

Steam Generation Technologies for a Sustainable Energy Evolution



Cover:
Turano Lodigiano
Combined Cycle
Sorgenia (ITALY)
2 HRSG behind
2 x 260 MW GT



AC BOILERS

in the Energy Transition

Steam Generation is evolving

In the Energy Transition the Steam Generation technologies are key factors enabling the “decarbonization” process to achieve a sustainable environmental impact of thermal power plants through high efficiency solutions with reduced greenhouse gas emissions and pollutant abatement. Steam Generators ensure on demand steam and power delivery with proven reliability and high performance.

AC Boilers reliably provides customized steam generators designed according to proprietary leading technologies for power plant applications, proven by our track records:

- Heat recovery steam generators for Combined Cycles
- Utility boilers for a full range of fuel combinations, power ratings and applications
- Waste-to-Energy steam generators
- Biomass-to-Energy steam generators
- Solar receivers for Concentrated Solar Power Plants

AC Boilers belongs to Sofinter Group, one of the major international industrial groups in the sectors of steam generators for power and industrial plants. AC Boilers head-quarters are located in Gallarate in the north of Italy, where all the engineering and project execution related activities are performed. AC Boilers facilities located in Gioia del Colle, south Italy, include the manufacturing workshop and the CCA Combustion Research Center.

Brescia - A2A (ITALY)
WTE and Biomass plant
MSW and Biomass grate fired boiler
700.000 t/year MSW
3 x 150 t/h steam capacity



Aprilia Combined Cycle
Sorgenia (ITALY)
2 HRSG behind
2 x 260 MW GT

Leading steam generation technologies

- Proprietary design for steam generators and firing systems
- Global reputation with major clients
- Excellent operational performance and proven track record for reliability
- Strong reference platform
- Wide portfolio of highly customized after sales services

Performance & Reliability

- Optimized, efficient, state-of-art designs for the toughest operations, encompassing heat recovery steam generators for the largest gas turbines in combined cycles, ultra-supercritical conditions for utility boilers, Waste-to-Energy and Biomass-to-Energy boilers designed for the highest availability
- A long-standing experience in integrated design, manufacturing & construction

Research & Product Development

- The direct ownership of one of the largest European R&D centres for boilers combustion technology allows full scale testing, whilst backing innovation capabilities

HEAT RECOVERY STEAM GENERATORS

Horizontal Gas Flow HRSGs

AC Boilers owns extensive experience and capabilities in Horizontal HRSG design and manufacturing

HRSGs are key equipment of the Combined Cycle power plants allowing the electric power generation “on-demand” necessary to balance the increasing share of fluctuating renewable energy sources, like wind and PV solar, and ensuring the electrical grid stability and the key challenges in flexibility of operations, with proven performance and reliability. Future use of Hydrogen in Gas Turbines will maintain the essential role of HRSGs to achieve the highest energy efficiency through the Combined Cycle configuration.

AC Boilers is an OEM with a huge number of HRSGs worldwide, delivering high performing HRSGs downstream of large capacity Gas Turbines of various models and sizes, firing a variety of fuels, up to the maximum ratings including H Class.

AC Boilers proven design incorporates enhanced solutions to meet the needs for fast start-ups and frequent load changing as well as purpose built, highly efficient optimized solutions for the most demanding steam pressure and temperature requirements of advanced Combined Cycles.

BASIC DESIGN FEATURES Steam & water cycle

- Multiple pressure levels, with or without reheat
- Up to the highest steam pressures and temperatures for advanced Combined Cycles
- Natural circulation, drum type

CUSTOMISED DESIGN OPTIONS

- Supplementary firing
- Fresh air auxiliary firing mode
- SCR – CO catalyst
- By-pass stack
- Boiler house

Operation:

Heavy cycling, fast start-ups, operational flexibility

Constructability:

Flexible solutions of modules, “C-Type” sections or harps

Arrangement:

Fully drainable, spiral-finned efficient heating surface, top supported, cold casing

Marghera Combined Cycle
AEN for Edison (ITALY)
1 HRSG behind
GT36 H class 500 MW GT



