

# Utilization and Combustion of Carbon-Free Fuels: Challenges and Opportunities

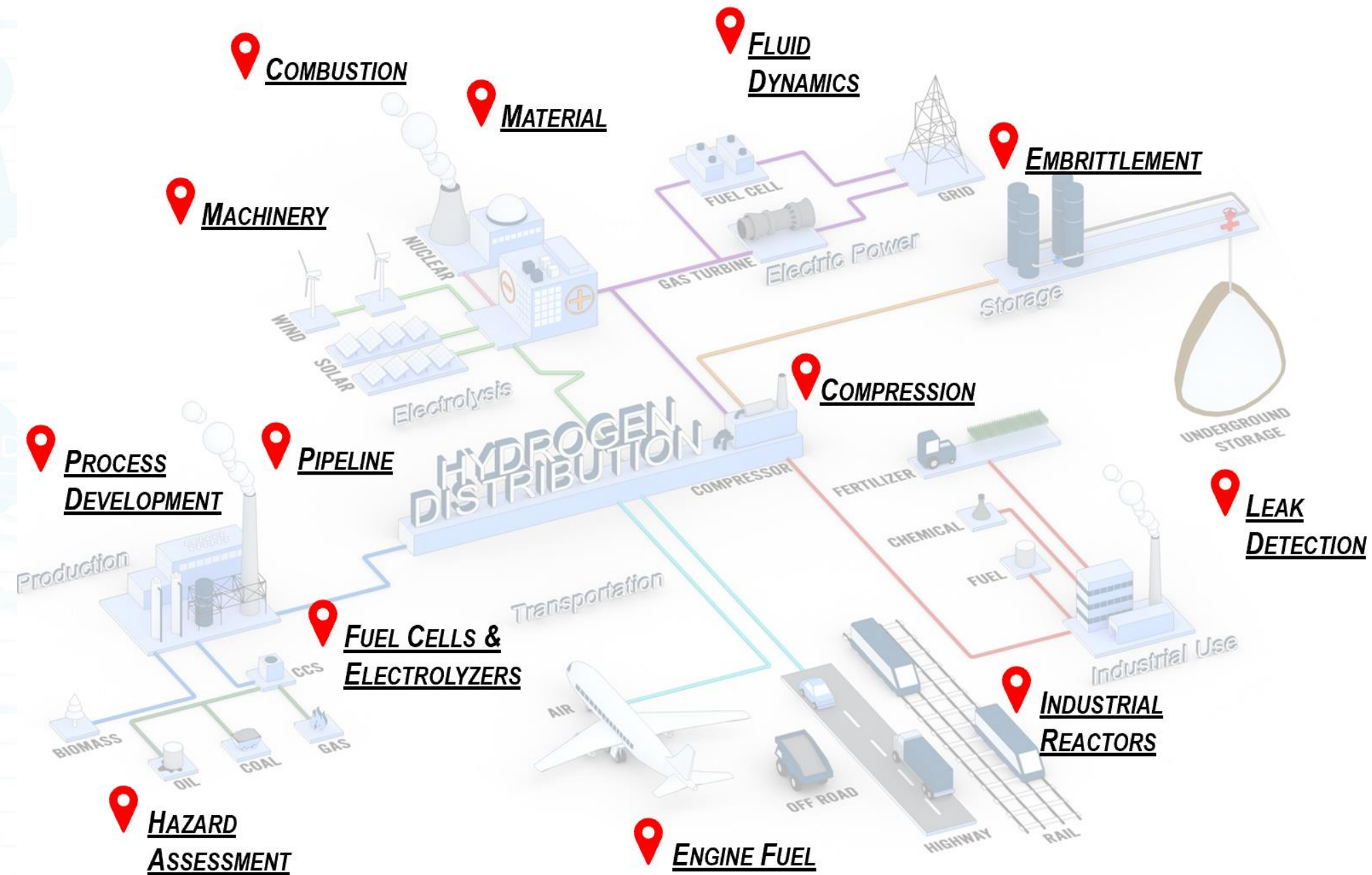
## UTSR 2022 Project Review Meeting

SOUTHWEST RESEARCH INSTITUTE®

September 27, 2022

Tim Allison, Ph.D.  
Director, Machinery Department

# SwRI R&D Technology Areas for Hydrogen Economy





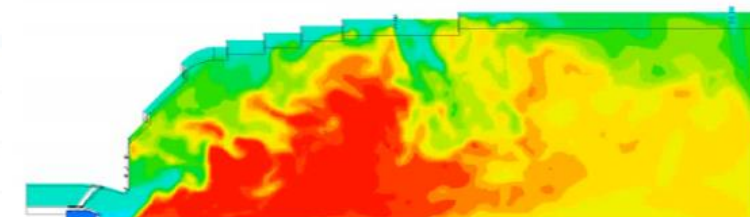
# Low-Carbon Fuels in Gas Turbines

## ■ Challenges:

- Emissions and performance limits of existing combustors
- Increased NO<sub>x</sub> emissions and performance/reliability issues in premixed combustors
