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By Electronic Filing and First Class Mail

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EPA Docket Center
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Attn: Docket ID No. EPA-HQ-OAR-2013-0602

Re: Comments on Behalf of the American Petroleum Institute on the Environmental Protection Agency's "Co-Benefits" Estimated in the Regulatory Impact Analysis Supporting the Proposed Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 Federal Register 34830 (June 18, 2014), EPA-HQ-OAR-2013-0602.

These comments on the Environmental Protection Agency's (EPA's) "co-benefits" estimated in the regulatory impact analysis (RIA) supporting the proposed existing source performance standards (ESPS) regulation for power plants,79 Federal Register 34830 (June 18, 2014), are submitted on behalf of the American Petroleum Institute.

This set of comments does not address the proposed standards directly, but instead addresses a key set of estimates developed in EPA's RIA in support of the proposed regulation.

EXECUTIVE SUMMARY

In this paper, we provide comments on the co-benefits that EPA estimates in the regulatory impact analysis (RIA) for the proposed existing source performance standards (ESPS) regulation for power plants.

EPA intends the regulation to reduce the carbon dioxide emissions associated with existing power generation sources in the U.S., and hence to provide benefits in the form of reduced adverse impacts on the world's climate. The proposed regulation would also result in ancillary reductions in emissions of precursor pollutants (e.g., SO_2, NOx, and directly emitted particles) from power plants, which in turn would lower ambient concentrations of $PM_{2.5}$ and ozone. In the RIA, in addition to estimating the climate benefits from the proposed rule, EPA also estimates the monetized "co-benefits" as lower concentrations of $PM_{2.5}$ and ozone result in a presumed reduction in the adverse health effects that these two criteria air pollutants may cause. We have the following comments on EPA's estimated criteria air pollutant health co-benefits.

1. It is not appropriate for EPA to justify a climate regulation based on criteria air pollutant co-benefits and not based on climate benefits.

Under many of the scenarios that EPA analyzes, the climate benefits that EPA estimates the US will accrue from the proposed rule are less than the costs of the proposal. Benefits exceed costs in EPA's analysis only if non-climate, non-CO_2 benefits are added also as a result of the incidental reduction in fine particle and ozone concentrations that EPA believes will occur. In our view, though, decisions about the appropriate ambient concentrations of $PM_{2.5}$ and ozone are supposed to be made in the course of reconsidering the NAAQS for these pollutants. Depending on which of several alternative assumptions are employed, up to 97 % of the monetized benefits that EPA ascribes to the proposed ESPS regulation are "co-benefits" involving criteria air pollutants rather than greenhouse gasses. Without the claimed co-benefits, the benefits of the proposed regulation are unlikely to exceed its costs.

2. EPA overestimates the mortality benefits associated with reductions in $PM_{2.5}$ concentrations.

In the benefits analysis, EPA ignores the significant share of long-term $PM_{2.5}$ mortality studies that find either no statistically significant increase in mortality with increasing $PM_{2.5}$ concentrations or an inverse relationship. EPA should reflect this uncertainty about whether long-term $PM_{2.5}$ exposure increases mortality by adopting a lower estimate for $PM_{2.5}$ mortality benefits that assumes no causal relationship between $PM_{2.5}$ exposure and mortality. EPA's chosen lower and upper estimates for the $PM_{2.5}$ concentration-response function both appear to be too high to fairly characterize the range of findings across most long-term mortality studies in the U.S.

3. EPA does not reflect the increasing uncertainty in claiming mortality benefits from reductions in $PM_{2.5}$ at lower ambient concentrations, where much of the claimed mortality benefits occur.

Although EPA states in the RIA that the Agency is less certain in the validity of the mortality concentration-response functions (CRFs) at lower levels, this increased uncertainty is not reflected in any way in EPA's quantified benefits estimates. Most of EPA's estimated co-benefits occur at "lower levels" defined in either of two ways:

- At levels lower than the primary NAAQS for $PM_{2.5}$, which presumably establishes an ambient concentration below which exposures are "safe;" and

- At levels lower than most of those considered in the epidemiology studies underlying the CRFs; at these lower levels the CRFs estimated in the studies become highly uncertain.

4. EPA has chosen concentration-response functions for $PM_{2.5}$ and ozone mortality that result in estimates of total excess deaths from exposure to these pollutants that are implausibly large when compared against aggregate national mortality statistics and other reference information.

We provide several comparisons between EPA's estimates of mortality attributable to $PM_{2.5}$ and ozone and other figures in an attempt to show that EPA's chosen concentration-response functions for these pollutants yield mortality estimates that are unreasonably large.

5. EPA introduces needless inaccuracy and apparently some upward bias to the Agency's benefits estimates by relying on a "short-cut" benefits-per-ton methodology instead of performing policy-specific *de novo* atmospheric modeling.

EPA estimates co-benefits for the proposed regulation by applying previously estimated "benefit-per-ton" figures to the projected reductions from electricity generating units (EGUs) of precursor emissions that can contribute to $PM_{2.5}$ and ozone formation. These benefit-per-ton figures were estimated based on a particular inventory of precursor emissions from EGUs and use of "source apportionment" techniques to identify the air quality impacts of this emissions inventory at receptor points. The inventory of changes in EGU precursor emissions expected from the proposed ESPS regulation will likely differ in ways that EPA has not examined from the inventory underlying the benefits-per-ton estimates, and the source apportionment approach introduces increased inaccuracy when the relevant atmospheric chemistry involves nonlinear processes and/or multiple pollutant species. Particularly for a regulation as costly and important as the proposed ESPS, EPA should consider simulating the geographic distribution of emissions reductions, atmospheric processes and population exposures using policy-specific *de novo* atmospheric modeling instead of the benefits-per-ton approach.

6. In the ESPS RIA, EPA has estimated the benefits-per-ton from reductions in precursor emissions from EGUs. But EPA has failed to estimate the "disbenefits-per-ton" to the

extent that precursor emissions from sources other than EGUs will increase as a result of the proposed rule. EPA should not ascribe positive value to the decreases in combustion-related emissions of $PM_{2.5}$ and ozone precursors from EGUs while failing to estimate negative value also for increases in precursor emissions from other source types.

EPA estimates monetized co-benefits from precursor emissions reductions at EGUs that will occur as States implement the four building blocks. We believe, though, that use of each of the four building blocks will result in at least some partly offsetting increases in precursor emissions, mostly from sources other than EGUs. EPA should account in the benefits analysis for the impacts of these emissions increases also.

7. 98% of EPA's estimated co-benefits involve avoided premature mortality. These estimated mortality benefits would decline sharply, perhaps by as much as 95%, if the Agency were to improve the analysis by estimating and valuing "statistical life-years gained" rather than "statistical lives saved"

Most premature mortalities that EPA contends could be avoided as a result of a reduced $PM_{2.5}$ and ozone concentrations would occur among older populations with many fewer average years of life expectancy remaining than the populations that have been assessed in the studies from which EPA draws the Agency's estimated value of a statistical life (VSL). EPA would improve the accuracy of the mortality benefits estimates by using an approach that estimates and values the years of additional life gained rather than simply the number of premature deaths avoided.

