Alstom’s Boiler Experience

2015 03 17
Gerhard Heinz
Agenda

• Our Group

• Thermal Power

• Our Thermal Service Offering focused on Boilers

• Examples for executed Boiler Projects

• Summary
Introduction Alstom
Alstom Group – Three Main Activities in Four Sectors

- Thermal Power: €8.8 bn
- Renewable Power: €1.8 bn
- Grid: €3.8 bn
- Transport: €5.9 bn

46,000 employees in 70 countries
19,000 employees in 70 countries
28,300 employees in 60 countries

Sales 2013/14: €20.3 bn
Order Intake 2013/14: €21.5 bn
Agenda

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• Summary
Thermal Power
Philippe Cochet
President

Gas
Steam
Nuclear
Power Automation & Controls
Thermal Services

Alstom Thermal Power Organisation
Introduction Alstom
Our successful Service model

Service Network

9 Service Network
- North America
- North Europe
- Asia
- South East Europe & N Africa
- Latin America
- South West Europe & Africa
- Central Europe & CIS
- Middle East & India
- Southern Africa Countries

Product Lines

7 Product Lines
- Gas Turbine OEM
- Gas Turbine OOEM
- Steam Turbine
- Generator
- Boiler
- AQCS
- Integrated Solutions

9 Areas
Maximise market share by plant
- Seamless relationship with customer at the Plant level
- Match between market and resources
- Development of local competencies

7 Product Lines
Fully leverage technology and fleet
- Seamless portfolio of products and solutions
- Specific capabilities, knowledge and expertise
- Competitive and efficient supply chain accessible globally

Trust – Team – Action / Success through collaboration!
Central Europe & CIS
TS – Area CE&CIS

- **520 GW** thermal installed base
- **471 m** people across the Area
- **>1000** Thermal Service employees across CE&CIS
Agenda

- Our Group
- Power Sector
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Thermal Services
Solutions for the installed base

Fuels
- Coal
- Gas
- Oil
- Nuclear

Plants
- Fossil Steam
- Gas (CC/SC)
- Nuclear
- Industrial Power Gen

Equipment
- Rotating Equipment
  - GT
  - ST
  - Geno
- Boilers
  - Coal/Oil
  - HRSG
- AQCS
  - ESP
  - SCR
  - FF
- BoP
  - Motor
  - Pump
  - Pipes

Services
- Parts
- Reconditioning & repair
- Field service
- Advice & operational support
- Performance improvement
- Service contracts

A complete portfolio from maintenance to performance improvement
Increase competitiveness of the plant

Adapt the plant with small adaptations and upgrades including environmental footprint to comply with IED

- Reduce cost
- Increase revenue

Evolution of Technology

- With adaptations & upgrades
- Without upgrades

Merit order that decides the power plant dispatch
# Introduction Alstom

Boiler Product & Services Offering – Overview

## Product Offering

<table>
<thead>
<tr>
<th>Type of fuel</th>
<th>Engineered Solutions</th>
<th>Field/Technical Services</th>
<th>Balance of Boiler</th>
<th>Firing Systems</th>
<th>Pressure Parts</th>
<th>Mills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignite</td>
<td><img src="image1.png" alt="Image" /></td>
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<tr>
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<td><img src="image17.png" alt="Image" /></td>
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<tr>
<td>Anthracite</td>
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<td>Oil/Gas</td>
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<td>Biomass/waste</td>
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## Product and Services Offering for own and other OEM fleets with the aim of

- Reducing Cost of Electricity
- Increasing Flexibility and Reliability
- Lower Environmental Footprint
Alstom step approach
Focus: Improve plant’s dark spread

Step 1 – Uncover & Tune
- Burner Tune
- Monitoring & Diagnostics
- Engineering Review
- Control Loop Tune

Step 2 – Adaptations & Minor Upgrade
- Burner Upgrade
- Flame Stability Monitor
- Mill upgrade
  Output > or low load

Step 3 - Modify
- IED Emissions Performance
- Low Load operation
- Low Load improvement
- Turbine Retrofit
- District Heating
- NOx Emission Perform. HWR

Reduce cost with OPEX and short term measures

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About Fuels

A wide variety of fuels are used to generate electricity

<table>
<thead>
<tr>
<th>Gas</th>
<th>Coal</th>
<th>Oil</th>
<th>Biomass</th>
<th>TDF/RDF</th>
</tr>
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</table>

Each of these fuels have advantages and disadvantages.

