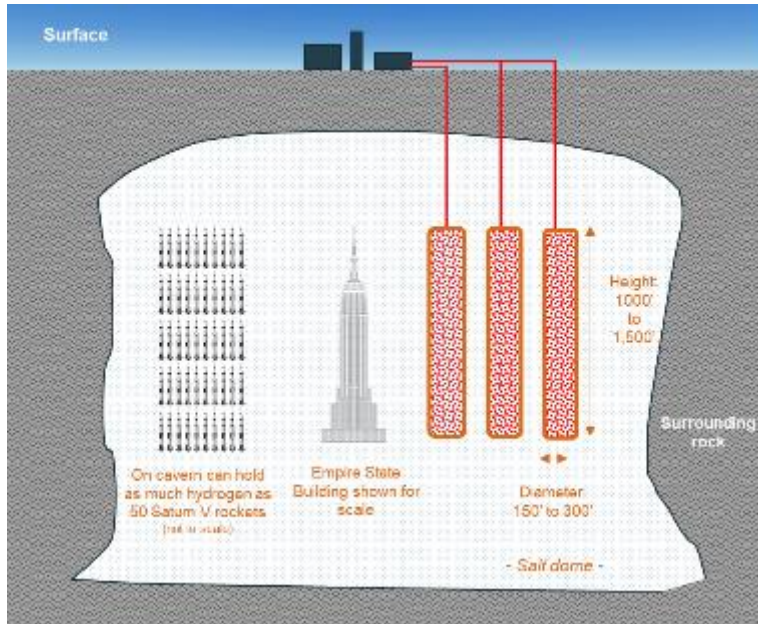


# Hydrogen Facility: Block Overview (4 TPH / 220 MW)



# Proven Gaseous Hydrogen Storage Methods

## Salt Cavern



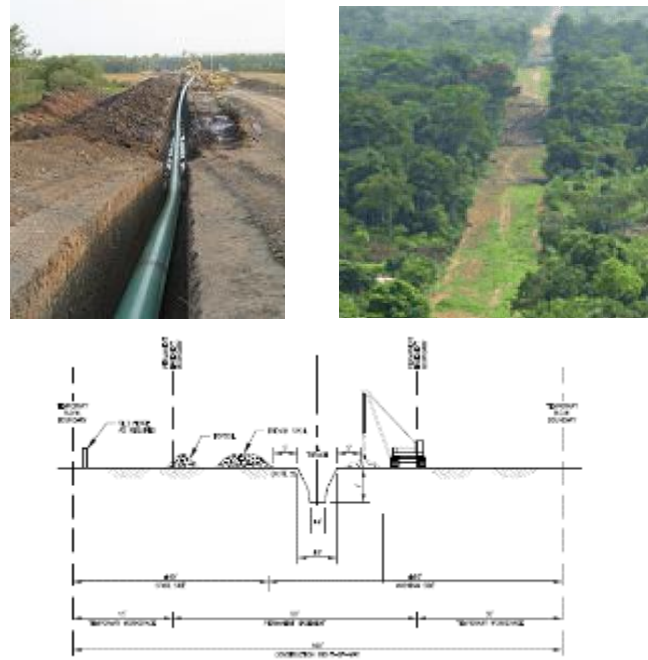
### Per 1 Cavern Stats

>100,000 MWh

5,500 tonnes H<sub>2</sub>

10 days to 1 month

## Hydrogen Pipeline Pack



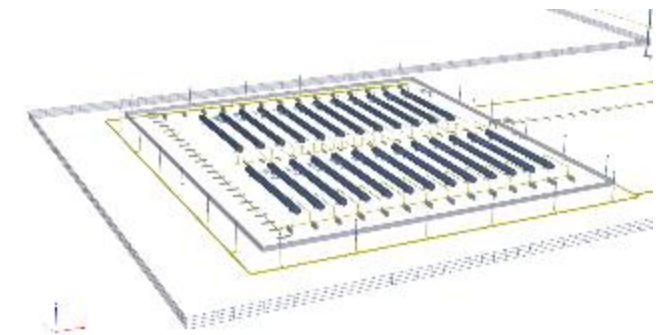
### Per 10-mile Stats

>1,000 MWh