8. EPA has not clearly defined the baseline for the ESPS RIA, nor has EPA justified whatever the chosen baseline is. The benefits, co-benefits and costs that EPA estimates for the proposed regulation are importantly dependent on whatever EPA has defined the baseline to be. Absent a clear statement of what the baseline is for the analysis and why it was chosen, the RIA is incomplete and very difficult for the public to review.

How much in the way of heat rate improvements, redispatch, fuel switching, additional renewables, demand-side energy efficiency (DSEE) improvements and other measures (i.e., the four building blocks) that EPA envisions as needed to meet the proposed standards will occur in the future, anyway, without the ESPS regulation? How much credit for health co-benefits can EPA claim in the RIA if much of the emissions reductions projected by EPA from the four building blocks in order to meet the proposed standards would occur even if the regulation were not promulgated? Without a clear explanation and justification of the baseline that EPA has chosen for the analysis, it is very difficult to answer questions such as these that are important when reviewing the RIA.

9. EPA overestimates the climate benefits of the proposed ESPS regulation.

In this paper, we focus our critique on benefits issues on EPA's estimated co-benefits involving criteria air pollutants. In this final section, though, we very quickly reiterate and summarize the recent comments on EPA's approach for estimating climate benefits that were provided by a large coalition of industry groups in response to OMB's invitation for public comments on the Administration's "social cost of carbon" (SCC) estimates.

* * * *

Our full detailed comments are attached to this cover letter. We appreciate the opportunity to provide these comments.

Respectfully submitted,

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President, Environomics, Inc.

Attachment

COMMENTS ON THE "CO-BENEFITS" ESTIMATED IN EPA'S REGULATORY IMPACT ANALYSIS SUPPORTING THE PROPOSED EXISTING SOURCE PERFORMANCE STANDARDS FOR ELECTRIC UTILITY GENERATING UNITS

Overview of Benefit and Cost Estimates in EPA's RIA

The following table shows EPA's estimated costs and benefits for a particular scenario that we believe may be the least unreasonable among those the Agency has analyzed:

EPA's Estimated Costs and Benefits for Proposed ESPS Regulation (US only)
(in year 2030, Option 1, State and not regional trading)
Billions of 2011$/year

Costs (7%/yr discount rate, US only)	
Electric utility efficiency measures	25.9
Electricity customer efficiency measures	25.9
Reduced generating costs from reduced electricity demand*	-34.0
Total	**17.8**
Monetized benefits	
Climate benefits (via SCC, 5%/yr discount rate)**	
Entire world	*9.5*
US only	0.7 to 2.2
Air pollution health co-benefits (US only, 7%/yr discount rate)	
$PM_{2.5}$	23.1
Mortality	*22.6*
Morbidity	*0.5*
Ozone	1.1
Mortality	*1.0*
Morbidity	*0.1*
Total	**24.9 to 26.4**

* It is not clear what discount rate EPA used in generating this figure

** EPA argues that it is appropriate to use a lower discount rate for SCC calculations than for other benefits or costs. Climate benefits have not been calculated at a discount rate of 7%, but would be lower than the figures shown here for a discount rate of 5%

For this scenario, climate benefits for the entire world fall short of the projected costs for the proposed regulation. For some other scenarios assuming lower discount rates for costs and/or benefits, costs for the proposed regulation exceed the climate benefits for the U.S., and climate benefits exceed the costs of the rule only if climate benefits are added for the non-U.S. world population. Note two key points:

- Positive net benefits for the rule depend on the large estimated criteria pollutant co-benefits. The proposed regulation would show negative net benefits if criteria pollutant co-benefits were not included.

- Criteria pollutant co-benefits account for more than 90% of US benefits
    - $PM_{2.5}$ accounts for 95% of co-benefits, ozone 5%
    - Avoided mortality accounts for 98% of co-benefits, morbidity 2%

In this paper, we provide comments on EPA's estimated co-benefits stemming from the reduction in criteria air pollutand-related health effects that the Agency estimates. We will comment on mortality benefit estimates only; not morbidity also, since the estimated morbidity benefits are so small as to make little difference. We will comment only on the benefit estimates involving avoided adult mortality, providing no comments on the infant mortality estimates that contribute little to benefits.

Furthermore, we will comment nearly exclusively on EPA's estimated mortality benefits for $PM_{2.5}$, and will comment very little on the estimated benefits involving ozone. The co-benefits involving $PM_{2.5}$ account for the great majority of the total co-benefits that EPA estimates.

In focusing on the criteria pollutant co-benefits that EPA estimates, we will not provide any original comments on the climate benefits that EPA estimates for the proposed regulation. However, at the end of this paper, we will quickly summarize the comments that an industry coalition has recently provided on EPA's "social cost of carbon" methodology for estimating climate benefits.

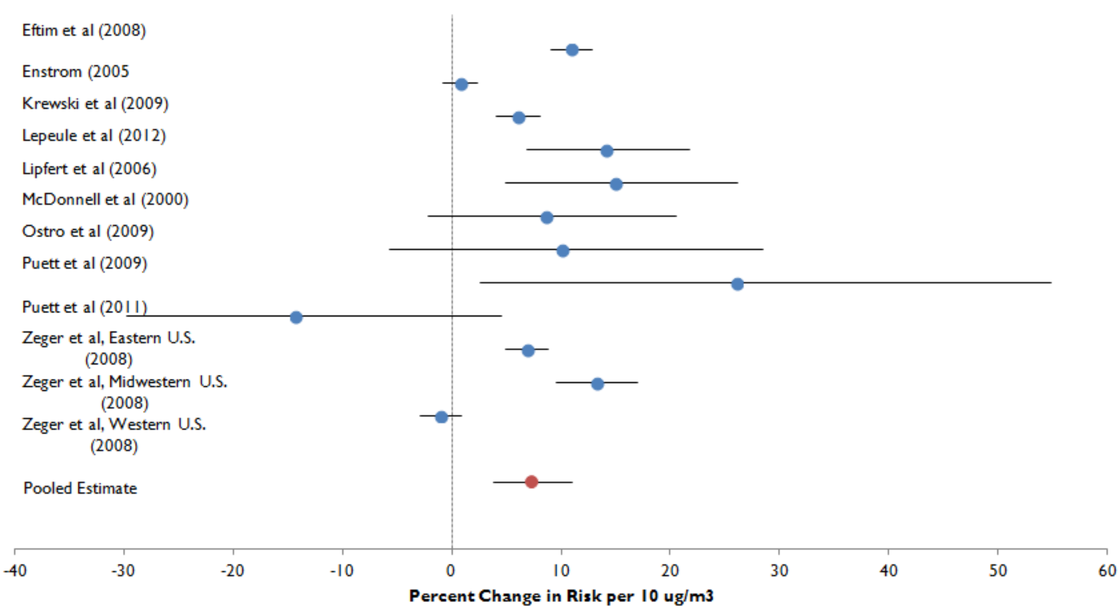
1. It is not appropriate for EPA to justify a climate regulation based on criteria air pollutant co-benefits and not based on climate benefits.

