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VIA ELECTRONIC MAIL

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Re: Comments on Working Group Meeting #3 for Proposed Amended Rules 1146 and 1146.1 Presented February 13, 2026

Dear James McCreary, Charlene Nguyen, Michael Morris, Michael Krause, and Heather Farr:

On behalf of the undersigned organizations, we submit the following comments on Working Group #3 for the Proposed Amended Rules 1146 and 1146.1 ("Rules"). The SoCal Clean Manufacturing Coalition (SCCMC) and our partners appreciate your work to date on the technology and cost assessments and specifically look forward to reviewing your segmentation analysis to better understand the different needs and costs by facility types. It is important to consider the vast differences across the facilities under the Rules' jurisdiction as we move forward with the rulemaking process. We are committed to continuing to work with you on these Rules in order to help ensure that the South Coast

Air Quality Management District (SCAQMD) meets its commitments under the 2022 Air Quality Management Plan.

The following comments outline key areas where the technology and cost assessments can be strengthened to ensure this rulemaking delivers progress toward our region's air quality goals.

I. The Rules Must Align with the Region's Air Quality Commitments

More than ever, SCAQMD must adopt zero-emission rules to meet health-based air quality standards. Recent federal attacks on programs and state authority will have significant consequences on California's ability to achieve its air quality, climate, and equity goals. According to the California Air Resources Board (CARB), the federal actions to limit and roll back regulations will result in an increase of 175 tons per day of nitrogen oxides (NOx) across the state in 2037.[1] Over the lifetime of the impacted regulations, the federal actions will be responsible for more than 14,500 additional cardiopulmonary deaths, 5,000 additional hospitalizations for cardiovascular and respiratory illness, and 6,700 additional emergency room visits.[2] Furthermore, increased diesel particulate emissions will cause millions of additional cases of cancer in environmental justice communities, including East Los Angeles and Boyle Heights.[3] Beyond their direct adverse effects on human health, the federal actions undermine the state's capacity to meet required commitments in the State Implementation Plan (SIP). Failure to meet the National Ambient Air Quality Standards (NAAQS) can result in severe sanctions and consequences, including the implementation of contingency measures, revisions to the SIP, increased offset ratios for permitting, and the loss of billions of dollars in federal highway funding.[4,5]

During February's Board Meeting, SCAQMD staff raised the substantial SIP obligations and significant emission reductions needed to meet the NAAQS.[6] Additionally, as SCAQMD explained in 2022, the only way for California's most polluted air basin to achieve the required emission reductions is "through extensive use of zero-emission technologies across all stationary and mobile sources."[7] Given the federal actions affecting mobile-source regulations and the region's persistent air quality crisis, staff must set ambitious targets for all stationary sources, including the boilers, steam generators, and process heaters covered by the Rules. We cannot afford otherwise. We need rules that prioritize zero-emission pathways to send the necessary and timely signals to manufacturers, installers, and impacted facilities. The Rules should limit further investment in low-NOx emission technologies that lock the region into continued fossil fuel combustion for decades to come. For example, because Ultra-Low NOx Burners (ULNB) still use fossil fuels, cumulative emissions over the equipment's lifespan remain higher than those of zero-emission technologies. To address the region's cumulative emissions, zero-emission technologies are essential. We urge staff to factor in the region's ongoing air quality concerns and the recent federal attacks as we proceed with the rulemaking.

For decades, communities across the region have advocated for stronger regulations and practical solutions to achieve cleaner air, improved public health, and lower health-related costs. Their advocacy and persistent leadership have been instrumental in passing life-saving rules at the Air District. Yet last year, SCAQMD missed several critical opportunities to reduce deadly NOx emissions; 2026 offers the opportunity to realign with the region's air quality goals and deliver long-overdue relief to communities that have been disproportionately burdened by pollution. The region cannot afford to continue investing in equipment that emits deadly pollution. We support staff's proposals to create pathways that facilitate the deployment of zero-emissions equipment, including incentives for early adopters.

