Industry: Gypsum Manufacturing
Author: Tim Bruewer - Marketing Manager, Sustainable Process Technologies at Watlow

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Electrifying Gypsum Production:

Engineering a Smarter, Cleaner Future

Summary:

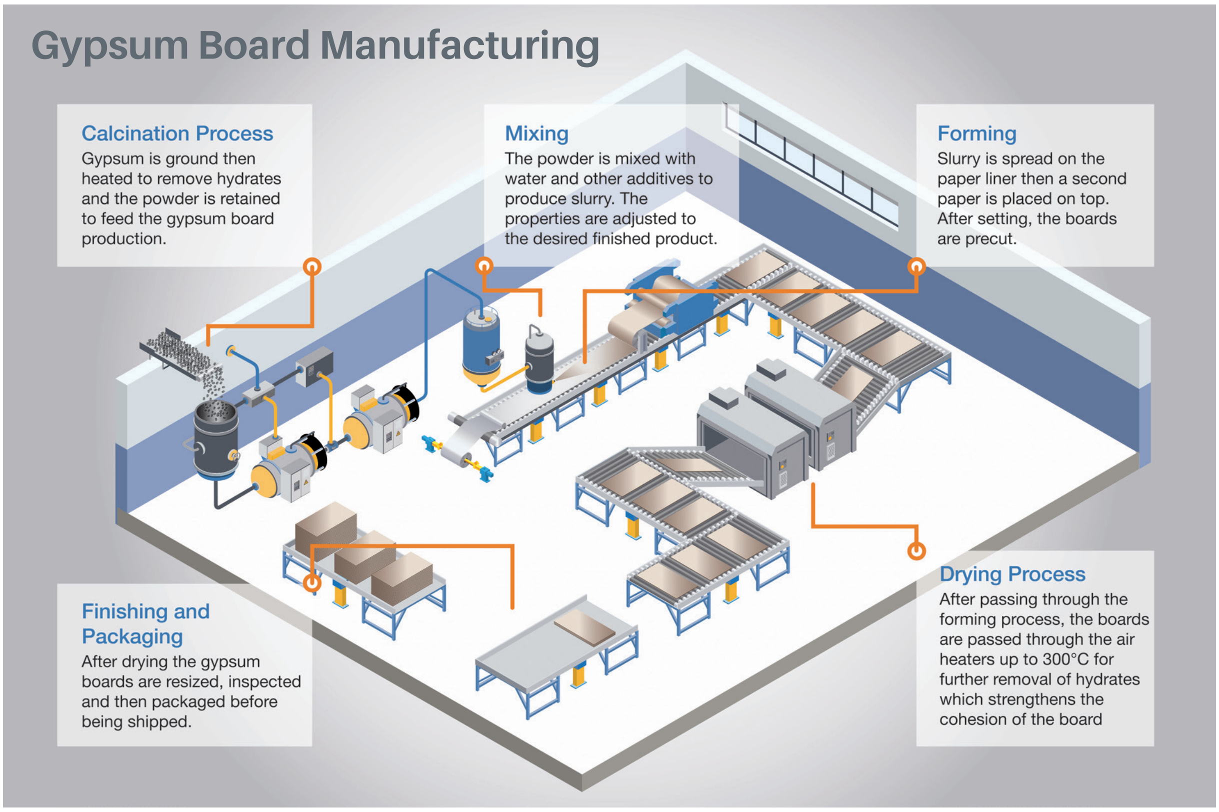
As industrial manufacturers across the globe confront the challenge of decarbonization, gypsum production has emerged as a compelling opportunity for electrification. With rising pressure to reduce emissions and improve energy efficiency, the industry is re-evaluating its long-standing reliance on gas-fired thermal systems.

While the move to electric heat is not a new idea, it is now becoming more viable due to advancements in power control, system integration, and scalable design. The most energy-intensive and emissions-heavy stages in wallboard manufacturing, drying and calcining, are particularly well suited to electrification. These processes are relatively uniform and continuous, making them strong candidates for the adoption of electric thermal systems that offer greater precision, efficiency, and long-term reliability.

The Manufacturing Process and Emissions

In typical gypsum production, raw gypsum is calcined to remove water, then mixed, shaped, and dried through a series of large drying zones that span the length of the plant. These systems can require between 15 and 40 megawatts of thermal energy, depending on facility size. Delivering that level of heat electrically demands more than installing electrified heating systems, it requires a comprehensive engineering approach that encompasses airflow management, temperature uniformity, thermal inertia, and electrical infrastructure.

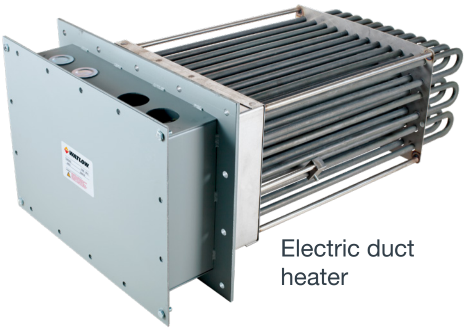
The energy intensity of this process directly correlates with emissions. A medium-sized gypsum plant producing 500,000 metric tons per year, a typical capacity in North America and Europe, can emit between 75,000 and 125,000 metric tons of CO_2 annually if fired by natural gas. Coal-fired operations can exceed 200,000 metric tons. Per ton of gypsum board, natural gas systems generate between 150 and 250 kg of CO_2, while coal-fired systems emit 250 to 400 kg. Plants utilizing grid electricity powered by non-renewables, typically add another 50 to 100 kg per ton in level 2 emissions. However, when these same plants are driven by renewable energy grids, they can achieve net-zero emissions (or zero additional emissions. These figures underscore the significance of thermal decarbonization in the gypsum industry's sustainability strategy.