Under many of the scenarios that EPA analyzes, the climate benefits that EPA estimates the US will accrue from the proposed rule are less than the costs of the proposal. Benefits exceed costs in EPA's analysis only if non-climate, non-CO_2 benefits are added also as a result of the incidental reduction in fine particle and ozone concentrations that EPA believes will occur. In our view, though, decisions about the appropriate ambient concentrations of $PM_{2.5}$ and ozone are supposed to be made in the course of reconsidering the NAAQS for these pollutants. The NAAQS for $PM_{2.5}$ was revised most recently in 2012 and the NAAQS for ozone is currently being reviewed with a proposed rule due later this year. By law, the standards for each of these air pollutants must be reviewed at least twice more between now and the 2025 - 2030 dates that EPA targets with the ESPS proposal. We believe that decisions on the appropriate levels of $PM_{2.5}$ and ozone should be left for the statutorily mandated NAAQS reviews. Depending on which of several alternative assumptions are employed, somewhere between 60 and 97 % of the monetized benefits that EPA ascribes to the proposed ESPS regulation are "co-benefits" involving criteria air pollutants rather than greenhouse gasses. It is not appropriate for EPA to justify the ESPS proposal based largely on incidental reductions of criteria air pollutant emissions.

2. $PM_{2.5}$ mortality benefits. In the benefits analysis, EPA ignores the significant share of long-term $PM_{2.5}$ mortality studies that find either no statistically significant increase in mortality with increasing $PM_{2.5}$ concentrations or an inverse relationship. EPA should reflect this uncertainty about whether long-term $PM_{2.5}$ exposure increases mortality by adopting a lower estimate for $PM_{2.5}$ mortality benefits that assumes no causal relationship between $PM_{2.5}$ exposure and mortality. EPA's chosen lower and upper estimates for the $PM_{2.5}$ concentration-response function both appear to be too high to fairly characterize the range of findings across most long-term mortality studies in the U.S.

In a recent quantitative meta-analysis of epidemiological studies that have examined the relationship between long-term exposure to $PM_{2.5}$ and the risk of premature mortality among adults, Fann, Gilmore and Walker (2013) pooled the results from the most recent publications (through 2012) for each of the 12 US cohorts that have been studied. Fann, et al's exhibit showing the estimated relationships and 95% confidence intervals for each of the 12 cohorts and for the pooled meta-analysis as a whole is reproduced below.

Pooled Estimate of Long-term All-Cause Mortality Using Studies Through 2012



The studies for five of the twelve cohorts did not find a statistically significant positive relationship between $PM_{2.5}$ concentration and mortality. Surely these negative findings are sufficiently frequent (42% of the twelve studies/cohorts) as to warrant a lower estimate in the RIA to the effect that there is no causal relationship between long-term $PM_{2.5}$ exposure and increased mortality.

In the ESPS RIA, EPA has established a lower mortality benefits estimate by applying the concentration-response relationship estimated in Krewski et al. (2009) (ACS cohort) of 6% per

10 ug/m^3. Four of the ten cohorts (excluding ACS and Harvard Six Cities) shown in this figure and included in the meta-analysis obtain estimates that are at or below this figure that EPA chooses as the Agency's lower estimate. In the RIA, EPA has established an upper mortality benefits estimate by applying the concentration-response estimate derived in Lepeule et al. (2012) (H6C cohort) of 14% per 10 ug/m3. Nine of the ten cohorts (again excluding ACS and H6C) considered in the meta analysis obtain estimates that are approximately at or below this figure that EPA chooses as the Agency's upper estimate. Both EPA's chosen lower estimate and the Agency's chosen upper estimate are too high to fairly represent the range of findings across most of the studies.

The pooled estimate from the meta-analysis, obtained after considering both the sample size and uncertainty of the individual studies, appears to be about 7% per 10 ug/m3 of $PM_{2.5}$. This is very close to the 6% estimate obtained by Krewski et al. (2009) and posed by EPA as the Agency's lower estimate. According to the meta-analysis, EPA's lower estimate appears instead to be something much more like a central estimate.

3. $PM_{2.5}$ mortality benefits. EPA does not reflect the increasing uncertainty in claiming mortality benefits from reductions in $PM_{2.5}$ at lower ambient concentrations, where much of EPA's claimed mortality benefits occur.

EPA calculates benefits from reductions in $PM_{2.5}$ exposure using the two selected concentration-response functions (CRFs), even when concentrations are below the level of the NAAQS or below the level of the great majority of the data considered in the epidemiology studies used to derive the CRFs. Although EPA states in the RIA that the Agency is less certain in the validity of the mortality association at lower levels,[1] this increased uncertainty is not reflected in any way in EPA's quantified benefits estimates. OMB Circular A4 requires a quantitative analysis of uncertainty for rules as costly as the proposed ESPS regulation. Specifically, page 41 states: "For rules that exceed the $1 billion annual threshold, a formal quantitative analysis of uncertainty is required." In the RIA, EPA instead simply adds the highly uncertain mortality benefits calculated by applying the CRFs at lower ambient concentrations to the less uncertain benefits calculated by applying the same CRFs at higher levels. A large share of the mortality benefits that EPA estimates will result from the proposed rule in fact accrue at lower ambient concentrations of $PM_{2.5}$ where uncertainties increase. We are concerned about applying the selected CRFs at "lower levels" defined in either of two ways:

1. At levels lower than the primary NAAQS for $PM_{2.5}$, which presumably establishes an ambient concentration below which exposures are "safe;" and

[1] On page 4-42 of the RIA, EPA states: "In general, we are more confident in the magnitude of the risks we estimate from simulated $PM_{2.5}$ concentrations that coincide with the bulk of the observed PM concentrations in the epidemiological studies that are used to estimate the benefits. Likewise, we are less confident in the risk we estimate from simulated $PM_{2.5}$ concentrations that fall below the bulk of the observed data in these studies."

2. At levels lower than most of those considered in the epidemiology studies underlying the CRFs; at these lower levels the CRFs estimated in the studies become highly uncertain.

The Clean Air Act requires the EPA Administrator to establish any primary NAAQS at a level that protects public health with an adequate margin of safety. Recently, at the end of 2012, EPA reduced the primary standard for $PM_{2.5}$ to an annual average of 12 ug/m^3. Presumably, then, exposures to $PM_{2.5}$ that occur at concentrations below 12 ug/m^3 are therefore "safe", in EPA's view. EPA has not estimated in this RIA the fraction of $PM_{2.5}$ mortalities avoided due to the proposed rule that will occur among individuals exposed at less than the current NAAQS, but several pieces of evidence suggest that this fraction is high:

- About 95% of the population exposed to $PM_{2.5}$ in EPA's modeling baseline used to generate the benefits-per-ton estimates is exposed at annual mean levels below the primary NAAQS (see Figure 4-4 in the RIA);

- Approximately 65% of the mortality that EPA estimated in the 2012 PM NAAQS RIA would be avoided due to this standard occurs among populations that would have been exposed at "safe" $PM_{2.5}$ concentrations of less than 12 ug/m^3 in the absence of the new NAAQS.

