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Coal-to-gas conversion at Spain's Aboño 2

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Engineering a gas-fired future for Spain's Aboño 2

Plant life extension, emissions reduction and cleaner, more flexible generation – just some of the key benefits of a coal-to-gas conversion carried out at EDP's Aboño 2 power plant in Spain

John Goldring Managing Director, RJM International



12 key project phases

1	Fact-finding (baseline performance test, site survey and combustion audit)
2	CFD modelling programme
3	Engineering design phase and first draft of O&M manual
4	Procurement and manufacture of new hardware
5	Installation, carried out by EDP's main contractor, Duro Felguera, under Wood and RJM supervision
6	BMS and DCS upgrade
7	Commissioning
8	Optimisation
9	Performance guarantee tests
10	Training of plant personnel on new operational procedures.
11	Final O&M manual issued
12	Project completed

The Aboño 2 plant was commissioned in September 1985 and consists of a 556 MWe opposed wall-fired Foster Wheeler boiler with 36 burners in a six column/three row configuration. As well as coal, the plant fired additional fuels including fuel oil, as well as blast furnace gas (BFG) from an adjacent Arcelor-Mittal steelworks.

Located at Gijón in Spain, Aboño 2 is owned and operated by EDP (Energias de Portugal), a major global utility generator with operations in Europe, the Americas and Asia-Pacific. EDP has a total installed capacity of over 32 000 MW and is committed to clean energy. It drives global growth through electrification, focusing on renewables, resilient networks, and balanced investment for a sustainable future.

Project objective – reconfiguring the plant to fire natural gas

As part of Spain's national plan to decarbonise the economy, legislation was introduced to cease all coal-firing by the end of August 2025. This meant that coal-fired power plants either had to shut down or transition to an alternative fuel.

In this case, EDP set aside an investment budget of mid-double-digit million euros and selected Wood (engineering consultancy and boiler OEM, via its acquisition of Amec Foster Wheeler) to undertake a project scope to explore what the plant's options were for continued generation.

Duro Felguera was selected as main EPC contractor.

Wood carried out a number of detailed feasibility studies to evaluate alternative pathways

for modifying the plant and proposed to EDP a set of engineering designs, based on economic viability, environmental impact and operational efficiency.

Project procedure

Once it was determined that a conversion from coal to natural gas would be the most viable way forward, Wood appointed RJM International to tackle the combustion part of the project. This followed a complex tendering process and submissions by a number of multi-national burner technology companies.

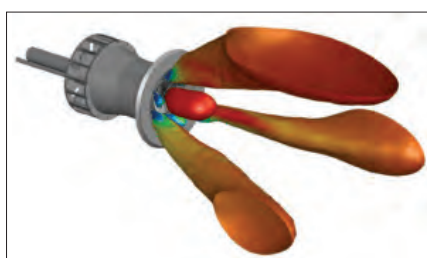
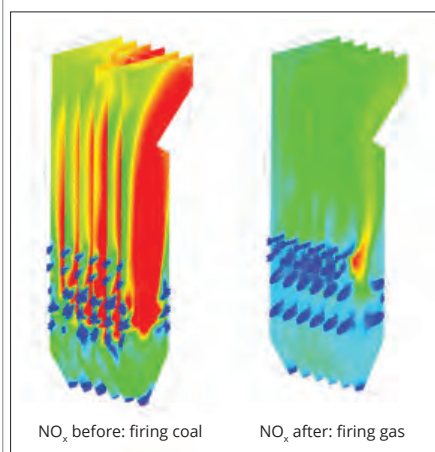
RJM's scope included the design and manufacture of the new burner system that would be needed to meet project objectives, in

terms of significantly reduced emissions, more reliable operation and continued fuel flexibility.

It was also important to retain the capability to fire blast furnace gas from the steelworks, as this enabled efficient use of a waste fuel contributing to green steel manufacture, as well as reducing Aboño's own consumption of natural gas.

An additional requirement was that the plant should be future-proofed with the in-built capability for the burners to fire hydrogen, thus ensuring that a "next generation" level of plant life extension in a zero carbon environment could be achieved.

At the start of the project, Wood and RJM conducted a site survey, a baseline unit performance test, a full combustion assessment, a boiler part pressure test and an economiser



Left: CFD image showing NO_x levels before (coal) and after (gas).

(Image: RJM International)

Above: CFD gas burner image showing compact flame profiles.

(Image: RJM International)

and secondary air heater audit. Data from these activities was then fed into RJM's analysis of the furnace and combustion air systems.

With over 10 000 MWe of gas and oil burner upgrades, RJM's experience of assessing and analysing large utility boilers was combined with deployment of its proven Ultra-low NO_x CleanAir Burner™ design to deliver the performance improvements demanded by the contract.

