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How the US Environmental Protection Agency Got It Wrong About Monetizing Benefits of Air Pollution Regulations

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Abstract

The Trump administration's US Environmental Protect Agency (EPA) has decided to stop quantifying and monetizing human health benefits when analyzing the impacts of federal regulations, overturning decades of established and peer-reviewed conventions. Instead, only the costs incurred by companies for complying with a regulation will be quantified when implementing regulatory decisions, leading to an unbalanced assessment of impacts. The EPA's arguments for not quantifying and monetizing benefits are unsupported and out of step with the best available science and established practice. We provide a point-by-point rebuttal to these arguments and conclude that by failing to include quantified and monetized benefits in economic impact analysis, EPA has chosen to abandon adherence to economic principles, decades of guidance from experts, its own economic analysis guidelines, and guidance from the Office of Management and Budget.

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1. Introduction

A critical part of the US Environmental Protect Agency (EPA) rulemaking process is the preparation of regulatory impact analyses (RIAs) that assess the costs, benefits, and economic and equity impacts of proposed and final regulations. By providing information about both the costs and benefits of proposed regulations, RIAs meet requirements of executive orders and ensure that the public is aware of how regulations may affect their health and economic wellbeing.

However, the Trump administration in its recent economic impact analysis[1] of new source performance standards for combustion turbines has proposed to not quantify or monetize human health benefits, focusing solely on the costs to the regulated industry (**EPA 2026**). Such an approach would ignore human health benefits, which EPA has previously estimated to be large, thereby tilting the analysis in favor of less stringent regulation. Excluding the health benefits of regulation would go against widely accepted economic and scientific methodology, run counter to the longstanding practice by the federal government under both political parties, and violate EPA's own formal guidance for conducting such analyses.

In this report, which builds upon a recent If/Then blog, we assess each of EPA's arguments for making such a drastic change to its proposed analytical process (**Hubbell and Krupnick 2026**). We find that its arguments don't hold up to even the most cursory scrutiny.

Both EPA (EPA 2011a) and outside analysts (Palmer, Burtraw, and Shih 2007; Chestnut and Mills 2005) have estimated large human health benefits of EPA's air pollution regulations. Mortality benefits from reduced ozone and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) have provided the majority of all benefits of federal regulations in the last several decades (OMB 2024).

Excluding air quality health benefits is inconsistent with EPA's Guidelines for Economic Analysis, Circular A-4 from the Office of Management and Budget (OMB), and with core economic principles (**EPA 2024a**; **OMB 2003**). If EPA fails to quantify the human health benefits of air quality regulations (or the foregone benefits of deregulation), it will likely lead to suboptimal decisions that result in foregone health and economic benefits and net losses in welfare to the American people.

While in many cases costs and benefits estimated in RIAs cannot form the legal basis for regulatory decisions, they are critical parts of the agency's public justification for the regulations. For example, when EPA issued the revised National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ in 2024, the first paragraph of the agency's press release focused on information provided in the associated RIA:

1 RIAs assess the overall benefits, costs, and impacts of proposed national air pollution regulations, while economic impact analyses (EIAs) quantify how existing regulations reallocate resources and impact the economy. In most cases, an RIA is structured similarly to an EIA, except that a benefits analysis is included along with an estimation of net benefits.

> *"By strengthening the annual health-based national ambient air quality standard for fine particulate matter ($PM_{2.5}$) from a level of 12 micrograms per cubic meter to 9 micrograms per cubic meter, the US Environmental Protection Agency's updated standard will save lives—preventing up to 4,500 premature deaths and 290,000 lost workdays, yielding up to $46 billion in net health benefits in 2032. For every $1 spent from this action, there could be as much as $77 in human health benefits in 2032."*
>
> – US Environmental Protection Agency, on the 2024 NAAQS for $PM_{2.5}$

When the agency is comparing different alternative regulatory options, RIAs can help identify whether society will be better off with the regulation and which alternative has the highest net benefits to society overall. For example, the RIA for the proposed Clean Power Plan from 2014 evaluated four different regulatory options and reported net benefits for each (**EPA 2014**).

