FOSTER WHEELER

Heat Recovery Steam Generators

Optimized for any Application

A FOSTER WHEELER HRSG
PRODUCING 70 MWe OF POWER
AT THE LA RÁBIDA REFINERY SINCE 2009

A LONG HISTORY WITH HEAT RECOVERY STEAM GENERATORS

Since we supplied our first HRSG to the Rio Pecos combined cycle plant (Texas, USA) in 1958, we have advanced HRSG technology to a new level of thermal and mechanical performance, reliability and ease of maintenance.

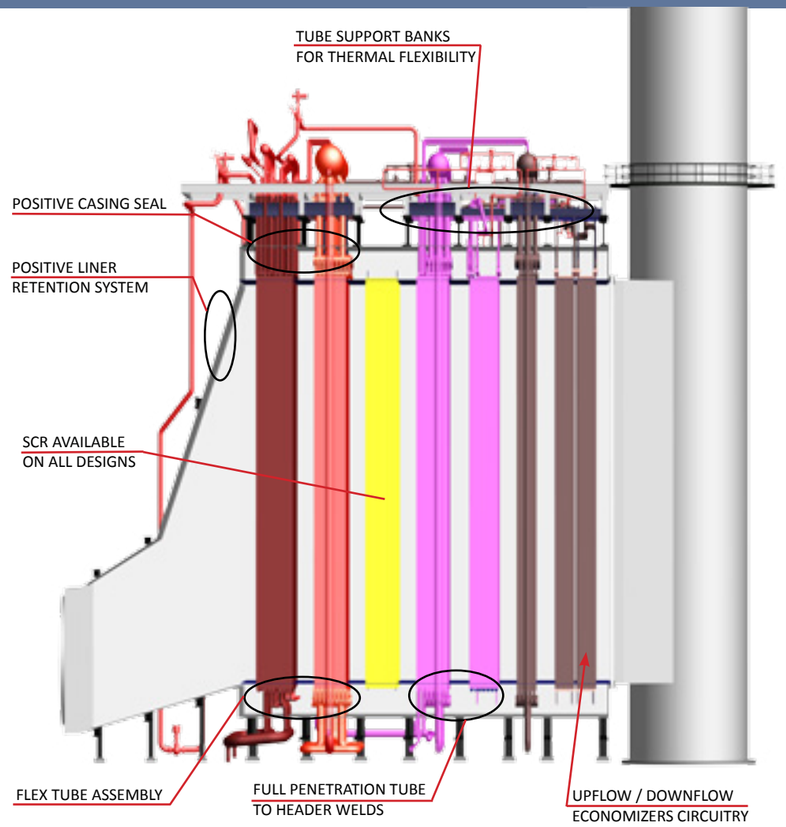
With over 350 Foster Wheeler HRSG's in the field today with millions of operational hours, Foster Wheeler HRSG's have developed a track record of reliable operation and high customer satisfaction for a wide range of combustion turbines.

We offer HRSGs for all applications ranging from large utility combined cycle power plants to small co-generation and industrial facilities. For each application, our designs are tailored to meet the performance, reliability and cost goals of our customers.

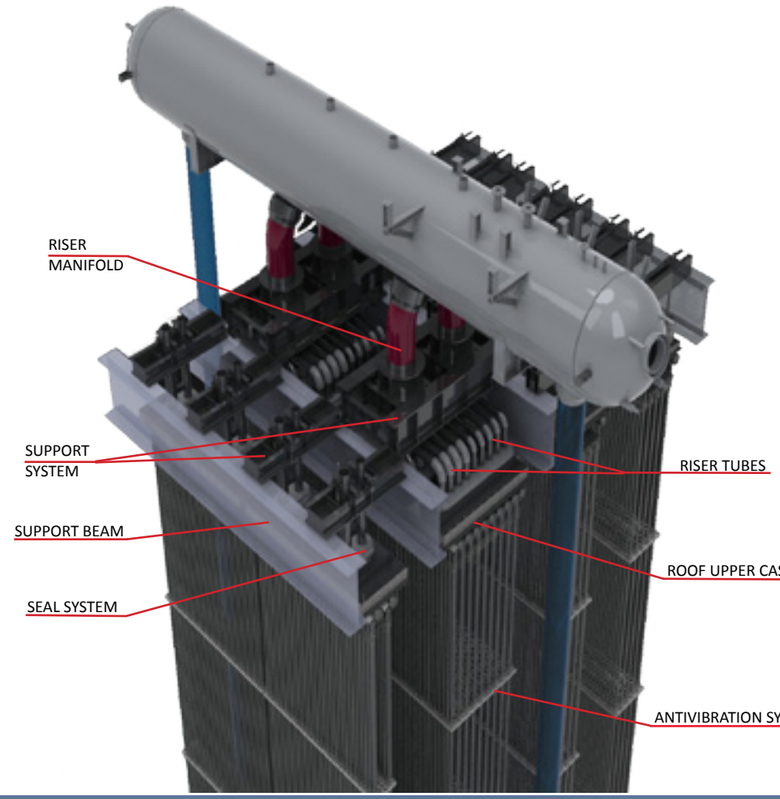
Our support to our clients doesn't stop once a FW HRSG is operational. We provide a broad range of after-market service to solve problems and improve performance and reliability of your HRSG. This applies to not only FW HRSGs, but to all HRSGs, no matter who the OEM.

