

2024

# University Turbine Systems Research (UTSR) and Advanced Turbines

## Project Review Meeting





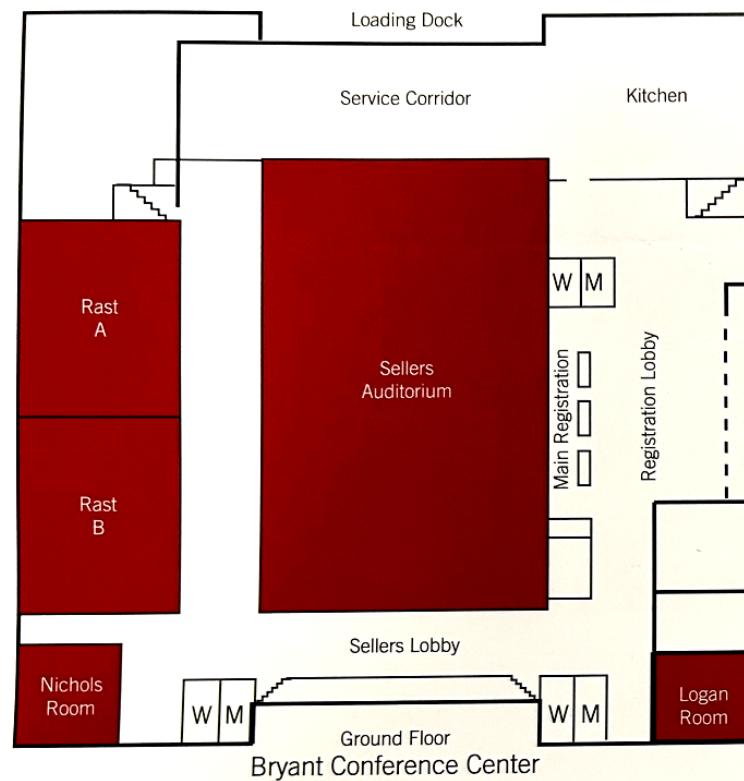
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# Map Directory



# About the University Turbine Systems Research and Advanced Turbines Project Review Meeting

The National Energy Technology Laboratory University Turbine Systems Research (NETL-UTSR) program manages a portfolio of university-based turbine research projects funded by the US DOE Office of Fossil Energy and Carbon Management (FECM). FECM sponsors the annual UTSR meeting where projects within the Advanced Turbines Program are publicly reviewed. The UTSR program offers a Gas Turbine Industrial Fellowship funded by sponsoring gas turbine manufacturers. This fellowship has helped to facilitate the transition of the best students from academia to the gas turbine industry, thereby helping to maintain U.S. leadership in this important area of technology.

The success of the UTSR program has been made possible by a network of universities, the collaborating gas turbine industry, and the DOE Advanced Turbines program - all of which are facilitated by an annual UTSR project review meeting, which is open to the public and brings together experts from academia, industry, and government to present and discuss ongoing turbine research sponsored by the DOE Office of FECM UTSR program under existing cooperative agreements.

The UTSR program committee selects meeting venues at or close to leading universities directly involved in UTSR research. The 2024 UTSR project review meeting, co-hosted by The University of Alabama, will be held at the Bryant Conference Center at The University of Alabama on September 24 – September 25, 2024. Four speakers will provide keynote addresses:

- Mr. Bob Schrecengost, Division Director of Hydrogen with Carbon Management, Department of Energy – “Workforce Development Under the UTSR Program.”
- Mr. John Crane, Advanced Turbines Technology Manager, National Energy Technology Laboratory – “Turbines for Dispatchable Zero-Carbon Power”
- Prof. Ajay Agrawal, Robert F. Barfield Endowed Chair Professor, Mechanical Engineering, The University of Alabama – “Recent Accomplishments and Opportunities in Rotating Detonation Combustion Research.”
- Mr. Jeremie Wetherby, Carbon Solutions Leader, GE Gas Power “The Role of Gas Turbines in a Decarbonized Future

The meeting will feature a panel discussion on the topic of “Decarbonization of the Existing Gas Turbine Fleet”. Panelists will include:

- Dr. Nathan Weiland, Senior Fellow at the National Energy Technology Laboratory (NETL)
- Dr. Joseph Meadows, Assistant Professor, Department of Mechanical Engineering at Virginia Tech
- Dr. Lance Smith, Senior Technical Fellow, Combustion & Propulsion Technology at RTX Technology Research Center (RTRC)
- Dr. Jeff Moore, Institute Engineer and STEP Project Manager at Southwest Research Institute.

