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This year at Turbo Expo, attendees represented 45 countries worldwide participating in 311 conference sessions. In these sessions, authors presented close to 1,000 final papers with 52 tutorial sessions, 25 panel sessions, and 7 lecture sessions.
SME Turbo Expo 2019, in Phoenix, Arizona, USA, maintained its reputation as the world’s premier turbomachinery gathering with over 2,400 professionals. Throughout the week, delegates shared practical experiences, knowledge and ideas on the latest turbine technology trends and challenges. Many expressed their appreciation for the conference, noting that it was an amazing experience, particularly for receiving valuable feedback on research from experts in the field.

This year’s Turbo Expo featured three focus tracks centered on high potential areas within the framework of the existing technical committees: Turbomachines for Clean Power and Propulsion Systems – Aviation Focus, Turbomachines for Clean Power and Propulsion Systems – Power Focus and Maintenance, Repair and Overhaul in the light of Digitalization (MRO/Digital). These focus tracks featured plenary sessions (Aviation and Power focus only), technical papers, as well as panel and tutorial sessions.

The moderated keynote panel session was again, well received as the attendees submitted their questions to the moderators via their smartphones or personal electronic devices. The audience actively submitted questions, while the moderators collected and asked the panelists for their insight. Bringing their expertise and experience, they made this format a worthwhile part of the conference.

Led by Ruben Del Rosario of NASA, and Atul Kohli of Pratt & Whitney, the opening session featured an exceptional keynote focused on “Turbomachines for Clean Power and Propulsion Systems”, with panelists Janet L. Kavandi, NASA Glenn Research Center; Guy DeLeonardo, GE Gas Power; and Thomas Alley, Electric Power Research Institute (EPRI). The keynote was followed by the prestigious ASME and IGTI annual awards program. The plenary panel sessions were well attended with great audience participation. Moderated by Tim Lieuwen of Georgia Institute of Technology and James Heidmann of NASA Glenn Research Center, the Tuesday morning plenary session, “Turbomachines for Clean Power and Propulsion Systems — Aviation Focus” featured panelists Mike Trego, Honeywell Aerospace; Alexander Simpson, GE Aviation; and Francis R. Preli, Jr., Pratt & Whitney. The Wednesday Plenary Session “Turbomachinery and Clean Energy — Future Trends and Opportunities” was moderated by Richard Dennis, DOE, National Energy Technology Laboratory and Karen A. Thole, Pennsylvania State University, featured panelists Kunal Chandra, Siemens Gas and Power; Guy DeLeonardo, GE Power; and Yasushi Fukuiizumi, MHI.

The Technical Conference offered four and a half days of almost 1,000 peer-reviewed technical paper presentations. After the technical sessions finished for the day, it was nice to unwind with the evening events throughout the week. On Monday evening close to 2,000 came out for the welcome reception where they enjoyed the networking opportunity. On Tuesday, Women in Engineering held a networking event featuring talks from Mary Anne Cannon, Pratt & Whitney and Mary F. Wadel, NASA. The event was sponsored by GE and Pratt & Whitney. On Wednesday many students and early career engineers got acquainted with one another at the mixer. During the three-day exposition, delegates met with representatives from premier companies supplying quality turbomachinery products and services. Special recognition during the Closing Ceremony went to ANSYS and Honeywell Aerospace, as exhibition visitors voted their displays the best. Student Posters were presented on Tuesday and Wednesday afternoon in the exhibition hall, with first place going to Xiao He, second place to Louis Christensen, and the People’s Choice awarded to Hebert Harrison.

If turbomachinery is part of your professional life, you cannot afford to miss the annual ASME Turbo Expo! Plan to attend Turbo Expo 2020 in London, United Kingdom! See page 60 for more details.

Visit ASME Turbo Expo online at asme.org/events/turbo-expo.
Lying testbed aircraft, used for research, testing and certification of commercial aircraft engines by jet engine OEMs can be glamorous—and expensive—but absolutely necessary.