- Fuel and exhaust system compatibility

## ■ R&D Projects:

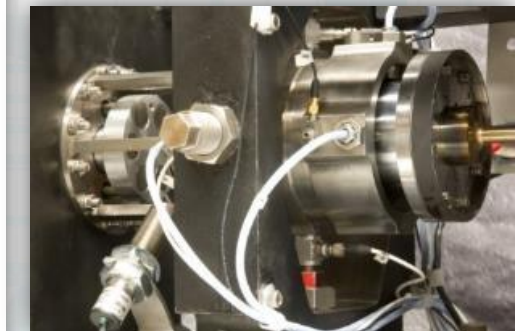
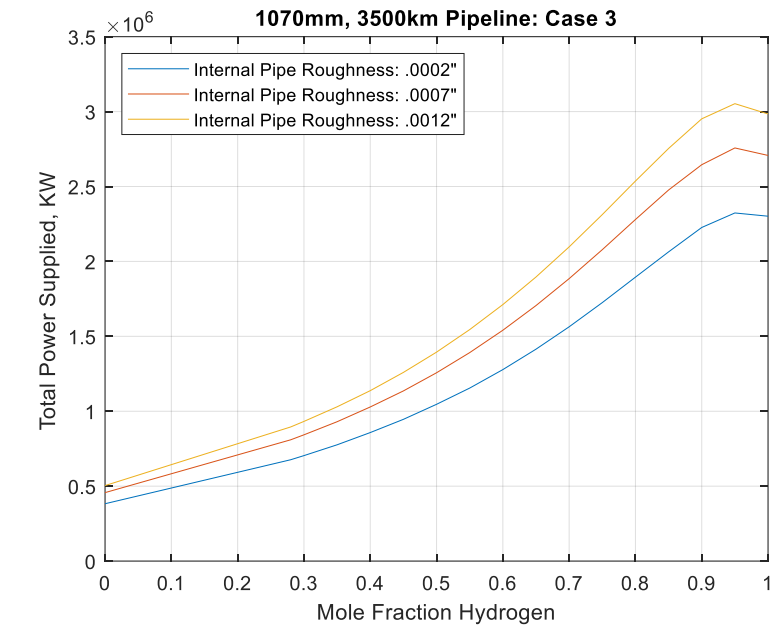
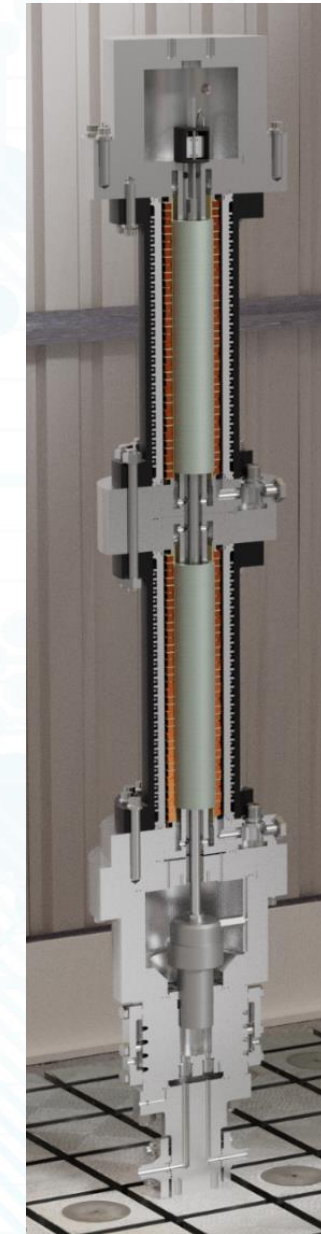
- Gas turbine combustion test facility operating up to 100% H<sub>2</sub> fuel for large-scale tests, injector rigs, and annular rig tests
  - Upgrading for NH<sub>3</sub>
- Effects of hydrogen on GT at high turndown
- Rotating detonation engine combustor testing and component development
- New injector development
- sCO<sub>2</sub> oxy-combustion for near zero-carbon natural gas