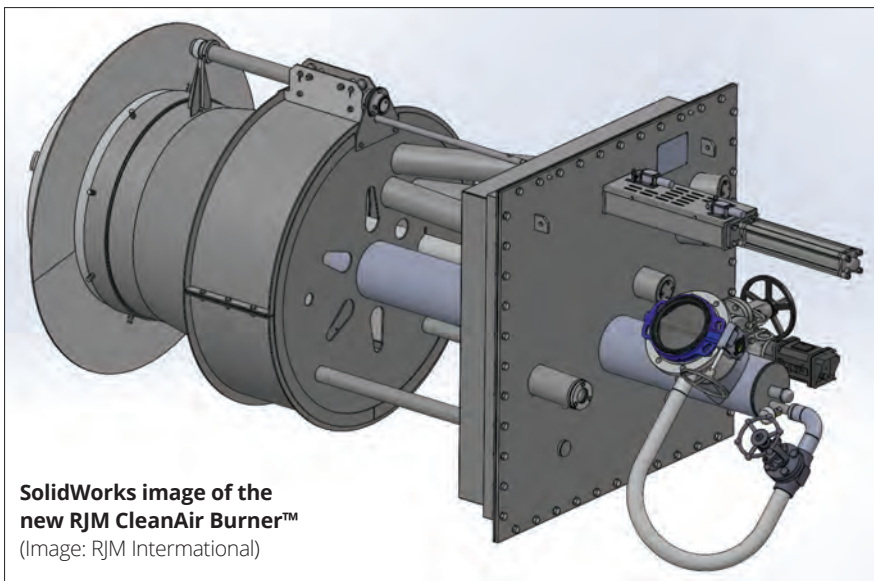
The importance of accurate CFD

Having inputted data gathered from around the plant, RJM conducted a detailed programme of CFD analysis which enabled it to optimise the combustion system design.

It also enabled RJM's CFD engineers to make changes to plant equipment within the virtual model. Burner design, configuration, nozzle sizes and locations, fuel and air velocity, fireball location, temperatures and emissions can all be progressively optimised as the model is run through a series of iterations.

Making incremental changes delivers step-by-step improvements each time, until the objectives of the plant's performance upgrade are met.

A successfully completed CFD programme is therefore instrumental in determining what new equipment needs to be designed, where it will be located and what the new operational settings should be to deliver the performance uplift.



SolidWorks image of the new RJM CleanAir Burner™
(Image: RJM International)

In terms of fuel/air delivery systems, CFD can also be used to identify locations where flow improvements are required to reduce system pressure drops and, in this case at Aboño, it was used to verify how well the BFG burners would perform as pseudo-OFA (over-fire air) ports, following the conversion to gas.

In conjunction with the CFD work, using its engineering experience and its well-proven engineering tools, RJM assessed the capability of the existing BFG burners to work in conjunction with its new Ultra-low NO_x CleanAir Burners™.

As well as assessing the ability of the BFG burners to be used as over-fire air ports for periods when BFG is not available, RJM designed further modifications to the BFG pilots to ensure BFG flame stability and performance.

Design and manufacture

For this Aboño 2 project, to make the upgrade as cost-effective as possible and to minimise the duration of the outage, RJM decided to retain as many interfaces and other "non-performance critical" parts as possible and only design and

manufacture the essential "performance critical" new kit that would be required.

RJM designed and supplied 30 new ultra-low NO_x gas burners to replace the existing coal burners and 12 conversion kits to allow the gas igniters from the coal burners (that were now no longer needed) to be re-used as pilots for the BFG burners. The 12 existing BFG burners were then fully refurbished. In addition, gas pilots replaced diesel firing, thereby providing a further reduction in emissions. Meanwhile, new burner frames and refractory stuffing boxes were designed by Wood, whilst the boiler protection system was upgraded and modernised.

Wood and RJM jointly supervised the installation of the gas burners and retrofitted the BFG burner pilots. Expert engineers also redesigned the superheater surfaces, whilst the tube alloys were upgraded to withstand the new operating conditions.

To accommodate the change in heat transfer characteristics arising from converting to gas firing, Wood extended the boiler economiser and conducted a remnant life assessment of the pressure parts that remained unchanged. Wood

Installation time-line	
January 2025	First batch of burners delivered to site
February 2025	Rest of burners, BFG pilot parts and ancillary components delivered to site
End February 2025	Outage begins
March 2025	Installation commences
April 2025	First new burners installed
May 2025	Installation of new components checked
June 2025	Cold commissioning and first firing
June/July 2025	Optimisation
July 2025	Boiler performance tests and performance guarantees met
July 2025	Hand-over to the customer



Left: **Customer inspection** (Photo: RJM International)

Above: **Completed burners prior to painting**
(Photo: RJM International)



Burners prior to dispatch (Photo: RJM International)



New burner being installed
(Photo: RJM International)

also ensured that legacy brownfield systems were modernised, including upgrading the Rothenmühle air heaters.

