HEAT RECOVERY
STEAM GENERATORS
FOR COMBINED-CYCLE
POWER PLANTS

ALSTOM
Shaping the future
Our world has an ever-growing appetite for energy – balanced by an increasing concern for the environment. Alstom delivers the clean power and clear solutions that power producers and industries need to meet these increasing challenges.

As a world leader in providing Heat Recovery Steam Generators (HRSGs) for combined-cycle power plants, Alstom helps power operators balance the difficult challenges of lowering output costs while reducing emission.

For more than 75 years, Alstom has established a track record of quality, safety and responsiveness to versatile market needs. Alstom’s more than 1,500 gas power plant experts are committed to meet any gas power plant operator’s need – whether it is designing and installing a plant from the ground up or retrofitting an existing facility.

Key facts

75 years of innovation

750 HRSGs installed worldwide

1,500 gas R&D professionals
Industry-leading expertise
Alstom has decades of experience in developing and installing HRSGs for combined-cycle and co-generation plants. Our in-house design, manufacturing and R&D make us one of the largest HRSG suppliers in the world. We are proud to say that leading power producers around the globe prefer our HRSG for demanding applications and a wide variety of plant operating regimes.

Operational flexibility
Unique Optimised for Cycling and Constructability (OCC™) design provides unparalleled flexibility needed for reliable high-cycling duty. Alstom HRSGs are capable of fast starts, high ramp rates and high turndown resulting in enhanced flexibility under a wide range of operational scenarios.

Reliability and maintainability
Decades of experience have gone into the design of our HRSGs. This has ensured not only a reliable design that reduces maintenance and inspection but also a design that enables optimal access to critical areas of pressure parts.

Emissions reduction
Increased concerns for environment are driving power plants to minimise their environmental footprint. Alstom offers proven solutions for CO, VOC and NOx emissions reduction and control technologies for full and part load operation.

Advanced engineering
Alstom’s HRSG design has been validated and proven over decades in hundreds of successful operating units. Alstom is committed to improving our designs to match evolutions in gas turbine technology while ensuring high reliability and availability. We continue to improve designs by learning from our past experiences. We utilise state-of-the-art systems for parametric modelling resulting in a high quality product.

Quality
We manufacture pressure part modules in-house at the Alstom manufacturing facilities in Europe and Asia. All HRSGs components are manufactured according to our stringent quality control systems resulting in a superior product meeting the most demanding project requirements and delivery schedules.

Advanced technology for your combined-cycle power plant

With more than 750 HRSGs installed worldwide, Alstom is a world leader in supplying HRSG behind all major OEM’s gas turbines.
Our Power generation offering is based on a deep understanding of power markets and our customers’ needs. It is organised around three levers to maximise the return of assets over their entire lifecycle.

**REDUCING COST OF ELECTRICITY**

It takes competitive assets to keep electricity affordable. We enable power companies to compete successfully in the marketplace and provide affordable electricity to consumers. We help you reduce the cost of electricity through:

- Efficiency improvements
- CAPEX reduction/scaling up
- Capacity Factor increase (renewable)
- Lead time reduction
- Competitive O&M
- Competitive financing

**LOWERING ENVIRONMENTAL FOOTPRINT**

Clean generation is one way of demonstrating environmental responsibility. Another is lowering resource usage, visual impact and noise pollution. In both cases, we can help you meet or exceed regulations and environmental standards. That is why Alstom innovates in the following areas:

- Renewable portfolio
- Natural resource optimisation
- Pollutants control (SO₂, NOₓ, PM, mercury)
- CO₂ emission reduction & CCS
- Land use, visual impact and noise
- Water intensity reduction & recyclability

**INCREASING FLEXIBILITY & RELIABILITY**

Intermittent power generation is a growing challenge of energy security, as is maintaining an aging installed base and adapting it to changing market conditions. We help you tackle both issues so that you can enjoy dependable operations with:

- Maintainability and outage time reduction
- Operational and fuel flexibility
- Designs and service for improved availability and reliability
- Climate packages
- Energy storage

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**CLEAN POWER CLEAR SOLUTIONS™**
Clear Solutions™
meet the challenges of energy sustainability

Our commitment to customers

Fuel prices and availability fluctuate more than ever and environmental concerns continue to make headlines.

