Modifications to Solar Titan-130 Combustion Systems for Efficient, High Turndown Operation

DE-EE0008415

SwRI, Solar Turbines, EPRI, UC Irvine, Georgia Tech

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Project Overview:

Modifications to Solar Titan-130 Combustion Systems for Efficient, High Turndown Operation

Timeline:

Project Start (Contingent Award):	10/01/2018
Full Award:	1/18/2019
Budget Period End Date:	12/31/2019
Project End Date:	4/30/2021

AMO MYPP Connection:

Small to medium Combined Heat and Power (CHP) Systems operating in grid support can improve grid response to changes in non-dispatchable renewable energy sources.

Barriers and Challenges:

- Current gas turbine combustors require reduced air flow to stably operate at part load
- Air diversion or bleed creates inefficiencies in gas turbine operation
- Goal of this project is to design combustion systems capable of operating in low NOx mode, at low part load, while maintaining high overall gas turbine efficiency

Project Budget and Costs:

Budget	DOE Share	Cost Share	Total	Cost Share %
Overall Budget	$1,218,785	$315,751	$1,534,536	20.58%
BP 1	$477,062	$123,187	$600,249	20.52%
BP 2	$415,698	$108,918	$524,616	20.76%
BP 3	$326,024	$83,646	$409,670	20.42%
Costs as of 5/1/19	$37,220	$0	$37,220	0.00%

Project Team and Roles:

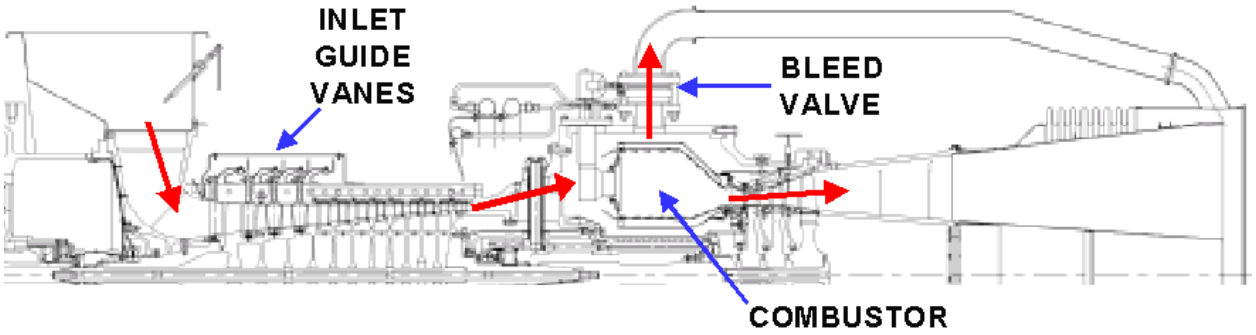
- Southwest Research Institute
  - Prime recipient, project management
  - Conceptual design of high turn down combustion system
  - Combustion testing
- Solar Turbines
  - Conceptual design of high turn down combustion system
  - Supply of combustion hardware
- EPRI
  - Grid integration, connectivity, and benefits study
- UC – Irvine
  - Conceptual design of high turn down combustion system
- Georgia Tech
  - Combustion dynamics

Project Objectives

- Increase market penetration of small/medium sized CHP systems for grid support
- Currently, to operate at very low loads current Solar Turbines combustion system must either:
  - Operate with high emissions (not allowed by regulation)
  - Sacrifice overall gas turbine efficiency
- Current project seeks to develop a combustion system capable of allowing high gas turbine efficiency over a wide range of loads while maintaining emissions compliance