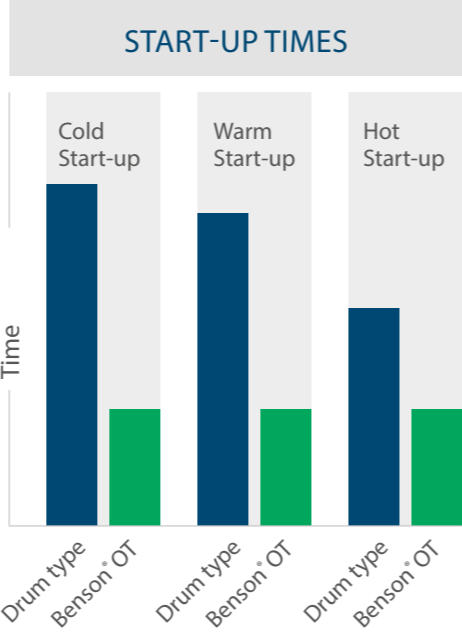
Mirfa Combined Cycle
ADWEA (Abu Dhabi- UAE)
3 HRSG
with supplementary firing
behind F class GT

Benson® Once-Through HRSGs

AC Boilers Designed and Manufactured the first three commercially-operating Benson Once-Through HRSGs in the world.

Where extreme demand fluctuations are the norm, Benson Once Through HP Evaporators allow for enhanced dynamic characteristics, flexibility and faster start-ups, making them suitable for advanced Combined Cycle power plants operating at the highest steam pressure and temperature.

Both vertical and horizontal gas flow arrangements are included within the AC Boilers products and capabilities.



Hamm Uentrop
Combined Cycle
Trianel (GERMANY)
2 HRSG behind
2 x 250 MW GT

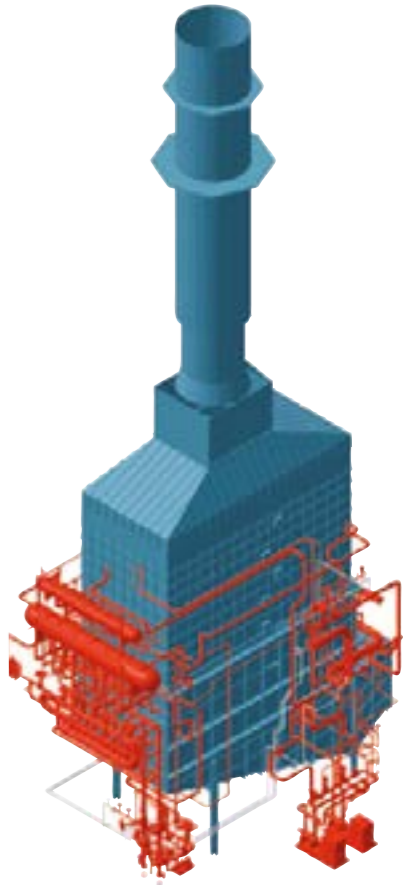
Vertical Gas Flow HRSGs

In brownfield projects with space constraints, or downstream of crude oil firing GTs, Vertical HRSGs can be the best option at hand

- ### SPECIFIC FEATURES INCLUDE
- Multiple pressure levels, with or without reheat
 - Natural or assisted circulation
 - Operational flexibility
 - Modular design for shop-assembled tube bundles
 - Horizontal tube bundles with spiral-finned, efficient heating surfaces
 - Top supported
 - Cold or hot casing

Tailored solutions for Steam Power Plants Repowering

Cleanable heating surfaces optimized for operation downstream crude oil firing GTs



Torrevaldaliga South
Combined Cycle
Tirreno Power (ITALY)
3 HRSG behind
3 x 250 MW GT



WASTE-TO-ENERGY STEAM GENERATORS

Waste-to-Energy plants utilize the residual, non recyclable portion of the municipal wastes in environmentally sustainable systems avoiding the significant pollution impact of landfilling. This is in compliance with the EU environmental target to minimize substantially the waste portion to landfill and is in accordance with the circular economy principles.