Project reviews will be organized into two parallel technology tracks: (1) Carbon Free Fuels and Advanced Materials; and (2) Advanced Manufacturing, Aerodynamics/Heat Transfer, Supercritical CO<sub>2</sub>, and Pressure Gain Combustion. The meeting will feature a broad range of DOE-sponsored projects in the form of oral presentations, including the majority of NETL’s extramural projects within the Advanced Turbines Program, as well as internal NETL R&D projects.





# UTSR Technology Summary

Since the inception of the DOE turbine program, the NETL-UTSR program has sought to support the underlying scientific research necessary to develop advanced turbines and turbine-based systems in support of the DOE's turbine program's strategic goals and program mission needs. The UTSR program has two primary goals. One is to produce results that resolve technical issues associated with DOE's Office of Fossil Energy and Carbon Management Advanced Turbines Program and the other is to maintain and enhance university-based turbine engineering capabilities in the United States. These two UTSR Program goals will continue to be realized through the involvement of professors and students in research and development on advanced turbine technical issues, while enhancing the education of future scientists and engineers in the U.S.

This is accomplished by funding university-based research projects that address scientific R&D and technical challenges in turbine-based systems and technology. This research focuses on the fundamental and applied issues associated with advancing the performance and efficiency of turbines in power generation beyond current state-of-the-art.

Technical areas of interest include hydrogen and ammonia combustion technology, supercritical CO<sub>2</sub> based power cycles, oxy-fuel combustion, materials, aerodynamics, heat transfer, and pressure gain combustion/rotating detonation engines.

The UTSR projects are typically three years in duration and focus on applied laboratory/bench scale R&D. Currently 9 universities and 10 projects are involved in the NETL-UTSR program. The innovations and scientific understanding generated under this program will then be transferred to industry manufacturers for incorporation into their next generation turbine technology products with the goal of producing reliable, affordable, clean, efficient, and cost-effective energy supplies.

One of the main purposes of this UTSR project review meeting is to facilitate peer-to-peer knowledge sharing and collaboration across boundaries to create a network of expertise and facilitate the acceleration of advancements in relevant fields.

## Organizing committee

- Matthew Adams – U.S. Department of Energy, National Energy Technology Laboratory
- John Crane – U.S. Department of Energy, National Energy Technology Laboratory
- Karen Lockhart – WE2
- Katie Hart – WE2
- Ajay Agrawal – The University of Alabama
- Gary Jesionowski – KeyLogic Systems

# Keynote Speakers

## **Bob Schrecengost – Workforce Development Under the UTSR Program U.S. Department of Energy – Acting Director and Senior Program Manager in the Hydrogen with Carbon Management Division**

Bob Schrecengost has over 38 years of fossil power industry experience in heading technology development programs, emissions reduction projects, and solving combustion and operational issues. Bob is currently with the Department of Energy's Office of Fossil Energy and Carbon Management, where he is Division Director of Hydrogen with Carbon Management and leads R&D programs in Advanced Turbines, Advanced Gasification, reversible Solid Oxide Fuel Cells, and Advanced Energy Materials. Prior to joining DOE in January 2020, Bob spent 12 years as the boiler R&D program manager for Alstom Power and GE Steam Power, managing an R&D portfolio that included both internally- and externally-funded projects.

## **John Crane – Advanced Turbines Technology Manager – U.S. Department of Energy National Energy Technology Laboratory**

Mr. John Crane is currently the Technology Manager for Advanced Turbines Program at the U.S. Department of Energy's National Energy Technology Laboratory (NETL). John has a BS in Aerospace Engineering from the University of Florida, an MS in Aerospace Engineering from the Georgia Institute of Technology, and an MS in Engineering Management from the University of Central Florida. From 2009 to 2023, John worked at Siemens Energy on development of high efficiency gas turbines with a focus on hot gas path components and associated technologies. His early career centered on development of emissions reduction technology for the H-class combustion system. Later, he led the transformative technology acceleration program that culminated in the 9000HL product family. He joined NETL in 2023 as the Technology Manager for Advanced Turbines to guide the technology development in support of the DOE mission to deliver low-cost, clean, and carbon-free electric power.