Designing a new coal-to-gas burner

Reconfiguring a coal-fired power station to convert it to fire natural gas is not a simple procedure, if the plant is to operate at its original design capacity, reliably, flexibly and cost-effectively.

This is particularly the case for older plants where the challenge is to gather sufficient data and measurements and to gain enough understanding of the plant's limits, in order to devise an appropriate solution. This means that no RJM project is ever the same – one size does not fit all.

The calorific value, thermal dynamics and combustion attributes of gas are very different to those of coal. Designing new burners that can achieve a combination of ultra-low emissions and a flame profile that will not damage the integrity of the burner mouth or the boiler walls can only be achieved by a detailed programme of CFD modelling that considers every variable, such as fuel properties, fuel and air flow distribution,

and combustion performance, and how these variables impact on MWe output and emissions.

The conversion retained the existing BFG burners, maintaining this prudent utilisation of a calorific waste product gas from the nearby steelworks that would otherwise have to be flared off. This was a key requirement of the Aboño 2 coal-to-gas conversion project.

Also, with power plants preparing the next stage of their transition to low-to-zero carbon power generation, RJM's new burners had to be designed to fire up to 10% hydrogen as a secondary fuel. Hydrogen releases no emissions upon combustion and so its use delivers an immediate NO_x and CO₂ reduction. RJM's new coal-to-gas burners were also designed to have the potential to fire a greater percentage of hydrogen as a further step towards lower carbon generation at a later date.

Major performance improvements

Following the Aboño 2 coal-to-gas conversion, all the key emissions metrics were significantly reduced and other performance improvements recorded:

- 1.3 million tonnes per annum of coal no longer being fired;
- primary NO_x emissions of 845 mg/Nm³ reduced by 70% to 250 mg/Nm³;
- CO₂ emissions reduced by 870 000 tonnes per annum, a reduction of 30%;
- SO_x emissions of 130 mg/Nm³ reduced to zero;
- Additional environmental benefits from using BFG as a second fuel, reducing emissions of CO₂ by a further one million tonnes per annum;
- 5 MWe of parasitic load freed up, delivering an improvement in cycle efficiency of about 0.4% (coal yard, flue gas desulphurisation plant, conveyors, hoppers, mills and classifiers no longer needed);
- improved flexibility, reliability and availability;
- plant life extension; and
- improved environment for the local community (noise, smell, views, etc).

This ground-breaking project was completed on time, within budget and met all the exacting performance upgrades asked of it.

It also demonstrates that coal-to-gas conversions can play a meaningful role for generators as they embark on their transition to zero carbon generation.

RJM is currently carrying out a similar coal-to-gas conversion for a plant operated by Omaha Public Power Department in Nebraska, United States.

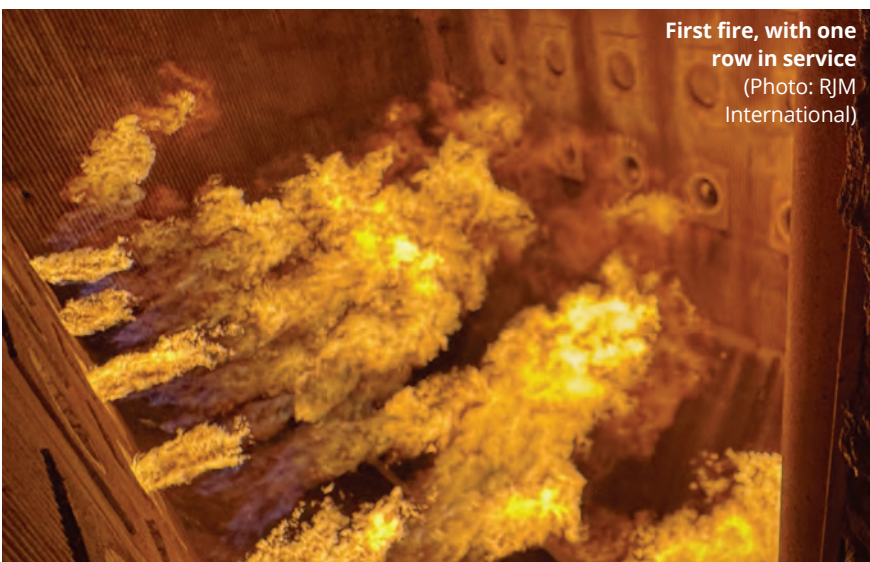
"This has been a successful project," commented Diego Martinez, Commissioning Engineer at Wood plc, "meeting all our performance guarantees." 

Further information:

<https://www.durofelguera.com/en/edp-and-corporacion-masaveu-award-duro-felguera-the-Aboño-gas-conversion-project/>

<https://www.woodplc.com/solutions/case-studies/smart-modifications-to-unlock-Aboños-future-through-fuel-switching>

<https://www.rjm-international.com>



First fire, with one row in service
(Photo: RJM International)