In the Waste-to-Energy plants, residual waste is used as a resource for:

- recovery of energy transformed into electricity, heat and steam, maximizing the energy efficiency
- recovery of secondary raw material to be re-injected into the economy

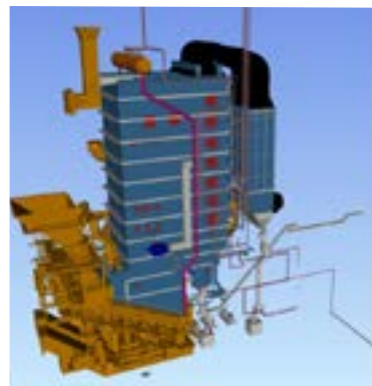
Waste to Energy is complementary to recycling: it treats waste that cannot be recycled or re-used including, in addition to municipal wastes or fuel derived from refuse, also other industrial wastes, hospital wastes and sludge.

AC Boilers has a longstanding history in supplying large capacity Waste-to-Energy steam generating systems for grate firing of municipal solid wastes and refuse derived fuels. AC Boilers is the steam generator OEM of the largest Italian Waste-to-Energy plant composed of three units, each with a maximum capacity of 900 t/day of municipal solid wastes. The third unit was designed also for the use of residual biomass at 100% capacity.

AC Boilers design provides the highest availability combined with the best steam conditions to maximize plant efficiency, meeting the low emission requirements.

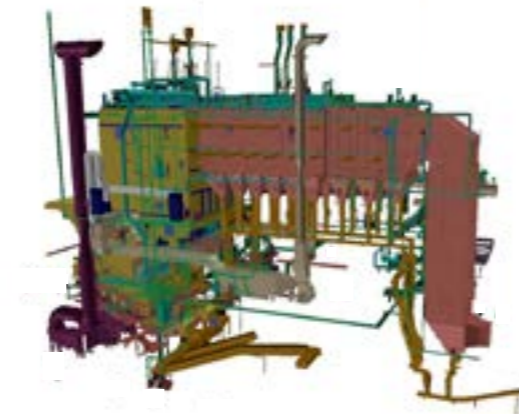
AC Boilers as system integrator provides competence and technology packages based on a sound design proven through a wide operational experience:

- Municipality Solid Waste (MSW) and Refuse Derived Fuel (RDF) grate firing
- Multi-pass boiler design
- Furnace with vertical radiant flue gas passes
- Inconel lined furnace
- Solutions for convective pass arrangement: Horizontal pass / Vertical pass
- Solutions for structural arrangement: top supported / mid supported



WTE grate fired boiler
90 MWth capacity
Vertical convective pass arrangement

Parona - A2A (Italy)
WTE grate fired boiler
870 t/day MSW
100 MWth 1x132 t/h steam capacity
Horizontal convective pass arrangement



BIOMASS-TO-ENERGY STEAM GENERATORS

Biomass-to-Energy plants are based on the sustainable use of a large variety of biomass types achieving energy and residual material recovery in compliance with low emission levels according to the Best Available Technologies.

High performance of Biomass to Energy Plants can be achieved by cogeneration solutions for Combined Heat and Power production.

AC Boilers proven design, depending upon the biomass characteristics, is focused on efficiency optimization solutions through high levels of steam temperatures and pressures as well on the selection of the boiler configuration suitable to high rates of availability across the plant lifetime.

AC Boilers offers large capacity, grate fired units based on multi-pass boiler design, customized for a wide range of biomass fuel including:

- Wood chips
- Wood pellets
- Forest residues
- Palm kernel shells
- Bagasse (sugar cane residues)
- Agro-biomass mixtures (olive oil wastes, pruning, vegetables residues, gardening wastes, etc.)
- Recycled wood

Boiler configurations:

- . two-pass arrangement for wood and forest biomass;
- . three-pass arrangement for agro-biomass with low ash melting point temperatures and potential high fouling conditions or for recycled wood firing according to waste emission regulations
- . austenitic stainless steel materials or Inconel cladding protection on critical pressure parts for high Chlorine agro-biomass.
- . boiler with reheater for the enhancement of the plant efficiency

Pulverised biomass (wood pellets, palm kernel shells) solution based on AC BOILERS Burner BE4G-Bio® is available for high plant efficiency targets.

