Engineering | Pharma / biopharma | Sustainability | Cost Benefit Analysis

Evaluating The Feasibility of Electrified Process Heating for Drug Substance Manufacturing

BUSINESS PROBLEM

As Amgen strives for carbon neutrality by 2027, it faces the challenge of reducing Scope 1 emissions, which have risen by 12.5% since 2019 - despite progress in cutting Scope 2 emissions through renewable electricity. The primary source of Scope 1 emissions is the on-site combustion of fossil fuels to generate plant steam, used in high-temperature pharmaceutical manufacturing processes such as Water-for-Injection (WFI) generation, clean steam production, and equipment sterilization. The core business problem lies in decarbonizing these process-driven heat loads, which are currently dependent on fossil fuel-based plant steam systems.

APPROACH

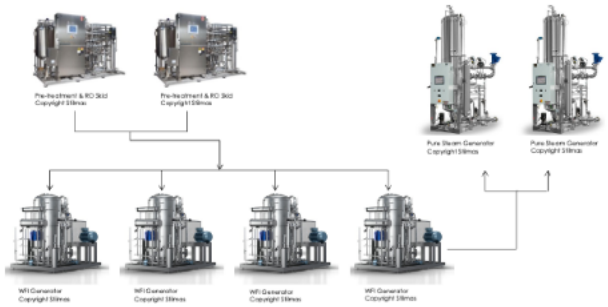
I conducted an analysis of Amgen's conventional plant steam system at a representative drug substance manufacturing site and explored electrification as a solution to eliminate usage of fossil fuels. Working with suppliers and stakeholders, I designed a fully electric system to meet the same high-temperature demands. A comparative analysis assessed cost, environmental impact, and feasibility.

DATA SOURCES

The project used data from construction management platforms - Procore (equipment submittals, P&IDs) and Autodesk BIM360 (3D site building models). Insights into existing infrastructure came from site visits and engagements with site engineering and sustainability teams. Supplier websites, vendor calls, equipment quotes, and invoices provided data to evaluate electric equipment options.

Data Types and Format

Primarily technical drawings, equipment specifications, and vendor documentation; supplemented by qualitative insights from engagements with key stakeholders at Amgen and with external suppliers.



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IMPACT

The proposed fully electric system has the potential to significantly advance Amgen's progress toward achieving carbon neutrality by 2027 by offering a viable alternative to fossil fuel-based process heating. The analysis indicates that capital investment requirements for the electric system are comparable to those of the conventional plant steam system, suggesting that upfront cost should not be a barrier to implementation. Additional construction savings are realized through the elimination of steam, condensate, and natural gas piping, as well as the boiler room. However, these may be offset by the need to upsize electrical infrastructure to meet increased power demand. The significantly higher cost of electricity relative to natural gas additionally emerges as a financial constraint. From a sustainability perspective, the electric system eliminates Scope 1 emissions associated with on-site combustion. While these are shifted to Scope 2 due to continued reliance on grid electricity, long-term environmental benefits will improve as the grid decarbonizes. Electrification also enhances operational flexibility by allowing decentralized equipment placement, modular facility design, and easier scalability. Overall, the findings support electrification as a viable strategy for reducing Scope 1 emissions and offer a scalable model that could be implemented across Amgen's global manufacturing network.

DRIVERS	The primary driver was Amgen's corporate commitment to achieving carbon neutrality by 2027, with a focus on reducing Scope 1 emissions. The industry also faces growing pressure to decarbonize pharmaceutical manufacturing in response to evolving ESG expectations, regulatory trends, and investor priorities. Electrifying fossil fuel-based steam systems in manufacturing aligns with industry-wide decarbonization efforts.
BARRIERS	The most significant barrier to this project was addressing gaps in data. Cost data for certain existing equipment was unavailable due to contractual arrangements that did not include detailed cost breakdowns. Additionally, information on the natural gas rate and the local energy grid profile could not be provided by the corresponding suppliers.
ENABLERS	Several features of the company enabled the success of this project. I had a supportive and knowledgeable supervisor who was able to provide invaluable technical mentorship throughout my internship. Cross-functional collaboration is ingrained within the company culture and enabled access to key data and operational insights. The company's strong commitment to carbon neutrality also provided clear strategic alignment for the project's goals.
ACTIONS	To advance implementation, I presented my findings and recommendations to the Amgen team. I also ensured that my supervisor was connected with the vetted suppliers to support future electric equipment procurement and installation. My thesis will also serve as a pitch for the adoption of the fully electric system to leadership.
INNOVATION	The electrification of high-temperature heat demands represents a significant departure from established pharmaceutical industry practices regarding clean utility generation. It challenges the pharmaceutical industry's longstanding reliance on fossil fuels and offers a pathway towards carbon-neutral operations.
IMPROVEMENT	The solution identified electrification pathways that could eliminate up to 100% of Scope 1 emissions associated with clean utility generation at drug substance manufacturing sites.
BEST PRACTICES	Best practices for replicating this solution include conducting detailed site assessments to thoroughly evaluate existing process heating systems and enable effective collaboration with suppliers to design appropriate electrification-based solutions. Additionally, engaging key stakeholders such as engineering, utilities, and sustainability teams early is essential to ensure alignment between technical requirements and organizational objectives.
OTHER APPLICATIONS	This solution can be extended beyond pharmaceuticals to effectively decarbonize process heating across various industries, including the food and beverage sector, which similarly relies on fossil fuel-based steam boilers in its operations.