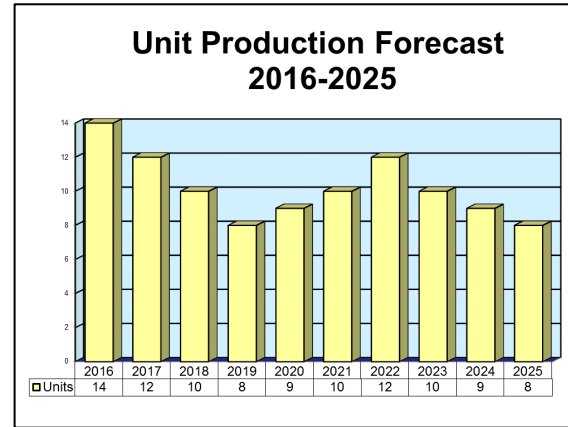


GE-Alstom Steam Turbines

Outlook

- Alstom steam turbines being merged into GE Steam product line
- Market projection declining in numbers as smaller numbers of high-capacity plants replace smaller units
- Steam technology slowly declining in importance as gas turbine use and alternative energy exploitation increase



Orientation

Description. Steam turbine machines of various types of more than 100 MW for fossil/nuclear/combined-cycle and cogeneration applications.

Sponsor. The Alstom line of steam turbines is now becoming part of the GE Steam line of products.

Power Class. Alstom's current steam turbine machines have a power output up to and in excess of 1,000 MW.

Status. The Alstom steam turbine models are in production.

Total Produced. Alstom has installed more than 337 coal and lignite fueled steam turbines worldwide. A further 92 use oil, gas, or other fossil fuels while 116 are powered by nuclear reactors.

Application. Applications include combined-cycle and cogeneration installations. Full capabilities include steam turbine/generator sets, turbine islands, and complete power plants.

Price Range. Forecast International estimates a price range of \$25.5-65.5 million for steam turbines of 100 MW and larger when used in combined-cycle installations.

Competition. The primary rivals of the Alstom line of steam turbines have been Siemens, Mitsubishi Heavy Industries, Dongfang Electric, LMZ and Ansaldo.

Contractors

Prime

GE Power	3 Rue des 3 Chênes, 90000 Belfort, France, Tel: + 33 384551000, Prime
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Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Services; Companies, Contractors, Force Structures & Budgets) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

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Technical Data

Dimensions. Since the Alstom line of steam turbine machines are customized to operator requirements, the data on size and weight displays wide variations.

Performance.

	STF15S	STF25	STF40	STF50	STF60
Output Range (MW)	120-175	210-275	300-400	500-595	600-729
Live-Steam Pressure (bar)	120-175	140-175	165-175	165-175	165-175
Live-Steam Temperature (°C)	535-565	535-540	535-540	535-540	535-540
Reheat Steam Pressure (bar)	25-45	n/a	37-44	37-44	39-46
Reheat Steam Temperature (°C)	535-565	n/a	535-540	535-540	535-565
Condenser Pressure (bar)	0.05-0.2	0.05-0.1	0.075-0.14	0.075-0.14	0.04-0.08
Number of Extractions	6	6	7-8	7-8	8
Operation Mode	F a/o S (a)	S (b)	F a/o S	F a/o S	F a/o S

n/a = not applicable

(a) Fixed and/or sliding pressure operation.

(b) Sliding pressure operation.

Design Features. Alstom has offered several series and models of steam turbines for the industrial process and power generation markets for combined-cycle operation. All machines use several modules of varying sizes to produce the power and steam output required. Blades are typically made from single-piece forgings. The HP turbine shafts are also made from solid, single-piece forgings, while LP turbine shafts are composed of three forged-steel discs welded together with integrated coupling sections. Single-shell, axial symmetric cases are used for HP sections. They are split horizontally along the turbine axis and bolted together with expansion bolts.

Alstom also produces an industrial steam turbine family through its Advanced Steam Turbine Program (ATP). ATP turbines consist of a number of modules that can be used separately or combined in industrial cogeneration and combined-cycle operations. The

modules may be used for backpressure, condensing, and extraction applications.