Conversion to biomass firing of the steam generators designed for coal use is one of the potential options for CO2 emission reduction of the existing power plants.

Martinica Albioma
(French Overseas Territory)
Biomass
(wood chips/ wood pellets /
bagasse)
grate fired boiler
135 t/h steam capacity



SOLAR RECEIVERS

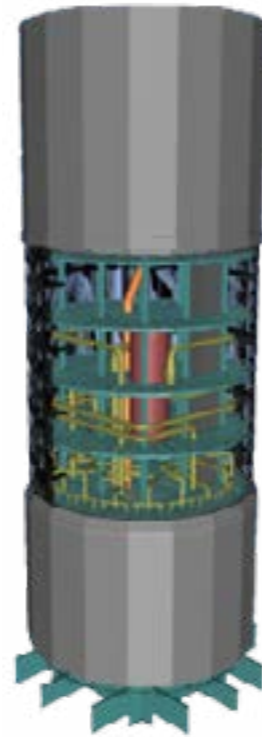
AC Boilers technologies and expertise include Solar Receivers - molten salts type as well as direct steam generation type - for Concentrated Solar Power Plants (tower type). The state-of-art technology is based on high capacity Solar Receivers which absorbs the concentrated solar energy and transfers it to molten salts as heated fluid.

Molten salts are suitable to store the absorbed solar energy in large tanks (with several hours storage capacity) placed in the intermediate circuit between the Solar Receivers and the Steam Turbine cycle. This is the best way to ensure solar power “dispatchability” or overnight electricity production with solar power available 24 hours a day, meeting utility demands just like conventional fossil fuels.

AC Boilers offers a state-of-the-art Solar Receiver design based on absorber panels with multi-pass arrangement and tubes from advanced high nickel alloy materials meeting the requirements for maximum heat flux and high availability according to the best practice.



Coalinga (California)
Solar receiver
for Concentrated Solar Power
tower type plant



Molten salts
solar receiver

INNOVATIVE SOLUTIONS Energy Storage

AC Boilers and Energy Nest, in the frame of a partnership agreement, have been developing the implementation of the Direct Steam ThermalBattery™ technology in Steam Power Plants as well as in Industrial Steam grids.

The ThermalBattery™ System stores and releases energy as high grade heat by means of a solid state media HEATCRETE®, specifically developed and field proven for energy storage.

The system operates simultaneously with superheated steam, two-phase steam/water and subcooled water. Steam based Thermal Batteries will boost flexibility of steam power plants, an aspect that not only will enable these power plants to balance high shares of renewables on the grid but will also increase profitability.

Industrial steam grids will benefit largely from increased energy efficiencies as well as from the replacement of fossil fuels with renewable energy via ThermalBattery™ contributing to CO2 reduction.



ThermalBattery™ System
with the associated steam
generation equipment

Digital Solutions



AC PERFORMANCE PLUS is an OEM system based on the most recent “Internet of Things (IoT)” solutions with the purpose to provide remote monitoring from the manufacturer head office of the steam generators for power generation of any kind and type.

The boiler performance is continuously monitored based on algorithms deriving from AC Boilers experience and know-how. Abnormal trends or parameters potentially affecting the performance or the lifetime of the steam generators are reported to the customers for corrective actions.

AC PERFORMANCE PLUS is implemented through a cloud architecture utilizing cloud-based database, data analysis system, machine learning algorithms and business intelligence systems for the elaboration and the visualization of the collected data.



AC PERFORMANCE PLUS
Head office control room

UTILITY BOILERS Design & Manufacturing Capabilities

In the frame of the progressive Transition to sustainable Energy Systems, the energy outlooks expect that, in the next two decades, fossil power generation by the installed units will maintain a substantial share in several Countries, depending on local energy sources availability, to ensure base load capacity.

In the above frame, AC Boilers extensive experience can provide customers, during the lifetime of their plants, with a range of solutions to enhance the steam generators performances: conversions to cleaner fuels, upgrading to improve plant efficiency and capacity , retrofits to reduce the emissions.