A new jet engine is developed by engineering design teams, refined by component testing and then run many hours in ground-based test stands. However static test stand test information is not sufficient, so flight testing must be carried out on testbed aircraft for such things as engine/nacelle integration, engine behavior at flight Mach numbers, altitude and angle of attack variations, icing and transient operation. Of greater importance, testbed aircraft certification testing is required by regulatory authorities such as the U.S. Federal Aviation Administration, before a new (or modified) commercial jet engine can enter service.

Testbed aircraft engine testing goes back to the early days of aviation. Jet engine OEMs such as Rolls-Royce and Pratt & Whitney who each started with piston engine production, have used testbed aircraft, going back to at least the 1930s. Candidate aircraft for testbed assignments could include surplus military airplanes and older, commercial airliners, each modified for the task. A major consideration for use as testbed aircraft is to have adequate wing area and ground clearance to accommodate test engine attachment. In some cases the test engine might be lowered from the bomb bay of a military aircraft, or mounted on a pylon on the testbed aircraft fuselage. The cabin also needs to accommodate onboard test equipment and test engineers necessary to monitor, measure and record the engine under test.
Testbed Aircraft Cameos

As a young engineer in the 1960s at Pratt & Whitney Aircraft (now UTC’s Pratt & Whitney) in East Hartford, Connecticut, I was involved (along with many others) in the development of their 44,000 pound thrust (lbt) JT9D turbojet, which powered the first Boeing 747 jumbo jet aircraft[2]. Because of its then ground-breaking large fan diameter (new for the 1960s), P&WA had to use a U.S. Air Force Boeing B-52 as a testbed. The Stratofortress, with its high wing, allowed the JT9D to be mounted with adequate ground clearance for takeoff and landing. In Figure 1, the P&WA testbed aircraft is shown landing at the Windsor Locks, Bradley International Airport, after a test flight, with a JT9D engine replacing two TF-33 inboard engines on the right wing of the eight-engined B-52.

The B-52 continued as a P&WA testbed aircraft until 1981, even after being damaged in its hangar by a violent tornado that raced through Windsor Locks in 1979. Pratt & Whitney more recently used two Boeing 747SP aircraft for testbeds, to flight test their new geared fan jet engines.

Last year in 2018, OEM GE Aviation commenced using one of their Boeing747 testbed aircraft[3] to flight test their new GE9X, 100,000 lbt engine that will power the new Boeing 400-passenger twin-engined 777X. Figure 2 shows the 747-400 testbed aircraft taking off in Victorville, California on its first test flight of the GE9X, currently the world’s largest turbofan. The test engine is mounted on the left wing in No. 2 engine position, and has a nacelle diameter of just under 15 feet, to house its 134 inch fan. (The nacelle housing exceeds a Boeing 737 fuselage width by more than two feet.)

The GE 747-400 was purchased from Japan Airlines, after it had two decades of commercial service. Fiber optic cables from engine instruments and sensors measuring thrust, temperature, pressure and fuel consumption connect to rows of work stations monitored by engineers in the economy cabin.

Honeywell Aerospace in Phoenix is an OEM that produces engines in 3500-10,000 lbt range for business, airline and military jets. Their Boeing 757-225 testbed aircraft is shown in Figure 3, with its test engine pylon located on the forward starboard section of the fuselage. (This “off-the-shoulder” location is also used by one of Pratt & Whitney’s Boeing 747SP testbed aircraft.)

The Honeywell 757 began life in 1983 with Eastern Airlines, and after other assignments was acquired by Honeywell in 2005. It has since been used to flight test and certify Honeywell engines, such as their popular TFE731 series. The 3500 lbt TFE731 is a geared fan engine, going back to 1968[4].