Operational Characteristics. Alstom provides its customers with the ability to improve older turbines, retrofitting them with technologies to bring them up to the capabilities of newer units. An international service organization is maintained to keep downtime to a minimum. Modular construction also allows rapid repair or replacement of sections as necessary. Included in the sale of each turbine is its own uniquely configured service program.

The company maintains an emergency service number that will dispatch an on-call engineer or engineering team to any site worldwide. In addition, an emergency spare parts service provides customers with a diverse inventory of prefabricated spare parts to minimize downtime.

Variants/Upgrades

STF15S. The STF15S is a two-casing steam turbine with an HPT and IPT/LPT, and an axial condenser. It also has an air-cooled generator for 60-Hz operation.

STF25. The STF25 is a two-casing steam turbine with an HPT and IPT/LPT, with a downward condenser. It has an air-cooled generator for 50-Hz or 60-Hz operation.

STF40. This Alstom machine is a three-casing reheat steam turbine with an HPT, IPT, and double-flow LPT, in addition to a downward condenser. It has a hydrogen-cooled generator. This machine is also

referred to as the Steam Turbine for 350-MW-Class Reference Plant.

STF50. The STF50 is a three-casing reheat steam turbine with an HPT, IPT, and double-flow LPT, with a downward condenser. It has a gas/water-cooled generator for 50-Hz operation.

STF60. The STF60 is a four-casing supercritical reheat steam turbine with an HPT, IPT, and two double-flow LPTs, in addition to a downward condenser. It has a gas/water-cooled generator for 50-Hz operation.

GE-Alstom Steam Turbines

Program Review

Background. The Alstom line of steam turbines traces its lineage back to Alstom/ABB. Earlier producers of steam turbines over 100 MW that are now part of Alstom include Alsthom-Atlantique, BBC Brown Boveri & Company Ltd, Brown Boveri & Cie AG, GEC Turbine Generators Ltd, and Stal-Laval Turbine.

Alstom in the early 1970s provided the first steam turbine for combined-cycle operation. The company's designs have incorporated sliding pressure operation for air-cooled, wet tower-cooled, and conventional water-cooled condensing or backpressure installations. The first steam turbine for combined-cycle operation was delivered by then-Asea in the early 1970s.

Asea Brown Boveri Ltd was formed in 1987 in a 50-50 partnership between Asea AB of Vasteras, Sweden (founded in 1883) and BBC Brown Boveri Ltd of Baden, Switzerland (founded in 1891). After it was established, ABB Ltd moved to its new headquarters in Zurich, Switzerland. The new company began operations in January 1988. By 1990, ABB had purchased approximately 55 companies, including the worldwide power transmission and distribution operations of Westinghouse Electric Corp and the Combustion Engineering Group of Stamford, Connecticut.

In 1990 and 1991, ABB began an aggressive campaign to expand into the Eastern Europe market (including joint ventures or cooperative agreements with Czechoslovakia and Poland) and laid the groundwork for expansion into Asia. In 1992, more than 20 new units were created in the Asia-Pacific region, while in 1993, ABB expanded into Russia and the Americas, and continued to push into Asian markets. The year 1994 was marked by strategic acquisitions in China, India, Malaysia, and Vietnam.

In March 2000, Alstom announced that it was acquiring ABB's 50 percent share in ABB Alstom Power. The Power activity, renamed Alstom Power Sector, was integrated and fully consolidated into Alstom's sector-reporting structure.

By early 2000, more than 250 machines produced or serviced by Alstom were in combined-cycle operation worldwide.

The production facilities for machines over 100 MW are located in Mannheim, Germany, and Midlothian, Virginia, USA.

In April 2003, Siemens AG's Power Generation Group (Siemens PG) acquired the industrial turbine business of Alstom (Paris, France) in two transactions. In the first transaction, Siemens took over the small gas turbine business for machines up to 15 MW. In the second transaction, it took over the medium-size gas turbine business for machines up to 50 MW, plus the business for steam turbines up to 100 MW. The combined total purchase price was EUR1.1 billion.

Alstom Concludes Industrial Partnership in China

In July 2004, Alstom signed a Joint Venture Frame Agreement with Beijing Beizhong Steam Turbine Generator Company Ltd (BSTG), a subsidiary of the Beijing Jingcheng Machinery Electric Holding Company Ltd (JCH), outlining a cooperative approach to developing an effective long-term business relationship for the manufacture of 600-MW-class steam turbines and generators.

