Boldrocchi continues to lead the way worldwide in air pollution control

How to succeed in reducing air pollutants and noise emissions in a biomass power plant to extremely low levels less than 1 mg/Nm^3 of PM

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Global pollution has increased exponentially through the years, and all the latest environmental studies have clearly shown the devastating effects this pollution can have on both nature and human health. Environmental organization/groups Worldwide including the populations living in these polluted areas have raised their voices, and governments have implemented increasingly stringent regulations.

Very strict Flue Gas Treatment Regulations have been applied by many of the worlds environmental bodies and countries to both biomass and energy sectors but still companies are preparing for the implementation of even stricter environmental laws soon.

Furthermore, the standards that regulate legally defined noise limits (for each class of intended use) set constraints on noise production to achieve reduced noise pollution in the area surrounding the plant.

Hence, in order to assess the sustainability of a project, it is important to know the impact of these emissions produced by the plant, no matter whether these emissions are related to chemicals generated from combustion and released into the atmosphere, or to sound produced by machinery located inside the plant.

In order to assess the project sustainability, it is important to know the impact of the emissions produced by the plant, both with respect to the chemicals released as well as to the sound produced by the machinery

For the Electric Power Station Lomellina Olevano, southwest of Milan, Boldrocchi devised a technical plan to reduce air pollutants and noise emissions to extremely low levels (less than 1 mg/Nm3 of particulate matter) – among the lowest emissions in biomass power plants in Italy.

The Case

Since its inception in 1909, Boldrocchi has continued to seek better solutions for its customers. In 1914, before most countries had even introduced environmental emission legislation, Boldrocchi started to sell air filtration equipment to reduce fumes in and around plants.

The installation at Olevano di Lomellina is amongst the most impressive results of Boldrocchi as the FGT system measured the following abatement results:

- SO_2 emissions were lowered to 0.00 mg/Nm^3
- HCl emissions were reduced to 0.02 mg/Nm^3
- NO_x emissions were decreased to 46.04 mg/Nm^3, well under the legal limit of 70.00 mg/Nm^3.
- Dust particulates were lowered to 0.16 mg/Nm^3, including fine particulate matter ($PM_{2.5}$)
- Noise down from 67 dB (A) to 54.1 dB (A), well under the stated objective of under 60 dB (A).

The Olevano Power Plant is designed to deliver 140 GWhe per year of renewable energy, sufficient to meet the needs of about 50,000 families, and consumes approximately 200,000 tons/year of wood chips (coming from Short Rotation Foresty).

The plant has the following characteristics:

- Nominal Heat Output: 64 MWt
- Gross Power: 20 MWe
- Net Power: 18 MWe
- Grate furnace
- Superheated steam Rankine Cycle
- Steam conditions at the inlet of the turbine 525 °C, 92 bar(a)
- Air-cooled condenser

Like any other biomass plant, the combustion generates particulate, nitrogen oxides, volatile organic compounds and a consequential increase of noise pollution.

Boldrocchi was commissioned by the Customer to achieve two groups of objectives:

- Residual emissions of polluting compounds: NOx <70 mg/Nm3, SOx < 10 mg/Nm3, HCl < 5 mg/Nm3, Dust: < 5 mg/Nm3 (dry values, referred to 11% of O2);
- Average equivalent level of A-weighted sound pressure: at the fence, equal to: ≤ 60 dB(A) – Daytime/ Nighttime; at 1 m from the outlet of the fumes extraction chimney (spherical measurement), equal to: ≤ 67 dB(A) – Daytime/Nighttime

Boldrocchi's highly trained engineering teams devised a

technical plan to reduce air pollutants and noise emissions to extremely low levels – this is now the lowest emitting biomass power plant in Italy.

Boldrocchi was commissioned by the Customer to achieve extremely low levels of air pollutants and noise - this is now the biomass power plant in Italy with the lowest emissions

Boldrocchi APC solutions have been tailored for plants firing

- Waste or virgin wood chips
- Biomass pellets (and other dry biomass)
- Straw
- Bagasse
- Green waste

Reducing air pollution

Boldrocchi experts in FGT designed and manufactured a tailored-made multi-pollutant removal solution for the plant's operation, in compliance with air pollutant reduction targets but keeping a close watch on the budget.