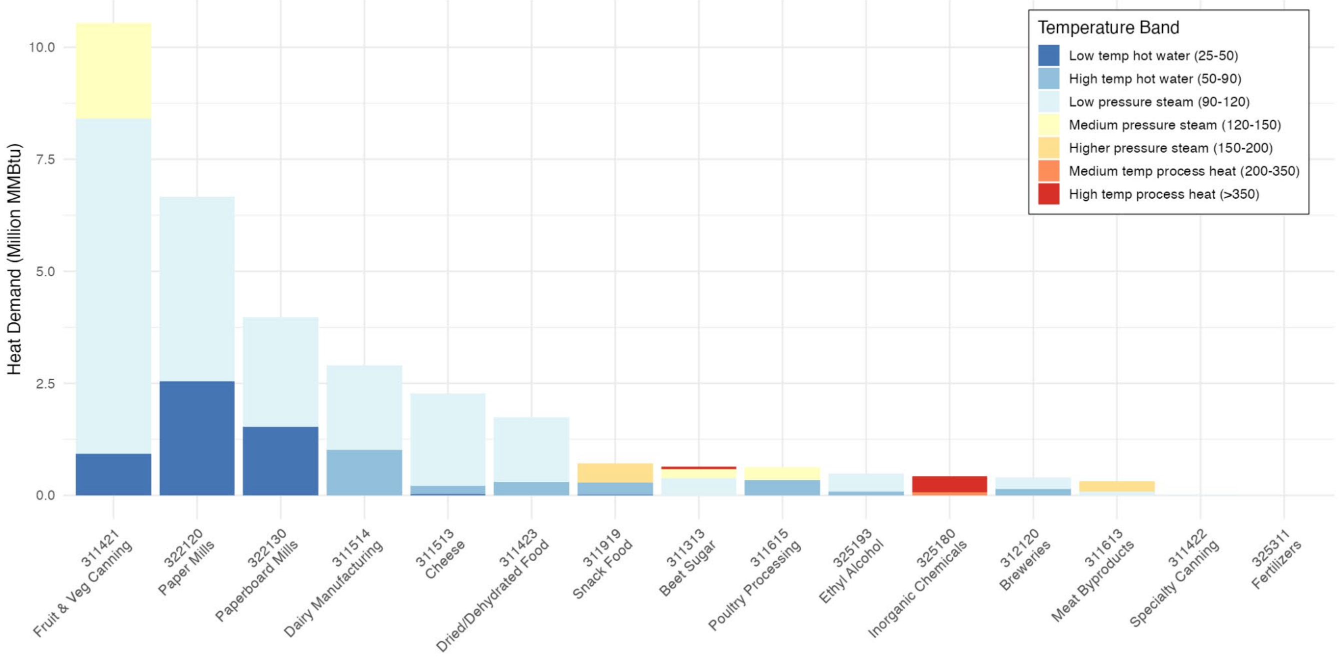
II. Segmentation: Manufacturing Sites

SCAQMD’s February 2026 analysis uses a uniform cost analysis for electrified technologies, with a single set of assumptions across all use cases. Staff indicated they are conducting a segmentation analysis that will consider cost differences across different applications which we support. A segmentation analysis could highlight specific cases where a zero-NOx technology standard drives cost-effective emissions reduction.

In industrial manufacturing, the coefficient of performance (COP) of a high-temperature heat pump can vary by the **temperature of the heat source** (input temperature) and **the temperature of the heat sink** (output temperature). The difference between the temperature of the heat source and the heat sink for a heat pump is known as the “lift.” The lower the lift, the more efficiently a heat pump can operate.

Much of the manufacturing in California involves heat at lower temperatures, which can be produced by a heat pump at a very high efficiency. Certain sectors have processes that require higher temperature steam, which results in a higher lift and lower efficiencies. However, many sectors only require hot water, as shown in Figure 1. For low temperature hot water processes, a COP of 3 likely constitutes the lower end of air-source heat pump efficiency, with COPs of 4 to 5 possible.[8]

Figure 1: *Heat demand by process temperature across California subsectors*[9]



In addition to differences in the required heat sink temperature, **some manufacturing sites have higher-temperature heat sources available for valorization**. Importantly, air-source heat pumps can draw on energy from both ambient air and waste heat from industrial processes. Industrial sectors vary in the waste heat temperatures available from other parts of the process and in the form that waste heat can take (Table 1). Higher-temperature waste heat results in lower lift and higher efficiencies for industrial heat pumps (Table 2).

Table 1: *Example waste heat sources across sectors.*[10]

Process	**Waste Heat Source**	**Waste Heat Temperature**	**Subsectors**	**Description**	**Heat Pump Technology**
Drying	Dryer vapors	60-90°C	Dried foods, dairy, pulp and paper, chemicals, beverages	Hot gases from dryer units contain the latent heat of the extracted moisture	MVC & MVR
Pasteurization, wort boiling, mash cooler	Hot water from product cooling	45-70°C	Dairy, beverages, chemicals	After thermal treatments, some products need to be cooled down for further processing; cooling fluid contains heat	MVC
Multiple effect evaporators, distillation columns	Low pressure evaporator or distillation vapors	70-100°C	Pulp and paper, condensed foods, chemicals, beverages	Vapor at the outlet of evaporators and distillation columns contains heat from extracted moisture	MVC & MVR

