Contact: Brian Schmidt, Director, Policy Analytics, Regional Economist > (847) 972.9042 > bschmidt@cement.org

Cement Industry Impacts of Lowering the Annual PM 2.5 Standard

Overview

The Environmental Protection Agency (EPA) has lowered the annual mean concentration of particulate matter (PM) 2.5 from 12 micrograms per cubic meter (µg/m3) to 9 µg/m3. The EPA began setting air quality standards for inhalable particles – particles equal to or smaller than 10 microns – in 1987, with standards for particles 2.5 microns or less first set in 1997 at 15 µg/m3. The National Ambient Air Quality Standards (NAAQS) for PM 2.5 had since been lowered once. In 2012, the EPA reduced the standard from 15 µg/m3 to 12 µg/m3, where it has remained for more than a decade since.

Aside from the cement industry, the reach of a lower standard is large. Moreover, the scope of geographic footprint and economic output associated with reducing the PM 2.5 threshold from 12 to 9 µg/m3 is not linear. Eighteen of 3,143 counties are currently in nonattainment for PM 2.5 under the 12 µg/m3 standard. Approximately 9.2 million people are employed in those counties. Under the 9 µg/m3 standard, 25.8% (41.5 million people) of the labor force reside in the 118 counties that fall into nonattainment. These figures are not inclusive of adjacent counties within a core-based statistical area (CBSA) of a nonattainment county. It is virtually certain some of these counties would be circumscribed in nonattainment areas under a stricter standard – further expanding the breadth of the regulation.

A lower standard will have a significant impact on the cement industry. PCA estimates that lowering the annual PM 2.5 standard to 9 µg/m3 could require $171.8 million in capital expenditures and $54.6 million in additional annual operating expenses for U.S. cement producers. Even after such a large investment, there is still uncertainty as to whether these investments would even allow for achievement of the levels necessary to meet the new standard.

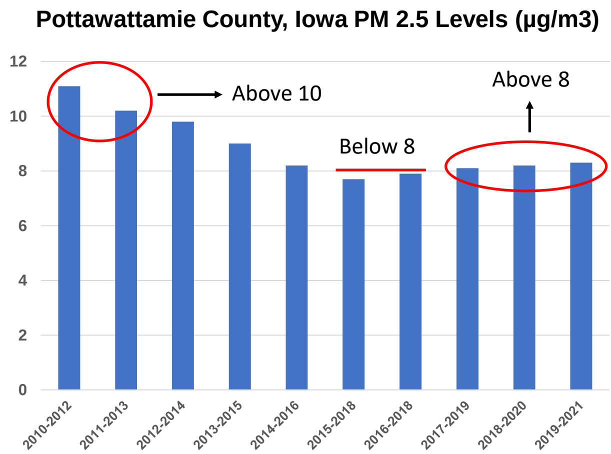
Such immense compliance costs would disincentivize expansion of domestic cement capacity. It is possible that a lower PM 2.5 standard will result in some plant closures if they deem the compliance investment required not justified on a financial basis. Moreover, increasing the footprint of nonattainment areas restricts more counties' ability to issue new permits due to emission offsetting requirements. The U.S. cement industry has experienced tight market supply conditions for the past several years and will soon need to supply tens of millions of tons of cement for public construction projects associated with the implementation of the Infrastructure Investment and Jobs Acts. There is a need for greater investment in U.S. cement production capabilities. The supply gap has been increasingly filled by imports. Costly new regulations do nothing to relieve these market realities.

Scope of a Lower Standard

The EPA measures PM 2.5 levels at ambient air monitoring sites. To determine attainment status, an annual arithmetic mean of PM 2.5 concentration is averaged over three years. This statistic, referred to as a design value, is what places a portion or whole county in nonattainment if it is currently over 12 µg/m3. The same process would be undertaken under a 9 µg/m3 threshold.