REFERENCES

ADVANCED MANUFACTURING & REPAIR FOR GAS TURBINES (AMRGT) SYMPOSIUM

MARCH 3–4, 2020
EPRI CONFERENCE CENTER
IN CHARLOTTE, NORTH CAROLINA, USA

Abstract Submission Deadline: October 22, 2019
This two-day symposium will bring together engineers, designers, researchers, repair professionals and business leaders at companies that design, manufacture, repair and own gas turbines. event.asme.org/AMRGT

ASME 2019 GAS TURBINE INDIA CONFERENCE

DECEMBER 5–6, 2019
IIT MADRAS, CHENNAI, INDIA

Registration is available online at event.asme.org/GT-India
DECARBONIZATION ALERT!

The worldwide energy sector is moving toward increased usage of renewables and overall reduction in carbon dioxide production. These trends have major implications on how the gas turbine industry produces and uses energy. Thus the evolving role of gas turbines to decarbonize the world’s energy conversion systems will be the theme of articles in upcoming issues of the Global Gas Turbine News. This series will include perspectives from across the industry and globe. We will hear from Original Equipment Manufacturers and researchers from three continents and various industries that use gas turbine technologies.

During the recent Turbo Expo in Phoenix, Arizona the participants were able to hear from leading figures in the turbomachinery industry speak about the theme of Clean Power and Propulsion Systems. High efficiency gas turbine combined cycle power plants burning natural gas have contributed significantly to major reductions in carbon dioxide emissions, as they replace less efficient, polluting coal fired power plants. In the US during the last decade, this CO₂ reduction has been almost equal to the total annual CO₂ production of Germany. In addition, hybrid concepts combining traditional gas turbines with electrical propulsion systems are being developed to further expand decarbonization into the aviation industry.

The ever adaptive nature of gas turbines lends itself to decarbonization. As an example, consider that currently, some renewable energy systems (solar and wind) are producing more electricity than can be consumed. This surplus could be used to electrolyze water, to produce non-polluting hydrogen gas. Gas turbines can use this hydrogen as fuel, as it can be added to existing natural gas lines, or even with combustion modifications, burned directly to emit only water vapor. Additionally, there are other emerging technologies in the energy storage market which will demand new requirements and capabilities from gas turbines and related technologies.

We urge our Global Gas Turbine News readers to watch for these upcoming decarbonization articles related to turbomachinery developments on the ground and in the air.

“The ever adaptive nature of gas turbines lends itself to decarbonization.”
Europe’s energy and climate ambitions

Following the Paris agreement on climate change from 2015, the European Union (EU) committed to deliver its share to keep global warming “well below 2 degrees”. This means reducing greenhouse gas emissions of the whole economy by 40% in 2030 (compared to 1990) and at least 80-95% by 2050. A climate-neutral target by 2050 is currently being considered.

Consequently, being one of the biggest emitters, European countries are rebuilding their energy systems. By 2030, the share of renewables in energy shall reach at least 32%, which translates into 57% renewables in the electricity mix. In the draft long-term strategy[1] published at the end of 2018 by the European Commission, a full decarbonisation of the power sector by 2050 is foreseen, while, at the same time, the electrification of additional sectors, like transportation, is expected.

In 2018, renewables accounted for 32.3% of the EU electricity[2]. While only 16% came from wind and solar, their capacities will grow strongly—as opposed to limited growth rates for the other main renewable sources, hydro and biomass. The bulk of future European electricity will therefore be generated with variable wind and sun, requiring a growing need for system flexibility.

The European energy system today is characterised by overcapacities. Renewables benefit from feed-in guarantees and are followed in the merit order curve by lignite, hard coal and nuclear power. Gas plants are at the end of the curve, which is why a considerable number of flexible gas plants in EU countries are not operating today. The EU energy system can easily handle today’s flexibility needs. However, once countries have phased out highly polluting capacities, they will need gas plants—existing and new—to provide the necessary share of dispatchable power and heat.

Investors and the stranded asset discussion

Most EU Member States regard gas power plants as a transitional technology, which will be needed for some time, but which is not compatible with a fully decarbonised energy system. This makes governments as well as investors wonder, whether investments in gas power generation are future-proof.