To attain those results, the flue gas line was engineered as following:

- Cyclones to act as particulate pre-separators;
- A Dry Reactor that nearly eliminates acid gases using bicarbonate of micronized sodium injections;
- A pulse-jet fabric filter (baghouse) that completes the acid abatement reaction;
- A DeNOx SCR (Selective Catalytic Reduction) system for dropping NOX using aqueous urea.

The choice to install a dry reactor for SOx/HCl removal was included considering the need for a compact and flexible design approach that would include a fraction of the capital, operational and maintenance costs vs. the installation of a wet system. Furthermore, the resulting by-product could have been used as filler or landfilled – without additional costs for treatment.

A similar CAPEX/OPEX analysis resulted into the decision of a DE NOx SCR system.

A complete De NOx system was supplied using urea as a reagent (which is transformed into ammonia once evaporated). The system includes the urea preparation, gasification, injection, and a dedicated NOx analyzer for process control at the catalyst reactor.

When a tail-end solution is chosen, particular attention must be paid to the operating temperature to avoid catalyst poisoning and/or obstruction, due to ammonium sulfate formation on the catalyst surface, that would reduce its performance. For this reason, the specialized Boldrocchi team decided to install a main gas burner for flue gas temperature control and catalyst thermal regeneration.

Finally, also the De NOx reactor sizing was conceived to grant a maximum operational flexibility: the casing holds 2 active layers and a spare layer in order to allow greater flexibility on operational parameters and minimize the downtime if maintenance is required.

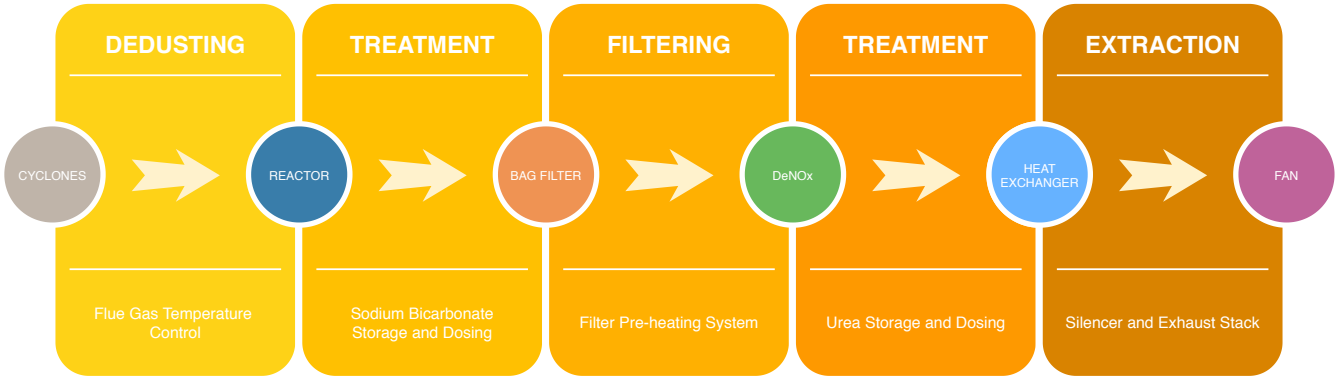
Boldrocchi achieved these objectives with specific choices and technological details based on experience acquired in the sector.

In particular, regarding chemical compound emissions, during the Performance Tests we registered extremely low emissions and – in some cases – (almost) zero emissions (**Table 1**).

Reducing noise pollution

Boldrocchi was also contracted to reduce noise. The specific objective was to reduce the sound pressure to scale A and to under 60 dB (A) from the perimeter fence 7 meters from a pipe linked to the smoke line where the original noise level was 67 dB (A).

Boldrocchi's noise specialists did a precise and



NO	NO2	NOx	NH3	HCL	HF	SO_2	Dust	
mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	UM
29,44	**0,99**	**46,04**	**0,56**	**0,02**	**0,00**	**0,00**	**0,16**	Average
		70,00	**5,00**	**5,00**	**2,00**	**10,00**	**5,00**	Limit

Table 1: Emissions at stack (11% O2 dry) measured during Performance Test.

detailed analysis of the noise sources, mapping the sound pressure level at the perimeter of the plant (using 40 measuring points and found over 50 sound sources).