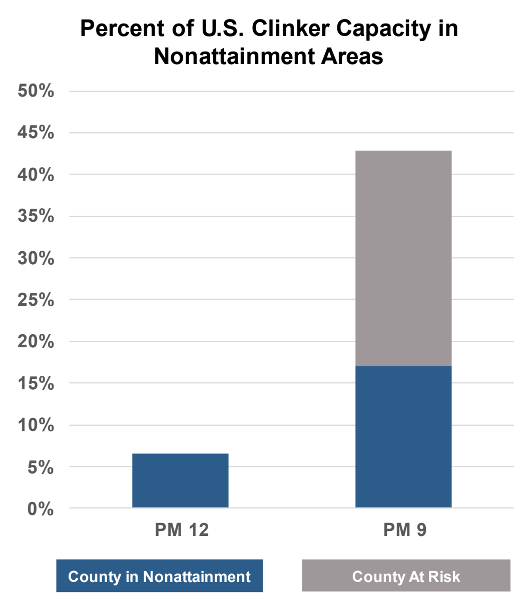
Yet, this is not the sole determinant of an area's potential nonattainment status. The EPA recommends that states, as part of their state implementation plan (SIP), use CBSA's as a reasonable starting point when establishing nonattainment area boundaries. The logic is that an adjacent county has the potential to contribute to a monitor violation within a CBSA. Using five consideration factors (air quality data; emissions and related data; meteorology; geography/topography; and jurisdictional boundaries), nonattainment boundaries are evaluated and determined on a case-by-case basis. It is possible that only portions of surrounding counties would be included in nonattainment areas. Given this methodology, a county could be more heavily regulated simply based on unfavorable wind patterns.

Using the latest EPA Green Book, PCA analyzed county design values. For the purposes of this report, counties with any monitor reporting a 2019-2021 average value at or above 9 µg/m3 are considered in nonattainment. All counties within a CBSA of a violating county, as well as counties that have at any time been above the 9 µg/m3 threshold in the past 10 years, are considered ***at risk*** for being in nonattainment areas. The majority of counties at risk are due to their CBSA association with a violating county.