# Gaseous Hydrogen Compression

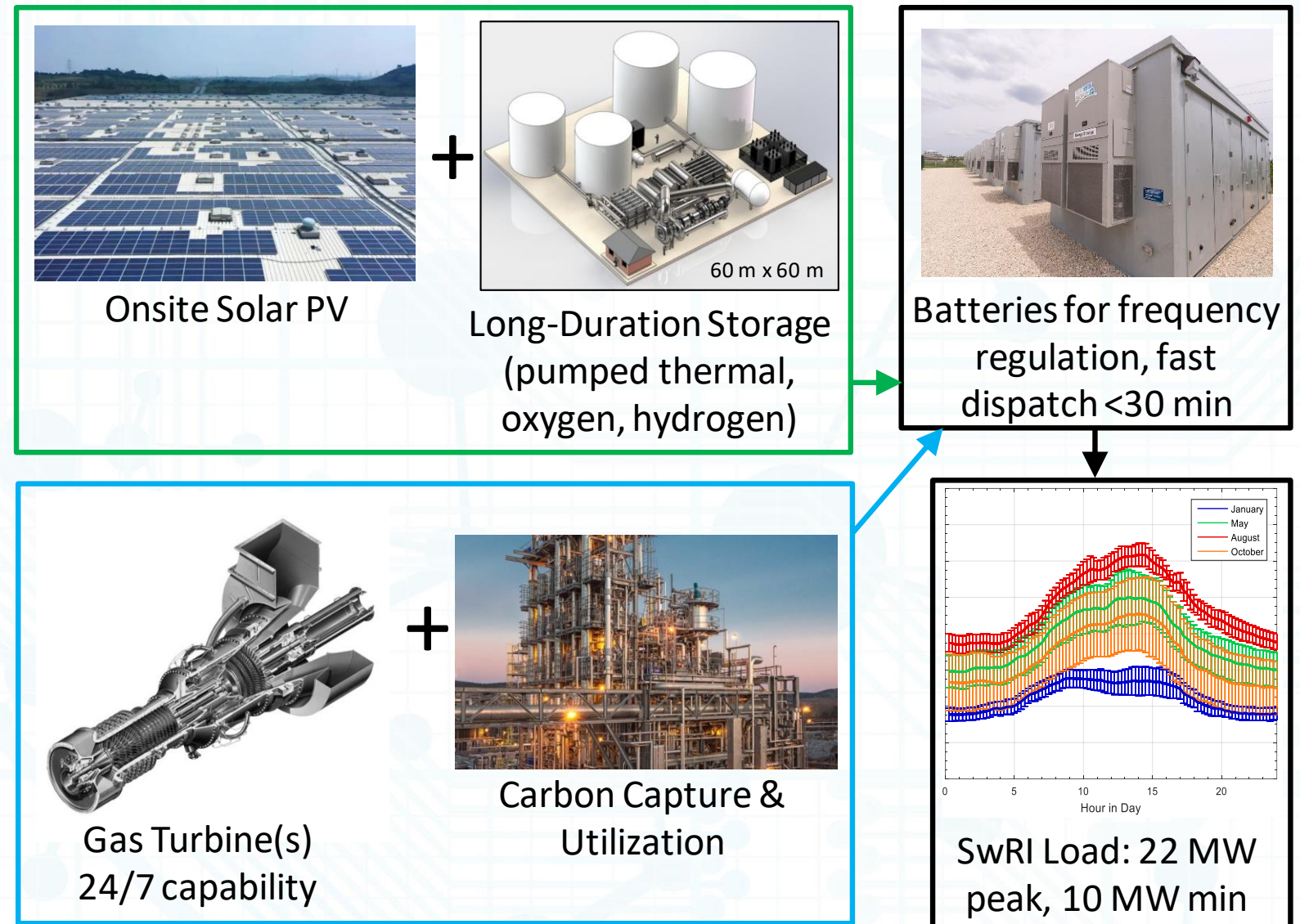
- Challenges:
  - High pressure, head, and flow requirements for compressors
  - Material compatibility
  - Gas leaks
- R&D Projects:
  - Novel compression system development
  - Linear motor reciprocating compressor proven up to 100 bar for vehicle refueling
  - Hermetic machinery components including magnetic and gas bearings
  - Pipeline simulation with hydrogen blends
  - Material compatibility testing
  - Evaluation of other compression system components, e.g. valves, leak detection, instrumentation, etc.