As one of the largest power generation solution providers in the market, Alstom’s gas clean technologies have kept pace with power producers dynamically changing needs for increased production at lower cost and with lower environmental impact.

**Reducing Cost of Electricity**

up to **+50%**
output without additional fuel consumption

**Lowering Environmental Footprint**

> **30%**
reduced emissions per MWh produced

**Increasing Flexibility & Reliability**

Alstom’s HRSGs can be configured and optimised for any type of gas turbine and steam cycle

Keppel 1 KA13E2-2 power plant, Singapore
As a leading supplier at a global level, we have a comprehensive portfolio of HRSGs for both 50 Hz and 60 Hz markets. Alstom HRSGs can be offered as a standalone component optimised for any type of gas turbine and steam cycle. It is also offered as a steam tail integrated with an Alstom steam turbine.

**Optimised for Cycling and Constructability (OCC™)**

**Cycling**
A high-cycling plant is critical to balance demand and ever-changing supply from renewables. Alstom’s unique OCC™ HRSG design uses single-row harps with smaller diameter headers resulting in lower stresses and faster start-up times. Alstom’s innovative drum and SH outlet manifold design permits high cycling and operational flexibility.

**Cost-effective construction**
Alstom is a world leader in cost-effective HRSGs from both design and constructability standpoints. Our OCC™ design maximises the use of our unique shop-assembled modular designs resulting in fewer heavy component lifts and fewer field welds. Alstom utilises reference designs to minimise costs while tailoring each unit to meet project performance and site-specific requirements. All of this results in a reduced field erection cost providing a truly cost-effective solution.

**CUTTING EDGE DESIGN**
Stress analysis of single-row versus multi-row design confirms smaller diameter, single-row harps provide three times less stress than the industry standard – conventional multi-row harps with bent tubes and large diameter, thick walled headers.

![Single-row harp design](image1)

![Conventional multi-row harp design](image2)
Comprehensive range of products and solutions

**Combined-cycle power plants**
Alstom’s HRSG can be configured and optimised for any type of gas turbine and steam cycle. Ideal for high-cycling plants experiencing daily starts and stops, our HRSGs provide:
- Optimised hot and cold end performance for maximised efficiency
- High thermal flexibility for fast start-up
- Variety of modular options available for the optimum solution

**Steam tail and add-on projects**
Alstom offers HRSGs as part of a steam add-on to convert a simple-cycle to combined-cycle increasing power output and efficiency with no additional fuel consumption. We also offer steam tail with optimised HRSG and steam turbine generators enhancing performance, start-up times and wrapped performance guarantees.

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**FOR A WIDE RANGE OF GAS TURBINES**
We have built HRSGs for leading international power companies across the world including over 300 for plants with gas turbines rated greater than 150 MW. With our portfolio including horizontal and vertical drum types, we can provide HRSGs for conventional class (E-Class), advanced class (F-Class) and very large class (G/H/J-Class) gas turbines.

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Alstom continues to set industry benchmarks for operational flexibility and constructability. Our HRSGs were the first to feature single-row harps and we achieved a milestone by shipping two fully assembled F-Class HRSGs into New York City in 2005.
Horizontal drum type OCC™

Horizontal drum type HRSG features vertical tube, natural circulation design with horizontal gas flow. HRSGs can be customised as single, dual or triple pressure with or without reheat. Design features on the OCC™ HRSG have been refined over decades based on cutting-edge R&D and field experience.

The HRSG is available in various configurations to ensure the overall project cost and schedule is minimised. Four modular options include harp bundle design, module design, C-frame design and fully assembled single piece HRSGs.

Vertical drum type

Vertical HRSG design features horizontal tube, with vertical gas flow optimised for steam tail add-on applications where space is at a premium. Alstom’s vertical HRSG features a natural circulation design that can accommodate heavy fuel oil operation. We have nearly 300 vertical HRSGs around the world including almost 40 with 150 MW gas turbines and above.