During the first analysis, the engineers identified (on project drawings) over 50 sound sources inside the plant and 40 measuring points along the perimeter, positioned at intervals of ~ 5 m, and at a height of 1.5 m from the ground. The first "blocks" of sound sources were selected:

- cyclones for the abatement of large particulate
- bag filter for the abatement of fine particulate
- ash unloading and loading zone Redler
- reactor for the abatement of acidic gases.

For each of these, we carried out a more detailed analysis, on the basis of our experience, the octave and A-weighted sound pressure levels of the known sound sources inside these "blocks".

One example for all is the bag filter, which was analysed and initially divided into "zones":

- high zone filter – pulse jet
- central zone filter – filter box
- low zone filter – hopper

to identify (always on the project drawings) the contribution from lesser sound sources, such as the rotary valves positioned under the cyclones.

This first essential analysis allowed us to start theorizing the emission limit values measured near receptors. We also identified which soundproofing works needed to be performed, assessing the technical and economic options, before actually assembling the plant and verifying its environmental impact.

Targeted soundproofing, ranging from acoustic insulation to absorption silencers and soundproofed booths, ensured that test values in the 40 measuring points identified during the design phase complied with the theoretical assumptions, following installation of the entire plant.

The team also extended acoustic insulation to all Redler transport systems, exhaust ducts from the De NOX extractor fan and other small sound sources to achieve the final objective at the fence.

The final values are reported in **Figure 1**.