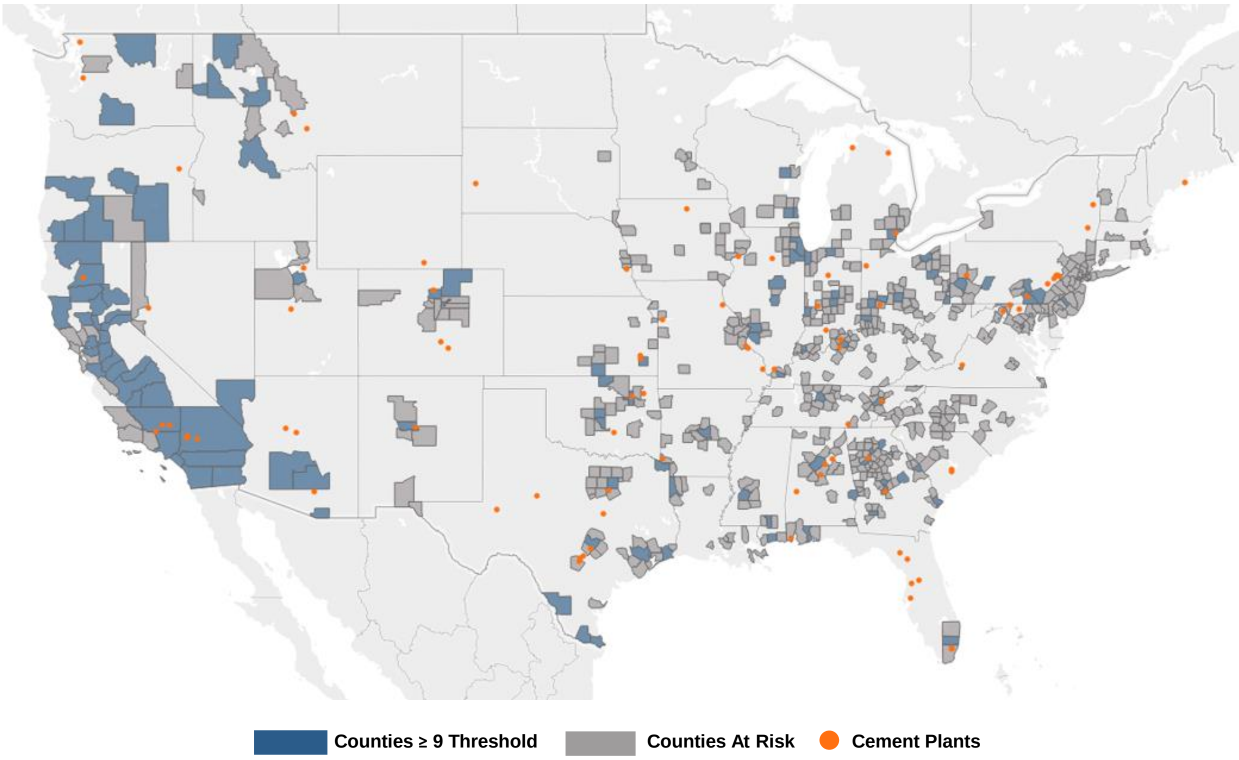


A complication with lowering the PM 2.5 standard to 9 µg/m3 is that the footprint of regulation grows more uncertain. There are simply far more counties teetering just below 9 µg/m3 than there are 12 µg/m3. Since adjacent counties within CBSA's have the potential to also fall into nonattainment areas, the unpredictability surrounding a county's future attainment status grows. This could deter investment dollars from counties that are viewed as at risk for falling into nonattainment and having to comply with comprehensive implementation plans, especially given the increased incidence of "background" PM like wildfires and farming.

Approximately 43% of the domestic cement industry, measured by clinker capacity, would either be in nonattainment or at risk of being in a nonattainment area with a standard of 9 µg/m3. Sixteen plants and two grinding facilities with a combined clinker and grinding capacity of 16.4 mmt and 21.8 mmt respectively dwell in counties that would fall into nonattainment areas. Another 21 plants totaling 24.9 mmt of clinker capacity and 28.6 mmt of grinding capacity would be at risk of inclusion in nonattainment areas.