From its outset, AC Boilers has supplied more than 1000 units (80 GW) worldwide, of which 20 GW Super-Critical Utility Boilers, also confirming itself as a Global Market Leader in the last 30 years with regard to Super-Critical Oil/Gas Fired Boilers, holding 35% market share.

AC Boilers has a base of proprietary know how and original design codes, integrated with Benson® Once-Through Licenses for Ultra Super-Critical and Super-Critical Designs.

AC Boilers is one of the global boiler manufacturers with the largest experience in natural circulation drum type boilers, firing coal as well oil & gas, operating at the highest sub-critical pressures at over 180 bar.



South Helwan
UEEPC (EGYPT)
SC thermal powerplant
3 x 650 MW
Gas/Oil Benson Boilers



Torrevaldaliga North
Enel (ITALY)
Clean Coal USC
3 x 660 MW
Benson Boilers
252 bar, 604/612 °C



Abu Qir power plant
WDEPC (EGYPT)
2 x 650 MW
Gas/Heavy Oil

Ultra-Supercritical & Supercritical Technology

Supercritical (SC) and Ultra Super-Critical (USC) technology allow the highest power plant efficiencies whilst reducing CO₂ and pollutant emissions.

The consolidated experience in SC Boilers for more than 50 years includes multi-fuel units firing coal, heavy oil and natural gas. AC Boiler reference design incorporates a complete range of state-of-the-art solutions up to the maximum proven steam temperatures for coal SC and USC boilers as well Heavy Oil/Gas SC boilers.

AC Boilers proven experience includes coal fired Ultra-Supercritical Benson Boilers, successfully operating in one the most advanced Clean Coal fired plants in the world and advanced Supercritical Benson Boilers, Gas/Heavy oil fired, supplied in Egypt.

Fuel Experience

AC Boilers wide experience with any kind of fuel is a valuable know-how for new build units and for the capability to support our customers for fuel conversions and retrofits of existing plants. Boilers leading technology for Heavy Oil/Gas boilers is based on a unique experience record of more than 55 GWe of installed units. Reference design models include box type as well as two-pass type arrangements.

The highest steam temperatures are reached using proven high alloy steels, in order to withstand the HFO high temperature corrosion.

AC Boilers has the knowledge and experience in firing internationally traded coals; 24GW of experience which spans from high-grade bituminous coals to the lowest-grade high-moisture lignite and the high-ash Indian coals. Reference design models are based on the two-pass arrangement, use of proven alloy steels for the highest steam temperatures and pressures. Cutting edge Opposite-wall Low-Nox combustion technology is used for major in furnace reductions and the widest fuel and operational flexibility.

Firing Systems

AC Boilers is one of the front runners in Clean Combustion Technology, according to BAT emission levels for any kind of fuel, and has an extensive experience with:

- In-furnace emission reduction techniques for:
 - New build
 - Retrofit projects
- Firing systems for solid fuels with high efficiency, low NOx burners:
 - Biomass burners
 - Co-Firing solutions suitable for coal and biomass

AC Boilers proprietary low NOx biomass burner BE4G-Bio® is suitable for operation with multiple fuels: pulverised wood pellets, coal, natural gas, fuel Oil. AC Boilers is capable to provide tailor-made solutions for the new coal-biomass co-firing installations and to convert the existing Coal-fired boilers to coal-biomass co-firing up to 100% biomass.

Since the '90s AC Boilers low-NOx burner design has been validated at its own Combustion Research Center, one of the largest in Europe, equipped with a 49 MWth boiler test rig used to validate individual burners in large scale operating conditions.



Biomass burner flame during validation tests

Biomass burner BE4G-Bio®



CCA COMBUSTION CENTER

AC Boilers relies on its own combustion R&D center CCA S.p.A. – Centro Combustione Ambiente, an independent company located at the facility in Gioia del Colle, assisting in new products and technologies development in the thermal energy combustion sector, focused on environmental sustainability and protection. CCA is one of the largest combustion centers in Europe and develops R&D burner testing activities for AC Boilers, for other Sofinter Group brands as MACCHI as well as for international Third Parties.