In the first Trump administration, analyses of the health benefits of air pollution regulation (or the health costs of deregulation) came under attack. Subsequently, EPA published several RIAs that excluded important human health benefits associated with reductions in greenhouse gases and air pollution. For example, the RIA for the Affordable Clean Energy rule (replacing the Obama administration's Clean Power Plan) excluded global benefits of greenhouse gas reductions in its primary estimates, and the RIA[2] for the proposed revision to the Mercury and Air Toxics Rule omitted benefits of particulate matter reductions, arguing that these ancillary effects of the rule shouldn't count when estimating net benefits (**EPA 2020**; **EPA 2019**). These analytical decisions were heavily criticized in the scientific community, including by Resources for the Future (RFF) (Aldy 2019). Under the Biden administration, EPA returned to producing RIAs that were consistent with best practices and peer-reviewed methods.

2 Technically, EPA did not complete a full regulatory impact analysis for the 2020 reconsideration of the Mercury and Air Toxics rule, instead submitting to the rule docket a memo titled "Compliance Cost, HAP Benefits, and Ancillary Co-Pollutant Benefits for National Emission Standards for Hazardous Air Pollutants: Coal-and Oil-Fired Electric Utility Steam Generating Units—Reconsideration of Supplemental Finding and Residual Risk and Technology Review."

However, now EPA is returning to the discredited methods of the first Trump term and taking them to a new level by making unsubstantiated claims about the benefits analysis methods that were developed through decades of consultations with experts in air pollution health and economics. In the recently released economic impact analysis for the stationary combustion turbines rule, EPA advances multiple angles of attack on the peer-reviewed approaches that the agency has used for decades (**EPA 2026**). In the new rule, the agency makes the following arguments:

1. EPA's past analytical practice did not adequately characterize uncertainties in benefits.
2. Providing point estimates (otherwise known as the expected values for monetized benefits) is inappropriate when there are uncertainties.[3]
3. EPA does not have sufficient confidence to monetize health benefits; for example, by using the value of a statistical life (VSL).[4]
4. Benefits from reducing $PM_{2.5}$ below the level of the national ambient air quality standards are so uncertain that they should not be included.[5]
5. Estimating $PM_{2.5}$ and ozone "co-benefits" for air regulations targeting other pollutants is inappropriate.[6]

In the following sections we discuss and rebut each of these arguments and show they are out of step with the best available science and established analytical practices.

2. Uncertainty Has Always Been a Part of Regulatory Analyses

EPA has quantified the human health benefits of regulations for decades under both Republican and Democratic administrations. The economic value of those benefits has been the largest contributor to the overall benefits of all federal regulations, largely

3 "However, the EPA historically provided point estimates instead of just ranges or only quantifying emissions, which leads the public to believe the Agency has a better understanding of the monetized impacts of exposure to $PM_{2.5}$ and ozone than in reality" (**EPA 2026**, p.34).

4 "Therefore, to rectify this error, the EPA is no longer monetizing benefits from $PM_{2.5}$ and ozone but will continue to quantify the emissions until the Agency is confident enough in the modeling to properly monetize those impacts" (**EPA 2026**).

5 "In particular, the EPA is interested in evaluating the validity of estimating the benefits of air quality improvements relative to the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone. These standards, which have been set at a level which the Administrator judges to be requisite to protect public health or welfare with an adequate margin of safety, are widely understood to represent the divide between clean air and air with an unacceptable level of pollution" (**EPA 2026**, p. 35).