HRSG scope features

HRSG lifetime monitoring system (AMODIS)
- Optimised plant operation
- Reduced lifetime consumption

Supplemental firing system
- Reliable peaking power
- Increased operational flexibility

SCR and CO catalyst
- Reduced NOₓ, CO and VOC emissions
- Low environmental impact

Noise reduction
- Acoustic enclosure
- Stack silencer
- Vent and safety valve silencers
Based on proven designs we tailor our HRSGs to meet our customer’s needs.

HRSG design features

Single-row harps
- Small diameter headers
- Reduced thermal stresses allow high cycling and faster start-up times
- Enhanced drain arrangement
- Minimised Flow Assisted Corrosion (FAC)

Innovative drum and superheater outlet manifold design
- Drum contoured nozzles
- High strength materials
- Enhanced manifold design

Compact inlet duct
- Improved flow distribution
- Reduced pressure drop
- Accommodates overhead pipe rack

Fully ventable economiser
- Eliminates vapour lock

Minimised FAC
- Use of low alloy in strategic areas
- Piping design with limited flow velocities in single and two phase regions

HRSG – Triple pressure reheat design with supplementary firing and emission control equipment for CO, VOC and NOx.
HRSG global footprint

Alstom’s worldwide footprint includes three execution centres, two manufacturing centres and a global supply chain. This gives us the flexibility that our customers value. We have delivered and installed more than 750 HRSGs across the world, and we have acquired a broad industry expertise that enables us support the customers in an efficient and responsive manner.

* The facility opening is planned for 2015.
Joint Venture set up with Arabian Bemco to establish a new manufacturing facility for the growing market in the Middle East.

The world-class facility near Jeddah in the Kingdom of Saudi Arabia (KSA) will focus on supplying HRSGs to Saudi Arabia and the wider Middle East market.

Research and development

Alstom Power employs 4,000 people worldwide in engineering and 1,500 in R&D. We also work with 30 of the best universities around the globe on cutting-edge research. All our research is motivated by our desire to find the best solutions for our customers. We focus on innovative technologies for all stages of our products’ life cycle.

Alstom is one of the few HRSG suppliers that have the support of a diverse R&D community consisting of scientists and engineers with diverse range of expertise from heat transfer, fluid dynamics, combustion, metallurgy and water chemistry. Alstom has state-of-the-art computational fluid dynamics lab, finite element analysis, transient modelling, lifetime assessment. Alstom supports various ASME and EN code committees, industry research and standard organisations such as Electric Power Research Institute (EPRI) and National Fire Protection Agency (NFPA).

Global service

With a network of over 60 local service centers around the world, Alstom has the portfolio to support you with all aspects of HRSG maintenance throughout the life of the plant. We also provide a full range of maintenance and customer service solutions.

The portfolio of services includes:

**Parts and products**
- Pressure parts and assembly
- Fabricated products including dampers, access doors, replacement ducts etc.
- Valves, desuperheaters, instrumentation

**Field services**
- Inspection and condition assessments
- Repair and outage support
- On-site testing and recommissioning
- Outage planning and support

**Advice and operational support**
- Operational flexibility assessment
- Design life studies
- Engineering studies

**Performance improvements**
- Improved operational flexibility
- Upgraded piping and pressure parts
- Component improvements
Global footprint
Alstom’s HRSGs

Project highlights worldwide

Alstom has decades of experience in developing and installing HRSGs for combined-cycle and co-generation plants behind all major gas turbines.

**AL-ANBAR (IRAQ)**

First break-through HRSG order for Alstom in Iraq

In 2013, Alstom was awarded a contract to provide power generation equipment (4 × GT26, 4 HRSGs, 2 × steam turbines, 6 × generators) for the 1,642 MW Al-Anbar gas-fired combined-cycle power plant being built 150 km to the west of Baghdad in Iraq.

The HRSGs into consideration are horizontal, drum-type, OCC™ bundle design, triple pressure, reheat and un-fired type. The HRSGs will be designed and manufactured as per ASME with code stamp.