Current High Turn Down Operation

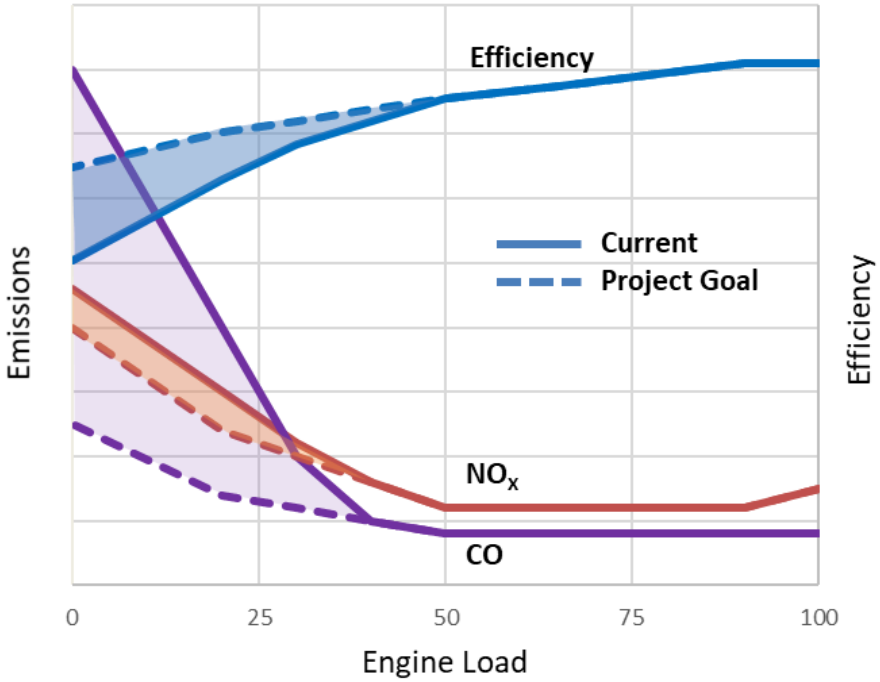
- During high turn down operation (greater than 50%) the combustion becomes too lean and unstable
- To combat this, air flow through the combustor is reduced by using inlet guide vanes or compressor bleed
- Both of these solutions cause significant efficiency penalties



How can we increase lean operating range, while maintaining acceptable emissions?

Project Goals

- Improve overall gas turbine performance by increasing combustor performance at low loads
  - Decreasing compressor bleed and IGV use
  - Reduce CO and UHC emissions
- The increased efficiency will decrease cost to operate small scale CHP gas turbines

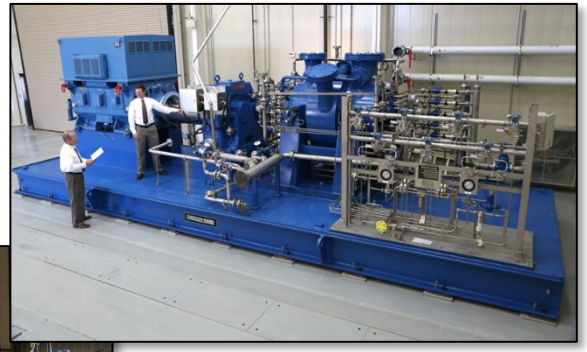


Development of a Combustion System for Efficient Part Load Operation

- Efficiency improvements to the gas turbine by improved combustor performance will pursue two lines in inquiry
  - What can be done to improve part load performance of the current system?
  - What level of performance can be achieved with a new combustion system?
- Concept Selection (SwRI, Solar, UCI)
- Detailed Design (Solar)
- Validation testing (SwRI, Solar, GT)
- Benefits study (EPRI, Solar, UCI)

Combustion Testing at SwRI

- Up to 8lbm/s air at near atmospheric conditions
- Higher pressure air at ~4lb/s at 125psi
- 1.92 MW electrical input to replicate compressor discharge temperatures
- Fuel supply: methane and hydrogen



Current Project State

- Completed concept brain storming and down select completed
- Leading candidates selected
- Modifications to test facility at SwRI to support high pressure testing begun

- Fall 2019 – Atmospheric test campaign
- 2020 – Commissioning of high pressure rig, complete design of new combustion system
- 2021 – Testing of new combustor system in high pressure rig

Questions?