Table 2: *Heat pump COPs with different waste heat temperatures.*[11]

Process	**Waste Heat Source**	**Waste Heat Temperature**	**Sink Temperature**	**Waste Heat COP**
Dryers	Product cooling water	70	120	3.32
Distillation	Drying vapors	65	115	3.28
Pasteurization	Product cooling water	70	85	7.26

The processes in Tables 1 & 2 vary meaningfully in both the temperature of available waste heat and the sink temperature required, which has significant implications for heat pump efficiency. Pasteurization stands out as the most favorable case: with waste heat available at 70°C and a relatively modest sink temperature of 85°C, the waste heat COP reaches 7.26. This suggests that sites with access to product cooling water could see dramatically lower operating costs when waste heat is valorized. Dryers and distillation columns, by contrast, require much higher sink temperatures (120°C and 115°C respectively), which constrains efficiency even when waste heat is available. In a segmentation analysis, we might therefore expect sectors dominated by drying and distillation (such as pulp and paper, chemicals, and certain food processing subsectors) to show higher per-unit electrification costs. Meanwhile, dairy and beverage operations centered on pasteurization could appear as relatively lower-cost segments, particularly where waste heat recovery infrastructure is already in place.

To capture this variation, SCAQMD should consider an analysis that is segmented by industrial sector or even more precisely, by specific processes within sectors. This would allow different equipment standards to apply to units supplying heat to specific parts of the process, targeting the most economical pollution-reduction opportunities first.

Lastly, geographical sites vary in the ambient temperatures available as heat sources for an air-source heat pump. Hotter weather allows a heat pump to operate more efficiently. Even within the SCAQMD, weather variations will make some sites more economical to electrify than others.

In sum, we urge the SCAQMD to consider segmenting the analysis by the expected efficiency at which electric heat technology will operate. This could be done through a site-specific efficiency estimate that holistically considers all the outlined factors that can affect a heat pump's efficiency.

III. Segmentation: Commercial Buildings, Hospitals, and Schools

The Rules encompass users of industrial-sized process heating equipment, including those that do not undertake traditional industrial process heating but instead use it for space and water heating. As such, they may have specific considerations that could influence the cost-effectiveness analysis, further supporting the need for segmentation by temperature band and end-use to better understand decarbonization potential. These are users like commercial buildings and institutional uses like healthcare facilities and educational campuses. We support exploring all of these in the segmentation analysis, but our comments below focus specifically on healthcare facilities.

Hospital heating needs differ from those of most other industrial applications. For example, healthcare facilities have 24/7 heating loads and maintain thermal systems tied directly to patient care, such as domestic hot water, steam, sterilization, and infection control. Operational hours exceed those of other industrial uses, resulting in high fuel costs and thus a high potential for emissions reductions. Where modeling applies average usage patterns to healthcare facilities, it likely understates both total potential emissions reductions and the higher-efficiency potential of zero-emission technologies in these settings. Healthcare capital planning also follows a distinct logic that the cost-effectiveness analysis should capture. For example, a case study from the American Society for Healthcare Engineering demonstrates that decarbonization of a hospital heating plant can break even on a lifecycle basis when replacement timing and avoided capital costs are properly accounted for, rather than being evaluated solely as a fuel-switching premium.[12]

The segmentation analysis should also account for the range of temperature needs within a single hospital. Most facilities require: low-temperature applications such as domestic hot water and reheating; medium-temperature hydronic systems; and, in some facilities, higher-temperature steam. A significant share of hospital thermal load falls in the low- to medium-temperature range, where heat pumps perform more efficiently. Modeling that treats all hospital demand as high-temperature steam equivalent likely overstates cost and understates feasibility. Segmenting by temperature band and end-use within a hospital would better reflect how decarbonization actually occurs in healthcare settings, which is typically phased and differentiated by load type.

Infrastructure in healthcare settings is also highly site-specific. Electrical capacity, transformer and substation needs, space constraints, and redundancy requirements all shape the direction and cost of decarbonization. However, these are constraints, not impediments; real-world examples demonstrate that these challenges are being navigated successfully. For example, UCI Health's all-electric hospital in Irvine was developed in close coordination with its utility to address load and reliability needs, illustrating that infrastructure costs are not one-size-fits-all. To best reflect this diversity, staff should represent its cost analysis as a range of scenarios rather than a single average assumption.