Annual PM 2.5 at 9 µg/m3

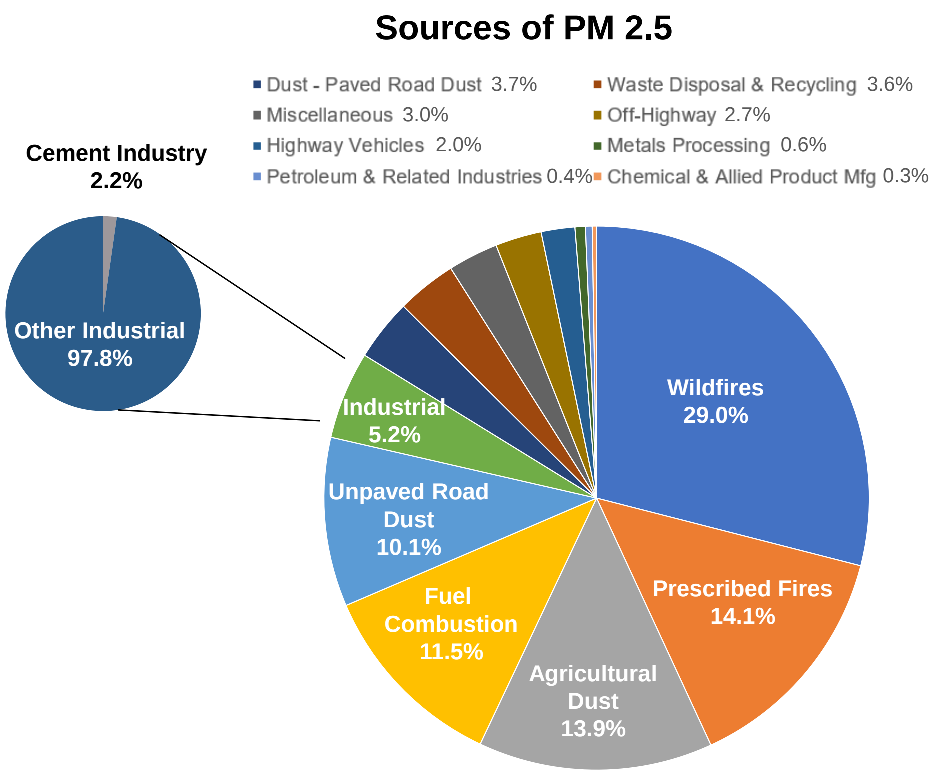


Composition of PM 2.5 Emissions

The chemistry of fine particle formation is complex and depends on a multitude of factors such as atmospheric conditions and other pollutants. Direct PM 2.5 emissions include organic carbon, sulfates, nitrates, elemental carbon, and crustal material emitted from a variety of sources including fires, dust from agricultural practices, paved and unpaved roads, and fuel combustion. These emissions then couple with secondary particles known as precursor emissions. These include nitric oxide (NOx), sulfur dioxide (SO2), volatile organic compounds (VOCs), and ammonia (NH3) and are emitted from things like cars and trucks, power generation, and agriculture.

Industry is not the primary source of PM 2.5 emissions. PCA assessed the latest EPA National Emissions Inventory (NEI) data. The data series contains both filterable and condensable PM 2.5 emissions at the national, state, and county level with estimates for sector sources of such emissions. Of all contributors to PM 2.5 emissions, industrial processes are a relatively minor one at 5.2% of total emissions.

On a national basis, the cement industry's contribution to PM 2.5 emissions is very small, accounting for a negligible 0.1% share of total PM 2.5 emissions. Since most areas of the country do not house cement plants and the true metric of concern is ambient air quality in specific areas of the country, this statistic is perhaps not the most representative. To this end, PCA went through the emissions inventory and isolated each county where there is a cement plant to see its share of total PM 2.5 emissions. In these counties, cement manufacturing on average represented 1.9% of PM 2.5 emissions.



Control Technologies & Associated Costs

Particulate matter, and notably PM 2.5, is different in nature than most other emissions. With a majority comprised of "background" emissions, attributed to things like wildfires, dust from unpaved roads and agriculture, there is not necessarily a silver bullet approach to effectively regulate its main causes. Tasked with the goal of reducing PM emissions and unable to regulate its scattershot origins like mobile or natural sources, imposing new rules on industry may seem like the silver bullet even though it is a relatively small contributor to the problem. Regulations on industry alone would not resolve the problem.

The cement industry is already heavily regulated for particulate matter through the National Emissions Standards for Hazardous Air Pollutants (NESHAP). With PM currently well controlled at cement plants, plants may face diminishing returns from upgrades to control technologies like baghouses. Moreover, PM 2.5 comprises a small share of total filterable PM coming from a baghouse.

To get a sense of what control technologies might be considered, along with estimated capital and operating expenses associated with each control technology, PCA turned to its member company producers. The survey data PCA collected reflects current estimated investment costs to reduce PM 2.5 emissions. This information contains significant upside risk in the context of likely market conditions facing emission equipment suppliers. In the face of more stringent PM 2.5 standards, the cement industry would likely be mandated to install even more PM capture equipment on top of the vast number of baghouses already covering nearly every source at cement plants. This equipment would likely need to be in-place relatively quickly. However, there are a limited number of emission capture equipment suppliers. Demand for their services from the cement industry would likely increase dramatically. A premium will likely be placed on the urgent need to install the systems over a short period of time. The likely outcome would be an escalation in the costs of these systems. A 10% to 20% premium over existing costs is possible. PCA assumes a 15% increase over the survey information. With high running inflation, labor shortages, and raw material scarcity, this markup is probably conservative.

There is still a great deal of unknown as to what Reasonably Available Control Technology (RACT) requirements would look like under a lower standard. There will be regional variations according to each SIP. Some counties currently in nonattainment for PM could still add requirements to their SIP for a variety of reasons like being moved from a marginal to serious classification. The cost of these plants' upgrades would be significant but represent less of a capital burden than plants moving from attainment to nonattainment areas. This consideration is factored into PCA's cost estimates.

Attempting to further mitigate PM 2.5 at cement plants could involve complete baghouse swaps, hopper modifications and upgrades to filter bags. However, many of these controls are already in existence at cement plants. In general, filter bags are more expensive when trying to meet lower standards as is the cleaning cycle more frequent, meaning bags must be replaced at a faster rate. It remains uncertain, however, if bags that could achieve lower PM 2.5 levels even exist. Cement plants are already heavily regulated for PM 2.5 through NESHAP, with bags required to meet extremely low levels. Baghouse manufacturers may become uncomfortable guaranteeing such levels in a contract. Thus, it is dubious as to whether there would even be a supply of such baghouses to attempt to meet a lower standard.