- In the final RIA for the Mercury and Air Toxics Standard -- a recent regulation that will provide reductions in $PM_{2.5}$ precursor emissions from EGUs, like the proposed ESPS regulation -- EPA found that 89% of the premature mortalities estimated to be prevented by the proposed standard would have occurred among individuals exposed at below an annual mean $PM_{2.5}$ level of 10 μg/m^3.[2] Probably more than 90% of the premature mortalities estimated as avoided as a result of this rule would thus have occurred at levels below the presumably "safe" annual NAAQS at 12 ug/m^3.

One would think that EPA would somehow reflect in the Agency's benefits analysis the uncertainty of benefits estimates at lower ambient concentrations if 65 – 95% of EPA's total calculated benefits accrue to individuals who are exposed at levels deemed to be "safe".

There is another sort of uncertainty when EPA calculates mortality benefits at ambient $PM_{2.5}$ concentrations approaching the lower extreme of the concentrations analyzed in the epidemiological studies from which EPA selected the CRFs. The statistical uncertainty of a slope relationship (e.g., a CRF) estimated from a scatter of data points will typically widen substantially as one moves toward the extremes of the underlying data. Uncertainty about the magnitude of the CRFs estimated in the two selected studies increases as one approaches the lowest measured levels (LMLs) of ambient average $PM_{2.5}$ concentrations that prevailed in the cities comprising the datasets analyzed in the two studies. The confidence interval may even

[2] U.S. EPA. Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards. December, 2011. Page 5-18.

widen sufficiently so that the estimated CRF is not statistically significantly different from zero at or near the LML, even though the average slope over the full range of the underlying data is statistically significant. EPA mentions this uncertainty in the proposed and final PM NAAQS RIAs:

> "… the range from the 25th to 10th percentiles of the air quality data used in the epidemiology studies is a reasonable range below which we have appreciably less confidence in the associations observed in the epidemiological studies." (page 5-80 of the RIA supporting the proposed NAAQS)

But the Agency does nothing in any quantitative way in the benefits analysis in the ESPS RIA to reflect this increasing uncertainty at lower concentration levels. EPA calculates that 89% of the U.S. population modeled in the ESPS RIA is exposed at $PM_{2.5}$ concentrations below 1 standard deviation below the mean[3] air quality in the Krewski et al (ACS) data set. EPA does not calculate a corresponding figure for the air quality prevailing across the Harvard Six Cities cohort analyzed by Lepeule et al (2012), but we estimate from Figure 1 in the Lepeule et al study that:

- Only about 20% of the person-years of exposure included in the cohort were at annual average concentrations lower than 12 ug/m3.
- The annual average air quality that is one standard deviation below the mean for this study appears to be somewhere between about 11.5 and 12 ug/m3.

Assuming then that one standard deviation below the mean for the extended H6C cohort (Lepeule et al 2012) is between 11.5 and 12 ug/m3 and reading from Figure 4-5 in the ESPS RIA (Cumulative Distribution of Adult Population by Annual Mean $PM_{2.5}$ Exposure in the Baseline Sector Modeling), we estimate that about 93% of the population considered in the ESPS RIA is exposed at levels below 1 standard deviation below the mean for this extended cohort. Our conclusion thus is nearly identical for both of the two epidemiological studies that EPA chooses to provide the Agency's lower and upper benefits estimates for avoided $PM_{2.5}$ mortality: the vast majority (89 - 93%) of $PM_{2.5}$ exposures that will be affected by the proposed ESPS regulation occur at concentrations below the levels at which EPA has "appreciably less confidence in the associations observed in the epidemiological studies." Neither Krewski et al (2006) nor Lepeule et al (2012) can be used confidently to assess risks at $PM_{2.5}$ concentrations of less than about 12 ug/m3, and virtually all of the air quality improvements projected as resulting from the proposed ESPS regulation will occur at these lower concentrations. EPA should acknowledge in the RIA this large source of uncertainty, and should consider alternative risk assessment approaches that might yield more confident risk estimates at the lower ambient concentration that are at issue for this regulation.

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[3] Assuming a normal distribution, 1 standard deviation below the mean represents the 17th percentile of the distribution, at approximately the midpoint of EPA's suggested "lower confidence zone" lying between the 10th and 25th percentiles of the air quality data.

4. Summed $PM_{2.5}$ and ozone mortality co-benefits. EPA has chosen concentration-response functions for $PM_{2.5}$ and ozone mortality that result in estimates of total excess deaths from exposure to these pollutants that are implausibly large when compared against aggregate national mortality statistics and other reference information.

In this section we provide two sets of comparisons between EPA's estimates of mortality attributable to $PM_{2.5}$ and ozone and other figures in an attempt to show that EPA's chosen concentration-response functions for these pollutants yield mortality estimates that are unreasonably large. In the first of these sets of comparisons, we compare an EPA estimate of mortality due to these pollutants against nationwide data on deaths and cause of death as reported for the year 2005 in the Centers for Disease Control and Prevention's (CDC's) National Vital Statistics reports.

Fann, et al (2012) developed estimates, using nearly identical CRFs as those that EPA has applied in estimating ESPS co-benefits, for the national public health burden associated with exposure to ambient PM2.5 and ozone at their 2005 concentrations[4]. We focus on one particular set of estimates that this group of EPA staff developed: among the U.S. population more than 24 years old and excluding Alaska and Hawaii, the 2005 concentrations of PM2.5 and ozone in excess of natural background (non-anthropogenic) levels would result in about 325,000 excess deaths; 320,000 attributable to PM2.5 and 4,700 attributable to ozone. We adjusted these estimates to include Alaska and Hawaii and to add mortality attributable to the natural background levels of these pollutants also. We thus obtained an estimate based on EPA's chosen CRFs that there would be roughly 370,000 fewer deaths per year among the entire U.S. population more than 24 years old if the ambient concentrations of PM2.5 and ozone (including both natural background levels and anthropogenic contributions) in the U.S. in 2005 were instead to have been zero. In effect, based on the Agency's chosen CRFs, PM2.5 and ozone at 2005 ambient concentrations are responsible for an estimated 370,000 deaths per year among the U.S. population more than 24 years old. PM2.5 alone is responsible for the vast majority of these estimated premature mortalities: 362,000 of the 370,000 deaths.

