

GAS PRODUCT SOLUTIONS

HEAT RECOVERY STEAM GENERATORS

FOR COMBINED CYCLE POWER PLANTS



POWER |

We are shaping the future |

ALSTOM

Welcome to Alstom Power

Alstom is a global leader in power generation, with a portfolio of products covering all fuel types. From fossil and biomass to nuclear and renewables, close to 25% of the world's power production capacity depends on Alstom technology and services. Whether in design, manufacture, procurement or servicing, Alstom is setting the benchmark for innovative technologies that provide clean, efficient, flexible and integrated power solutions. Alstom can supply anything from single components to complete turnkey power plants. Our Plant integrator™ approach and power automation and control solutions ensure the optimisation of all elements to derive the maximum lifetime value from all our customer's investments.

Alstom has more than 100 years of experience in engineering, procurement and construction (EPC) of new power plants. But our engineers are also experts in retrofitting, modernising and servicing existing plants. With operations in 70 countries, Alstom is close to customers all over the world, ensuring rapid responses and service excellence at all times.



25
percent of the world's
power production
capacity depends on
Alstom technology

52,000
employees around the
world in 70 countries

100
years of industry-
leading expertise

CLEAN POWER TODAY!®

With our recognised expertise all over the power generation market, we are able to find solutions to the challenges of today.

We recognise the need to improve the environmental balance of legacy plants while increasing adoption of new clean energy solutions.

A WIDE PORTFOLIO FOR YOUR GAS POWER PLANTS:

GAS TURBINES

TURBOGENERATORS

STEAM TURBINES

**HEAT RECOVERY
STEAM GENERATORS**

PUMPS

AUTOMATION AND CONTROL

SERVICES





With **more than 750 HRSGs installed worldwide**, Alstom is a world leader in supplying HRSG behind all major gas turbines.

Advanced technology for your combined cycle power plant

Industry-leading expertise

Alstom has decades of experience in developing and installing HRSGs for combined cycle and cogeneration 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.

Emission reduction

Increased concerns for environment are driving power plants to minimise their environmental footprint. Alstom offers proven solutions for CO, VOC and NOx emission 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.

Optimised Any configuration.

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.

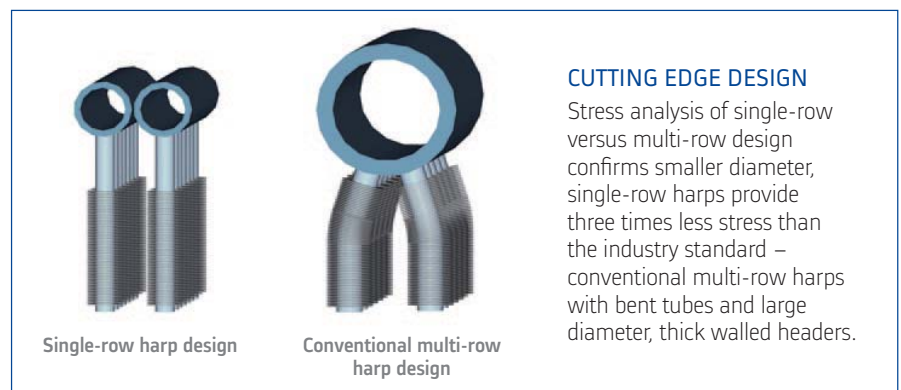
Optimised for Cycling and Constructability (OCC™)

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.



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.

HRSG solutions

Anywhere in the world.

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.

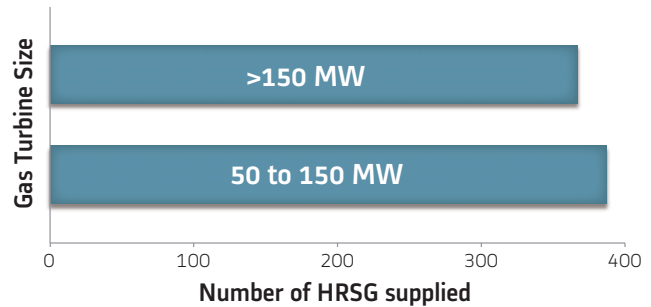
Steam Tail and Add-On projects

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.

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.