Plants that move from attainment to nonattainment may also have to upgrade or install high-efficiency cyclones, wet scrubbers, and spray bars. Additionally, SIPs may require control measures for material storage piles including domes for raw materials like limestone, as well as for certain process and conveying equipment. These particular measures would have occupational health and safety (OHS) implications. Housing certain transfer points would expose workers who enter that structure to highly concentrated dust. This OHS concern may require further mitigation through personal protective equipment (PPE).

Installation of these technologies is expected to result in a serious financial burden to plants whose attainment status changes. In PCA's control technologies survey, the estimated cost associated with baghouse upgrades such as insulation, bag type or material used changes, or expansion of baghouse capacity ranged from around $600,000 to $2.9 million depending on the scope of the changes required. PCA estimates the average capital expense for plant baghouse upgrades is $1.9 million, with an annual operating expense of $550,000. Material control measures such as domes total from the hundreds of thousands of dollars to several million dollars depending on the size of the plant. Other control measures represent sophisticated technology that may not currently be at the plant. PCA estimates average per-plant other non-baghouse-related costs to be $1.4 million with associated annual operating costs of $400,000.

It is possible that certain SIPs may dictate that plants convert utility dust collection to membrane collection, requiring membrane bag installation throughout the plant. Cost estimates for this range from $575,000 to $1.6 million. PCA calculates the average cost for a plant to be $1.1 million with an average annual operating expenditure of $400,000. There is also the potential that on-site trucks could face regulation for PM. This could come in the form of membrane-based bags on truck exhaust systems. Retrofitting a fleet of a dozen trucks with this technology would total around $100,000 and could be far higher if plants were to purchase new trucks with this system already installed.

The PM 2.5 standard applies to both filterable and condensable particulate matter. Control measures to reduce condensable PM may be the same as existing controls aimed at decreasing SO2 or new controls entirely. While plants generally have SO2 well controlled through existing regulatory and permitting requirements, if SIPs place a focus on condensable PM controls, it is possible plants would have to install things like hydrated lime systems, control measures for potential short-duration, infrequent SO2 spikes. Further, ammonia hydroxide could be used to reduce the effects of a detached plume. In terms of costs, controls for condensable PM reflect the largest risk to estimate. If new control measures are required, it could easily total tens of millions of dollars at a single plant.

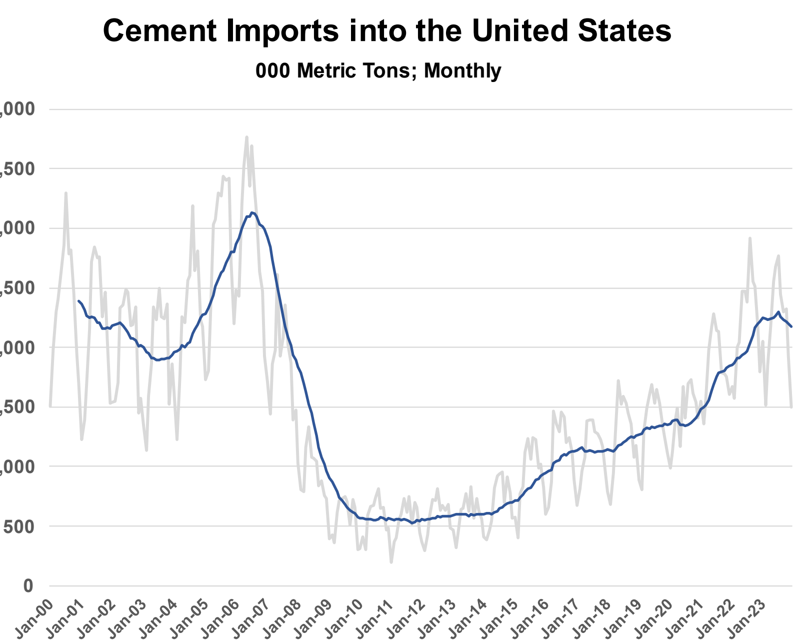
For the most part, the aforementioned controls are aimed at point emissions. Plants would also have to address fugitive dust emissions. Depending on RACT requirements, this could be particularly onerous and could encompass dust collector performance requirements on material storage silos, rumble grates and wheel washers, lower opacity limitations, unpaved roads and parking lot requirements and restrictions, additional controls during high wind events, materials moisture standards, and testing requirements for production and stockpiled materials. For cost context, a street sweeper, wheel washer, paving a quarter mile worth of road, and moisture testing are estimated to collectively cost approximately $1 million. The general survey consensus for ongoing annual costs was around $70,000. It is worth noting that not all these controls can be implemented everywhere. Access to the quantity of water necessary for wheel washers or spraying piles does not exist everywhere or is rationed in areas during extreme drought conditions; a condition that we're experiencing more and more recently. Furthermore, not all these controls can be operated during certain times of the year, like a wheel washer using water in the winter. Increasing moisture contents of certain materials is detrimental to processing that material or increases the amount of drying that must occur in the process, which may result in unintended adverse consequences like increased fuel combustion and carbon dioxide (CO_2) emissions.