CCA is equipped with several test rigs including a 49 MWth boiler furnace for full scale testing of burners firing any kind of fuel: natural gas, gas mixtures, hydrogen, fuel oils, pulverized solid fuels like biomass, secondary fuel derived from refuse (SRF) and coal. In addition a complete system for biomass crushing and feeding the biomass to the burner is available. Other test rigs are specifically sized for a variety of combustion systems like gas turbine burners, burners for industrial furnaces and smaller capacity industrial burners. The facilities cover an area of approximately 15.000 m².

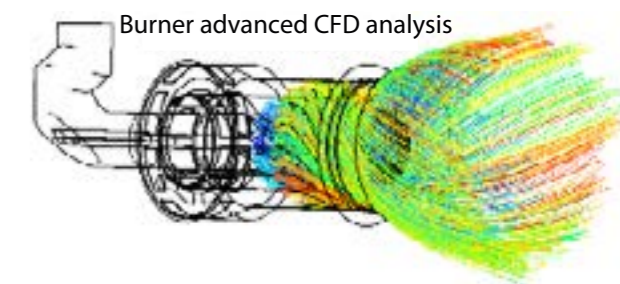
CCA is capable to perform industrial scale combustion tests for different burner applications and energy conversion systems as:

- Burners for steam generators in power generation and industrial applications;
- Burners for Gas Turbine applications;
- Burners for various process applications (refineries, steel industry, etc.);
- Gasifiers;

In addition, CCA with its highly skilled staff can provide additional services like: on field audits for emission diagnostic or performance tests; engineering and construction of prototypes for the energy conversion sector; development of specific diagnostic devices. The advanced diagnostic equipment installed at CCA enables the full understanding of the combustion performance and the complete characterization of the combustion system benefits. Testing activities are supported by proven and advanced CFD numerical modelling capabilities. CCA belongs to the MIUR (Italian Ministry of University and Research) register of research laboratories and has a strong track record of scientific cooperation with Universities and Research Centers in Italy and abroad, including a partnership with Polytechnic University of Bari cooperating into the ETF (Energy Transition to the Future) laboratory, focused on complex numerical modeling for basic research and novel solutions in the energy field.



CCA facility – 49 MWth test rig



MANUFACTURING

AC Boilers has a valuable experience and know-how in the manufacturing of any kind of steam generator pressure parts, from carbon steel to advanced high alloy and austenitic steel integrating design and fabrication requirements.

AC Boilers facility is located in Gioia del Colle, south Italy in the province of Bari, close to the industrial ports of Bari and Taranto (40 km). The facility has a total area of 300,000 m², of which 72,000 are covered.

The shop is equipped for the manufacturing of pressure parts for utility boilers, WTE boilers (including Inconel cladding), Biomass boilers, HRSGs, as well as for the assembly of HP drums and burners.

Manufacturing strategy, according to the specific project requirements is based on in-house fabrication facilities in Italy and in the Sofinter Group shop in Romania supplemented by the use of qualified referenced fabrication sub-contractors in low cost Countries, providing AC Boilers' customers with time and cost flexibility. Global operational and procurement offices are located in Italy, Egypt and China.



BOILER SERVICE

Sofinter Group offers a full range of boiler services, spanning from full Rehabilitations to Spare parts procurement

Maintenance

Reliability

- OEM spare part manufacturing
- Spare part supply management
- Long Term Service Agreements

Intervention

- Failure analysis & improvement studies
- Material & design modifications

Improvement

- Inspection, diagnostics & expertise
- Outage planning, repairs, supervision

Lifecycle

Status Extension

- Equipment condition analysis
- Remaining lifetime assessment
- Full rehabilitation projects

Experience & Expertise

- Supervision of erection, commissioning & start-up
- Operator training
- Technical studies

Regulations & Environment

Emission

- Low emission burners
- In-furnace emission reduction systems

Operation

Flexibility

- Fuel conversions & multi-fuel applications
- Flexible load & cycling mode adjustments

Availability

- Pressure part replacement
- Material change
- Cladding

Efficiency

- Combustion optimization
- Efficiency improvement

Performance

- Restoration to design output
- Steam flow increase, boiler up-grade



remote monitoring systems for boiler performance and maintenance continuous advisory service