The following table shows some specific comparisons between this PM2.5 mortality estimate based on EPA's chosen CRFs and aggregate mortality figures from the CDC for the identical population. We omit ozone mortality from these comparisons because in EPA's analysis ozone accounts for a far lesser portion of total mortality than does PM2.5, and including ozone in the

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[4] Fann N., Lamson A.D., Anenberg S.C., Wesson K., Risley D., Hubbell B.J., (2012): Estimating the National Public Health Burden Associated with Exposure to Ambient PM2.5 and Ozone. *Risk Analysis* 32, pp. 81–95. For the comparisons that we provide in this section, we select the particular estimates for premature mortality that these authors developed using a CRF for ozone that is identical to one used by EPA in the ESPS RIA (Bell, et al, 2004) and a CRF for PM2.5 that is based on an earlier analysis of the findings from the Harvard Six Cities cohort (Laden, et al, 2006) rather than the updated and slightly different findings that became available subsequently and that EPA used for the ESPS RIA (Lepeule, at al, 2012).

comparisons would require extensive additional data and calculations that would yield little additional insight.

Comparisons of EPA's Estimated Premature Mortality Due to $PM_{2.5}$ Against National Death Statistics

Cause of Death	Number of Deaths, 2005*
Due to $PM_{2.5}$ (EPA/Fann, et al. estimate, adjusted)	362,000
All Causes	2,373,985
Infectious and parasitic diseases (viral hepatitis, septicemia, TB, AIDS, etc.)	65,779
HIV/AIDS	*12,367*
Malignant neoplasms (cancer)	556,143
Diabetes melitus	74,876
Cardiovascular diseases	853,552
Acute myocardial infarction (heart attack)	*150,916*
Alzheimer's disease, Parkinson's disease	91,140
Accidents, suicide, homicide, events of undetermined intent, med/surg complications	143,631
Motor vehicle accidents	*32,225*
Nontransport accidents (falls, drowning, fires, poisoning, etc.)	*62,081*
Suicide	*28,153*
Homicide	*11,636*
All other	588,864

* Data for 2005, for age > 24 years. Source for all but the first row: CDC's "National Vital Statistics Reports"

In our view, several of these comparisons suggest that EPA's estimate for the number of premature fatalities due to $PM_{2.5}$ is too high to be believable:

- Does $PM_{2.5}$ actually cause about 2/3 as many deaths as all forms of cancer?[5] Is this single air pollutant really a public health concern nearly as important as cancer? To shed some light on these questions, we collected information on the morbidity (not mortality) costs associated with cancer and with $PM_{2.5}$. The direct medical costs (diagnosis, treatment and follow-up) associated with cancer were estimated by the American Cancer Society (ACS) at $103.8 billion for 2007, and these costs are projected by the National Cancer Institute (NCI) to increase to $158 to $207 billion in 2020.[6] In comparison, using

[5] Note that exposure to outdoor/ambient PM2.5 is not thought to contribute to the total number of lung cancer deaths. See, for example, Jonathan M. Samet, Erika Avila-Tang, Paolo Boffetta, et al., Lung Cancer in Never Smokers: Clinical Epidemiology and Environmental Risk Factors. *Clin Cancer Res* 2009;15:5626-5645, page 5638. It is not likely that the excess deaths that EPA attributes to PM2.5 include any cancer deaths. Without any overlap between the two sets of deaths, then, it is appropriate to compare directly the number of cancer deaths as estimated by CDC against the number of deaths that EPA estimates is caused by exposure to PM2.5.

[6] See American Cancer Society. "Economic Impact of Cancer" at http://www.cancer.org/cancer/cancerbasics/economic-impact-of-cancer. Also, National Cancer Institute. "Cancer

the data and methodology from Fann, et al. and from EPA's $PM_{2.5}$ NAAQS RIA, we estimate the direct medical costs associated with $PM_{2.5}$ in 2005 to be only $5.5 to $21 billion.[7,8] Is it plausible that $PM_{2.5}$ causes nearly as many deaths as cancer, but only 5% to 20% as much in the way of morbidity impacts? We doubt this. We would expect that mortality contributes a much higher proportion to total cancer costs than mortality contributes to total $PM_{2.5}$ costs, since cancer cases are very frequently fatal whereas illnesses potentially caused by $PM_{2.5}$ exposure are less frequently so. Instead, EPA's benefits numbers for $PM_{2.5}$ show an opposite relationship from what we expect: the number of deaths that EPA estimates due to $PM_{2.5}$ is nearly equal to the number of deaths from cancer, yet the morbidity costs that EPA estimates due to $PM_{2.5}$ are small relative to those from cancer. It appears that EPA has either greatly overestimated the mortality due to $PM_{2.5}$ or greatly underestimated the morbidity due to $PM_{2.5}$. We believe it is the former, and us that EPA's mortality estimates for $PM_{2.5}$ are implausibly high.

- In another comparison, we estimate the degree to which $PM_{2.5}$ contributes to cardiovascular deaths, and ask whether this contribution is plausible. The Lepeule, et al. (2012) study from which the ESPS RIA draws the CRF used to estimate all-cause mortality also provides a CRF specifically for cardiovascular mortality -- cardiovascular mortality is estimated to decline by 26% for each 10 ug/m^3 reduction in annual average $PM_{2.5}$ concentration.[9] We estimate that the population-weighted average concentration of

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costs projected to reach at least $158 billion in 2020" at http://www.nih.gov/news/health/jan2011/nci-12.htm

[7] The range in this estimate reflects EPA's two alternative ways of estimating the annual number of non-fatal myocardial infarctions caused by exposure to $PM_{2.5}$. The higher estimate reflects an incidence estimate based on an impact function from Peters et al. (2001), while the lower estimate is based on an impact function that EPA developed by pooling four other studies.

[8] We developed this estimate for $PM_{2.5}$ in four steps by: 1) Starting with Fann, et al.'s estimates of the annual morbidity impacts caused by $PM_{2.5}$ at 2005 concentrations – including 11 different morbidity end points that match exactly those for which EPA estimated monetized benefits in the PM2.5 RIA; then 2) Adjusting Fann, et al.'s estimates upward so as to reflect the impacts "due to" all $PM_{2.5}$ instead of only those due to $PM_{2.5}$ concentrations above natural background; then 3) Multiplying the number of morbidity impacts of each sort by an appropriate unit value for each sort of impact. We drew the unit values from EPA's RIA, but stripped out of each unit value any amounts that reflected anything other than direct medical costs, such as willingness-to-pay estimates, the imputed value of lower productivity or time losses, lost wages, etc.. For some morbidity effects, EPA's unit values consisted solely in these sorts of costs other than direct medical costs. In these instances, we added into the unit value a very rough estimate of the daily costs for individuals suffering the morbidity impact to self-medicate with over-the-counter medications until they recover. Thus, for example, in the RIA EPA values a "minor restricted activity day" at about $64 to reflect what one study concluded was the average willingness-to-pay (WTP) to avoid a day with symptoms including coughing, throat congestion and sinusitis. We stripped out this WTP value, and instead assumed that the direct medical costs associated with a "minor restricted activity day" might be about $2/day, including costs for Tylenol, throat lozenges, cough syrup, a decongestant, and the like. We made these sorts of changes to some of EPA's unit values so as to include only direct medical costs and thus to make the unit costs directly comparable with the ACS and NCI cost estimates for cancer which included only direct medical costs. Finally, in step (4), we obtained an estimate for the total direct medical costs of morbidity associated with $PM_{2.5}$ by multiplying the number of each effect by the unit value for that effect and then summing across effects.