PCA recognizes that not every plant will have to install every single technology listed. Reasonable assumptions must be made. In total, it is estimated that increased control technologies will cost the average plant $5.6 million in capital expenses and $1.8 million in annual operating-related expenses.

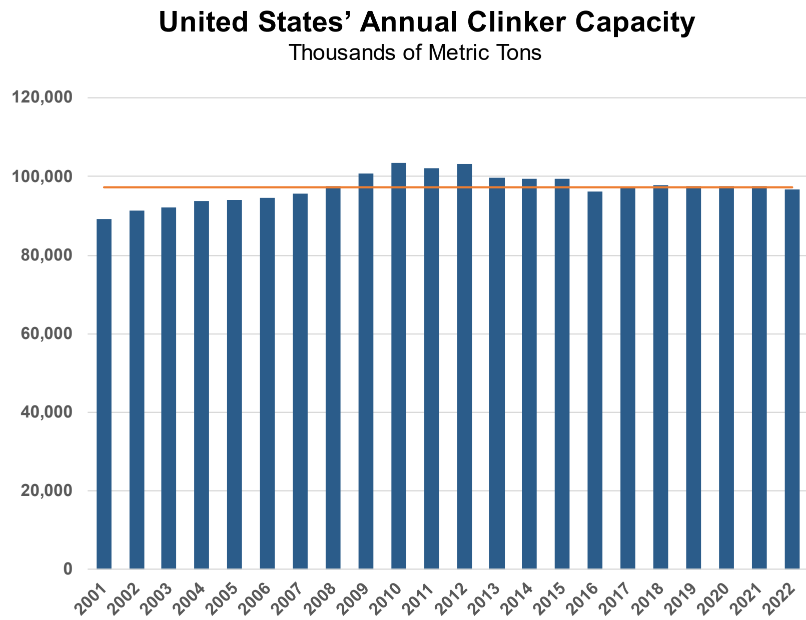
Effect on Domestic Cement Capacity & Industry Investment

The United States cement industry is comprised of 23 companies operating 88 plants and four grinding facilities with a clinker capacity of 96.9 million metric tons (mmt) and a grinding capacity of 115 mmt. In 2022, the U.S. consumed 110.8 mmt of cement. While higher mortgage rates have resulted in declines in residential construction, the recently passed Infrastructure Investment and Jobs Act (IIJA) represents $550 billion in new public construction spending. Construction projects associated with IIJA are expected to begin in earnest in 2024 and add tens of millions of tons of increased cement consumption over its five-year life and beyond.

Cement plants' theoretical maximum sustained utilization rate is assumed to be 90%, given the need for planned shutdowns for maintenance and repair. To meet the supply gap between domestic production capabilities and cement consumption, the U.S. cement market relies on imports. Cement imports finished 2023 with 26.9 mmt entering U.S. ports to meet demand in the year.