38 tonnes H<sub>2</sub>

2 hours<sup>3</sup> to 16 hours

## Pressurized Vessels



### Per 10-Vessel Stats

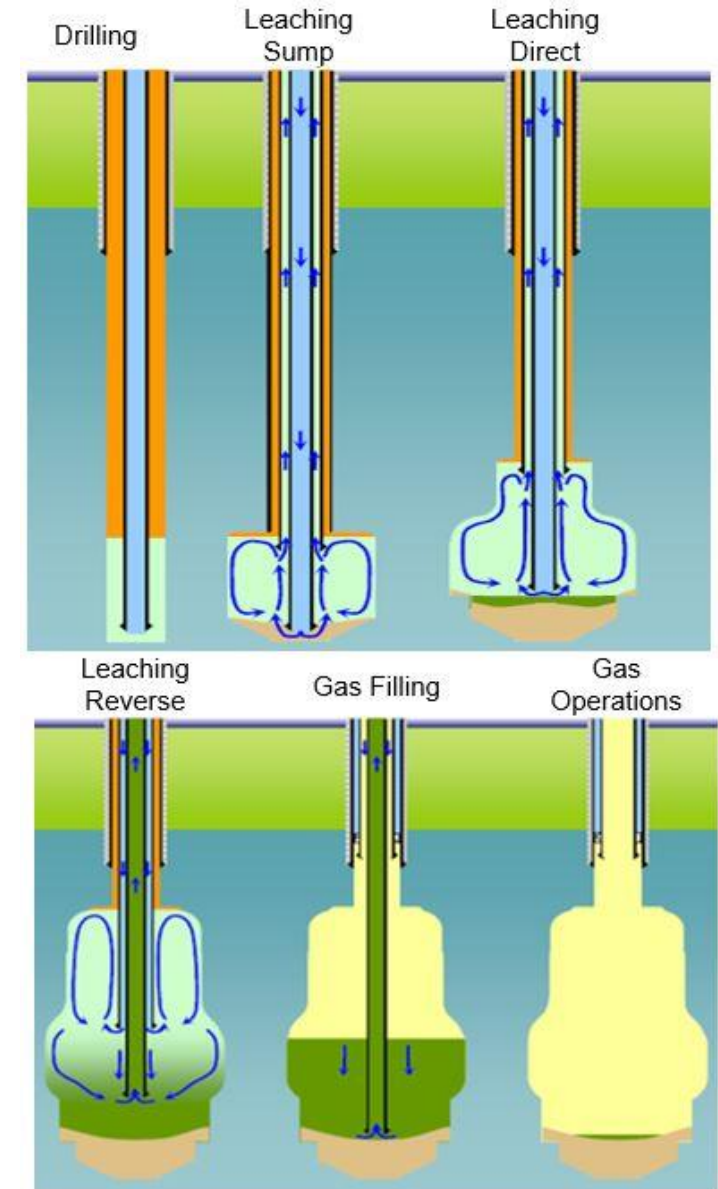
>200 MWh

8 tonnes H<sub>2</sub>

0.5 hours to 4 hours

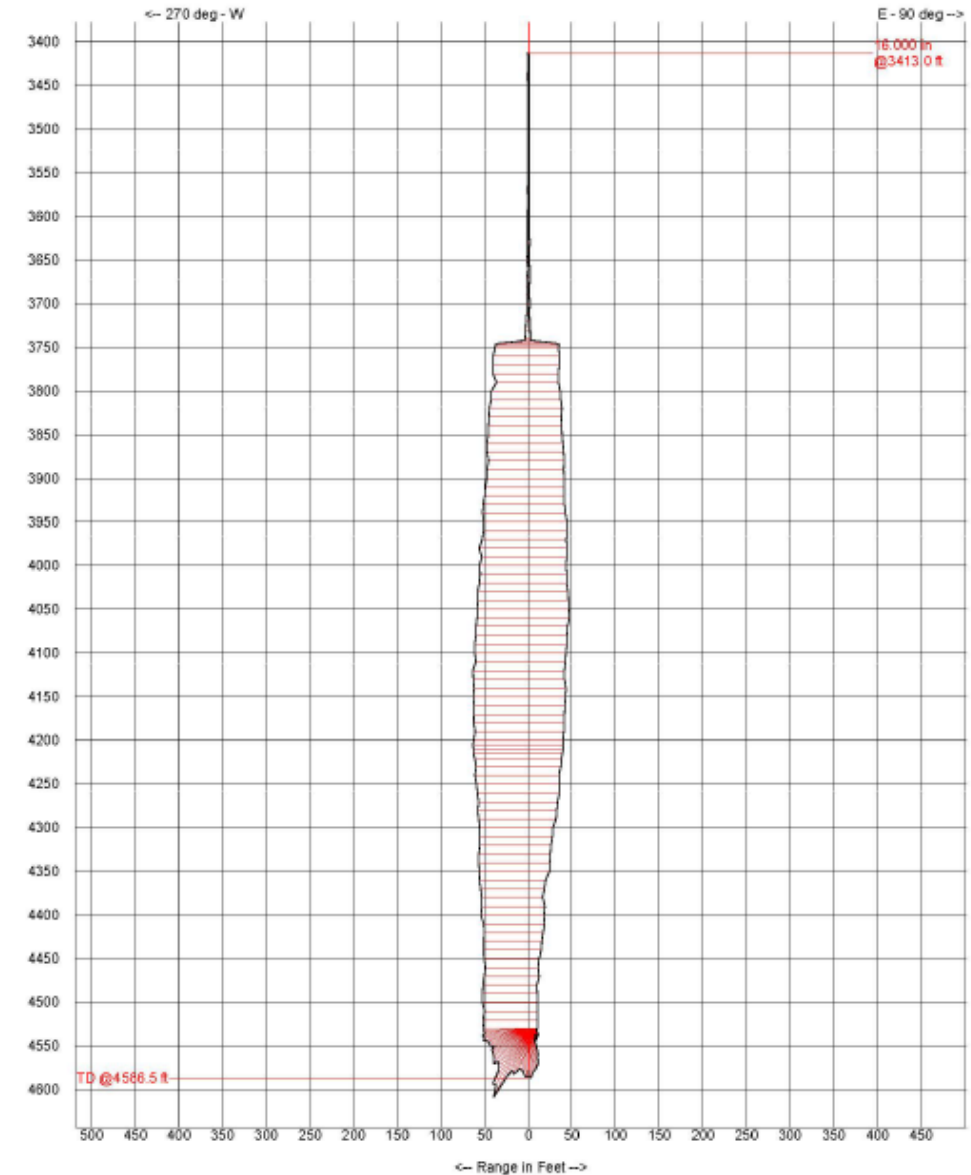
# Cavern Storage

- Over 2,000 operating salt caverns in the US alone
- Salt is an excellent storage medium
  - Very strong with a compressive strength similar to concrete
  - Salt, at depth, is plastic and therefore “self healing”
  - Inert to Hydrocarbons, Hydrogen, Helium, and other industrial gasses and fluids.
  - Salt storage is very cost competitive
  - Caverns can be sized to fit need
- Storage pressure is dependent on depth of salt
- A storage pond is needed to collect the brine water created in the solution mining process