6 "Historically, the EPA estimated the monetized benefits of avoided $PM_{2.5}$- and ozone related impacts, which accounted for most, if not all, of the monetized benefits of many air regulations–even when the regulation was not regulating $PM_{2.5}$ or ozone–within Regulatory Impact Analyses (RIAs)" (**EPA 2026**).

driven by the benefits of reducing $PM_{2.5}$. EPA's methods for quantifying and monetizing the health benefits of air pollution, including how uncertainties are characterized, have been the subject of intense peer reviews, including by the **National Academies of Science, Engineering, and Medicine**; the **EPA Science Advisory Board Council on Clean Air Act Compliance Analysis**; the **EPA Clean Air Scientific Advisory Committee**; the **EPA Environmental Economics Advisory Committee**; and the **EPA Science Advisory Board**. These scientific review bodies have consistently supported EPA's approaches for quantifying and monetizing human health benefits, including EPA's approaches to characterizing uncertainty.

In response to feedback from the panels, EPA consistently improved its approaches to better address uncertainties in benefit estimates. For example, based on recommendations from the National Academies in the report *Estimating the Public Health Benefits of Proposed Air Pollution Regulations*, EPA collaborated with OMB to conduct an expert elicitation to better characterize uncertainties in the relationship between annual mean $PM_{2.5}$ and premature mortality (**National Research Council 2002**; Roman et al. 2008). Results of that analysis were incorporated into dozens of RIAs in the 2000s and 2010s, including the reviews of particulate matter NAAQS conducted in 2006 and 2012 (**EPA 2006**; **EPA 2012**).

Benefits of reducing fine particulate matter are not as uncertain as the Trump EPA has suggested. Since the $PM_{2.5}$ standards were established in 1997, EPA and other federal science organizations, such as the National Institutes of Health, have spent hundreds of millions of dollars to strengthen the science evaluating the links between particulate matter and health and address identified uncertainties (National Research Council 1999). Fundamental conclusions of expert scientific panels in the United States and globally reviewing this science have been consistent in their findings that short- and long-term exposures to $PM_{2.5}$ are causally linked to premature mortality and that the overall body of evidence supports the use of a linear, no-threshold relationship in estimating mortality impacts (**EPA 2010a**; **WHO 2021**).[7] The most recent review of the particulate matter science by the EPA Clean Air Scientific Advisory Committee noted that new advances in causal modeling have only strengthened the conclusions regarding the determination that $PM_{2.5}$ is causally linked to premature mortality (**EPA CASAC 2010b**). A set of important studies[8] demonstrated that when $PM_{2.5}$ concentrations have been reduced, life expectancy has increased.

At least since the 1990s, EPA's RIAs for air regulations have always acknowledged uncertainties in both benefit and cost estimates, arising from multiple sources, including market information, emissions, air quality modeling, concentration-response

7 Recent studies, such as Nasari et al. 2016 and Burnett et al. 2018 that have focused on the shape of the concentration-response relationship, have found that there may be a non-linear relationship which is in some cases supralinear at low $PM_{2.5}$ concentrations (which indicates a greater mortality response to $PM_{2.5}$), with some flattening of response at very high concentrations. The Global Burden of Disease uses a nonlinear relationship with a lower bound centered at 3.5 ug/m^3 (**Cohen 2017**).

8 These include Correia et al. 2013 and Bennet et al. 2019, both of which examined gains in life expectancy in the United States resulting from reductions in $PM_{2.5}$ during different time periods with higher and lower $PM_{2.5}$ concentrations.

functions, health data, and economic valuation. Many of these sources are difficult to quantify, but EPA has been estimating confidence bounds on its estimates of health benefits for decades, reflecting the statistical power of the epidemiological studies from which concentration-response functions are estimated, and uncertainty distributions around key economic valuation parameters such as the VSL. EPA has operationalized the quantification of uncertainties in its peer-reviewed, open source, publicly available benefits estimation software: the environmental **Benefits Mapping Analysis Program (BenMAP)** (Sacks et al 2018).