GAS TURBINES EXPERIENCE	
ALSTOM / ABB	**SIEMENS**
• GT-8C, 10, 35	• SGT, 600, 800
	• SGT5 - 4000F
GENERAL ELECTRIC	• SFT6 - 5000F
• PG 6531, 6581, 7121, 9171	• V64.3, .4
• LM 1600, 2500, 6000	• V94.2, .3A
• Frame 6, 6B, 6F, 6FA	
• Frame 7, 7B, 7E, 7F, 7FA	**SOLAR**
• Frame 9, 9E, 9F	• Cemtaur, H
	• Mars
MITSUBISHI	
• M501F, FD, SDA	**WESTINGHOUSE**
	• 501D5A
ROLLS ROYCE	• 501F
• RB211	• 251 B6

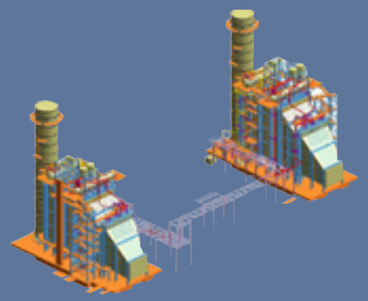
FOSTER WHEELER HRSGs ARE DESIGNED FOR RELIABILITY AND LONG LIFE



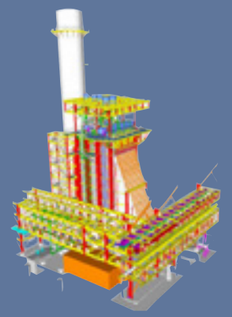
- Horizontal and vertical designs available for both utility and industrial applications
- Steam temperatures up to 600°C (1115°F)
- One, two or three pressure levels to suit any application
- Unfired, co-fired and fresh air fired for guaranteed steam production even without gas turbine operation
- Top supported coils for thermal mechanical flexibility
- Harps, C Sections or modular fabrication for delivery and field erection flexibility
- Large sized drain system to reduce fatigue stress during rapid start-up and shut-down
- Extra strength full penetration welds to handle fast transients and thermal shocks



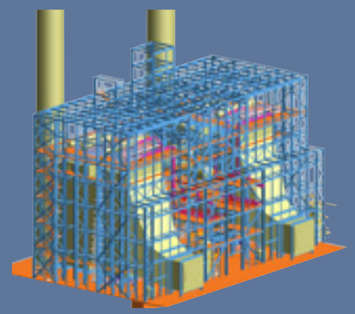
Emal
Location: Abu Dhabi, UAE
Customer: Samsung C&T Corp.
Start-Up Year: 2014
HRSG Capacity: 4 x 133 MWe
GT Model: GE 9FA
Fuel: Natural Gas



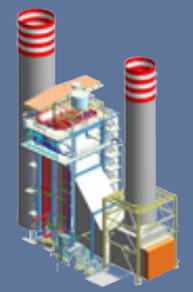
Qurayyah
Location: Saudi Arabia
Customer: Samsung C&T Corp.
Start-Up Year: 2014
HRSG Capacity: 12 x 117 MWe
GT Model: Siemens SGT6-5000F
Fuel: Natural Gas & Diesel Oi



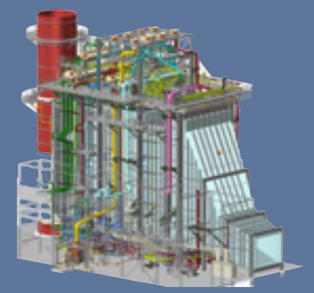
Dongducheon
Location: Kyung-gi-do, Republic of Korea
Customer: Samsung C&T Corp.
Start-Up Year: 2014
HRSG Capacity: 4 x 160 MWe
GT Model: MHI M501J
Fuel: Liquefied Natural Gas