A segmented cost-effectiveness analysis that distinguishes healthcare facilities, other non-manufacturing industrial facilities, and different types of manufacturing facilities from one another, and accounts for sector-specific operating hours, temperature band, and end-use, and replacement timing and avoided capital costs would produce a more accurate picture of where zero-emissions technologies are already cost-effective and better inform rulemaking.

IV. Capital Costs: Understated ULNB/SCR Costs and Overstated ZE Technology Costs

SCAQMD staff have undertaken significant research in quantifying the capital costs (CAPEX) as part of the total cost for the cost-effectiveness analysis, but we urge staff to review some of those cost assumptions for ultra-low NOx burners (ULNB), selective catalytic reduction (SCR), and ZE technologies. Notably, cost assumptions for ULNB and SCR may be understated, and ZE tech may have more opportunity for cost-effectiveness than represented in the analysis.

The cost assumptions for ULNB installation may be understated, as the analysis only includes the switch premium of installing a new part of existing equipment. For example, during Working Group #3, boiler owners mentioned that transitioning to ULNB would likely require facilities to undertake wholesale replacement of their equipment rather than just parts. This would increase the cost of ULNB, potentially significantly, if entire boilers need to be replaced. As such, the ULNB CAPEX cost assumptions should be updated to reflect this situation.

Similarly, participants in Working Group #3 raised that capital cost assumptions for SCR may be understated. Analysis could also consider a scenario that includes the costs of a new natural gas boiler alongside SCR, rather than assuming a retrofit of pre-existing equipment and simply factoring in the cost of SCR equipment. Furthermore, although electrical infrastructure costs are accounted for in the form of use-based transformers or substations, since SCR can require significant space for all its process parts (i.e., ductwork, ammonia storage, and piping), redesign of facility layouts may be necessary, thus increasing the cost potential of SCR.

CAPEX assumptions for zero-emission technologies may be significantly more favorable when analyzed through a displacement lens rather than a full replacement lens. Upcoming research from Turner Construction and UC Berkeley's Center for the Built Environment suggests that sizing a heat pump for 90% of energy use, rather than full capacity, can significantly reduce upfront costs, and many facilities that have oversized their existing systems may be able to meet the majority of their actual needs with lower overall zero-emissions capacity.[13] The favorable economics of replacing a chiller rather than a boiler to offset significant boiler use also present a further opportunity worth examining.[14] A cost-effectiveness analysis that accounts for these displacement strategies and the avoided capital costs from right-sizing would likely yield a more optimal assessment of the economics of zero-emissions technology adoption.

It is also important to factor in the potential economies of scale for facilities that would need to replace multiple units rather than single units. Currently, SCAQMD calculations seem to consider the same cost threshold per unit. However, if a facility needs to upgrade on-site infrastructure across multiple units, those whole-system costs would need to be factored in only once, rather than multiple times for each unit replaced. This would spread out the cost per unit along with the greater tons of NOx reduced, potentially illuminating new cost-effectiveness gains.

Additionally, capital costs should scale with capacity rather than annual energy use. Specifically, it appears that SCAQMD calculates the equipment and installation cost of zero-emissions technology by multiplying the capital cost by the power requirement, which is expressed as annual energy (MWh). It is not clear here if the use of annual energy is meant as a proxy for capacity, which would be expressed as MW. Expressing capital cost in $/MWh means that a facility running 8,000 hours per year would appear to face nearly twice the capital cost of an identical facility running 4,000 hours per year, even though both would require the same equipment. If the power requirement refers to annual energy, it is possible that equipment utilization is double-counted in capital and operating costs.

Furthermore, it is unclear whether the analysis accounts for the increased efficiency of heat pumps and electric boilers when scaling equipment costs to heat demand. If so, the assumptions here could be articulated explicitly. If not, the analysis should utilize a reduced capacity requirement for the electric components to account for the COP and superior efficiency of the electric technologies, compared to the heat input for the natural gas boiler savings.

Finally, there are state and regional programs that can help defray CAPEX for facility transition, which could have significant impacts on cost-effectiveness and should be taken into account in the analysis. The California Energy Commission (CEC) has two such programs: Industrial Decarbonization and Improvement of Grid Operations (INDIGO) and Food Production Investment Program (FPIP). INDIGO supports companies to adopt clean industrial decarbonization technologies and has funded projects such as industrial heat pumps at Hilmar Cheese and an industrial laundry in Patterson, California. FPIP supports the food industry in particular, a main user of the industrial heating equipment regulated by the Rules, in decarbonizing its operations, such as supporting Heirloom and Red Bay Coffee in electrifying their coffee roasting. LADWP's Business Offerings for Sustainable Solutions (BOSS) program can also support users with their overall CAPEX costs.