In addition to point estimates, BenMAP routinely produces percentiles of uncertainty distributions for both the counts of health effects and the monetized values of those effects. Beyond providing probabilistic estimates of benefits, EPA also provides numerous sensitivity analyses examining important parameters, including estimates of benefits at different particulate matter ambient concentration cut points, alternative concentration-response functions, additional health endpoints, and discount rates. EPA's approach to estimating health benefits of air pollution regulations is well documented in a publicly accessible technical support document (**EPA 2024c**). In the case of particulate matter-attributable premature mortality, EPA has also provided a range of benefits based on two different key epidemiological studies and clearly noted that they represent separate estimates and should not be averaged given lack of knowledge about the relative likelihood of each estimate. Thus, EPA has striven to balance different types of uncertainties, providing expected values (i.e., point estimates) and probability distributions where appropriate, and presenting ranges where probability distributions were unknown.

Moreover, there are substantial uncertainties (and biases) in cost estimates, such as an inability to predict future innovations and the results of human ingenuity in finding the cheapest mitigation strategy. But EPA, while arguing uncertainties are so large as to warrant not monetizing health benefits, including through the use of the VSL, makes no mention of the equivalent concerns about presenting point estimates or distributions of costs. The combustion turbines EIA devotes only six lines to cost uncertainties, ending with the conclusion that "costs presented in this RIA may be overestimates." (**EPA 2026**, p. 63). There is no quantified treatment of cost uncertainties presented. Ranges of costs presented in the EIA reflect different assumptions about rates of construction of new turbines, not uncertainties in the cost estimates (**EPA 2026**, p.31).

Federal guidance in OMB Circular A-4 calls on agencies to "discuss the expected benefits and costs of the selected regulatory option and any reasonable alternatives," address uncertainties, and "report benefit and cost estimates (including benefits of risk reductions) that reflect the full probability distribution of potential consequences" (OMB 2003). Where possible, Circular A-4 asks agencies to present probability distributions of benefits and costs and include the upper- and lower-bound estimates as complements to central tendency and other estimates. EPA's practice for decades has been to do just that, as well as providing extensive sensitivity analyses for analytical elements that are difficult to characterize probabilistically.

EPA's own Guidelines for Preparing Economic Analyses recommends that "[c]onsistent with recommendations in these Guidelines for communicating uncertainty, quantitative entries should generally include a central or best estimate in addition to a range or confidence interval" (**EPA 2024a**). EPA's assertion that providing point estimates when there are substantial uncertainties flies in the face of decades of established and peer-reviewed practices. Moving away from these best practices hinders the ability to compare benefits and costs to produce estimates of net benefits, which in turn provides less information to inform decisions.

3. Benefits Gained by Reducing Particulate Matter Concentrations Below National Standards

EPA sets standards that are "requisite" to protect public health, including vulnerable populations with an "adequate margin of safety."[9] Of course, what defines an adequate margin of safety is a policy decision, not an absolute determined by the science. EPA has interpreted "requisite" to mean that standards should be set where, in its interpretation, the confidence in the associations between $PM_{2.5}$ and health effects is strongest. In the most recent revision to the $PM_{2.5}$ NAAQS in 2024, the rule notes that, "[i]n considering the appropriate level for a revised annual standard, the Administrator concludes that a standard set at a level of 9.0 mg/m^3 reflects his judgment about placing the most weight on the strongest available evidence while appropriately weighing the uncertainties" (**EPA 2024d**).

This does not mean that there is no risk below the standard. In the 2024 NAAQS rule, EPA states clearly that, "[s]tudies evaluated in the 2019 [Integrated Science Assessment (ISA)] and the ISA Supplement examine this issue, and continue to provide evidence of linear, no-threshold relationships between long-term $PM_{2.5}$ exposures and all-cause and cause-specific mortality" (**EPA 2024d**). EPA also acknowledges that there are uncertainties about the shape of the concentration-response function (which specifies how mortality risk changes with increases in $PM_{2.5}$) at lower concentrations (below 8 ug/m^3). EPA also summarized expert opinions regarding the existence of a threshold in the concentration-response function for $PM_{2.5}$-related mortality, and in almost all cases,[10] experts agreed that the evidence supports a non-threshold, linear relationship (**EPA 2010a**).