The fuel „defines“ the technical concept
About Boiler Technologies

Boiler technologies are different and driven by fuel types. Alstom has ALL technologies:

- **Drum-type boilers**
  - Oil, Gas, BFG

- **Once-through boilers**
  - Bituminous coal, Lignite

- **Once-through boilers**
  - Brown Coal, Lignite

- **Circulating Fluidized Bed**
  - Bituminous coal, Lignite

Anthracite Wet Bottom
Firing Technology impacted by coal quality
From brown coal to anthracite

Firing technologies are different & driven by fuel types Alstom has
ALL firing technologies

Low NOx Wall Burners
- Bituminous Coal
- Antracite
- Lignite
- Biomass
- Oil / Gas

Low NOx tangential fixed or tilting Burners
- Bituminous Coal
- Oil / Gas

Low NOx tangential fixed Burners
- Lignite
Reduction of NOx emissions primary methods
Combustion / Burners RoBTaS

Optimization of the combustion process using CFD for each boiler and burner
Optimization measures for Hard Coal Performance upgrade on oOEM Mills

Coal Mill - the ‘traditional’ bottle neck of the unit equipment

Alstom offers oOEM upgrade solutions Mills

Extended Coal Range resulting in lower fuel costs
Optimization measures for Bituminous Coal
Capacity upgrade Mills & Primary Air System

- Faster Start-up
- Extended Fuel Range
- Faster Load Changes
- Extended Fuel Range
- Extended Fuel Range

Source: ROTAMILL GmbH

- Additional Air Fan
- Dynamic Classifier
- Duct Burner

Source: REBURNFLAM® r;
Pillard Feuerungen GmbH

Gas Supply
Station

Raw Coal
to Mill

Coal Mill

Mill upgrade
Output > or low load
Secondary NOx reduction
Cost efficient compliance with Emission Regulation

NOx Reduction

In-situ
- Low-NOx burner
- Low-NOx firing (OFA)

Post combustion
- SNCR
  - SNCR with Urea
  - SNCR with ammonia
- SCR
Agenda

- Our Group
- Power Sector
- Our Thermal Service Offering focused on Boilers
- Examples for executed Boiler Projects
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Example oOEM 370 MW, Belchatow 6 PL
LowNOx+Performance & output Increase

Integrated Boiler&Turbine Retrofits,
Performance Improvement
Environmental Compliance

Before Retrofit
- NOx content in flue gas: > 400 mg/mN3
- MW output: 370 MW
- Cycle efficiency: > 38%
- Feed water temp.: 255 °C
- Live steam/RH temp.: 540 °C / 540 °C

After Retrofit
- NOx content in flue gas: < 200 mg/mN3
- MW output: > 394 MW
- Cycle efficiency: > 41.3%
- Feed water temp.: 275 °C
- Live steam/RH temp.: 570 °C / 570

Saving of >400,000 t CO2/year
Examples oOEM 500 MW - Meirama - ES
Fuel Flexibility & Environmental Compliance

Coal to Coal - Fuel Switch
Lignite to Hard Coal
Low NOx, SO2 modification

Nominal output MW 550
Unit commissioned - 1980
SH/RH steam temp. °C 540/540
SH steam press. Bar 182,5
OEM Hitachi

Before Modification
- NOx : >500 mg/Nm3;
- Boiler Efficiency : < 90% ;
- SO2 : > 3.000 mg/Nm3;

Achieved (guaranteed) performances
- NOx : 223 mg/Nm3 (500);
- Boiler Effic. : 93,7 % (93,2%);
- SO2 : <400 mg/Nm3 (400);

Before
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After
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- Boiler Efficiency : 93,7 %
- SO2 : <400 mg/Nm3

Improvement Boiler η +4%, Saving ~ 25% CO₂ Emissions

Fuel - before after
LCV MJ/kg 8 20,9-25,5
Moisture % 50,6 7,2-24,5
Ash % 26,9 0,9-13,7
Sulphur % 1,3 0,07-0,38
Flue Gas kg/s 933 647
Examples oOEM 2x450 MW - Schkopau - DE
Fuel Flexibility

Before

Reduced LCV
11-12 MJ/kg to
9,5 -10,5 MJ/kg

After

- Cut Economizer
- Re-design
- Resuction duct heads
- New PF Burner
- Increased diameter of DGS Beater Wheel, Modification Cuppling
- Modification FD fan &
- Elimination of FGR

Coal to Coal - Fuel Switch
Lignite modernization to changed LCV, Low NOx
Examples oOEM 2x150 MW - UA
Modernization Zmijev 8A & 8B

Main characteristics
• 2 x 475 t/h Russian (Taganrog) once through boilers, supercritical, wet bottom