Recent years have been characterized by tight cement supply conditions. The cement industry is not immune to the supply chain disruptions that have plagued the general economy and are the result of strong cement demand, in some cases lingering disruptions associated with the coronavirus pandemic and logistic hindrances. Aside from recent years, the U.S.'s clinker production capacity has remained largely unchanged over the past 20 years. The last two greenfield plants built in the U.S. occurred in 2009-2010. Over the last 20 years, 25 plants (including 4 grinding facilities) have closed. Most of the closures have occurred since stringent environmental regulations were imposed on the industry through the introduction of NESHAP regulations; 21 plants have closed since September 2008. While kiln size has grown over the past several decades and the plants that have been retired over the past 20 years tend to be smaller, domestic clinker production capacity has decreased from its high of 103.6 mmt in 2010 to 96.9 mmt today.



Large multinational companies own the overwhelming majority of U.S. cement manufacturers. Within a multinational company each geographic region, such as the U.S., competes for scarce corporate investment dollars (keep in mind, expanding cement production capacity is extremely expensive – a two million metric ton plant now costs close to a billion dollars, if not more). The rate of return on investment for new clinker production capacity in the U.S. is compared against returns in other countries. An uncertain regulatory environment could reduce expected returns on investments in the U.S and contribute to corporate decisions to take a wait-and-see approach before making further investments. Moreover, investments of this magnitude are determined well in advance. It often takes great time and effort to dedicate funding for U.S. projects. If the U.S. regulatory structure becomes less certain, it is easy for these firms to redirect resources to other parts of the globe.

In order for the U.S. cement industry to meet the needs of projected future consumption levels, expansion of its current production capacity may be required. Continuing to fill the domestic supply gap with imports leaves the U.S. vulnerable to economic conditions outside its control.

The vast majority of cement is consumed in urban metro regions. Many of the areas that fall into nonattainment under a 9 µg/m3 standard are among the fastest growing population centers in the country – implying less ability for local sourcing.

Increased production capacity brought online in areas that change from attainment to nonattainment would be stunted by a lack of new permitting. The EPA requires all new source review (NSR) permitting to include the lowest achievable emission rate (LAER), emission offsets, and the opportunity for public involvement. In many jurisdictions, there are little or no bankable emission offset credits available. With counties' ability to issue permits restricted, existing facilities may have to be shuttered in order for new ones to be built. PCA assumes no new production capacity will materialize in areas that fall into nonattainment.

None of this will help ease the supply tightness currently facing the U.S. cement market. Quite the opposite. Compliance costs averaging $5.6 million per plant would disincentivize capacity expansions and greenfields, even if permitting allows for it. Even worse, lowering the PM 2.5 standard could result in plant closures. Some plants, many of which are designed to supply a tight market in close proximity to the plant, may deem the compliance investment required not justified on a financial basis if they must comply with more stringent SIPs. If some plants do indeed close, cement will need to be transported into the affected areas. This will result in more truck vehicle miles traveled, meaning more PM 2.5 emissions generated from vehicles and roadways. Furthermore, imports will be more heavily relied upon in the event of plant closures. An increase in ships sitting offshore and unloading of cement in ports would increase fine particle emissions in coastal communities, many of which would be in nonattainment areas under the new proposed standards.

Cement manufacturing jobs are highly technical and well-paying, with an average wage of $97,790 per year. Approximately 6,212 people work at cement plants in counties that would be encompassed in nonattainment areas or at risk of it under a 9 µg/m3 standard. Hiring a worker translates to hiring a taxpayer. Plant workers eat at restaurants and shop at stores in the surrounding area – further multiplying their economic impact and contributions to local taxes. Cement plants themselves contribute significantly to the local and state tax base.

Disincentivizing investment in domestic manufacturing through expensive compliance costs, permitting red tape, and creating greater uncertainty at a time of global supply chain unease would be counterproductive. Filling supply gaps through an increased reliance on imports runs counter to the spirit of Buy American and the Administration's goal of bolstering the U.S. manufacturing sector.

It is not just simply the compliance and ongoing operating expenses that represent costs. The potential for closed plants/lost jobs and ensuing lost tax revenue, the opportunity cost of forgoing expanded domestic production and its multiplier effect, and the potential increased cost to construction itself is real and represent cost. All these costs must be considered when performing a cost-benefit analysis of the new standard.