## **Prof. Ajay K. Agrawal – Robert F. Barfield Endowed Chair Professor, Mechanical Engineering – The University of Alabama**

Professor Ajay K. Agrawal is Robert F. Barfield Endowed Chair Professor in the Department of Mechanical Engineering at The University of Alabama (UA) since 2005. His current research focuses on rotating detonation combustion, high-pressure fuel sprays, diesel combustion, liquid fuel atomization, thermo-acoustic instabilities, biomass combustion, and in general, low-emission combustion systems for propulsion, power generation, and industrial processes. His research has been supported by DOE, NASA, Army, Navy, Air Force, NSF, US Department of Education, among others. He holds 3 U.S. patents and has authored over 100 archival journal papers, and over 200 conference publications. He has supervised 23 PhD graduates, and 11 PhD students are presently working with him.

Professor Agrawal served as Chair of US Sections of the Combustion Institute and as Chair of ASME Turbo Expo Coal, Biomass, and Alternative Fuels (CBAF) Committee. He is Fellow of ASME, Fellow of The Combustion Institute, and Associate Fellow of AIAA. He has received the top awards given to a faculty member across all disciplines at UA, including the Blackmon-Moody award for innovation in 2013, lifetime Burnum Distinguished Faculty Award in 2020, SEC Faculty leadership award in 2022, and T. Morris Hackney Endowed Faculty Leadership award in 2023.

## **Jereme Wetherby – Carbon Solutions Leader – GE Gas Power**

Jereme is the Carbon Solutions leader for GE Vernova's Gas Power division. In this role, Jereme will focus on both the market & commercial strategy to support the energy transition, key partnerships to enable the decarbonization of the power industry, and new & emerging technologies that will be required to decarbonize GE Gas Power's existing and new unit gas turbine fleet.

Over the last 5 years, Jereme has been instrumental in the development of GE Vernova's business-wide strategy associated with the energy transition and how gas turbines will play a critical role in a decarbonized future. He continues to work across our portfolio to strategize the best uses of power generation equipment, including gas, renewables, energy storage and nuclear technologies. For the past two years, Jereme has also co-lead our Energy Industry Leadership Forum and Igniting Powerful Energy Leaders courses bringing together hundreds of GE Vernova employees to understand the unique value of the GE Vernova portfolio as we prepare for spin and operate as 12 businesses with one cohesive mission.

Jereme has been in the power generation business for over 25 years and has held multiple engineering roles across multiple business segments. Jereme has had the privilege to work with numerous power generation technologies that include Aero-derivative & Heavy-duty gas turbines, Coal Fired Boilers, liquid/Air/hydrogen cooled Generators, Steam Turbines, Heat Recovery Steam Generators, Post-Combustion capture & treatment, gas turbine accessory system design, and control optimization.

Jereme has a Bachelor's degree in Chemical Engineering from Rensselaer Polytechnic Institute and currently resides in Atlanta, GA.





# Campus and Lab Tour

Bus Transportation will be provided.

Participants for the 2024 University Turbine Systems Research (UTSR) Meeting will tour the University of Alabama (UA) campus and visit UA's Engine and Combustion Laboratories (ECL).

Engine and Combustion Laboratories – | The University of Alabama (ua.edu)

<https://ecl.eng.ua.edu/>

ECL is a modern facility with multiple test cells, smaller labs, and high-performance computing to conduct combustion and engines research. Since its inception in 2012, ECL has greatly expanded its capabilities in areas of fundamental and applied studies on gas turbines for power generation and propulsion, diesel and gasoline engines, and industrial/household burners. Focused on low-emission, high-efficiency, and sustainable fuels research, ECL facilities are equipped for demanding combustion research and include rotating detonation engines, high-pressure sprays, small and large engines and dynamometers, and a wide range of high-speed optical diagnostics and conventional gas analyzers, all contributing to a variety of leading-edge research projects.

# Agenda at-a-glance

Day 1: Tuesday, September 24, 2024

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8:00 AM

## Registration/Continental Breakfast

*Sellers Auditorium Foyer*

9:00 AM

## General Session

*Sellers Auditorium*

9:00 AM

## Welcome and Introduction

*Dr. Stuart R. Bell, President, The University of Alabama*

9:25 AM

## Opening Remarks

*John Crane, Advanced Turbines & sCO<sub>2</sub> Technology Manager, NETL*

9:30 AM

## Keynote Speech

*Workforce Development Under the UTSR Program*

*Robert Schrecengost, Advanced Turbines & sCO<sub>2</sub>, Program Manager, U.S. DOE*