The JV focuses on the manufacture of subcritical and supercritical steam turbine generator components. Alstom holds 60 percent of the stock in the JV, with JCH/BSTG holding 40 percent. The full JV covers sales, project management, procurement, manufacturing, commissioning, and service, and benefits from the transfer of Alstom's relevant steam turbine technology.

Both parties are becoming major long-term participants and suppliers in the Chinese high-tech steam turbine and generator markets.

Funding

Development of the Alstom steam turbines was privately funded by several early manufacturers that over time were absorbed into Alstom (some of which are now under the aegis of Siemens AG).

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Contracts/Orders & Options

<u>Contractor</u>	<u>Award (in millions)</u>	<u>Date/Description</u>
Alstom	N/A	Apr 2013 – Contract with Polk Power Company for engineering and procurement of the 500-MW STF60C turbine for the Tampa Electric Company.
Alstom	\$110	Jul 2012 – An order from the East Delta Electricity Production Co (EDEPC) for the supply of equipment for a 650-MW combined-cycle power plant at a site located in the vicinity of the city of Suez, 150 kilometers east of Cairo, Egypt.

N/A = Not Available

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1987	Asea Brown Boveri (ABB) formed
	1990/91	ABB commences campaign to expand market in Eastern Europe
	1993	ABB expands operations into Russia and the Americas
	1994	Strategic acquisitions made in China, India, Malaysia, and Vietnam
Mar	2000	Alstom announces its planned acquisition of ABB's 50 percent share in ABB Alstom Power
Apr	2003	Siemens PG acquires Alstom's steam turbine business for machines up to 100 MW
Mar	2005	Alstom wins EUR560 million contract to complete power plant in Saudi Arabia
Dec	2005	Alstom wins contract for 1,000-MW combined-cycle plant in Oman, with two steam turbines
Mar	2011	Alstom signs a contract worth over EUR20 million with the Ministry of Electricity in Iraq for the rehabilitation of Najaf power station
Nov	2012	Alstom-Atomenergomash (AAEM) retains the Volgodonsk site (Rostov oblast) to produce equipment and components for turbine islands in Russia
Jun	2014	GE announces alliance with Alstom, acquiring the power and grid businesses
Mar	2015	Alstom and Dalia commission 835-MW gas-fired plant in Israel
Apr	2015	Alstom signs contract with NG Metalurgica in Brazil to sell steam turbines in Brazil
May	2015	Alstom Bharat Forge Power begins construction on turbine manufacturing facility in Gujarat, India
		Alstom signs contract with NASL to retrofit steam turbines at Ukai and Wanakbori power stations in Gujarat
Aug	2015	Alstom signs two biomass contracts in the U.K.

Worldwide Distribution/Inventories

<u>Country</u>	<u>Year Installed</u>	<u>Total</u>
Argentina	2011	1
Australia	1999 (1), 2001 (1), 2009 (2)	4
Bangladesh	1988	5
Belgium	1985	5
Bulgaria	2011	2
Canada	1981 (2), 1985 (1), 1993 (4)	7
China	1985 (2), 1990 (4), 1991 (2), 1992 (4), 1995 (2), 1996 (10), 1997 (6), 1998 (4), 1999 (6), 2000 (5), 2001 (6), 2003 (2), 2004 (2), 2005 (2), 2006 (6), 2007 (13), 2008 (10), 2009 (11), 2011 (2), 2014 (4), 2015 (4), 2016 (6), 2017 (6)	119
Colombia	1999	1
Cyprus	1993 (2), 2005 (3)	5
Czech Rep.	2002 (2), 2014 (2)	4
Denmark	1982 (1), 1992 (3), 1997 (2)	6
Dominican Rep.	1994	1
Egypt	1991 (5), 2002 (2), 2013 (2)	9