**RIYADH PP12 (SAUDI ARABIA)**

Alstom’s first steam tail in the Kingdom of Saudi Arabia with equipment offered in a novel integrated package.

Alstom was awarded in 2012 a contract to supply two steam tails to the new Riyadh PP12 gas-fired power plant. Under the scope of the contract, Alstom will deliver 8 × HRSG, 2 × STF30C and 2 × generators.

This is the first break-through HRSG order for Alstom in Saudi Arabia. Once completed, the plant located 140 km west of the Saudi capital will produce a net output of 1,992 MW at high temperatures with high efficiency.

The HRSGs are horizontal, drum-type, OCC™ module design, triple pressure, reheat and un-fired type, designed and manufactured as per ASME with code stamp.

**WILDCAT POINT (USA)**

In 2014, Alstom has been awarded a steam tail package for Old Dominion Electric Cooperative's Wildcat Point combined-cycle power plant in Cecil county, Maryland. The plant will generate approximately 1,000 MW, enough to power 390,000 homes. The plant is scheduled for commissioning in mid-2017.

Alstom will provide two OCC™ module triple pressure reheat horizontal drum type HRSGs designed for cycling and constructability. Alstom’s OCC™ module is designed such that it can be transported by sea, rail or truck depending on the site location while providing a high level of modularisation. The scope for the HRSG includes supplemental firing and emissions control equipment for NOx, CO and VOC emissions.

**NORTH BANGKOK 2 (THAILAND)**

2 × KA26-1 single-shaft 850 MW power plant in consortium with Sumitomo Corporation in Nonthaburi province.

Under this project, Alstom Surabaya Execution Centre (SEC) provides two units horizontal, natural circulation, triple pressure with reheat, double wide, top supported, HL-51 type, HRSGs – supplied to site in harp bundles (like Tuas concept), located downstream of a GT26 gas turbine for use in a combined-cycle power plant. The steam produced by one HRSG is used to drive one steam turbine generator set.
and project highlights
in action

FUJAIRAH 2 (UAE)
Co-generation for desalination

In 2007 Alstom was awarded a full turnkey EPC contract for the largest newly constructed independent water and power project in the UAE.

Based on GT26 gas turbine, this 2,000 MW and 130 MIGD hybrid desalination plant used multi-effect reverse osmosis technologies to become one of the best performing power plants in the world – proving highly efficient in minimising both gas consumption and CO₂ emissions.

Alstom provided five dual pressure OCC™ harp bundle horizontal drum type HRSGs designed for high cycling and constructability. Each HRSG is equipped with a dual fuel supplementary firing system capable of firing 245 MW thermal while maintaining low NOₓ and CO emissions.

KEPPEL (SINGAPORE)
Flexible and efficient solution

In 2010, Alstom was awarded a full EPC contract to build and maintain a new 2 × 400 MW power plant in Singapore for Keppel Merlimau Cogen (KMC) Pte Ltd. Keppel II will be built next to the existing KA13E2-2 Keppel I in the Tembusu sector of Jurong Island. Alstom also built the initial 500 MW power plant and is now delivering an 18-year operation and maintenance contract.

Alstom will provide two OCC™ module triple pressure reheat horizontal drum type HRSGs designed for high cycling and constructability. Alstom’s OCC™ module is designed such that it can be transported by sea, rail or truck depending on the site location while providing a high level of modularisation. Keppel II HRSG is designed and manufactured per ASME and meets local codes and standards.

CYCOFOS (FRANCE)
Fast, innovative integrated power solution

Located in Fos-sur-Mer in Southern France, this Alstom project was composed of two power plants: a 420 MW gas-fired combined-cycle power plant based on the GT26 turbine and a 60 MW steam power plant. Alstom developed an integrated power solution to meet CyCoFos’ requirements of having two different power plants using different fuels and supplying energy in a short time frame.

Alstom supplied one triple pressure with reheat OCC™ C-Frame drum type HRSGs. Alstom C-Frame design greatly reduced the field labour needed to install the HRSG pressure parts and casing leading to shorter lead times to produce electricity. The HRSG was designed to meet ASME PED and local codes and standards.