This concern is further enhanced by growing “sustainable finance” considerations, denying the compatibility of investments in gas infrastructure—including power plants—with sustainability.

Without demonstrating how gas power plants fit into a 2050 system with close-to-zero carbon-emissions, the pressure on investors and operators of power plants to avoid stranded investments and to no longer invest in gas power generation will increase.

Therefore, the European turbine industry, organised within EUTurbines, has complemented the storyline on the advantages of a coal-to-gas switch with a natural-gas-to-renewable-gas switch.

EUTurbines members’ commitment

For most policy makers, gas turbines are tied to “fossil” gas; similarly, they mistakenly link steam turbines with coal.

Right: Official presentation of the commitments in Brussels on January 23. From left to right: Zuozhi Zhao (Siemens), Evan McAvoy (Solar Turbines), Emmanouil Kakaras (MHPS), Michael Ladwig (EUTurbines President), Daniela Gentile (Ansaldo Energia), Harald Stricker (MAN Energy Solutions), Andrew Lammas (GE).
Explaining that gas turbines need a combustible gas—be it fossil or renewable—requires great efforts and a bold and simple message. Our message: If you want to achieve full decarbonisation and need dispatchable power, we have the solution: turbine technology with renewable gases!

Technically, this can easily be achieved via the use of synthetic methane or defined qualities of biomethane. However, Europe’s discussion strongly focuses on hydrogen. Accordingly, our industry commitment specifically addresses the use of hydrogen.

The result: EUTurbines members declared that already today, renewable gases in the form of synthetic methane can be used, that by 2020 natural gas blended with up to 20% hydrogen can be utilised and that, by 2030, customers will be able to acquire turbines operating with hydrogen only. In addition, retrofit solutions for existing turbines shall be developed.

The commitments[3] have been signed by the manufacturers’ CTOs as a visible signal that the industry is serious.

Why now?

Most gas pipelines will not accommodate a share of 20% hydrogen by 2020, but the figure was necessary to demonstrate that the turbine industry will be ready when the gas network operators provide new gases.

Over the next two years, the EU plans a gas market reform. There are critics—NGOs and within the renewables sector—that question the continued need for a European gas grid and support a full electrification—also of the heating and transport sectors. Without a connection to the pipeline, the gas turbine technology would become obsolete.

The alternative: the decarbonisation of gas. Discussions have already started, and for policy considerations, it is essential to be sure that the main gas consumers—like power plants—are able to handle the new (renewable) gases. The commitments reassures legislators and operators that a decarbonised energy system, efficiently coupling the gas, electricity and heat networks, can be achieved and that investments in gas infrastructure and power plants are future-proof.

What about the combustion challenges?

It is obvious that using hydrogen or blended natural gas, creates challenges for the turbine’s combustion system. These include safety, emissions and efficiency areas—but they will be properly addressed. It will need time and cause costs—but all turbine manufacturers have started developing solutions.

The biggest challenge arises from variations in the gas composition, which seem very likely in a system where increasing amounts of “green” hydrogen from power-to-gas will be injected. A mix of measures, from early and structured information from the grid to blending skids and fast reacting burner adjustments will be needed—together with some agreed limitations at the pipeline’s exit point.

The way forward

The commitments are accompanied by several policy requests, from financial support for R&I and large-scale demonstration to the provision of the necessary quantities of renewable gas.

A predictable schedule for the network transformation is key: to adequately adapt its technology, the turbine industry needs to know whether blended gas pipelines or separated grids for methane and hydrogen will be preferred in the transitional period.

While it will take time until customers demand specific hydrogen-based turbines, it is essential to be prepared. The proven capability of turbines to operate with renewable gases—whenever they become available—and solutions to retrofit existing and newly built plants to make them “renewable-gas ready” are essential. Only this will build the trust of policy makers that our technology and a decarbonised energy system are not only compatible but complement each other.

