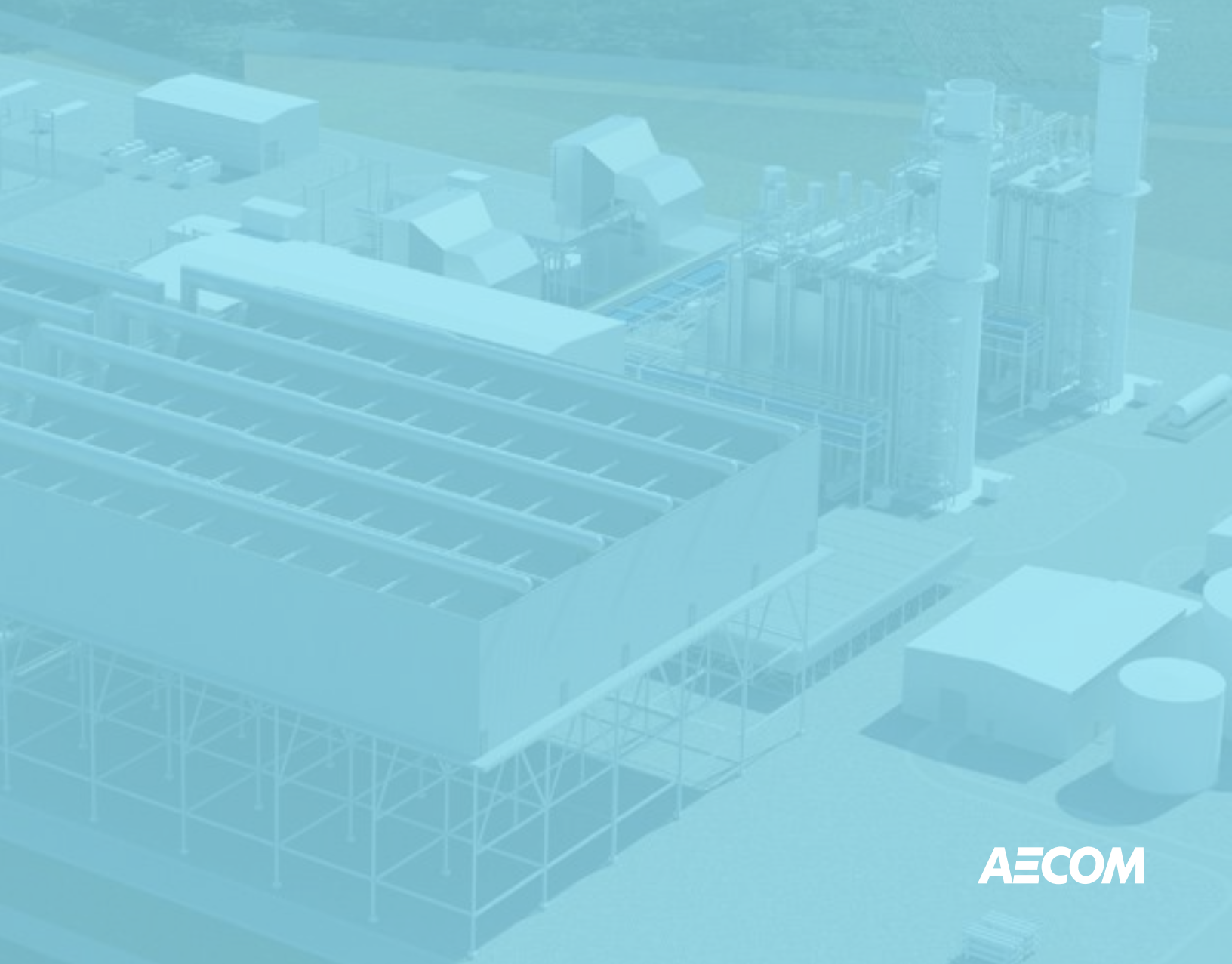


# Power

Combustion Turbine  
Simple and Combined  
Cycle



## Introduction

AECOM's history in cogeneration and combustion turbine (CT) projects began in the 1940s and accelerated significantly through in the 1980s and 1990s, and into the 21<sup>st</sup> century, as this market expanded.

To date, we have provided services ranging from feasibility studies and Owner's Engineer, through full Engineering, Procurement, Construction, and Startup services. This experience base represents more than 33,000 MW of new generation, and covers every technology including aero-derivative and Frame (E, F, G, H and J) machines. We have provided services for all technical and operating applications, including simple cycle, combined cycle, cogeneration, dual fuel firing, repowering, baseload operation, and peaking operation.

The CT market continues to be driven by low natural gas prices as well as the environmental and regulatory benefits gas offers over other fossil fuels. Gas also offers shorter, more predictable schedules vs. both coal and nuclear. AECOM has the capabilities and resources to meet these market demands through our experienced team of professionals who have maintained an active role in every phase of the design and execution of projects of these types and magnitudes.

**AECOM's combustion turbine experience and capabilities, including advanced class machines, represents more than 33,000 MW, bringing exceptional value to our clients in terms of quality, consistency, cost savings, schedule, and ultimately project performance.**

## Summary of Market Presence

AECOM has provided engineering and/or construction services for more than 200 units in the CT project market and has built 24 combined cycle projects since 1995 for clients using both balance sheet and non-recourse financing.

The vast majority of these projects have involved detailed engineering, procurement, construction, and startup services, both at greenfield sites as well as in existing

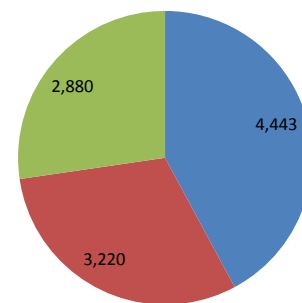
plants requiring modifications and retrofit services or the replacement of coal-burning units with gas. Several projects have also included services such as conceptual engineering, feasibility studies, and Owner's Engineer services. More than half of our 33,000 MW of combustion turbine generation have been commissioned since 1999, demonstrating that our expertise, professional resources, and technology knowledge have remained current and in step with the technical advances in the CT marketplace.