9:45 AM

## Keynote Speech

*Turbines for Dispatchable Zero-Carbon Power*

*John Crane, Advanced Turbines & sCO<sub>2</sub> Technology Manager, NETL*

10:15 AM

## AM BREAK

10:45 AM

## Keynote Speech

*The Role of Gas Turbines in a Decarbonized Future*

*Jeremie Wetherby, Carbon Solutions Leader, GE Gas Power*

11:30 PM

## LUNCH

*Sellers Auditorium*

12:30 PM

## Proceed to Breakout Rooms



# DAY 1

## Breakout sessions

### Track A - Carbon Free Fuels: Rast A

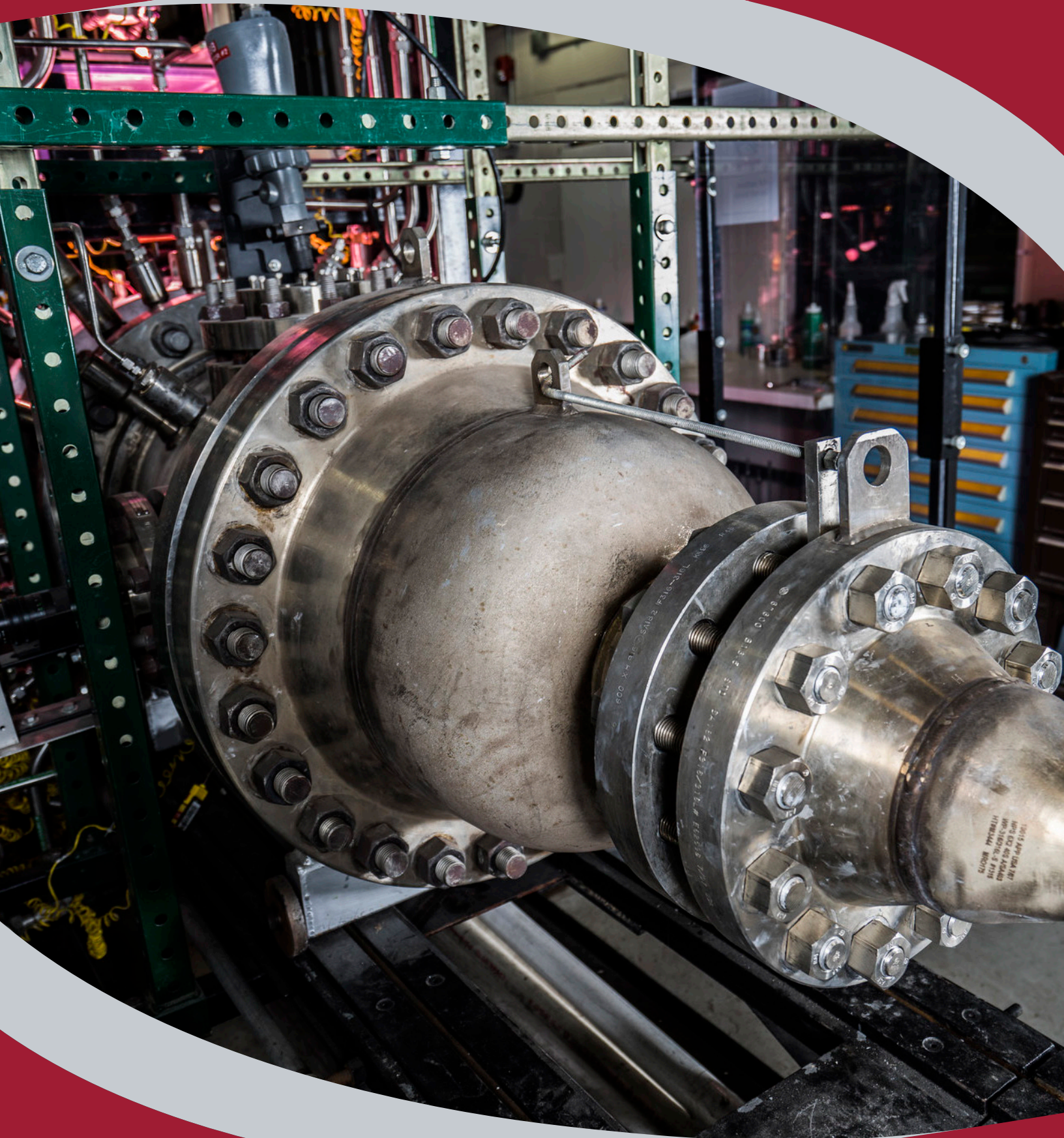
Moderators: Katelyn Ballard & Mark Freeman