ASTORIA (USA)
An innovative solution

Alstom was awarded a contract for two triple pressure with reheat OCC™ horizontal drum-type fully assembled HRSGs for the Astoria I’s project in 2005. Astoria I HRSGs are behind GE 7FA gas turbines and are a part of the 500 MW combined-cycle power plant located in Queens, New York, USA and owned by Astoria Energy II LLC.

The scope for the HRSG included supplemental firing equipment and emission control equipment for NOₓ, CO and VOC emissions. With this project, Alstom has taken modularisation to the next level. Astoria I HRSGs were fully assembled in Indonesia and delivered to the Astoria project site, with each HRSG being 36 metres high and weighing 2,600 tonnes. Each HRSG was delivered fully fitted out with platforms, valves, piping, insulation and electrical equipment.

Alstom was awarded a follow up project for two additional HRSGs for Astoria II in 2008. The Astoria I and II projects reinforce Alstom’s leading position as a provider of cost-effective HRSGs from both design and constructability.
Forward thinking services

In today’s dynamic markets, the traditional concept of base load production is increasingly challenged by the influx of intermittent sources. Price competition and stringent emissions regulations make the need for flexible operations greater than ever. Therefore, plant owners and operators look for partners who are willing and able to develop flexible solutions that will increase production efficiency and reduce emissions throughout the whole lifetime of their equipment.

In combined-cycle power plants or industrial co-generation plants, the Heat Recovery Steam Generator (HRSG) makes a vital contribution to total plant efficiency. But as a large metal structure exposed to wide temperature fluctuations, the HRSG needs proactive attention to ensure continued reliability as operational modes become more dynamic. From optimising operations or upgrades for power and flexibility, Alstom has the expertise and the implementation capabilities that only a global OEM and field service provider can deliver.

Solutions
The HRSG system plays a crucial role in the overall performance of a power plant. That is why Alstom offers a one-stop shop with a full portfolio of solutions for this valuable but often underestimated asset.

Alstom solutions cover the whole HRSG lifecycle and include:
- Technical expertise and operational support
- Field service, parts and repairs
- Life extension and performance improvement

Presence
With operations in more than 70 countries, Alstom is close to customers all over the world. Thanks to our teams of trained and certified HRSG field specialists, you are assured of service excellence and rapid responses at all times. Building on our historical HRSG competence centres and OEM construction capabilities we now have a powerful and cost-effective global presence.
- 62 local service centres serving 70 countries
- 12 locations with HRSG field service resources
- 2 global HRSG service engineering centres

Technology
Thanks to our OEM expertise and service-focused R&D, Alstom has a number of technology-driven solutions for HRSG operations, maintenance, outage management and lifecycle optimisation. Our key technologies focus on:
- Life assessment – from code calculation to detailed finite element analysis
- Performance modelling
- Numerical or physical flow modelling
- Structural design – pipework or structures
- Metallurgical analysis
- Water and steam cycle chemistry

Facts & figures

> 100 years boiler-building experience

> 50 HRSG inspections per year

> 50 trained HRSG inspectors

> 260 project and design engineers

> 62 local service centres
Alstom

Alstom is a global leader in the world of power generation, power transmission and rail infrastructure and sets the benchmark for innovative and environmentally friendly technologies.

Alstom builds the fastest train and the highest capacity automated metro in the world, provides turnkey integrated power plant solutions and associated services for a wide variety of energy sources, including hydro, nuclear, gas, coal, wind, solar thermal, geothermal and ocean energies. Alstom offers a wide range of solutions for power transmission, with a focus on smart grids.

Power generation

Alstom Power offers solutions which allow their customers to generate reliable, competitive and eco-friendly power.

Alstom has the industry’s most comprehensive portfolio of thermal technologies – coal, gas, oil and nuclear – and holds leading positions in turnkey power plants, power generation services and air quality control systems. It is also a pioneer in carbon capture technologies.

Alstom offers the most comprehensive range of renewable power generation solutions today: hydro power, wind power, geothermal, biomass and solar. With ocean energies, we are developing solutions for tomorrow. Alstom is one of the world leaders in hydro power, the largest source of renewable energy on the planet.