All of this is to say that the standards are a public health policy instrument, not a level below which no health effects occur. Therefore, and following EPA and OMB guidance, it is fully appropriate to include the expected benefits of reductions in $PM_{2.5}$

9 Clean Air Act 42 U.S.C. §7409 (1970). See **https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7409.htm**.

10 In one case from 2005, the EPA Clean Air Scientific Advisory Committee suggested for quantitative risk assessments that a threshold of 10 ug/m^3 should be assumed for short-term mortality (EPA 2010a). However, subsequent CASAC reviews did not carry through with this recommended assumed threshold.

concentrations below the NAAQS, with appropriate characterization of uncertainties. EPA has addressed these uncertainties in previous RIAs by including sensitivity analyses showing the distribution of benefits across concentration levels, including above and below the relevant NAAQS at the time the RIA was conducted (**EPA 2011b**). EPA also qualitatively notes that there is increasing uncertainty in benefits estimates at concentrations well below the mean levels in the underlying epidemiological studies.[11]

4. The Value of a Statistical Life Is the Best Method for Monetizing Mortality Benefits

The VSL is emphatically not the value of a human life. Rather, this value of *statistical* life can be useful for regulatory impact analyses. The VSL quantifies people's willingness to pay to reduce their risk of death by a small amount. The VSL can be based on decisions made in everyday life; for example, by choosing a safer occupation or buying more expensive but safer cars and bike helmets. Economists also can determine the VSL by analyzing responses to highly structured surveys. The VSL itself is defined as the willingness to pay for lower death risk divided by the amount of risk reduction that payment provides; for example, if people are willing to pay on average $10 for a 1-in-100,000 reduction in risk, then the VSL will be $10 multiplied by 100,000, giving a VSL of $1 million for reducing one expected death in a population of 100,000 people. These calculations also involve statistical representations of uncertainty, such as confidence intervals and sensitivity analysis.

Environmental economists, like ourselves, have been conducting such analyses for about five decades, resulting in hundreds of published studies, many in the United States, but also covering populations around the world. Because of their importance in RIAs, these values have, in turn, been reviewed and heavily scrutinized by EPA's Science Advisory Boards, the National Academy of Sciences, and similar bodies in other countries.

In the United States, a series of executive orders have endorsed use of the VSL for all major rules affecting health and safety going back to President Jimmy Carter and including all Republican (and Democratic) presidents. It is codified in OMB Guidance Documents, such as Circular A-4 (OMB 2003). With those and many other global endorsements and codifications, VSLs have appeared in thousands of benefit-cost analyses in the United States and around the world, not only in EPA's RIAs for major rules (including under the first Trump administration and early in the second) but in RIAs from other health and safety agencies, such as the US Food and Drug Administration and US Department of Transportation).

As for the uncertainties in the VSL, the heavy review this literature has received, the continuation of academic publications to the present and the VSL's long history of use speaks volumes that uncertainties in the estimates—which are always present in

11 See for example the RIA for the 2023 Good Neighbor Rule (**EPA 2023**, p. 212).

any statistical and technical analysis—are well within acceptable levels for informing public policy. Of course, EPA and other agencies represent such uncertainties with confidence intervals and sensitivity analyses (such as about how the lag between exposures to particulate matter and reductions in the risk of death affects their value) and continually review the literature, while adjusting the VSLs for income growth and inflation. The latest authoritative review of VSL studies comes from the Organization for Economic Co-operation and Development, which analyzed and compared 277 studies covering 49 countries from 1970 to 2023, with 30 new US studies just from 2009 to 2023 (OECD 2025).

If mortality impacts are not valued, then the impact of this important health endpoint, which is often the largest contributor to economic benefits in air pollution regulations, cannot be compared to regulatory costs, resulting in a large bias toward issuing rules that are too weak.

5. No Co-benefits—Only Benefits

The scientific and economic consensus is that cost-benefit analysis should include all of the positive and negative effects of a regulation, not just those related to the targeted pollutant.

