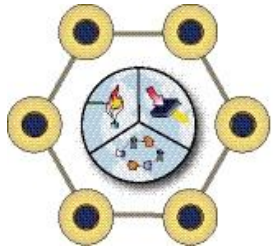
Hydrogen Based Energy Storage System for Integration with Dispatchable Power Generation

Award FE0032021

Virtual Kickoff Meeting

5 April 2021

DOE: $200,000
Non-DOE: $85,000
TOTAL: $285,000



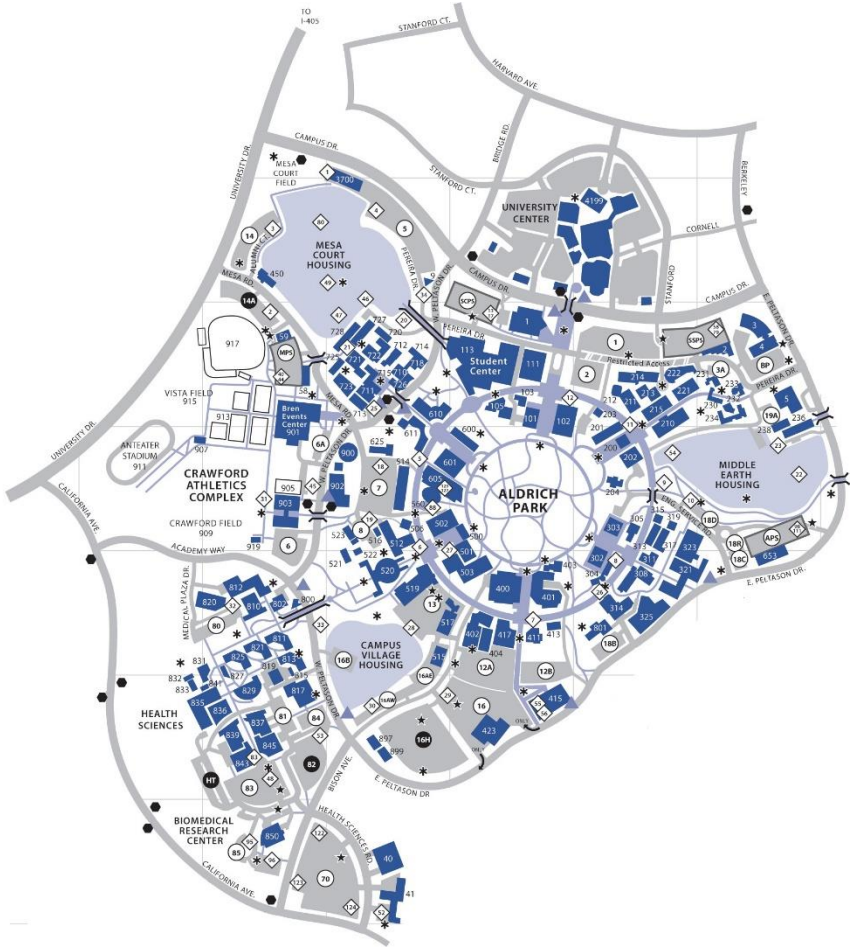
ADVANCED POWER & ENERGY PROGRAM
UNIVERSITY of CALIFORNIA • IRVINE