[9] The impact coefficient of 1.26 per 10 ug/m3 that Lepeule, et al. (2012) estimated for cardiovascular mortality is much larger than the coefficient of 1.14 that the researchers estimated for all-cause mortality. As a result, these researchers project that a reduction in $PM_{2.5}$ levels will result in a much larger proportional reduction in

$PM_{2.5}$ in the U.S. in 2005 was perhaps roughly 9 ug/m^3. If this average concentration of $PM_{2.5}$ were reduced to zero, then by applying the Lepeule, et al. CRF for cardiovascular mortality, we estimate that cardiovascular deaths would decline by 9 ug/m^3 x 26%/10 ug/m3 = 23.4%. Or, looking at this calculation in a different way, the Lepeule, et al. CRF implies that 23.4% of cardiovascular mortality is "due to" $PM_{2.5}$. Is this plausible? We think not. There are so many important and broadly agreed-upon risk factors for cardiovascular illness -- smoking, diet, obesity, heredity, lack of exercise, and other illnesses (e.g., diabetes), to name a few -- that it is difficult to imagine $PM_{2.5}$ air pollution as responsible for nearly 1/4 of all cardiovascular mortality and for a larger share than most of these acknowledged important risk factors.

- Another comparison involves the mortality estimates for $PM_{2.5}$ vs. those for accidental and intentional causes of death. EPA's estimate of mortality in 2005 due to $PM_{2.5}$ (362,000) is more than 11 times larger than the number of deaths due to motor vehicle accidents (32,225) and about 2 ½ times the number of deaths due to all sorts of accidents, homicides, suicides, etc. in total (143,631). Yet the amounts the U.S. spends to prevent accidental and intentional deaths and injuries -- for highway and air transportation safety, for avoiding non-transport accidents, for gun safety, for suicide prevention, to prevent accidental poisonings, for chemical safety, for safer vehicles, to prevent fires, falls, drownings and electrocutions, etc. -- are much larger than the perhaps $50 billion or so per year that we spend to reduce $PM_{2.5}$.[10] If $PM_{2.5}$ really causes 2 ½ times as many deaths as all accidents and injuries combined, as EPA's estimates suggest, then our priorities and expenditures for public health and safety are badly misaligned. We doubt this; we believe instead that EPA's mortality estimate for $PM_{2.5}$ is unrealistically high.

Comparisons for the year 2020:

EPA's estimates of the health and economic benefits of reducing ambient $PM_{2.5}$ and ozone appear similarly implausible when the reductions are carried forward to the year 2020, the first year for which the ESPS RIA estimates costs and benefits.

In the Agency's most recent report on the Benefits and Costs of the Clean Air Act, EPA evaluated a scenario where the Clean Air Act and Amendments were assumed to reduce U.S.

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cardiovascular mortality than in total mortality.

[10] The figure of approximately $50 billion in spending per year to reduce PM2.5 concentrations was derived in: Environomics, Inc. "Briefing Paper on the Costs and Benefits of EPA's Proposed Reduction in the $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS)," a report prepared on behalf of a large group of industry trade associations and submitted to the Office of Management and Budget in December, 2012. We have not made the effort to total current national spending on safety and accident prevention, but it undoubtedly far exceeds $50 billion per year. The cost of the Federal motor vehicle safety standards (FMVSS) (not including highway safety spending, not including other transportation safety expenditures, and not including spending to avoid other sorts of accidents and injuries) is now approximately $850 per vehicle, and for sales of 15 million new vehicles per year the costs of the FMVSS alone now total about $13 billion per year.

national average $PM_{2.5}$ levels from about 19 ug/m^3 to about 9 ug/m^3.[11] To estimate the resulting reductions in mortality and economic benefits, EPA used a similar methodology and similar CRFs to those utilized in the ESPS RIA and in Fann et al., (2012), relying on the CRFs from Pope, et al., (2002) (ACS cohort) and Laden, et al., (2006) (H6C cohort), extrapolating mortality well below the typical ambient concentration levels that prevailed in the underlying health studies, and using a valuation approach for mortality based on a high VSL figure rather than using a VSLY approach that would have yielded much lower values (see our comment on this issue later in this paper).

In this report, EPA projected that such a reduction in ambient $PM_{2.5}$ as a result of the Clean Air Act and Amendments will prevent 230,000 to 490,000 deaths, or 10-20% of all deaths estimated to occur in the year 2020. In our view, again, these figures are not plausible.
By comparison, EPA's central and upper estimates of 230,000 or 490,000 deaths per year bracket the range of the total number of deaths in the U.S. that the Surgeon General estimates occur each year from smoking, which is 480,000 deaths per year currently, and an average of over 400,000 deaths per year for the past ten years.[12] It is not plausible that a 50% reduction in ambient levels of $PM_{2.5}$ has about as much public health impact as completely eliminating active smoking in the U.S. population.

EPA also projected that the economic value of mortality reductions attributed to reductions of $PM_{2.5}$ under the Clean Air Act would be $1,800 trillion/year (central estimate) to $5,100 trillion/year (upper estimate). Thus, in 2020:

- EPA's central estimate of the economic benefits of $PM_{2.5}$ reductions would exceed the projected GDPs of all but 10 countries in the world;[13]

- EPA's high estimate of the economic benefits of $PM_{2.5}$ reductions would exceed the total GDPs of all countries except the U.S. and China; and

- EPA's estimate of the economic benefits of $PM_{2.5}$ reductions is equal to 10-28% of the total projected U.S. GDP in the year 2020.

Again, for the year 2020 as well as for 2005, EPA's estimates of the reduction in mortality and the monetized value of the mortality benefits that could ensue from reductions in $PM_{2.5}$ concentrations appear implausibly large.

5. EPA estimates co-benefits for the proposed regulation by applying previously estimated "benefit-per-ton" figures to the projected reductions from EGUs of precursor emissions that can contribute to $PM_{2.5}$ and ozone formation. These benefit-per-ton figures were

[11] U.S. Environmental Protection Agency, Office of Air and Radiation. The Benefits and Costs of the Clean Air Act from 1990 to 2020. Final Report. March, 2011.
[12] U.S. Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress. A Report of the Surgeon General. 2014.
[13] GDP projections for the year 2020 for each of the world's larger economies are obtained from Goldman Sachs (2007). Goldman Sachs Group, Inc., Global Economics Group. BRICs and Beyond. 2007.

estimated based on a particular inventory of precursor emissions from EGUs and use of "source apportionment" techniques to identify the air quality impacts of this emissions inventory at receptor points. The inventory of changes in EGU precursor emissions expected from the proposed ESPS regulation will likely differ in ways that EPA has not examined from the inventory underlying the benefits-per-ton estimates, and the source apportionment approach evidently introduces increased inaccuracy when the relevant atmospheric chemistry involves nonlinear processes and/or multiple pollutant species. Particularly for a regulation as costly and important as the proposed ESPS, EPA should consider simulating the geographic distribution of emissions reductions, atmospheric processes and population exposures using policy-specific *de novo* atmospheric modeling, not the "short-cut" benefits-per-ton approach. EPA introduces needless inaccuracy and apparently some upward bias to the Agency's benefits estimates by relying on the benefits-per-ton approach.