Reevaluating the potentially understated cost assumptions for ULNB and SCR and further exploring economies of scale, capacity costs, and incentive programs for ZE tech could shift the cost-effectiveness analysis for each of these technologies. Staff should incorporate these points into their research to paint the clearest picture of potential across the South Coast.

V. Operating Costs: Load Shifting and Thermal Batteries

The cost-effectiveness analysis could be refined by assessing operating costs in the context of facilities' ability to shift load to cheaper, off-peak hours when adopting electric technologies. Load flexibility enables facilities to take advantage of time-based energy charges offered by their utility. Capitalizing on dynamic price signals reduces the price differential between electric and gas rates. This, in turn, can reduce the operating cost of zero-emissions technologies.

Currently, Southern California Edison (SCE) offers certain rate designs that reward shifting electricity consumption to low-cost periods. SCE's standard industrial rate includes time-of-use elements. SCE also offers customers who consume more than 200 kW the option to access real-time generation rates. SCE also offers demand response programs for customers, such as the Capacity

Bidding Program and the Emergency Load Reduction Program, which offer incentives for demand response and support actions to improve demand flexibility.

Most significantly, SCE is currently seeking approval from the Public Utilities Commission for a proposed Large Power Customer Dynamic Rate that would more directly expose large industrial customers to day-ahead wholesale market prices and be available initially for large sub-transmission customers.[15] If approved later this year, this new rate would significantly reduce non-coincident demand charges, further improving the economics of load flexibility and the adoption of zero-emissions heating equipment. SCAQMD should consider the impact of SCE's current and future rate offerings on operating costs via a sensitivity analysis.

In California, 95% of gas consumed by industrial customers is procured through third-party marketers, not through the utility.[16] The gas purchased through these third-party contracts is typically "purchased on a wholesale basis including basic commodity and transmission costs."[17] Due to this direct indexing to spot markets, many of California's industrial gas customers are exposed to gas market volatility. California's energy mix is increasingly derived from renewable resources, which helps shield electric users from price volatility. For example, in 2024, 62% came from renewable sources.[18] While average gas prices are a key consideration for cost-effectiveness, ongoing and even increasing volatility in gas markets may warrant future sensitivity analysis that examines monthly energy and fuel costs to incorporate volatility's impacts.

An analysis by Industrious Labs, ACEEE, and Sierra Club finds that with reform of industrial electricity rates, load shifting can significantly improve the overall economics of electrified heat technologies.[19] Electricity costs can be reduced by 40-60% from standard electric rates today if facilities are incentivized via rate reforms to shift 100% of load from peak to off-peak hours.[20]

Another zero-emissions technology that is worth SCAQMD's consideration is thermal batteries. Thermal battery adoption with access to variable rates enables price hunting and can help customers realize lower operational costs while reducing system emissions. Today, thermal batteries capable of storing heat at 1000 degrees Celsius are commercially available.[21]As thermal batteries are continually deployed, they will gain economies of scale.

A Brattle report found that the operating costs for thermal energy storage systems as a 1:1 replacement for gas-based heating equipment can be cost-competitive in renewables-rich regions of the country such as California.[22] This cost competitiveness, however, hinges on the facilities' ability to access direct wholesale energy pricing or cost-reflective rate structures and assumes a $6/MMBtu delivered cost of natural gas. In California, where delivered gas prices can be higher than this, the cost-competitiveness of thermal energy storage systems depends on utility rate structures.

Additional analysis could consider technology arrangements designed to take advantage of time-of-use or wholesale market electricity prices. Industrial heat pump applications today, including the Skyven Arcturus model, use the heat pump during the day and gas as a backup during peak hours. Thus, SCAQMD analysis should include scenarios for 100% off-peak electricity use by zero-emission equipment.

Ultimately, based on each facility's load profile and access to dynamic pricing, the range of operating expenses for zero-emissions technologies varies. SCAQMD should consider various rate offerings and load-shifting scenarios in its cost-effectiveness calculations and incorporate the findings into its rulemaking.

VI. Conclusion

More than 17 million people will continue to breathe harmful air unless we accelerate the transition to a zero-emission future. As a result, SCAQMD has a meaningful opportunity to reduce emissions and improve health outcomes in communities that face some of the region's highest environmental and public health risks. Our advocacy is rooted in attainment of NAAQS and ensuring our communities breathe clean air. We are committed to continuing to work with staff on these important rules and look forward to reviewing staff's analyses of cost-effectiveness and facility segmentation.

Sincerely,

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