Boiler scope of supply
• Boiler Rehabilitation
• New furnace and burners
• Ash handling equipment, supervision of erection and commissioning

Performances
• combustion efficiency 97.5%
• combustion capacity 467 MWth
• load range without support 70-100%
Examples oOEM 2x150 MW - UA
Modernization Zmijev 8A & 8B

Pressure Part and Firing Modification
Example OEM 750 MW – Bexbach, DE
Ultra Low NOx Rehabilitation 1998

Targets
Reduce NOx emissions
Decrease power generation costs
Increase boiler efficiency

Steam Parameter
SH  225 bar, 535°C, 625 kg/s (2,250 t/h)
RH  40 bar, 535°C, 573 kg/s (2,063 t/h)
Bituminous Coal (high volatiles)

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<th>Unit</th>
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<td>mg/m³ s.t.p. (6 % O₂ dry)</td>
<td>850</td>
<td>350</td>
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<tr>
<td>CO-emission</td>
<td>mg/m³ s.t.p. (6 % O₂ dry)</td>
<td>&lt; 10</td>
<td>100</td>
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<td>Combustibles in fly ash</td>
<td>%</td>
<td>approx. 1</td>
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Example OEM 750 MW – Bexbach, DE
Ultra Low NOx Rehabilitation 1998

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Before       After

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Examples oOEM 4x230 t/h - Hard Coal, PL
Primary NOx reduction with SNCR

Optimization of the combustion process using CFD for each boiler and burner is possible to be combined with USNCR

- Secondary (SNCR/USNCR)
- Primary LowNOx firing system (≤ 350mg/m³i.N.)
Examples oOEM 50 MW - AT
Fuel conversion Sappi Gratkorn

- Main characteristics
  - OEM AE&E (WAGNER BIRO)
  - Capacity: 165 t/h; 120 bar; 520°C

- Scope of supply
  - Conversion from brown coal to hard coal + sludge (up to 20 t/h with LCV <2MJ/kg)
  - Improvement of cyclone efficiency
  - Replacement of a wall superheater by an in furnace double Omega exchanger.

- Achieved (guaranteed ) performances
  - NOx (NG): < 200 mg /Nm3 (6% O2a)
  - Furnace outlet temperature < 900°C

Coal to Coal - Fuel Switch
Lignite to Hard Coal
Low NOx, SO2 modification
Examples oOEM 100 MW - Lubljana, SL
Conversion to Biomass Co-combustion #3

Hitachi Boiler
Unit 3, 1981

Dampfleistung 270 t/h
Heißdampf-Austritt-Temperatur 535°C
Heißdampf-Austritt-Überdruck 94 bar
Hochstzul.-Betriebsüberdruck 115 bar
Trommel-Überdruck 107 bar
Speisewasser-Temperatur 225°C
Rauchgas-Temp. Kaminaugang 160°C

Kessel-Herstell-Nr. 12 181
Überzüge-Herstell-Nr. 7 413
Herstellung 1981

Up to 30% Biomass co-firing by travelling grate with spout air feeding into the boiler hopper

Main fuel: Indonesian Lignite
Bio Fuels: crushed Biomass with 20 - 45% Moisture

Fuel Switch Coal to Coal/Biomass
Low CO2 modification
Examples OEM 50 MW - Sandreuth, DE
Conversion from Hard Coal to NG

Scope of supply:
• NG burners and supply lines
• Ducts including gas recirculation
• Heat exchanger
• Pressure parts modifications

Main characteristics:
• ALSTOM boiler
• Natural Gas front firing (4 burners)
• MMC: 135 t/h ; 535 °C

Results and Outcome:
• Achieved (guaranteed) performances
  • NOx (NG) : 90 mg/Nm³ 3 % O₂ dry (100)
  • NOx (FO) : 140 mg/Nm³ 3 % O₂ dry (150)
  • CO (NG) : 50 mg/Nm³ 3 % O₂ dry (100)
  • CO (FO) :70 mg/Nm³ 3 % O₂ dry (170)

Ultra low emissions
• Our Group

• Power Sector

• Our Thermal Service Offering focused on Boilers

• Examples for executed Boiler Projects

• Summary
Summary

Increase Profitability by Adaptations & Upgrade Solutions

Alstom offering
to adapt existing Power and Industrial Plants
to the changed market conditions

- **REDUCE PRODUCTION COST**
  - Combine increased reliability with fuel cost reduction & rapid ROI

- **REDUCE EMISSION**
  - Comply to emission limits also at load operations

**ADAPTATIONS & MINOR UPGRADES**
- OPEX
- Fast ROI
- During planned outage

... and discover more with Alstom BOILER Technology