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Country	Year Installed	Total
Estonia	2015	1
Finland	1982 (2), 1983 (5), 1985 (2), 1986 (1), 1988 (3), 1994 (1), 1995 (1)	15
France	1971 (5), 1975 (2), 1977 (2), 1979 (5), 1981 (7), 1983 (3), 1984 (13), 1985 (6), 1986 (9), 1988 (9), 1991 (4), 1992 (2), 1993 (2), 1995 (2), 2000 (4), 2018 (1)	76
France (Reunion)	1995	1
Germany	1985 (2), 1989 (2), 1992 (6), 1994 (6), 1995 (2), 1999 (2), 2000 (2), 2004 (2), 2012 (2), 2013 (1), 2014 (4), 2015 (4)	35
Greece	2003 (1), 2010 (1)	2
India	2000 (2), 2002 (1), 2010 (4), 2012 (5)	12
Indonesia	1995 (4), 1996 (2), 2000 (4), 2011 (3), 2012 (2)	15
Iran	1987 (4), 1989 (2)	6
Ireland	1977 (4), 1978 (3), 1982 (1), 1987 (3), 2000 (1)	12
Israel	2001 (4), 2015 (1)	5
Korea (South)	1973 (2), 2002 (6), 2005 (6)	14
Kosovo	1975 (5), 1984 (2)	7
Lebanon	1987	1
Libya	1980	5
Malaysia	2003 (2), 2015 (1), 2016 (1)	4
Mexico	1996 (10), 2004 (2)	12
Morocco	1994	4
Netherlands	1982 (4), 1989 (3), 1992 (1), 1993 (2), 2016 (1)	11
Oman	2005	2
Philippines	1999	2
Poland	1998 (3), 2009 (1), 2010 (1), 2011 (1)	6
Portugal	1989 (4), 1995 (2)	6
Romania	1979 (4), 1988 (2)	6
Saudi Arabia	2001 (4), 2005 (3), 2009 (3), 2012 (4)	14
Serbia	1997	4
Slovenia	2015	2
South Africa	1975 (6), 1979 (6), 1983 (6), 1985 (6), 1987 (6), 1990 (6), 2016 (6), 2017 (6)	48
Spain	1975	3
Sweden	1990	2
Taiwan	2002	2
Thailand	1999	2
Turkey	1988 (1), 1989 (4), 2004 (2)	7
UAE	1996	6
United States	1986 (2), 1988 (1), 1989 (6), 1991 (1), 1992 (1), 1993 (1), 1994 (1), 1995 (1), 1996 (1), 2000 (1), 2002 (2), 2004 (1), 2008 (2), 2013 (1), 2015 (2)	24
Venezuela	1997	1
Vietnam	2006	2
TOTAL		6

Forecast Rationale

The analysis of Alstom installations is greatly complicated by the intricate path of corporate reorganizations and acquisitions over the last 30 years. Installations that were carried out by companies prior to their absorption by Alstom may have no relationship to the product range offered by the company as it existed in 2014. This process reached a final stage when GE purchased Alstom and integrated its product line with the GE Steam Power range. This report, therefore, will be the final edition covering the Alstom products as a separate commercial identity.

An examination of the sales pattern of Alstom's steam turbines shows a slow but steady change in the structure of sales. The number of steam turbines sold is steadily declining, but the capacity of those turbines is climbing. While once a given plant may have had four 200 MW units, current sales suggest the same plant now would have a pair of 500 MW turbines, and even those are being increasingly supplanted by single 1 GW units.

Now under GE management, Alstom appears ready for the future generation mix, with customers experiencing

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a mindset change and integrating combined-cycle projects into their portfolios. In the future, 50 percent of new installations (in value) will pertain to combined cycle. The demand for steam turbines suited to renewable power projects has increased over the past two decades, with impressive renewable growth expected in the future.

Thus, even though substantial growth in energy production is expected regardless of the scenario, this is

not translating into added sales when measured on a unit basis. Prior to being acquired by GE, Alstom had already sold its smaller (less than 100 MW) turbine business and it appears to be concentrating on the above 180 MW sector to the exclusion of other segments. The interesting question is how its interests in the nuclear power generation sector will develop. Opinions are very much divided on whether nuclear power generation will experience a renaissance or whether the strong objections to its adoption will continue to hold sway.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence				Good Confidence			Speculative			Total	
	Thru 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		2025
Alstom Group Headquarters												
Alstom Steam Turbine Series <> Industrial Generation - Combined Cycle												
	481	14	12	10	8	9	10	12	10	9	8	102
Total	481	14	12	10	8	9	10	12	10	9	8	102