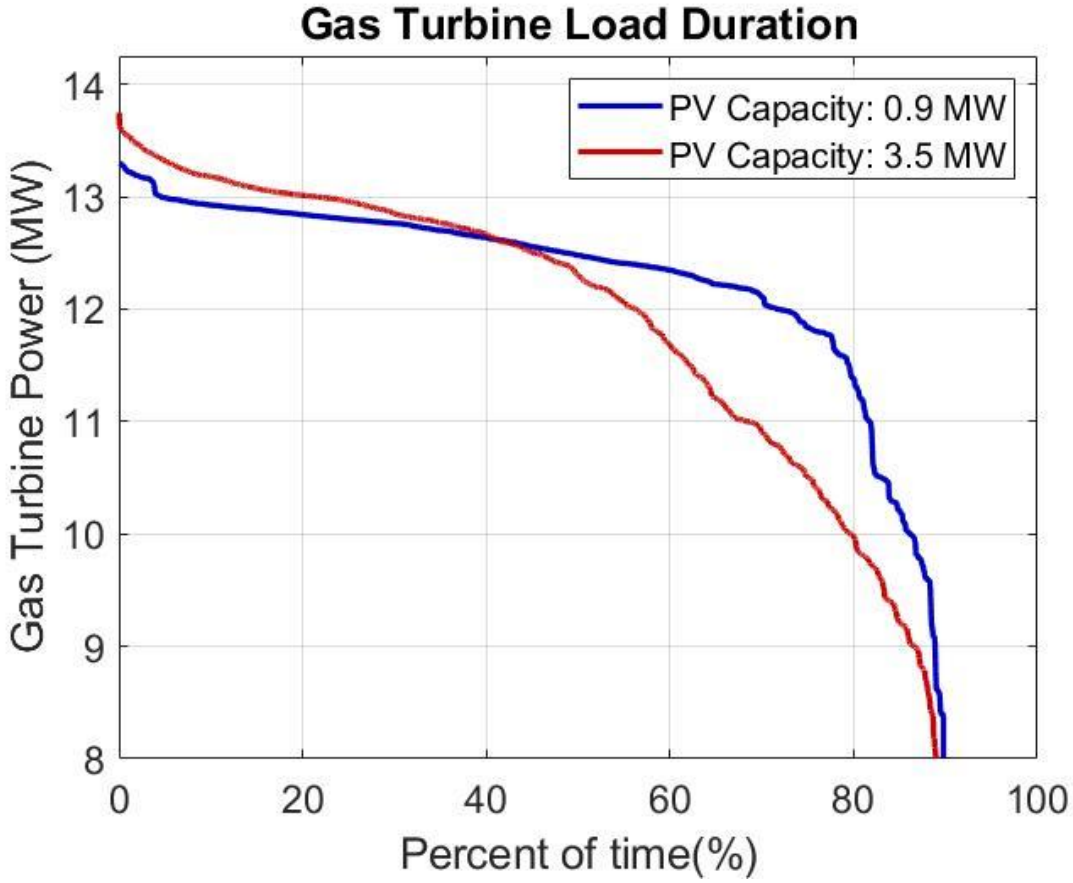
Principal Investigators: Vincent McDonell and Jeffrey Reed

Collaborators: *Solar Turbines, Incorporated*
Southern California Gas
University of California, Irvine

Motivation

- **Added intermittent renewables have required non-optimal operation of existing 19 MW combined heat and power plant on the campus**





Flores, Robert, and Jack Brouwer. "Optimizing Natural Gas Combined Cycle Part Load Operation." *ASME Power Conference*. Vol. 59100. American Society of Mechanical Engineers, 2019

Motivation

- **UC Office of President is interested in significant carbon reduction for campus operations in the next ten years**
  - **Hydrogen is part of the solution**
    - ✓ **Emphasis on renewable hydrogen but cognizant of value of existing assets warrants transitional approach**

- **Growing installed base of solar on campuses and in solar resource areas with ability to wheel to campuses impacts the operating profile of the thermal fleet (GTCC and CHP)**

- **Exploring the potential for electrolytic hydrogen production for use in thermal resources in hours of low or no solar production under investigation**

- **Enabling high(er) blend fraction tolerance in the generation fleet is key to this strategy**

Objective

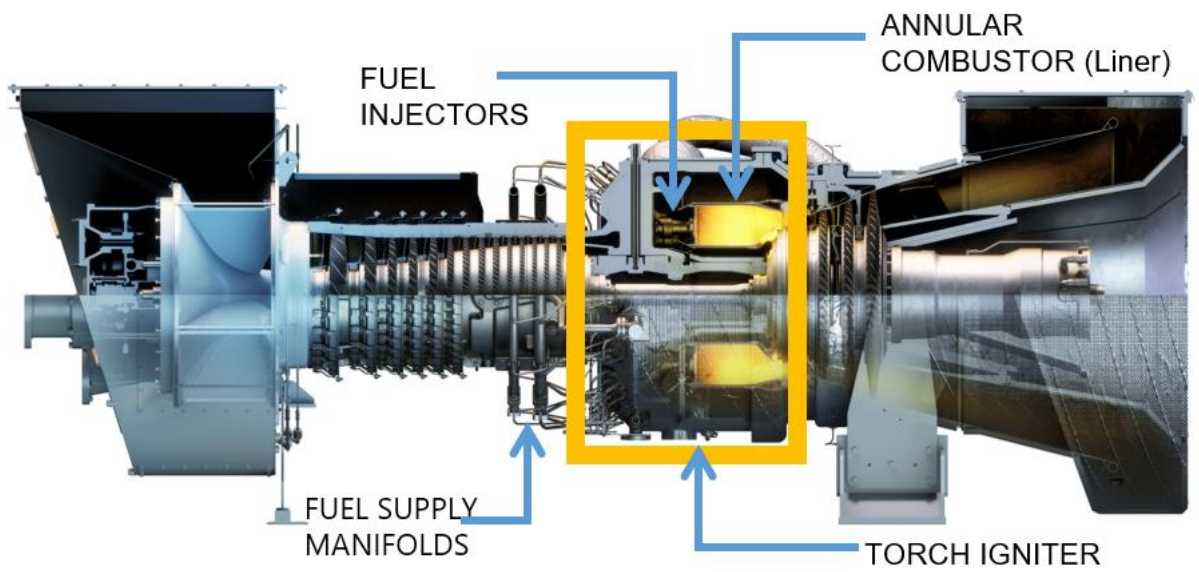
Establish a *preferred design* for a 10 MW-hr integrated hydrogen-based energy storage system with the existing central plant natural gas fired gas-turbine on the campus at UC Irvine which will allow:

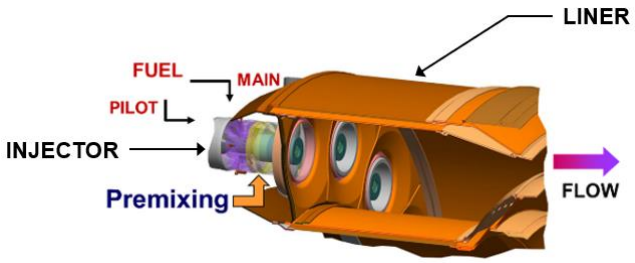
- *"increased flexibility of Electricity Generating Units to assure increased flexibility to assure short and long-term reliability in the delivery of electric power as the use of renewable power generation increases"* \1
- *"mitigate inefficient, off-design operation of the Electricity Generating Unit (e.g., frequent, deep cycling of units designed for baseload operations)" which results in negative impacts such as 'decreased power efficiency, increased environmental impacts associated with some operations, equipment damage, accelerated equipment degradation, and increased operational costs' "*\1

\1 from FOA-DE-002332

Technical Approach

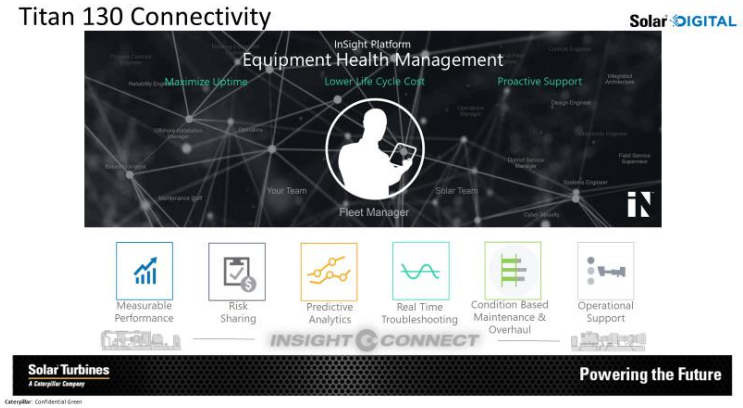
- **Focus Areas and Project Team Engagement**
  - **Evaluation of Turbine retrofits to attain up to 30% hydrogen addition**
    - ✓ **Solar Turbines**





Technical Approach

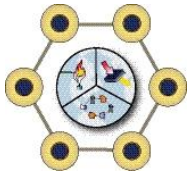
- **Focus Areas and Project Team Engagement**
  - **Scenarios to integrate hydrogen generation technology(ies) with and without ability to incorporate waste heat from the turbine**
    - ✓ **Southern California Gas**
  - **Consideration of physical interconnections between potential hydrogen generation and storage infrastructure options**
    - ✓ **UCI Campus**
  - **Assessment of potential economics in the 2025 – 2035 timeframe**
    - ✓ **UCI APEP, Solar Turbines**
  - **Consideration for integrated controls**
    - ✓ **Solar Turbines, UCI Campus**



Performance Metrics

- **Basis**
  - Initial cost estimate to construct preferred system(s)
  - Initial performance estimates for preferred system(s) with existing system
    - ✓ Carbon and pollutant emissions
    - ✓ Cost of operation targets ($150/MW-hr stored energy; $2/kg hydrogen)
    - ✓ Payback analysis

- **Tools**
  - DEROpt Performance Code
    - ✓ Scenario Analyses
  - Technoeconomic Analyses
    - ✓ NETL tools and methods + leverage H2A model for hydrogen elements
    - ✓ Scenarios



Relevance and Outcomes/Impact

- Outcomes directly help UC Irvine (and vis a vis UC as a whole) assess how the integrated resources can help reduce emissions impact, wear and tear on the existing fossil-fueled asset, and potential save on utility and fuel costs
- Potential for replicability within California with its unique constraints/requirements/targets
  - 10 UC Campuses (several with NGCC systems)
  - 47 CSU Campuses (several with NGCC systems)
- Potential applicability to college campuses nationwide as well as other commercial or industrial “campus” setting with similar thermal generation resources such as hospitals and hotels

For more information….

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