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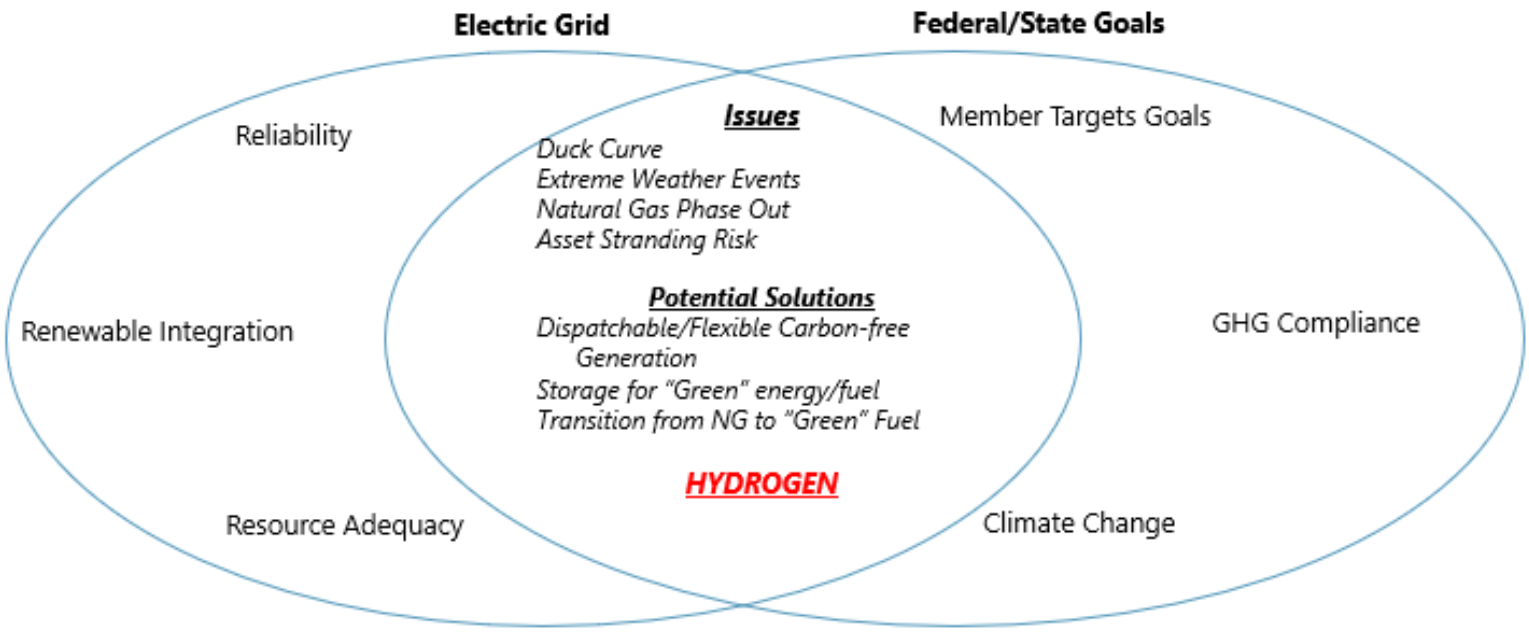
Lodi Energy Center

Pathway to Hydrogen

Lodi Energy Center

- Capacity of ~ 300 MW 1x1 Combined Cycle
- Siemens F-class combustion turbine
- Fast Start Flex Plant
- Heat rate of ~ 6,850 Btu/kWh, state average similar units 8,538 Btu/kWh, Aging plant average 11,683 Btu/kWh
- Capability of up to 45% hydrogen by volume blending

The Hydrogen Opportunity



What are we seeing on the grid?

- **Citigate Price (Commodity)**

  Up 206% compared to last year. Is this a trend or events?

- **CAISO Energy Balance**

  Gas continues play a significant role, 2nd to Renewables past 2030.

- **Current CAISO Generation Supply**

  Roughly 30-50% Natural Gas Fired Plants make up total supply to ensure grid reliability.

- **CAISO Generation Supply**

  Diablo Canyon Power Plant retirement 2024/2025.