Costs vs. Benefits of a Lower Standard

The benefits of lower concentrations of fine particulate matter include less incidence of heart attacks, respiratory conditions, and asthma exacerbations, as well as a lower premature mortality rate. The monetary benefits of lower hospital admissions, doctor and emergency room visits, savings on medication, and less frequent work absences associated with lower levels of PM 2.5 can be quantified. In 2021, the EPA quantified estimated per-ton benefits of reducing direct PM 2.5 emissions as well as precursor emissions by emitting sector. While the methodology to reach these estimates is questionable, for the moment they will be taken at face value. For cement kilns, the EPA calculates that every ton of PM 2.5 reduced results in a benefit of $157,000.

For the purposes of this analysis, PCA assumes roughly 50% of the cement plant capacity in at-risk counties would end up in designated nonattainment areas. If all assumed impacted plants in nonattainment areas were able to reduce their PM 2.5 through the various control technologies by 25% – an ambitious number – that would translate to 405.1 tons of reduced PM 2.5 under a 9 µg/m3 standard.

Using the EPA's benefit estimation for the cement industry, this would yield $63.6 million in monetized benefits at a 9 µg/m3 standard. It's important to note that this use of the EPA's monetary benefit for reducing PM 2.5 is specific to cement kilns. It's unclear if fugitive dust controls contain the same level of benefits as PM reduced at the kiln. Based on a literature review, it is likely not the case. Furthermore, the benefits EPA estimates of reducing precursor emissions like SO2, NOx, and NH3 are an order of magnitude less than direct PM 2.5 emissions. If some reduction in these secondary emissions through certain control technologies as part of the emissions abatement mix is assumed, the monetized benefits would be overstated. Both these phenomena imply that the monetized benefits of using strictly direct PM 2.5 emissions from cement kilns are overstated for the cement industry as a whole. PCA estimates the monetized benefits to be closer to $54 million.

On the cost side, lowering the annual PM 2.5 standard to 9 µg/m3 is estimated to result in $171.8 million in capital expenditures and $54.6 million in additional annual operating expenses for U.S. cement producers. Ongoing operating expenses every year rival the estimated monetary benefits of the reduced PM 2.5 emissions. When accounting for and apportioning the initial capital compliance costs, the level of spending far exceeds the estimated monetized benefits.

It is important to note just how massive these costs for the cement industry would be when viewing them from a dollar spent per ton of PM 2.5 emission reduction basis. Even with apportioning compliance costs over a decade, the expected financial burden imposed on the cement industry would be approximately eight times greater than the $2.5 billion spent annually on wildfire mitigation and prevention under a 9 µg/m3 standard on a per-ton of PM 2.5 basis. Even this is not a fair representation because these costs for the cement industry reflect *additional* expenses under stricter standards. The industry has already spent and continues to spend extensively on PM control technologies. This implies much more PM 2.5 emission reduction potential through increased spending on wildfire mitigation both on a total ton basis and getting the most out of scarce financial resources.

None of this includes the opportunity costs of decreased industry investment, or the threat of plants closing. A mere 5% decline in capacity in nonattainment areas under a 9 µg/m3 standard reflects $21 million in annual lost wages.

Over the past 30 years, emissions of fine particulate matter have been reduced very significantly. Given the current composition of PM 2.5 emissions, with industrial processes only responsible for 5.2% of total PM 2.5 emissions, and natural causes comprising such a substantial share, it is unlikely the same rate of reduction will be mirrored in the future.

During the same reporting period, PM 2.5 emitted from Siskiyou County, CA fires alone generated nearly 18 times the amount of total PM 2.5 emissions generated from the entire U.S. cement industry. A single wildfire event could wipe out all the gains made by the cement industry. This does not mean the U.S. shouldn't take appropriate steps to mitigate PM emissions. The cement industry is already heavily regulated for PM by NESHAP. Incremental reductions in PM 2.5 emissions from an already low base will face diminished returns. The costs, however, are real and would result in a less robust domestic manufacturing base.