EPA's Guidelines for Preparing Economic Analyses recommend that analysts should "…capture all relevant outcomes to the extent possible…" and "…[not] exclude an important benefit or cost category…even if it cannot be placed in dollar terms." OMB Circular A-4 directs federal agencies that, "[y]our analysis should look beyond the direct benefits and direct costs of your rulemaking and consider any important ancillary benefits and countervailing risks" (**EPA 2024a**, OMB 2003).

RFF's researchers have addressed the issue of co-benefits in a 2021 peer-reviewed article, noting that "co-benefits are simply a semantic category of benefits that should be included in benefit-cost analyses" (**Aldy et al. 2021**). They find that excluding co-benefits could lead to inappropriate conclusions about whether policies are economically efficient or provide net benefits to society. Graham and Wiener (2024) also evaluated the appropriateness of including co-benefits and "countervailing risks", and recommended estimating the full scope of impacts, both positive and negative.

Co-benefits have long been considered when evaluating regulations or other policy actions, and not just for air quality. A classic example noted in the RFF article (Aldy et al. 2021) is the Emergency Highway Energy Conservation Act of 1974, which established a speed limit of 55 miles per hour, with the primary goal of fuel conservation, and also achieved a co-benefit of reduced road fatalities (Friedman et al. 2009). Ancillary effects are not always beneficial. For example, the RIA for the 2010 National Emission Standards for Hazardous Air Pollutants and New Source Performance Standards for the Portland Cement Manufacturing Industry estimated the disbenefits of carbon dioxide increases resulting from increasing electricity use from rule compliance (**EPA 2010b**).

More generally, inclusion of co-benefits (or costs) improves rather than weakens regulatory analyses. As a society, we want regulations that achieve the most net benefits (i.e., that are the most efficient). In the best case, policies can incorporate these co-benefits into their designs, and even if co-benefits are not part of the policy design, efficiency is enhanced when a regulation targeting one societal problem results in additional benefits for another.

Failing to include all benefits and costs of a regulation, whether the direct intent or not, will bias estimates of net benefits and if applied in decision-making, could lead to worse policy outcomes.

6. Conclusion

In a recent If/Then blog, Alan Krupnick made the case that as the Trump administration's EPA moves forward with its ambitious deregulatory agenda, it should follow good principles of regulatory impact analysis that uses transparent methodologies (**Krupnick 2025**). The blog noted that, under the first Trump administration, RFF researchers developed an approach for looking at the merits of deregulation. The researchers called for a structured approach that examined the net benefits of deregulation, looking at both the costs and benefits, consistent with economic theory and best practice as well as OMB's 2003 version of **Circular A-4** and EPA's **Guidelines for Preparing Economic Analysis**.

RFF analyzed regulations that were considered for repeal in the first Trump administration (**Krupnick et al. 2018**). The analysis showed that in a number of cases, for example EPA's **2016 Oil and Natural Gas Sector Emission Standards rule**, only including industry cost savings would lead to a decision to repeal a rule. Considering both costs and benefits showed that such a repeal would lead to negative net benefits, making society worse off. This emphasizes the importance of including benefits and costs for all major regulations.

In the second Trump administration, EPA's arguments against best practice benefit-cost analysis seem likely to be applied across the federal bureaucracy and set the stage for proposing major changes in Circular A-4 and federal agency RIA guidance documents. By failing to include quantified and monetized benefits in economic impact analysis—for the recent rule on combustion turbines and likely for many upcoming deregulatory actions—EPA has chosen to abandon adherence to economic principles, decades of guidance from experts, its own economic analysis guidelines, and guidance from OMB.

EPA's arguments for abandoning health benefits in the recent rule are neither persuasive nor well founded in science. The whole idea of a RIA becomes irrelevant without the assessment of economic benefits. Without applying the important tool of benefit-cost analysis, air-quality regulators cannot evaluate clearly whether rules have positive net benefits for society, and this lack of clarity will likely lead to worse policy outcomes for public health.

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