LEC Investment Questions

"How fast will natural gas be phased out?"

"Will NG Infrastructure be repurposed for renewable hydrogen"

"What renewable fuels will replace natural gas to meet carbon-free goals?"

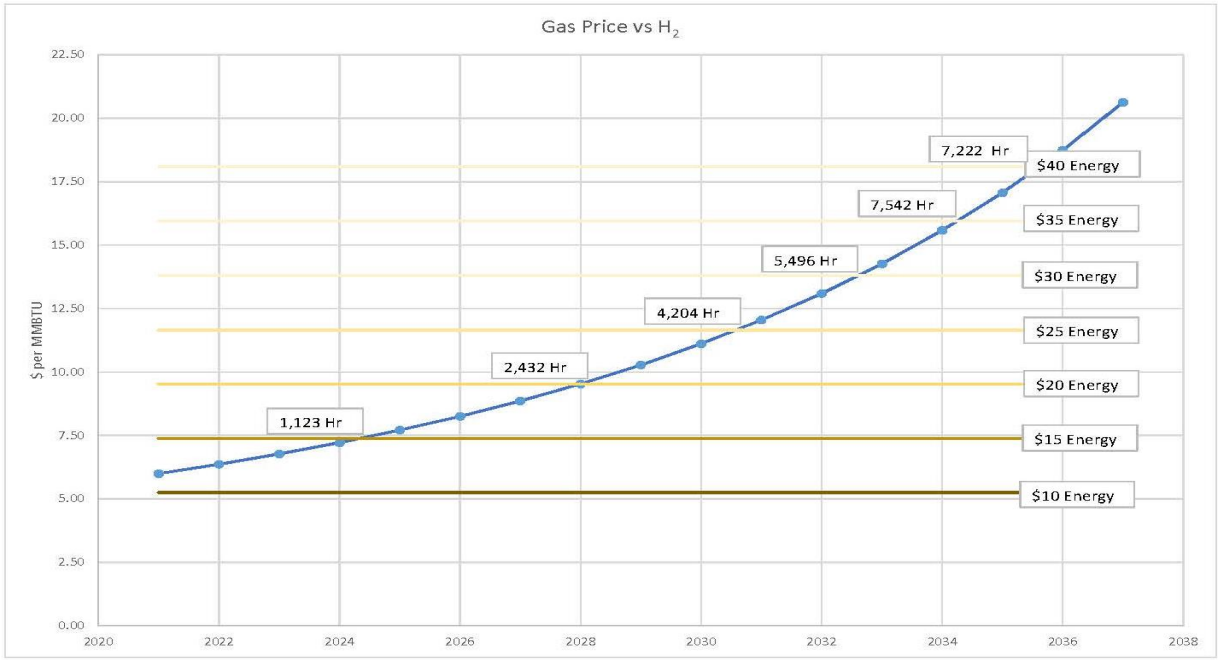
What's Creating Uncertainty?

- Long horizon energy price forecasts are not consistent
- What will the energy market look like in the future?
- Stranding capital investments in our Natural Gas Plants
- Is hydrogen production and storage/transportation bleeding-edge or leading-edge emerging technologies?
- Will Hydrogen become commercial or economical for the CTs or LEC

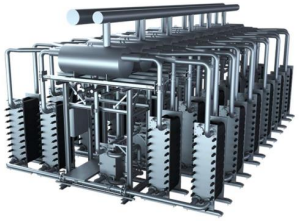
When will Hydrogen be affordable?

- Bloomberg's estimate from about a year ago that green hydrogen would be at $0.70-$1.60 per kilogram by 2050 with an equivalent natural gas priced at $6-$12 per MMBtu.
- U.S. DOE announced the first Energy Earthshot-Hydrogen Shot program which seeks to reduce green hydrogen by 80% to $1 per kilogram in one decade (~2030).
- NCPA – Conservative projection of gas prices around $11.00 per MMBtu in 2030.