# Cavern Storage in Delta

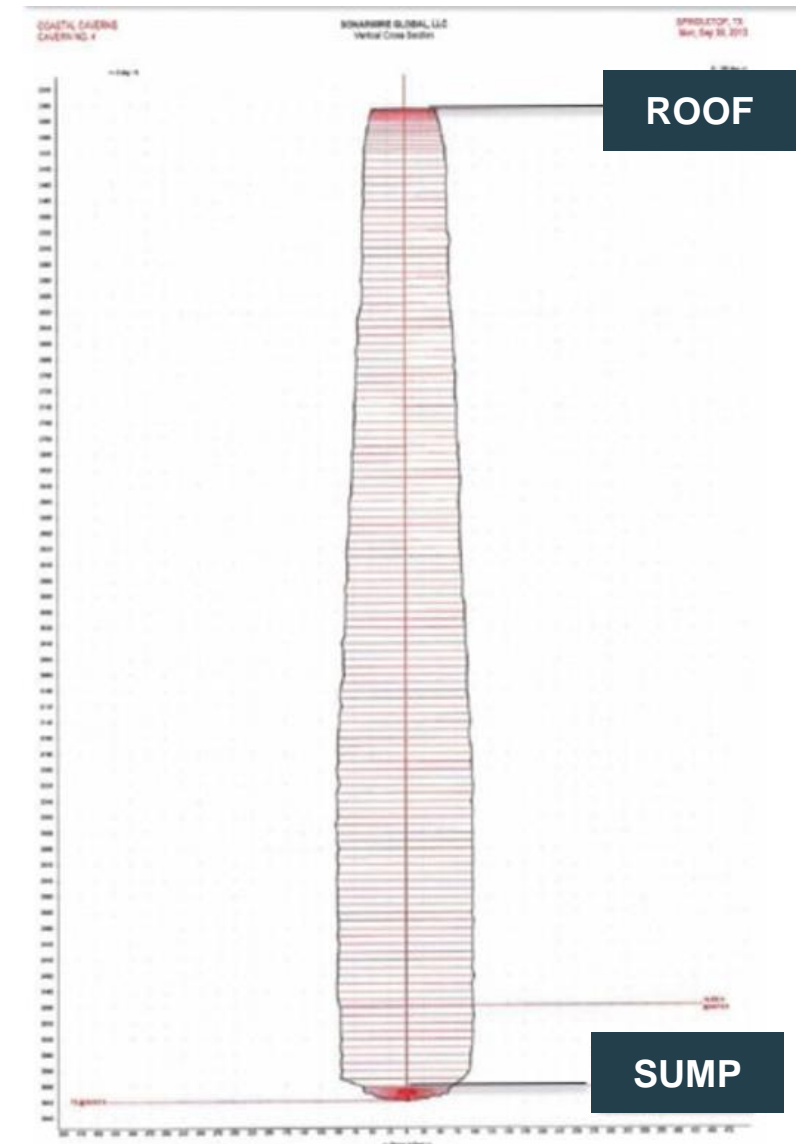
- Cavern shape and size is confirmed by sonar imaging during and at the end of the solution mining program
- Sonar provides an opportunity to revise the solution mining program in anomalous shaping is present.
- The existing caverns in this Utah salt dome have a very uniform structure