In the ESPS RIA, EPA estimates the monetized health co-benefits accruing from reduced emissions of four precursor pollutants[14] by multiplying the projected reductions in EGU emissions of each pollutant by the average "benefits per ton" for EGU emissions reductions for each of these pollutants. Some time prior to beginning the ESPS RIA, EPA had estimated the typical nationwide benefits-per ton from reducing emissions of the four precursor pollutants on a national basis for 17 different source categories, such as refineries, cement plants, on-road mobile sources, and others as well as for EGUs.[15] For the ESPS RIA, EPA reworked the previously estimated national average benefit-per-ton figures for EGUs to generate somewhat more refined average benefit-per-ton figures on a regional basis: for the East, for the West, and for California.

EPA's benefits-per-ton approach is flexible with respect to the later steps involved in benefits estimation that follow after estimating population exposures, including the choice and application of health impact functions (i.e., concentration-response functions) and the choice and application of monetary valuation procedures (i.e., monetary values for each of the avoided health effects). We comment elsewhere in this document on how EPA for the ESPS RIA performed these later steps in the Agency's benefits analysis. In this section of the comments we will discuss the emissions inventory, atmospheric chemistry and population exposure elements of EPA's benefits-per-ton approach.

About two years ago, by using a "source apportionment" procedure, EPA estimated the air quality impacts at each of thousands of grid cells or receptor locations around the country attributable to each of the 17 source types. This modeling was done for a series of different

[14] EPA calculates benefits involving reductions in ambient $PM_{2.5}$ concentrations by using benefit-per-ton estimates for three co-pollutant precursors: direct $PM_{2.5}$, SO_2 and NOx. For ambient ozone, NOx is the only co-pollutant precursor for which EPA applies a "benefit-per-ton" figure.

[15] U.S. EPA. Technical Support Document: Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 17 Sectors. January 2013.

nationwide emissions inventories covering all individual sources among the 17 source types -- for a 2005 base case inventory (the 2005 v4.3 emissions platform), for 2016, 2020, 2025 and 2030 projected national emission inventories, and perhaps for others.[16] EPA performed this modeling for each precursor pollutant from each source type individually, thus obtaining for each inventory an estimate for the impact of that precursor/source type alone on the $PM_{2.5}$ and ozone concentrations each of the thousands of grid cells or receptor locations. Dividing the resulting air quality impact at a particular grid cell by the total national quantity of emissions in the inventory for the precursor pollutant and source type, EPA thus obtained an average "air quality impact per ton" figure at each grid cell for emissions of a particular precursor by a particular source type. For the ESPS analysis of co-benefits, EPA used the average impact per ton figures for EGUs specifically, since EGUs are the only source type for which EPA assumes that precursor emissions will be affected by the proposed regulation.

This source apportionment procedure is apparently reasonably accurate in identifying the contribution of each precursor, source type and individual source to the concentrations of $PM_{2.5}$ and ozone at the receptor locations. However, in making use of this information when subsequently estimating how concentrations will decline with a reduction in emissions, as we understand it, EPA applies the equivalent of a "proportional rollback" approach. The Agency assumes that the estimated source-apportioned concentration of $PM_{2.5}$ or ozone at a receptor site will decline in identical proportion with the reduction in precursor emissions from the source. This involves at least three underlying assumptions:

i. First, EPA assumes that the average impact per ton will remain constant without regard to the number of tons of precursor emissions that will be reduced. EPA assumes that the air quality change at each receptor site is a direct linear function of the number of tons.

ii. Second, EPA assumes that the change in air quality per ton would be identical in either direction. EPA assumes that the modeled deterioration in air quality at a receptor site caused by adding a ton of, say, EGU SO_2 emissions would be exactly equal to the improvement in air quality that would occur if a ton of EGU SO_2 emissions were to be eliminated.

iii. Third, EPA assumes that the average impact per ton of precursor emissions from a particular source type would be unaffected by whatever the air quality is at the receptor

[16] The projected inventories for future years raise a host of issues that I will not discuss here, including, for example, how emissions are projected to grow or not with projected changes in emissions drivers (e.g., economic activity, vehicle miles traveled, electricity demand); which regulations, SIP requirements, consent decrees, etc. are projected to be implemented by each future year and how they will affect future emissions; and whether emissions will increase from sources such as forest fires, Mexico and Canada. In effect, the projected inventory for a future year represents a sort of baseline. A problem inherent in EPA's use of the benefits-per-ton approach for estimating ESPS co-benefits may well be that the inventory baseline underlying the benefits-per-ton calculation does not match the baseline that EPA has adopted for the ESPS RIA.

site in the absence of the precursor emissions from that source type. EPA assumes, for example, that the average impact per ton of SO_2 emissions from EGUs would be the same whether the preexisting baseline concentration of SO_2 at the receptor site from other sources was low, high, or nonexistent, and that the average impact per ton would also be similarly independent of the preexisting baseline concentrations of all other air pollutants at the receptor site.

The first and third assumptions together are equivalent to assuming that there are no significant non-linearities or cross-pollutant interactions in the atmospheric chemistry whereby precursor emissions (consisting in this analysis of direct $PM_{2.5}$ of several sorts, SO_2, and NOx) eventually become concentrations of $PM_{2.5}$ and ozone that may cause the alleged health damages.[17] We suspect that the non-linearities and cross-pollutant interactions involving NOx in particular will result in lesser reductions in ozone and $PM_{2.5}$ concentrations in practice than those that EPA projects based on the benefits-per ton approach (source apportionment followed by something akin to assumed proportional rollback.

Perhaps more importantly, the set of average impact per ton and average benefits per ton figures that EPA derives by this process is a function of the particular inventory of precursor emissions that EPA used in deriving these figures. The average impact at any particular receptor location per ton of total EGU precursor emissions in the inventory obviously depends on the geographic location of the EGUs that comprise the inventory that EPA chose for the source apportionment analysis. For example, the average impact per ton of EGU emissions at a receptor location in Georgia would be much greater if the inventory were to include mostly emissions from EGUs in Georgia and neighboring southeastern States than if the inventory were to include mostly emissions from EGUs in, say, New York and New England. Other attributes of the inventory can be important also, in addition to location, such as:

- The release characteristics of the EGUs comprising the inventory (stack height, exit velocity, etc.). This will affect the mix of air quality impacts that the inventoried emissions will cause -- whether the resulting air quality impacts will tend to be more local or more distant.

- The meteorologies around the inventoried EGUs.