Natural Gas vs. Price Projection

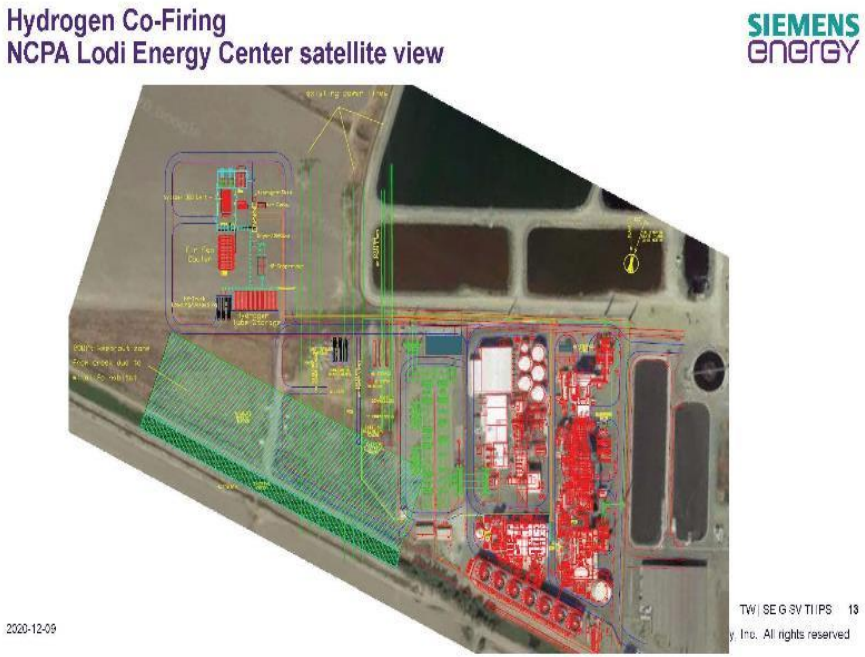


- Natural gas price and hydrogen $11 per mmBTU around 2030 therefore competitive



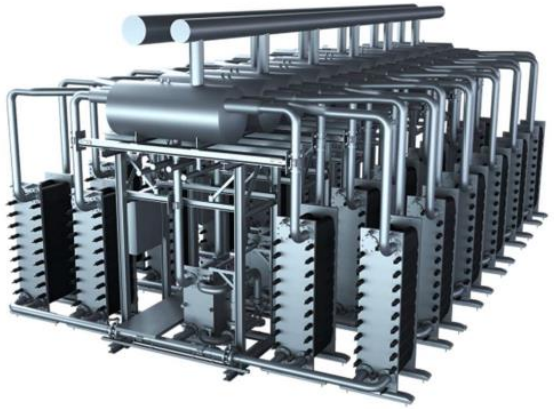
Why Lodi Energy Center?

- Power plant is “shovel ready” to update
- Hydrogen production friendly
  - Available H20 for electrolysis
  - Renewable Energy Grid Access
  - Footprint available next to LEC
- Close to regional gas pipeline for storage and/or access (blending A&D)
- Potentially available adjacent land for scalablity
- National & State decarbonization goal overlaps:
  - Proximity to Interstate 5 and Hwy 99 for transportation section partnership
- All the right pieces naturally together!



Hydrogen Production Feasibility Study
February 2021

- **155 MW Electrolyzer Plant**
  - 122 GPM of on-site demineralized water
  - Wholesale renewable energy via new switchyard
  - 52 kWh/kg hydrogen production efficiency
- **Compressed Storage**
  - Capacity factor of electrolyzer: 25%
  - 4 kWh/kg hydrogen storage efficiency
- **Liquified Storage**
  - Capacity factor of electrolyzer: 50%
  - 12 kWh/kg hydrogen storage efficiency