Please note that residual values above the guarantee

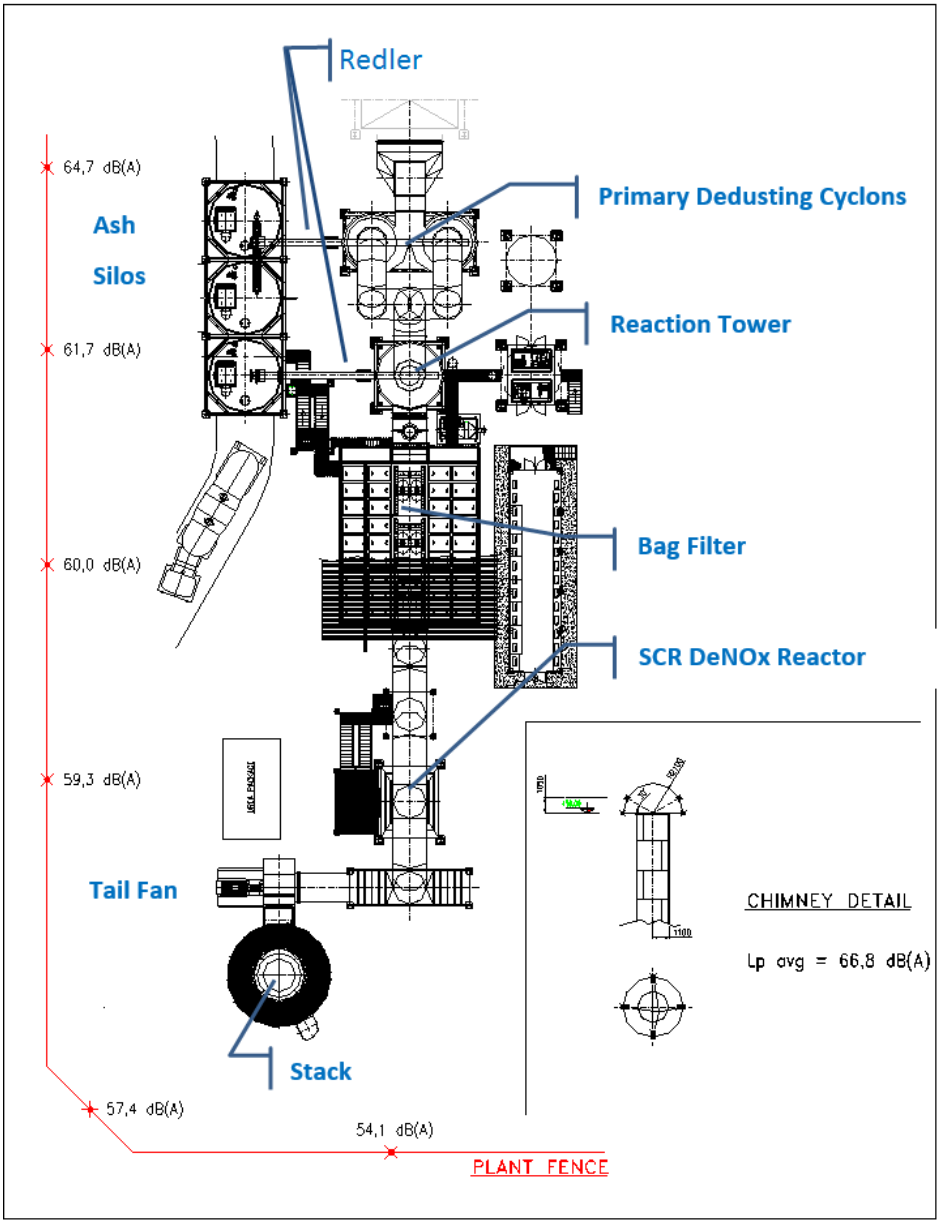


Figure 1: Sound pressure emission points

value are influenced by sources outside the fume treatment line.

6 years later

The plant has been operating since 2012, and has been subjected to regular maintenance to keep performance levels under legal limits. However, performance has been well above expectations. Residual emissions did not only remain consistently below legal limits, they were also extremely low, similar to or even lower than those found during the performance test.

After six years of operations, the Lomellina Olevano power plant has always operated within the stringent legal limits for emissions. It also demonstrated excellent performance in terms of reliability, since it has required only downtime for ordinary maintenance, guaranteeing an average of 8,350 operation hours per year.

Table 2 illustrates the residual emissions at the chimney after an operating period of about 6 years. In addition to the excellent results in reducing Nitrogen oxides, we also want to highlight the residual emission of dust at only 70 micrograms per cubic metre, which is 70-fold less than the authorised limit value, and almost 150-fold less than the limit established by EU standards!

The plant has also demonstrated excellent performance in terms of reliability, since it has required only downtime for ordinary maintenance, guaranteeing a mean of 8,350 operation hours per year.

Conclusions

Boldrocchi provided complete air pollution control and noise protection solutions for this biomass plant. Analyses shows complete success: air pollutants have

Pollutant in combustion flue gas [mg/Nm^3]	Emission limits According to EU Norms	Emission limits According to Local Authorization (daily average)	Emissions after 6 years operation [mg/Nm^3]
Dust	10	5	**0,07**
CO	50	50	**14**
TOC	10	10	**0,4**
NOx as NO_2	200	70	**42,3**
NH_3	10	5	**1,2**
SOx as SO_2	50	10	**0**
HCl	10	5	**0,2**
HF	1	1	**0**
Sound pressure at plant fence			
Sp dB (A).		60	**54,1**

Table 2: Emissions measured after 6 years of operation

been removed to well under area limits and noise is nearly completely eradicated.
A particulate matter concentration at the stack less than 1 mg/Nm3 set the plant among the low emissions power plants in Italy (and possibly the world). Once the entire plant was completed, the sound at the fence was reduced to 54.1 dB (A) from the original 67 dB (A), well under the Customer's stated objectives.

Giuliamaria Meriggi

Giuliamaria Meriggi is the Managing Director at Boldrocchi North America and Executive Director of International Operations at Boldrocchi. She splits her time between Atlanta and Milan. She began working in air pollution control shortly after finishing her bachelor's degree in engineering in 2001 and has since amassed expertise in a wide array of industrial processes with particular dedication to engineering activities and innovative solutions in the air quality field. Over the past 20 years, she has held various engineering, commercial and operational roles.

Matteo Giavazzi

Matteo Giavazzi is responsible for technology development and projects coordination in Air Pollution Control Division of Boldrocchi Group. He started his career in automotive industry with FCA environmental research team; afterwards he focused professional activity in manufacturing industry. Over the last 20 years, he has held varying roles in environmental process engineering for industrial plants. He is a specialist in air quality, pollution prevention and environmental problems analysis, with particular reference to air pollution from industrial sources. Giavazzi has a Master's degree in Environmental Engineering from the University of Pavia, Italy; he collaborate with Chemical Engineering Department of Naples University "Federico II".

Luca Monzardo

Luca Monzardo graduated in structural aeronautical engineering in 1995 at the Politecnico of Milan, is now senior project engineer in Boldrocchi Group; his activity is oriented to the development of projects related to GT ancillaries (air intake and exhaust systems), as well as to the research and development for Gas Turbine Systems & Noise Protection division. He is experienced in computational analysis (Acoustics, Fluid-dynamics, Structural) and has contributed to the issue of several courses for the diffusion of basic acoustics inside the company.