AC Boilers CONTACTS

- AC Boilers Operational
Headquarters

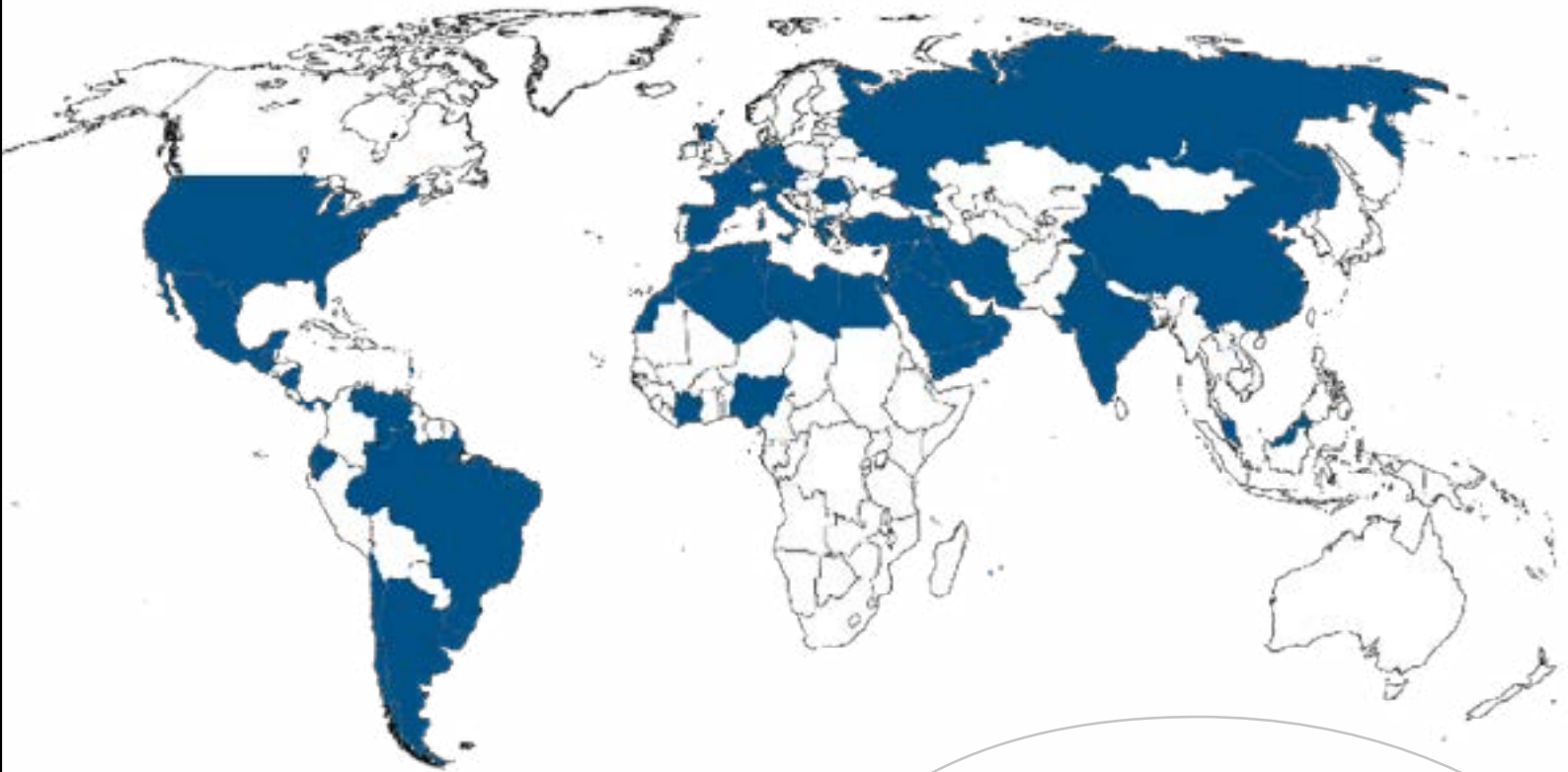
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- Countries with AC Boilers Installed Units
- AC Boilers Headquarters
- AC Boilers Factory and Combustion Center

www.acboilers.com