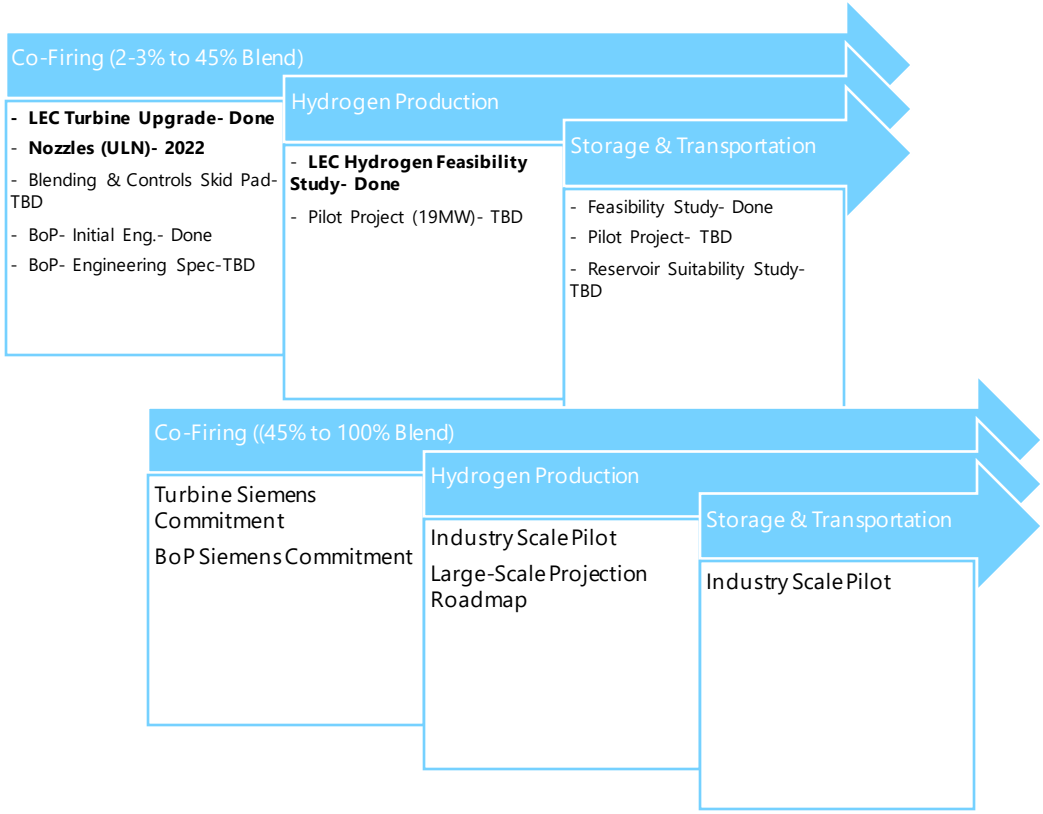
Objective: Analyze the feasibility of an adequately sized Hydrogen production and storage facility that can achieve cost parity with LEC's current operations.

Study Conclusions

- Production of hydrogen via water electrolysis and storage as a compressed vapor or cryogenic liquid is **technically feasible**
- Numerous vendors exist for each of the key processes considered in this study, and **many offer commercial experience**
- Although numerous electrolyzer facilities exist worldwide, hydrogen energy storage facilities **on the scale considered** in this study is in its initial stages
- **Capital costs** for hydrogen production and storage equipment **remain high** and contributed significantly to levelized costs
- **Electricity pricing** contributes significantly to levelized costs, but projected pricing throughout the life of a potential project at LEC **appears reasonable**
- Black & Veatch expects LCOE **cost parity** could be potential with hydrogen co-firing at LEC in instances where **capital costs are minimized** to the extent practicable, **recovery and sales of oxygen** are pursued, and **REC revenue sharing** with renewable energy providers is pursued

Approach: How to get there?

- It's a transition
  - Turbine co-firing Capability
  - Hydrogen production and availability
  - Storage and transportation
  - Funding/incentive/ Accelerators



Early Adopter Investment Challenges

- State policy to phase out NG should include a transition plan renewable gas and hydrogen to incentive asset investment over 30-year horizon.
- State agency coordination on energy market and gas rate structures to not burden NG EG's with gas system fixed and transportation costs as electrification continues.
- State policy on electricity grid reliability should include hydrogen at scale. Supportive of statewide infrastructure to store and transport rather encouraging distributed production and storage. R&D needed.
- NG EG's should be incentivized to repower/repurpose to avoid rate payers costs to decommission plant infrastructure and build new infrastructure with the same purpose. Additionally, decommissioning may cause local reliability problems requiring new rate payers costs to upgrade/bolster electric grid.

Questions