	Organization	Title	Presenter
12:45 PM	University of Central Florida	FE0032072 - Fundamental Experimental and Numerical Combustion Study of H <sub>2</sub> Containing Fuels for Gas Turbines	Subith Vasu
1:15 PM	NETL Support Contractor	Techno-Economic Analysis of Hydrogen Production and Compressed Air Energy Storage from Variable Renewable Energy	Troy Teel
1:45 PM	Purdue University	FE0032074 - Investigation of Flame Structure for Hydrogen Gas Turbine Combustion	Robert Lucht
2:15 PM	University of California, Irvine	FE0032073 - Development and Application of Multipoint Array Injection Concepts for Operation of Gas Turbines on Hydrogen Containing Fuels	Vincent McDonell
2:45 PM	PM Break		
3:15 PM	The Ohio State University	FE0032076 - Hydrogen Fuel Effects On Stability and Operation of Lean Premixed and Staged Gas Turbine Combustors	Jeffrey A. Sutton
3:45 PM	NETL	Flashback Measurements in Hydrogen Enriched Low Swirl Flames Using High Speed OH-PLIF	Peter Strakey
4:15 PM	General Electric (GE) Company	FE0032173 - Advanced Mixed Mode Combustor for Hydrogen F-Class Retrofit	Michael Hughes
5:00 PM	LAB TOUR - Bus Transportation Will be Provided		

### Track B - Advanced Manufacturing & Aero/Heat Transfer: Rast B

Moderators: John Homer & Megan Trapuzzano

	Organization	Title	Presenter
12:45 PM	Pennsylvania State University (PSU)	FE0031806 - Development And Evaluation of a Novel Fuel Injector Design Method Using Hybrid-Additive Manufacturing	Jacqueline A. O'Connor
1:15 PM	San Diego State University	FE0032080 - Development of Design Practices for Additively Manufactured Micro-Mix Hydrogen Fueled Turbine Combustors with High-Fidelity Simulation Analysis, Reduced Modeling and Testing	Gustaff Jacobs
1:45 PM	GE Vernova	FE0031611 - High Temperature Additive Architectures for 65 Percent Efficiency	Richard M. DiCintio
2:15 PM	NETL	Additive Manufacturing Research at NETL-RIC for Turbine Applications: Leveraging Additive Manufacturing and Coatings for Turbine Thermal Management Evaluation of Additively Manufactured Candidate Alloys for Hydrogen Turbine Fuel Injectors	Matthew Searle David Alman
2:45 PM	PM BREAK		
3:15 PM	Argonne National Laboratory (ANL)	TCF-21-25027 - A Deep Learning Enabled Fast and Robust Chemistry Solver for Reacting Flow Simulations	Pinaki Pal
3:45 PM	Purdue University	Thermal Management of Zero-to-Near-Zero, CO <sub>2</sub> -Emission Gas Turbines	Tom I-P. Shih
4:15 PM	Pennsylvania State University (PSU)	FE0032232 - Advancing Turbine Technologies for Relevant Inlet Temperature Profiles in the Steady Thermal Aero Research Turbine (START) Lab	Reid A. Berdanier
5:00 PM	LAB TOUR - Bus Transportation Will be Provided		





# Agenda at-a-glance

Day 2: Wednesday, September 25, 2024

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8:00 AM

## Registration/Continental Breakfast

*Sellers Auditorium Foyer*

9:00 AM

## General Session

*Sellers Auditorium*

9:00 AM

## Keynote speech

*Recent Accomplishments and Opportunities in Rotating Detonation Combustion Research, Prof. Ajay Agrawal, University of Alabama*

9:45 AM

## Panel Discussion: Decarbonization of the Existing Gas Turbine Fleet

*Nathan Weiland, Senior Fellow at the National Energy Technology Laboratory (NETL)*

*Joseph Meadows, Assistant Professor, Department of Mechanical Engineering at Virginia Tech*

*Lance Smith, Senior Technical Fellow, Combustion & Propulsion Technology at RTX Technology Research Center (RTRC)*

*Jeff Moore, Institute Engineer and STEP Project Manager at Southwest Research Institute.*