HRSG Experience – GT Range



Superior design and



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 NO_x, CO and VOC emissions
- Low environmental impact

Noise reduction

- Acoustic enclosure
- Stack silencer
- Vent and safety valve silencers

construction

Meeting objectives



Based on proven designs
we tailor our HRSGs to meet
our customer's needs.

HRSG design features

Single row harps

- Small diameters 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



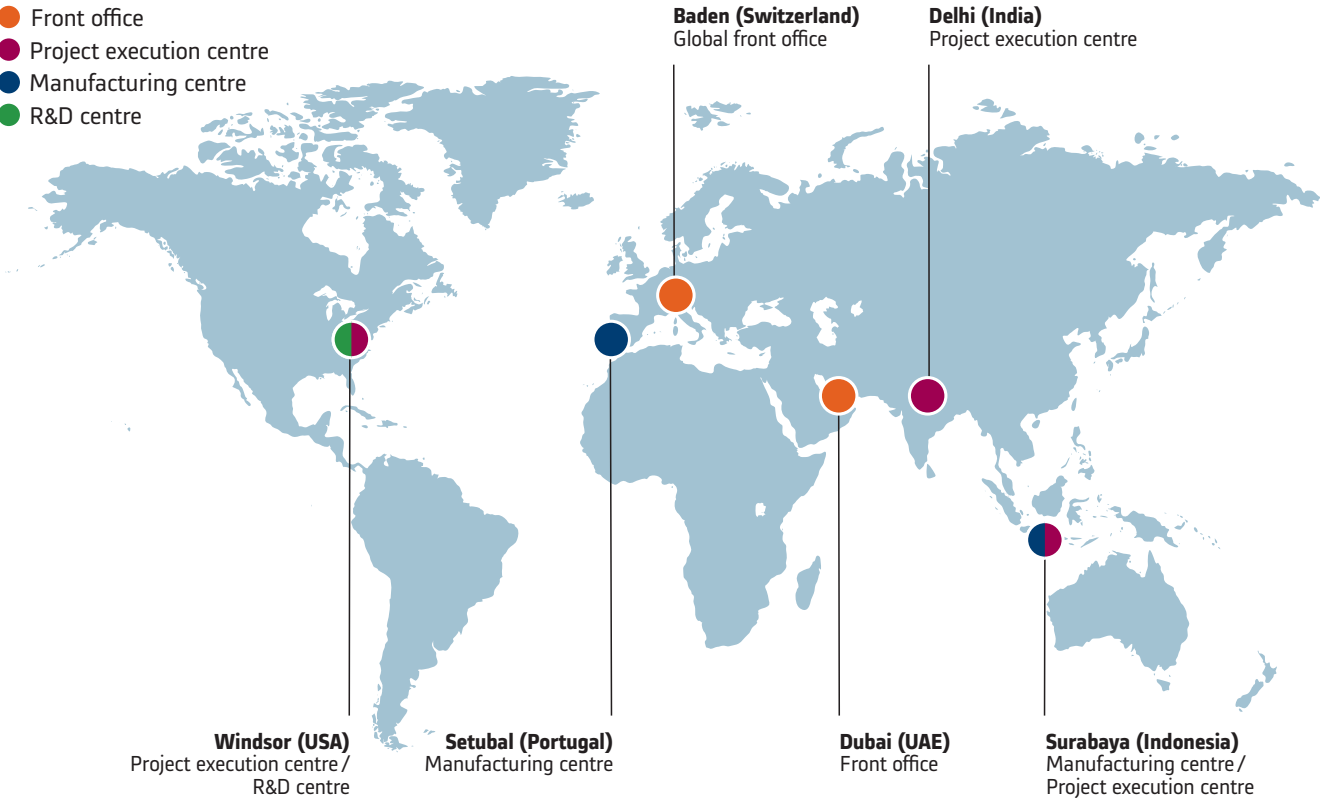
HRSG – Triple pressure reheat design with supplementary firing and emission control equipment for CO, VOC and NOx

Working Innovation and



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.



in partnership

customer focus



Research and development

Alstom Power employs 4000 people worldwide in engineering and 1500 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

Alstom's Heat Recovery Steam Generators **in action**

FUJAIRAH 2 UNITED ARAB EMIRATES



Cogeneration 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 2000 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 NO_x 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 x 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 I 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 NO_x, 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 2600 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.



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