# Cavern Storage in Delta

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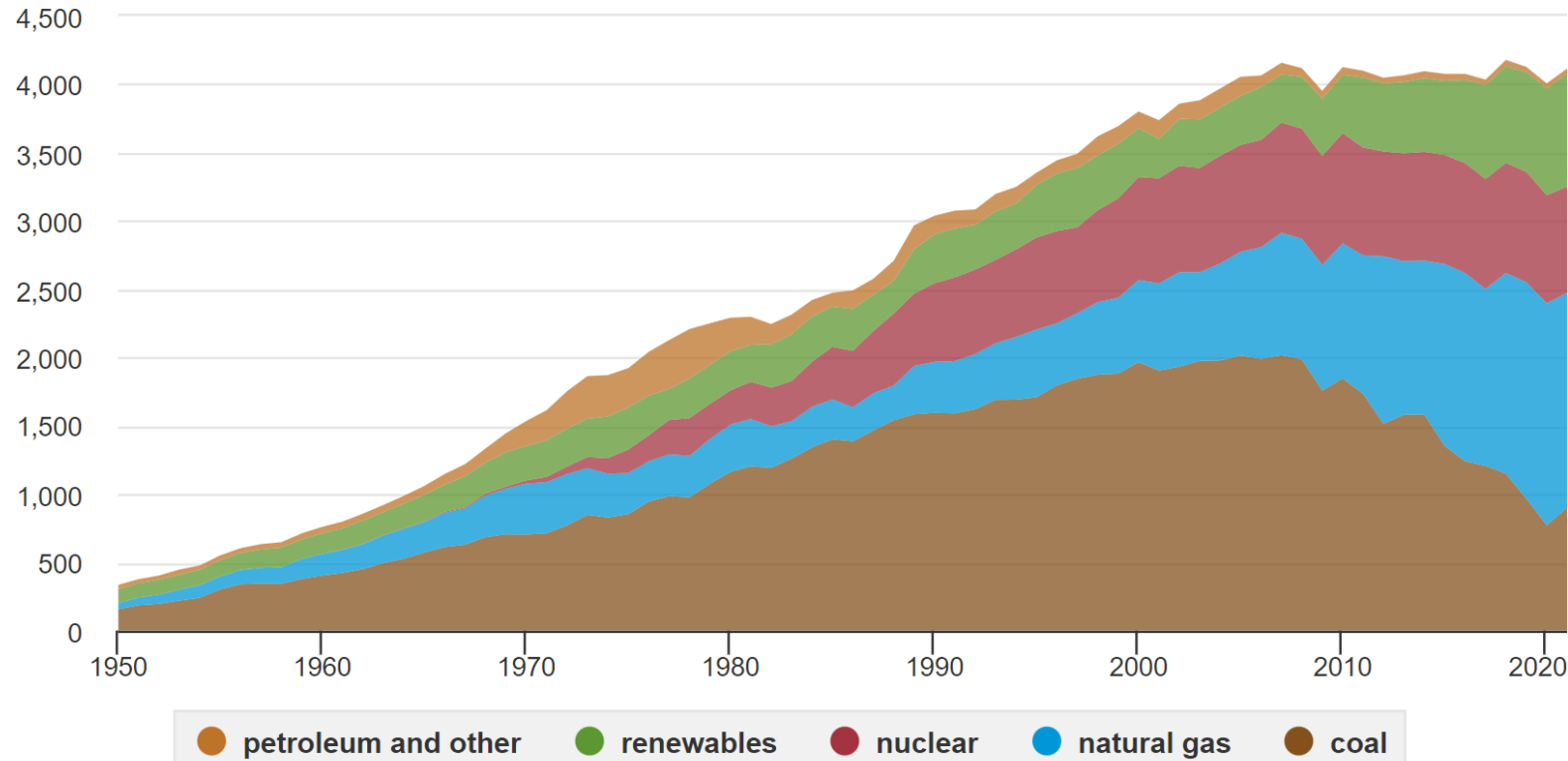
# A Brief Bio – My Career Adventure

- **Bringing the Utah Hydrogen Hub To Life**
- Passionate about leading high performing teams that develop and build America's energy infrastructure projects.
  
- B.S. Mechanical Engineering – University of Colorado, Boulder
- MBA - University of Utah
- Certificate, Energy Innovation & Technologies – Stanford University
- Certificate, Architecture & Systems Engineering – MIT
- U.S. Air Force veteran
  
- 30+ years as a professional project director & manager at notable U.S. companies including Micron Technology, Basin Electric Power Cooperative, Blattner Energy, Roberts & Schaefer (Elgin), US Solar, and now ACES Delta.