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3. www.powertheeu.eu
CONGRATULATIONS

to all award recipients and thank you to all ASME IGTI committee award representatives whose work assists the awards and honors chair and the awards committee in the recognition of important gas turbine technological achievements. Thank you to John Blanton for serving as the IGTI Honors and Awards Committee Chair, John Gülen as Industrial Gas Turbine Technology Award Committee Chair, and Andrew Nix as the Aircraft Engine Technology Award Committee Chair.

2019 ASME 
R. Tom Sawyer Award
Dr. Om Sharma
United Technologies Research Center

2017 ASME Gas Turbine Award
Dr. Heinz-Peter Schiffer
Technische Universität Darmstadt
Maxmilian Jüngst
Technische Universität Darmstadt
Dr. Christoph Brandstetter
Ecole Centrale de Lyon

ASME Dedicated Service Award
Patricia Cargill
GE
Adnan Eroglu
Siemens Gas and Power

ASME IGTI Scholar Award
Dr. Kenneth Suder
NASA Glenn

2019 Industrial Gas Turbine Technology Award
Ron Natole
Natole Turbine Enterprises

2019 Aircraft Engine Technology Award
Thomas Prete
Pratt & Whitney
Congratulations to the

STUDENT WINNERS

2019 Dilip R. Ballal Early Career Award
Dr. Lisa Branchini
University of Bologna

Young Engineer Turbo Expo Participant Award Winners (YETEPEP)

Parash Agarwal
Nathan Balke
Nikhil Baraiya
Tania Sofia Cacao
Cis Guy M De Maesschalck
Xin Deng
Antoine Durocher
Theofilos Efstathiadis
Chiara Gastaldi
Shuai Guo
Jee Hee
Yousef Kanani
Bonjin Koo
Eric Kurstak
Madasseri Payyapalli
Manas
Pedro Milani
Avinash Renuke
Jon Runyon
Jacob Snyder
Tingcheng Wu
Jing Yang
Wenqiang Zhang

Student Advisory Committee Travel Award Winners (SACTA)

Jeffrey A. Bennett
Lakshya Bhatnagar
James Braun
Bogdán Cernat
Louis E. Christensen
Andres Curbelo
Penghao Duan
Simone Giorgetti
William J. Gooding
Xiao He
Shreyas Hegde
Lachlan J. Jardine
Mavroudis D. Kavvalos
Akshay Khadse
Sneha Neupane
Marcel Otto
Marek Páty
Hien Minh Phan
Smruti Sahoo
Jonathan R. Tobias

UPCOMING AWARD OPPORTUNITIES

2021 ASME IGTI Scholar Award
Nominations due to igtiawards@asme.org by September 15, 2019.

2020 Student Scholarships
Application process is open
December 1, 2019 – March 1, 2020.
asme.org/asme-programs/students-and-faculty/scholarships

2020 ASME IGTI Aircraft Engine Technology and Industrial Gas Turbine Technology Awards
Nominations due to igtiawards@asme.org by October 15, 2019.
you are invited to offer a paper for publication at the ASME 2019 Turbo Expo Turbomachinery Technical Conference, June 22-26, 2020 in London, United Kingdom. Prepare your abstract and submit it to the list of track topics for which ASME IGTI Technical Committees are seeking papers.

Abstracts are due by **October 4, 2019** and must be submitted online (plain text, 400 word limit) via the ASME Turbo Expo Conference Website at [asme.org/events/turbo-expo](asme.org/events/turbo-expo).

**ASME IGTI Journals**

If warranted by review, papers may also be recommended for publication in the *Journal of Engineering for Gas Turbines and Power* or the *Journal of Turbomachinery.*

**Indexing**

All ASME Conference Proceedings are submitted for indexing to Scopus, Compendex, ISI Conference Proceedings Citation Index, and other major indexers. In addition, all ASME Conference papers are discoverable through Google Scholar search and all other major search engines. Indexing publishers are independent organizations and determine which and when conference proceedings are indexed.