10:30 AM

## Proceed to Breakout Rooms

# DAY 2

## Breakout sessions

### Track A - Carbon Free Fuels: Rast A

Moderators: Richard Dalton & Drew O'Connell

	Organization	Title	Presenter
10:45 AM	Solar Turbines, Inc.	FE0032106 - Development of a Retrofittable Dry Low Emissions Industrial Gas Turbine Combustion System for 100% Hydrogen and Natural Gas Blends	Leonel Arellano
11:15 AM	RTX Technology Research Center	FE0032171 - Development of Hydrogen Burner for FT4000 Aeroderivative Engine	Justin Locke
11:45 AM	<b>LUNCH - Sellers Auditorium</b>		
1:00 PM	Georgia Institute of Technology	FE0032079 - Ignition, Turbulent Flame Speeds, and Emissions from High Hydrogen Blended Fuels	Wenting Sun
1:30 PM	Creative Power Solutions (USA), Inc.	DE-SC0020903 - Ammonia Gas Turbine Combustor	Majed Toqan
2:00 PM	NETL	Ammonia Combustion for Gas Turbine Engines	Clint Bedick
2:30 PM	EPRI	DE-FE0032172 Investigation of Ammonia for Combustion Turbines (LACT)	Robert Steele
3:00 PM	<b>PM BREAK</b>		
3:30 PM	RTX Technology Research Center	DE-FE0032169 Low NO <sub>x</sub> , Operable Ammonia Combustor for Zero-Carbon Power	Lance Smith Eric Wood
4:00 PM	University of Central Florida	FE0032228 - Ceramic Matrix Composites for Hydrogen Combustion	Jihua Gou
4:30 PM	Oak Ridge National Laboratory (ORNL)	Next Generation Environmental Barrier Coatings	Michael Lance
5:00 PM	GTI Energy/ University of Central Florida	Ammonia Combustion System Modeling	Marzuqa Ahmed
5:15 PM	UTSR Fellow (Georgia Tech)	UTSR Fellowship Report Out	Richard Porqueddu
5:30 PM	UTSR Fellow (Texas A&M University)	Research on High Temperature Dry Gas Seal Test Rig	Elliot Moore
5:45 PM	<b>End of Breakout Sessions</b>		
6:00 PM	<b>University Sponsored Dinner at Tuscaloosa River Market – Bus Transportation will be provided</b>		



## Track B - Pressure Gain Combustion & Supercritical CO<sub>2</sub>: Rast B

Moderators: Matt Adams & Don Ferguson

	Organization	Title	Presenter
10:45 AM	University of Michigan	FE0031773 - Pressure Gain, Stability, and Operability of Methane/Syngas Based RDEs Under Steady and Transient Conditions	Mirko Gamba
11:15 AM	Purdue University	FE0032075 - Physics-Based Integration of H <sub>2</sub> -Air Rotating Detonation into Gas Turbine Power Plant (HydrogenGT)	Eric Bach
11:45 AM	<b>LUNCH - Sellers Auditorium</b>		
1:00 PM	University of Alabama	DE-EE-0032077 - Area Profiling to Improve Flow Uniformity and Pressure Gain in Rotating Detonation Combustion	Ajay Agrawal
1:30 PM	Argonne National Laboratory (ANL)	FWP-39888.1 - Physics Exploration and Analysis of Hydrogen-Fueled Rotating Detonation Engines Using Advanced Turbulent Combustion Modeling and High-Fidelity Simulation Tools	Pinaki Pal
2:00 PM	NETL	Applied Research on Rotating Detonation Combustion at NETL	Don Ferguson
2:30 PM	GE Aerospace Research	Novel Modular Heat Engines with sCO <sub>2</sub> Bottoming Cycle Utilizing Advanced Oil-Free Turbomachinery	Bugra Ertas
3:00 PM	<b>PM BREAK</b>		
3:30 PM	GE Aerospace Research	FE0032170 - Demonstration of a Gas Turbine-Scale Rotating Detonation Combustor Integrated with Compressor and Turbine Components at 7FA Cycle Conditions	Kapil Singh, Tommy Genova, and Luke D'Aquila
4:00 PM	Southwest Research Institute (SwRI)	FE0031929 - Development of Syngas Oxy-Combustion Turbine for use in Advanced sCO <sub>2</sub> Power Cycle	Jeffrey Moore
4:30 PM	Parametric Solutions, Inc.	FE0031922 - Supercritical Carbon Dioxide Oxy-Syngas Combustor Development and Testing	David Cusano
5:00 PM	Southwest Research Institute (SwRI)	FE0028979 - Supercritical Carbon Dioxide Pilot Plant Test Facility	Jeffrey Moore
5:30 PM	UCI/Solar Turbines	Capturing Engine Emissions Responses via Reduced Order Modeling	Malcolm Overbaugh
5:45 PM	<b>End of Breakout Sessions</b>		
6:00 PM	<b>University Sponsored Dinner at Tuscaloosa River Market – Bus Transportation will be provided</b>		



## Wifi

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