## U.S. electricity generation by major energy source, 1950-2021



billion kilowatthours

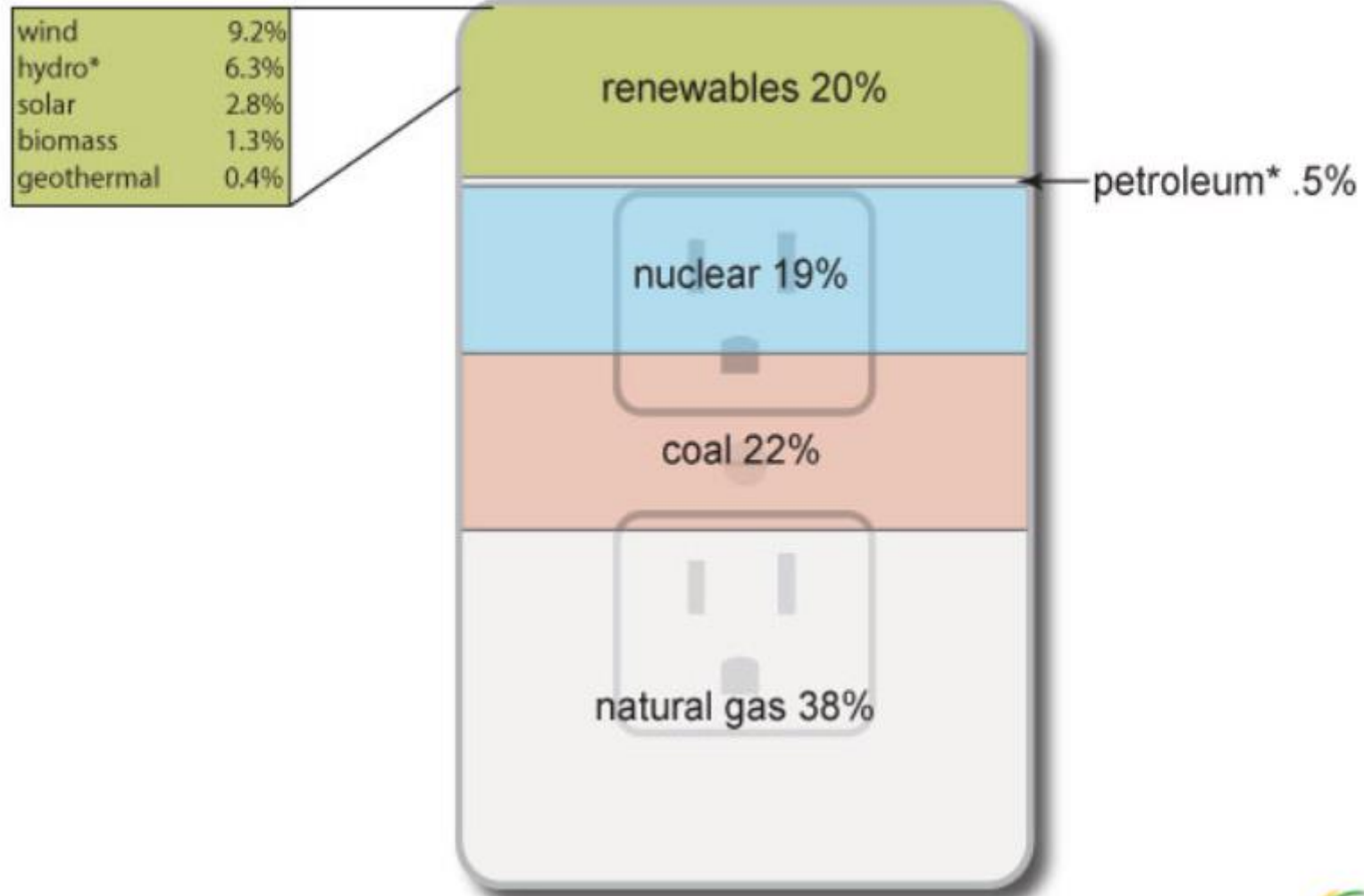


Per Capita Electricity Usage Has More Than Doubled In My Lifetime The Past Half Century With a 4X Increase In Generation/Usage To 4 Petawatthours And Nearly A 2X Increase in U.S. Population.

What Does The Future Hold? It's Up To Us...

# Sources of U.S. electricity generation, 2021

Total = 4.12 trillion kilowatthours



## **ACTION PLAN:**

- 1) Power Engineering is just as exciting and rewarding as a career in Computer Science or IT.**
- 2) The certificate program strategy is excellent and will work.**
- 3) The field should invest greatly in marketing itself to inspire and attract the next generation of American students and workforce leaders.**
- 4) Join the power engineering field and be a pioneer - help to transition our grid to zero carbon and increased electrification.**

***The Best Way to Predict The Future Is To Create The Future!***

# Questions