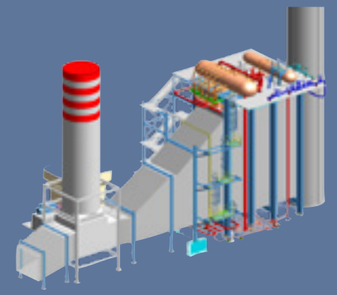
Manifa Cogeneration
Location: Manifa, Saudi Arabia
Customer: Tecnicas Reunidas Power
Start-Up Year: 2012
HRSG Capacity: 2 x 62 MWe
GT Model: Mitsubishi M501F
Fuel: Natural Gas



Norte II
Location: Chilhuahua, Mexico
Customer: Samsung Engineering Co.,Ltd
Start-Up Year: 2012
HRSG Capacity: 2 x 72 MWe
GT Model: GE Frame 7FA
Fuel: Natural Gas



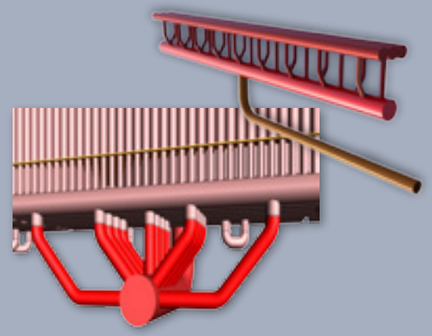
Cartagena
Location: Murcia, Spain
Customer: Repsol Petroleo S.A.
Start-Up Year: 2011
HRSG Capacity: 1 x 15 MWe
GT Model: GE PG6581
Fuel: Natural Gas



NOT ALL HRSG DESIGNS ARE THE SAME

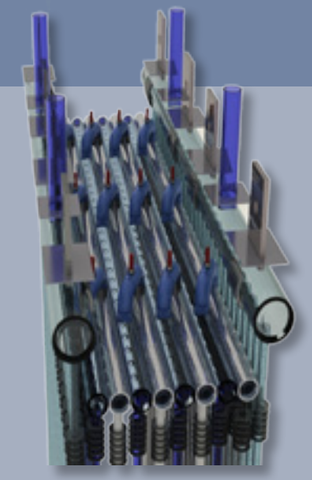
Incheon CCPP

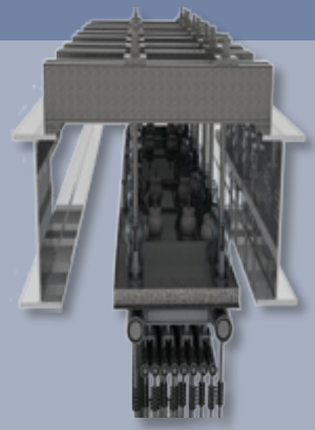
Location:	Incheon, South Korea
Customer:	POSCO Engineering & Construction
Start-Up Year:	2010, 2011
HRSG Capacity:	4 x 105 MWe
GT Model:	Siemens SGT6-5000F
Fuel:	Natural Gas

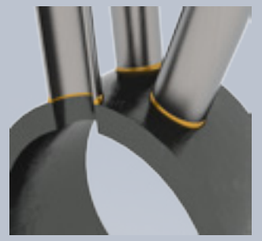


- Superheaters designed with oversized headers, downcomers, feeders and drain systems to reduce fatigue stress during rapid start and shut down

- Counter flow economizer maintains water velocities in tubes and efficient heat transfer for all operating conditions
- Economizer coils are drainable and ventable for fast fill / drain while minimizing steaming during start-up and shut down
- Flow accelerated corrosion eliminated by use of high chrome tube materials in critical areas

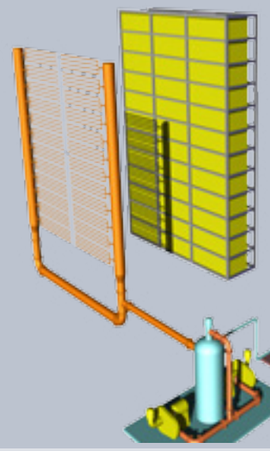




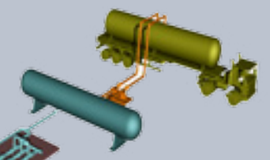


- Full radial penetration welds are used for each transfer tube to header weld so unit can tolerate fast transients and thermal shocks with less risk of weld cracks and tears associated with lower quality welds

- Flex tube design provides inherent mechanical flexibility ensuring long HRSG life while enduring fast start-ups, upsets and transients
- Every heat transfer tube in every section has at least one tube bend