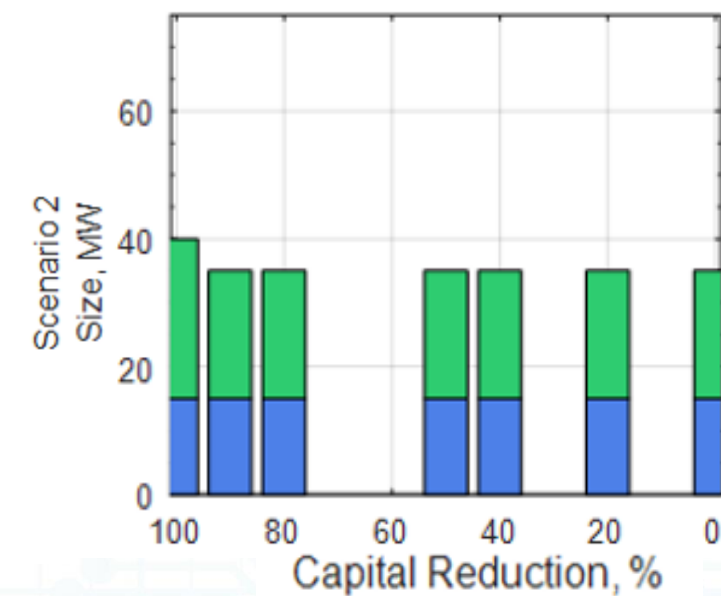
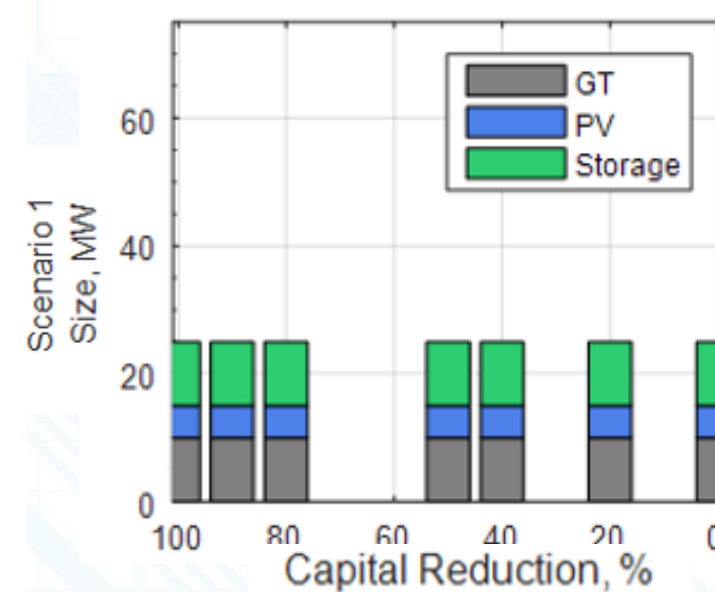
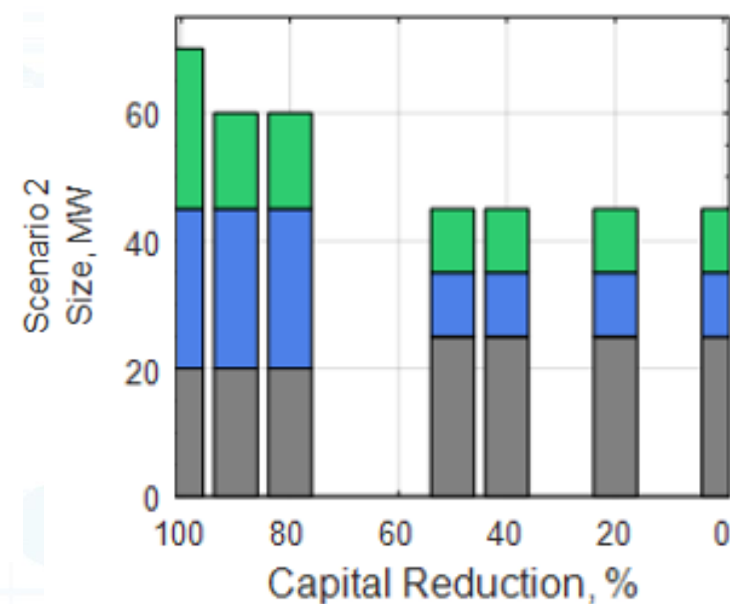
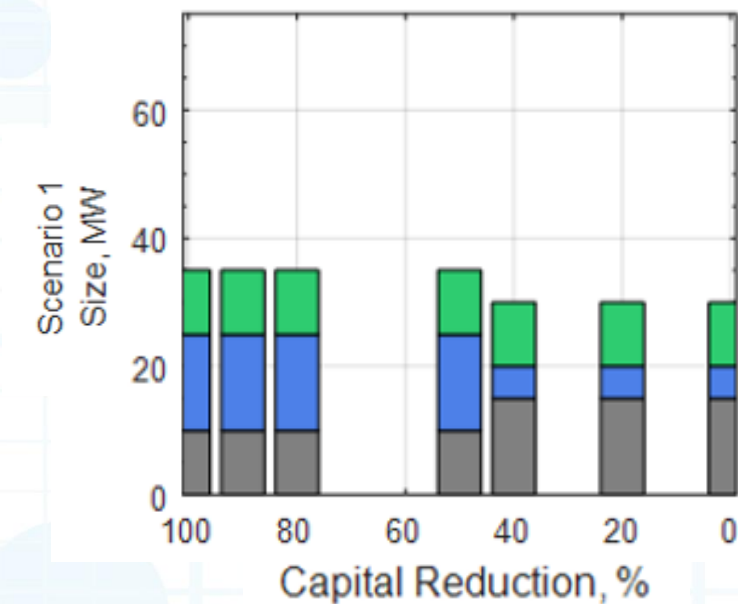
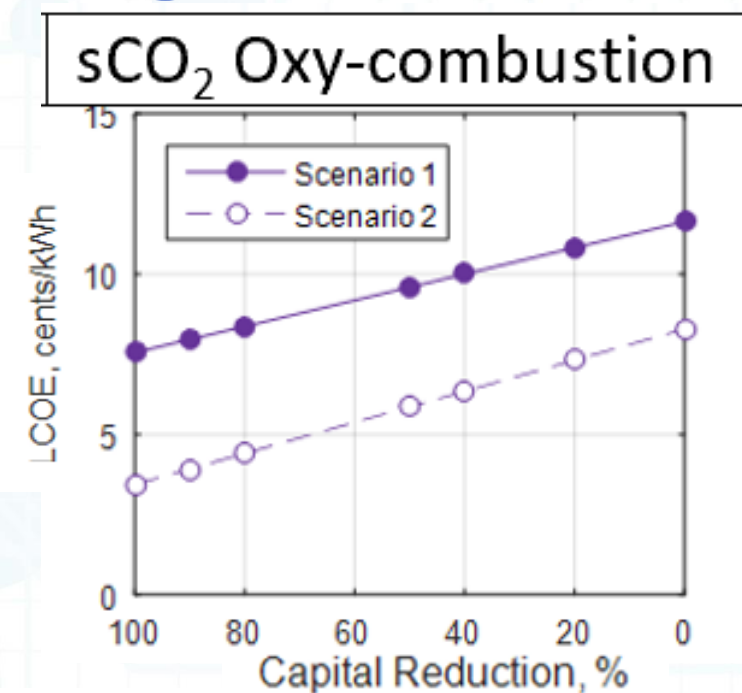
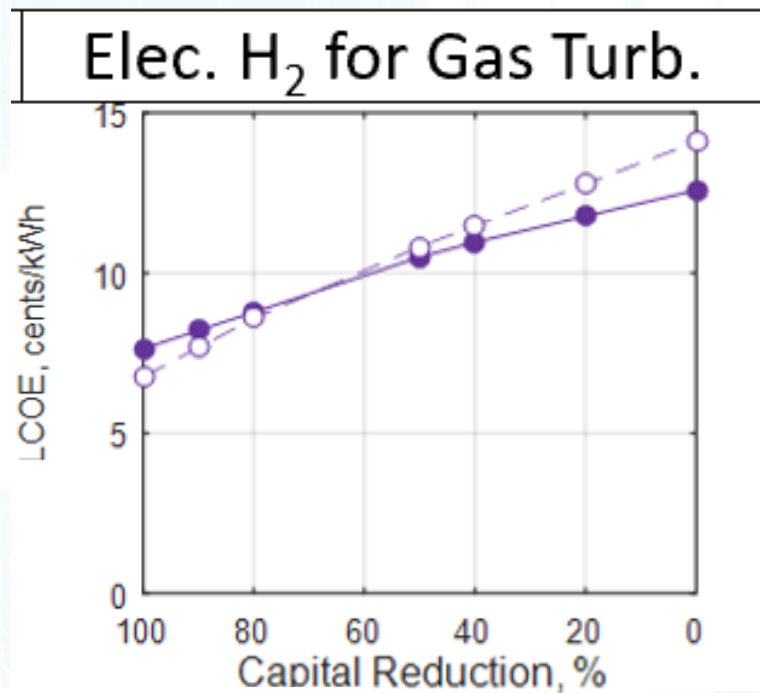


# SwRI Project Z: A Net-Zero Research Pilot

- Two parallel full-size energy systems for redundancy and research flexibility
- Concept mirrors “grid of the future” dynamics including baseload and variable power sources
- Multiple technology pathways for pilot-scale research
  - Carbon capture/utilization technologies
  - Electric-to-electric energy storage
  - Hydrogen production, storage, and use
  - Air separation and oxy-combustion
  - Battery usage/degradation



# Lowest LCOE for Select Configurations





# Thank You