Advanced Electrification Solutions

Duct heating systems have proven to be a practical and efficient solution. These systems can be scaled to match the plant's thermal requirements and integrated into existing infrastructure with minimal disruption. Their robust design also makes them easier to maintain, particularly in gypsum environments where airborne dust is a persistent operational concern. Systems designed with field-replaceable heater elements and rugged housings can significantly reduce maintenance downtime and improve long-term uptime.

An equally critical element is power control. Electrified thermal systems can incorporate closed-loop control strategies, often using silicon-controlled rectifiers (SCRs), to deliver proportional power based on real-time process conditions. This improves thermal performance and reduces electrical stress, particularly during startup or peak load. Just as importantly, integrated sensors, data logging, and control algorithms transform the heating system into a source of process intelligence. For example, a drop in resistance may indicate a change in upstream air pressure rather than a heater failure. These insights support predictive maintenance and strengthen overall reliability.



Electric duct heater

Operational and Environmental Benefits

Reliability is especially important in gypsum production, where 24/7 operation is the norm. Unlike gas systems, which require regular cleaning and inspection, with proper power control, electric heaters typically have fewer failure modes.

Soft start functionality and thoughtful material selection are vital design considerations that directly impact system longevity and performance. Soft start profiles reduce thermal shock and mechanical stress during power-up, minimizing the likelihood of localized overheating that can contribute to fouling or coking in the heat exchanger. This is especially important in gypsum environments where airborne particulates can accumulate on hot surfaces, potentially leading to carbonized deposits and reduced heat transfer efficiency. Pairing this with materials that are inherently resistant to scaling and corrosion, such as high-grade stainless steel or specialty alloys, can further mitigate the risk of buildup. Together, these design choices help maintain consistent thermal performance, reduce unplanned maintenance intervals, and extend equipment life, all of which are essential for plants operating in continuous production cycles.

Dependability and Efficiency Offset Initial Investment

Though capital expenditures for electric systems are generally higher, particularly in retrofit applications, operational savings often offset those costs. Gas-fired systems typically operate at 30 to 50 percent efficiency, with substantial losses through flue gas and radiant heat. Electric systems, by contrast, routinely achieve efficiencies in the 75 to 99 percent range. Reduced maintenance requirements and lower personnel demands also contribute to a lower total cost of ownership over time.

Energy consumption figures reflect this operational difference. Natural gas-fired gypsum plants consume approximately 5,275 - 10,550 MJ per ton of board, while electricity consumption for electrified systems ranges from 100 to 200 kWh per ton. Water usage, another resource consideration, generally falls between 100 and 300 liters per ton[1].

Some gypsum manufacturers are exploring hybrid systems, where electric heat supplements gas during off-peak hours or serves as a backup. These systems may serve as interim steps in broader electrification plans. However, most plants that pursue electric retrofits tend to commit to fully integrated systems once feasibility is confirmed.

[1] U.S. Environmental Protection Agency (EPA) - AP-42, Chapter 11.16: Gypsum Manufacturing

The decision to electrify is rarely driven by technical feasibility alone. Local policy, energy pricing, and carbon regulation are all influential. In jurisdictions with strong carbon pricing or access to low-cost renewable energy, such as regions where hydropower is available, the economics of electrification are favorable. Elsewhere, subsidies, carbon credits, or environmental mandates may tip the balance. Manufacturers must weigh these incentives alongside their internal ESG strategies and operational goals.

Integrated Systems are Key to Electrification

Gypsum production is not a niche industry. There are more than 470 plants worldwide, and while only a small number have fully electrified, or planned to be, the trend is shifting. Between now and 2028, gradual adoption is expected. Once validated at scale, standardized system designs will enable faster replication across multiple plants, particularly for manufacturers operating similar layouts.

To support this rollout, thermal systems are increasingly being designed for standardization. By creating heater platforms with repeatable configurations, it becomes possible to apply the same solution across ten or more facilities with only minor adaptation for voltage, airflow, or power capacity. In gypsum production, drying temperatures are fairly consistent, typically ranging between 150°C and 300°C, although higher temperatures may be required, which further supports the use of replicable designs.

Watlow has contributed to this transition by developing integrated thermal systems that combine unique heater design with SCR-based control and real-time sensing. These systems are engineered for ease of retrofit, low maintenance in dusty environments, and compatibility with plant control networks. This level of integration supports performance guarantees, simplifies commissioning, and reduces the complexity of coordinating across multiple vendors.

Conclusion: The Future of Electrification in Gypsum Production

Ultimately, electrifying gypsum production is not just about reducing emissions; it is about improving system intelligence, reliability, and efficiency. The move to electric heat introduces a new standard of process visibility and operational control that was difficult to achieve with legacy gas systems.

This marks more than a technical upgrade; it is a systems-level evolution. Success depends on careful engineering, collaboration between disciplines, and a willingness to rethink what thermal performance means in a decarbonizing world. The gypsum industry is ready, and the technology is here. The challenge now is to align strategy, economics, and execution to build smarter, cleaner plants for the future.