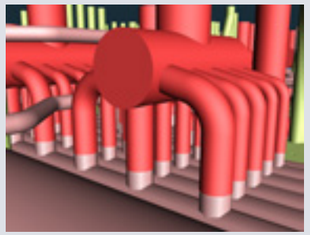


- SCRs are available on all FW HRSGs to achieve very low NOx emissions
- Designs allow for future addition of SCR components when requested



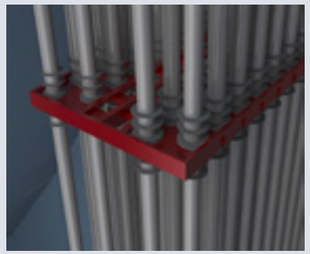
Misurata & Benghazi CCPP

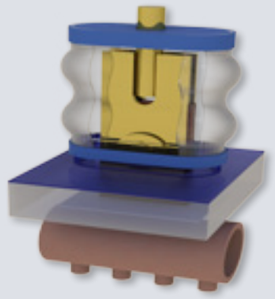
Location:	Misurata & Benghazi, Lybia
Customer:	Daewoo E&C
Start-Up Year:	2010
HRSG Capacity:	4 x 117 MWe
GT Model:	Siemens SGT5-4000F
Fuel:	Natural Gas & Diesel Oil

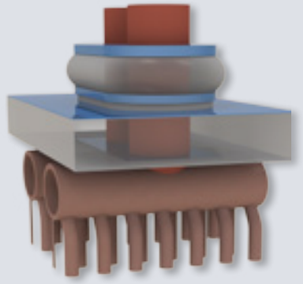


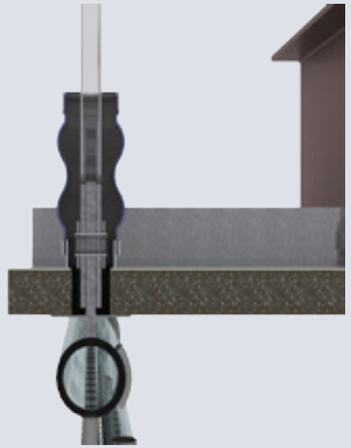
- HRSG modules hung from risers manifold with simplified top supported design to reduce space, erection time and manpower

- Optimally placed anti vibration grid plates to minimize noise and vibration induced by perpendicular gas flow to tube bundles









- Flexible bellow casing seal ensures leak-tight connection while allowing free thermal expansion through all operating conditions

FW's HRSGs ARE DESIGNED FOR TRANSP ORT AND SITE ERECTION FLEXIBILITY

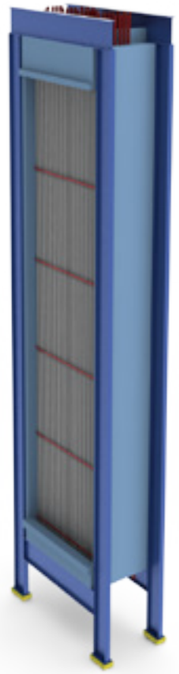
Our capability to supply our HRSGs in different configurations provides the most flexibility to our clients, allowing them to minimize site erection work and the ultimate installed cost of their HRSGs.

Our global network of manufacturing facilities and engineering centers, allows us to provide a quality product at very competitive cost levels and delivery times, no matter where the project is located.

Harps

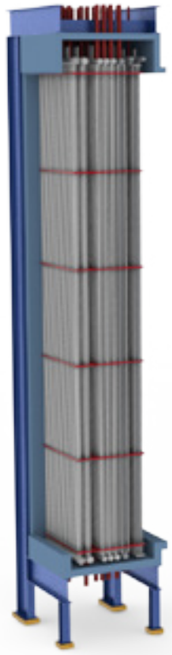
- Individual tube bundles without casings or roof
- Most cost effective for small HRSGs

O-Sections



- Fully cased tube bundle for modular assembly
- Most cost effective for units one module wide

C-Sections



- Partially cased tube bundles
- Most cost effective for HRSGs that are two modules wide

Modules

- Individual tube bundles without casing but with roof
- Most common option for large combined cycle HRSGs

Ute Iberese - Somague

Location:	Sines, Portugal
Customer:	Iberese / Somague
Start-Up Year:	2010
HRSG Capacity:	47 MWe
GT Model:	Siemens SGT-800
Fuel:	Natural Gas & Fuel Gas

La Rabida

Location:	Huelva, Spain
Customer:	CEPSA
Start-Up Year:	2009
HRSG Capacity:	1 x 119 MWe
GT Model:	GE 6FA
Fuel:	Natural Gas

Wacker Chemie

Location:	Burghausen, Germany
Customer:	Fortum Engineering GmbH
Start-Up Year:	2001
HRSG Capacity:	1 x 97 MWe
GT Model:	GE Frame 9E
Fuel:	Natural Gas

AFTERMARKET HRSG SERVICE

With more than a century of designing, fabricating, erecting and starting our own equipment, we have the experience and capability to assess your HRSG, recommend improvements, and predict the impact on performance, reliability and operation before any fieldwork is started.