**AECOM has the experience and resources to execute any CT configuration or technology.**

## AECOM Experience by Advanced Class CT Technology Classification

As the market for combustion turbine power projects continues to expand, AECOM is extremely well positioned to respond — whether the application is simple cycle, combined cycle, or cogeneration. Our extensive experience base includes every major manufacturer and state-of-the-art technology including the advanced technology ("G", "H"

**Advanced Class Combustion Turbine Technology  
 Total 10,543 MW**



■ G ■ H ■ J

and "J") machines. In this domain, and as noted on the above chart, AECOM has over 10,500 MW of advanced class combustion turbine experience. This experience has been garnered through a variety of contractual scope responsibilities that includes:

- Owner's Engineer (OE)
- Conceptual and Preliminary Engineering (CE/PE)
- EPC Contractor (EPC)
- Construction Manager (CM)

As shown below, our experience with the various combustion turbine original equipment manufacturers

(OEM) spans most all major domestic and international suppliers.

**Combustion Turbine OEM Experience**

Manufacturer	CTs	MW
General Electric	170	19,900
Siemens / Westinghouse	34	6,200
Mitsubishi Heavy Industries	19	6,900
Alstom (ABB)	4	500
Brown Boveri	5	70
Allison	3	20
<b>Total</b>	<b>235</b>	<b>33,590</b>

AECOM's experience with each of these OEMs covers virtually every CT model within their respective product lines. Accordingly, our expertise has grown to include each of the four technology classes that are most prevalent in today's market, F, G, H, and J; the latter three (3) representing current [2018] advanced class technology.

Our knowledge of these CTs is not limited to a single design aspect or feature. We are experienced with each machine in terms of performance, overall plant integration and cycle optimization, production schedules, installation issues and schedules, startup and testing procedures, and operability issues. The net result of AECOM's complete knowledge of the CT benefits the Owner in the form of an optimized overall plant performance and schedule.

There are various CT models that fall within each technology frame size classification. AECOM has direct engineering, procurement, construction, and startup experience with virtually all of these models, as depicted in the succeeding table.

**AECOM brings a successful performance record with every type of CT technology class, including advanced class G, H and J.**

**Experience with CT Frame Sizes**

CT Technology	Models Utilized in AECOM Projects
A (Aeroderivative)	GE LM 6000, LM 5000, GE LM 2500
E Class	GE Frame 5, 6A, 6B, 7EA, 9EA SW – V84.2, V94, 251B, 501 D5, 701D MHI – 701D ABB – 8, 13D2 Alstom – 501 KH
F Class	GE 6FA, 7FA, 7FB, 9FA MHI – 501F, 501F3, 701F2 SW – 501F
G Class	MHI – 501G
H Class	GE 7HA.02
J Class	MHPSA JAC

**Experience with Major Equipment Suppliers**

AECOM has an experience base with the manufacturers and suppliers of every piece of equipment, materials, and associated systems that comprise a combustion turbine project. As a result, the same design and cost saving benefits that we derive from our CT knowledge, e.g., performance, availability, cycle integration, can be applied to balance-of-plant equipment, pumps, valves, electrical switchgear, piping, concrete, etc.

Steam Turbine	HRSR
General Electric (Alstom, ABB)	General Electric (Alstom, Doosan)
Toshiba	Nooter Ericksen
Ansaldo	Vogt
Hitachi	NEM (Siemens)
MHI (MHPSA, Hitachi)	Deltak (Hamon)
Siemens (Westinghouse)	Foster Wheeler (AMEC)
	Ansaldo
	Austrian Energy

**Technical Applications/Configurations**

In addition to our knowledge of all major equipment suppliers, AECOM can provide full engineering services on every configuration and application of the CT technology. Whether it is simple cycle, combined cycle, greenfield repowering, base load or peaking units, we have the resources and proven track record to ensure a project will be executed efficiently and that will meet all performance metrics.

**Simple Cycle/Combined Cycle Experience**

	Since 1999		Total to Date	
	Number of Units	MW	Number of Units	MW
Simple Cycle	22	1,645	52	4,800
Combined Cycle	103	19,926	189	28,790

Any CT project involving cogeneration, repowering or dual fuel turbines brings with it numerous technical challenges involving complex instrumentation and controls, fuel handling, and system interfaces.

Cogeneration requires the system interface, monitoring, and control of two separate off-products, electricity and steam, often in situations where process steam must be uninterrupted. Instrumentation and controls play a key role in the success of this application.

Dual fuel combustion turbines require a thorough knowledge of various liquid and gaseous fuel handling systems and the ability to quickly change fuels as may be necessary and while remaining in compliance with emission permit limits.

Repowering requires the interface between existing and new equipment and systems. Review of existing drawings and assessment of existing equipment requires a contractor who has experience with a wide range of suppliers and their products, and who can work safely in a retrofit environment and seamlessly interfaces with operating plant personnel.

AECOM has extensive experience in successfully addressing all of these challenges in these applications.

**Total Experience in Specific Applications**

	Number of Units	MW Generation
Cogeneration	80	8,200
Dual Fuel	55	10,150
Repowering	10	1,700

#### About AECOM

AECOM is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM had revenue of approximately \$17.4 billion during fiscal year 2017. See how we deliver what others can only imagine at [aecom.com](http://aecom.com) and @AECOM.