Service is an integral part of our business. Preventive condition monitoring, expert maintenance, rapid response repair work, and replacement part deliveries are key factors in achieving maximum plant reliability and cost effective performance year after year.

Through our service agreements, we provide comprehensive and cost effective maintenance programs, ranging from HRSG inspections to the supply of parts and equipment including construction services, resulting in minimum unplanned repair work.

Our service is backed by a global network of manufacturing, engineering and customer service centers that can meet the tightest schedules while achieving the most competitive pricing through global sourcing.

WE OFFER A FULL RANGE OF HRSG SERVICES

- **Thermal Performance Modeling**
  - To identify causes of performance shortfalls
  - To evaluate benefit of design improvements
  - Modeling is done using Foster Wheeler's expert performance design software which is continually updated and validated with field data
- **Feasibility and Engineering Studies to Evaluate the Thermal and Mechanical Impact of**
  - Addition of in-duct burners
  - Turbine changes
  - Capacity increases
  - SCR additions
- **Site Services**
  - Performance, efficiency benchmarking
  - Assessment of water quality issues
  - Investigation of casing issues, hot spots, leaks
  - Burner tuning
  - Investigation of tube corrosion issues
  - Condition, remaining life assessments
- **Metallurgical Analysis**
  - UT testing to determine cracking and tube wall thinning
  - To determine causes of tube failures and develop solutions
- **Vibration Analysis**
  - To address vibration-related failures in tube assemblies, baffle plates, liner plates
- **Dynamic Analysis**
  - To investigate tube, header, nozzle temperature differentials and flexibility during start-up, shut-down, and steady-state operation
  - To evaluate life cycle fatigue

HRSG Upgrade
Unit & Location: Saica 3, Zaragoza, Spain
Customer: Saica Paper
Work Completed: 2010
CC Capacity: 50 MWe
GT Model: PG 6581
HRSG OEM: Deutsche Babcock

FW Scope:
- Engineering study
- Recommended design and operational improvements
- Supply and erection and new duct, primary and secondary superheaters, attemperator, BMS and safety PLC

Benefits to Customer:
- Improved HRSG and plant availability, operational flexibility and plant performance
- New HMI for easier plant operation and diagnostics
- Lowered HRSG gas leakage

HRSG Steam Drum Replacement
Unit & Location: Unit 3, Barcelona, Spain
Customer: ENDESA GENERACION
Work Completed: 2011
CC Capacity: 400 MWe
GT Model: GT-26
HRSG OEM: CMI for Alstom

FW Scope:
- Replacement of high pressure steam drum and auxiliary equipment including engineering, design, supply and erection

Benefits to Customer:
- Improved HRSG and plant availability
- New high pressure drum designed to eliminate cracking in both circumferential and nozzle-to-drum welds
- Project engineered to minimize HRSG modification, site labor and plant down time

We offer a full range of steam generator equipment, aftermarket products and services to the power, industrial, and waste-to-energy sectors. Our global manufacturing and engineering network can deliver cutting edge products and expertise, quickly and cost competitively with best-in-class quality. Established in 1891, our experience comes from a heritage of designing, servicing, and continually improving steam generating equipment.

Steam Generators
- Circulating Fluid Bed
- Pulverized Coal
- Oil & Gas
- Solar
- Bubbling Fluid Bed
- Package
- Grate and MSW
- Metallurgical Waste Heat
- HRSG

Environmental Products
- Circulating Fluid Bed Scrubbers
- Fabric Filters
- SCR and SNCR Systems
- Low NOx Combustion Systems
- Biomass Combustion Retrofits
- Coal/Air Control System Upgrades

Aftermarket Services
- Condition Assessment
- Engineered and Replacement Pressure Parts
- Weld Overlay and Refractory Upgrades
- Replacement Parts
- Cyclone Burner Retrofits
- Coal Mill Service and Upgrades
- Maintenance Services
- Outage Construction
- Engineering Studies

Auxiliary Equipment
- Condensers
- Feedwater Heaters
- Biomass Gasifiers

Plant Operation
- Plants owned and operated by FW
- Long-term Service Agreements

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