[17] This assumption is clearly inaccurate in the case of NOx emissions as a precursor to ozone formation. Ozone formation chemistry is highly non-linear with respect to the amount of NOx emissions, and it depends critically also on the relative balance between NOx and VOCs. The impact of an additional ton of NOx emitted from a particular source on the ozone concentration at an affected receptor site will depend strongly on the existing concentrations (and emissions) of both NOx and VOCs. EPA asserts that formation of sulfate particles -- which account for the large majority of $PM_{2.5}$ benefits or disbenefits -- is in fact quite linear with SO_2 emissions. The process by which NOx emissions form nitrate particles is somewhat non-linear. Because sulfates and $PM_{2.5}$ account for most of the criteria pollutant co-benefits that EPA estimates for the ESPS regulation and they exhibit linear atmospheric chemistry, EPA contends that the linearity assumption inherent in the the average-benefits-per-ton approach is not a problem.

- The distances of the inventoried EGUs from population centers. This will determine whether the share of these EGUs' precursor emissions that have more local impacts will affect sparsely populated areas or more densely populated areas.

- The air quality and concentrations of air pollutants from other sources currently surrounding the particular EGUs likely to be affected by the ESPS regulation. Might local air quality around the affected EGUs be such as to reduce the $PM_{2.5}$ or ozone-forming impact of precursors emitted from these EGUs below the average impacts that EPA estimated via the source apportionment and proportional rollback process?

The benefits per ton figures derived from one inventory of EGU precursor emissions would clearly be inappropriate for application to a policy situation where the inventory of EGU precursor emissions or emissions reductions that is at issue is substantially different from the first inventory in some important attributes. Just as one would not want to apply a benefits-per-ton estimate developed for EGU precursor emissions in the southeast to a policy situation where precursor emissions would be reduced in the northeast, one might also not want to apply an estimate developed for precursors from a mix of coal- and gas-fired EGUs to a set of emissions reductions from coal-fired EGUs only. The more the inventory of precursor emissions or emissions reductions in the new policy case being investigated differs in salient ways on average from the inventory of precursor emissions on which the benefit-per-ton estimates were based, the greater the likely inaccuracy in using the benefit-per-ton approach for estimating benefits rather than conducting new, policy-specific air quality modeling.

The inventories that EPA used in developing the average benefits-per-ton figures for EGU precursor emissions were either national or regional inventories that included the estimated precursor emissions for *all* EGUs in the nation or in a region in a chosen year. When EPA in the ESPS benefits analysis then applies these figures to a much smaller set of projected precursor emissions reductions from only *some* of these EGUs, the key question is whether the average character of the inventory of ESPS emissions reductions is somehow importantly different from the average character of the EGU emissions inventory underlying the benefits-per-ton estimates. EPA does not examine this question. The Agency simply assumes implicitly that the character of the two inventories is sufficiently similar in all important respects so that the average disbenefits-per-ton for the emissions comprising the first inventory are approximately equal to the benefits-per-ton for the emissions reductions comprising ESPS inventory. We have some reasons to suspect that the two inventories might differ in potentially important ways:

- The distribution of precursor emissions reductions across individual States will likely be substantially different from the distribution of inventoried baseline precursor emissions across States. We have not found in the docket any estimate of the percentage reduction in each State's precursor emissions that will result from the proposed ESPS regulation, but the target percentage reduction in each State's EGU CO_2 emissions perhaps provides a rough guide to the expected reductions in each State's precursor emissions. If so, the fact that States are assigned widely varying percentage reductions in EGU CO_2 emissions (ranging from 0 % in Vermont and the District of Columbia to 72% in Washington and 52% in Arizona) suggests that the State-by-State distribution of precursor emissions reductions is likely to differ significantly from the State-by-State distribution of baseline EGU precursor emissions.

- The proposed ESPS regulation will likely elicit reductions in precursor emissions mostly from older, coal-fired units. The inventory of EGU precursor emissions for which the benefits-per-ton figures were derived consists additionally, in contrast, of emissions from many newer and/or gas-fired units.

We don't know whether these sorts of differences between the character of the EGU precursor emissions reductions from the proposed ESPS regulation and the character of the EGU precursor emissions inventory underlying the benefits-per-ton estimates are sufficient to result in meaningful revisions to the co-benefits estimates. We suggest that EPA should examine this issue in detail.

In the ESPS RIA, EPA in fact provides some evidence suggesting that the monetized co-benefits estimates may be biased high in the aggregate as a result of the benefits-per-ton approach that the Agency has chosen to use. For both the MATS and CSAPR regulations -- which EPA suggests as offering helpful perspective on the uncertainty inherent in the benefits-per-ton approach -- EPA performed full policy-specific air quality modeling to estimate the air quality impacts of the projected reductions in EGU precursor emissions. In the ESPS RIA, EPA reports the results of an analysis the Agency recently conducted in which MATS and CSAPR benefits involving sulfates (accounting for the great majority of $PM_{2.5}$ benefits) were re-estimated by applying a benefits-per-ton approach instead of using the policy-specific air quality modeling that had been done. The benefits-per-ton approach, when applied to the MATS and CSAPR SO_2 emissions reductions, resulted in sulfate benefits estimates 29 % and 14% higher, respectively, than were estimated using the more accurate, policy-specific *de novo* modeling. We could perhaps generalize from these results to surmise that EPA's use of the benefits-per-ton approach for the ESPS regulation might have over-estimated co-benefits by a similar amount of roughly 14 - 29%.

We have suggested that two sorts of inaccuracies are likely to occur when EPA uses the benefits-per-ton approach to estimate the value of reductions in EGU precursor emissions instead of policy-specific modeling:

- The inventory of emissions reductions from the policy may differ in some important respects (e.g., location, proximity to concentrations of population, etc.) from the inventory of emissions upon which the benefits-per-ton estimates were based; and/or

- The proportional roll-back assumption that is made in conjunction with the benefits-per-ton approach may overestimate the air quality changes resulting from emissions reductions for precursors involving non-linear or multi-pollutant atmospheric chemistry.

Since EPA's MATS and CSAPR results were obtained specifically for sulfates, which involve relatively little in the way of non-linear and multipollutant chemistry, we suspect the first of these two sources of inaccuracy may have predominated. We suspect there must have been some sort of important systematic differences of character between the inventories of MATS and CSAPR SO2 emissions reductions and the inventory of SO2 emissions underlying the benefits-per-ton estimates.

One might think about such a difference between the benefits-per ton inventory of emissions and a policy inventory of emissions reductions as consisting of two steps. The inventory of emissions reductions from a policy may differ in character from the inventory of emissions upon which the benefits-per-ton estimates were based if:

1. The baseline inventory of emissions for the policy differs in character from the inventory of emissions on which the benefits-per-ton estimates were based; and then

2. The inventory of emissions reductions for the policy further differs in character from the baseline inventory of emissions for the policy.

EPA provides some evidence in the ESPS RIA that the first of these two steps has occurred to a significant degree in the ESPS analysis. In Figures 4-A7 (SO2 emissions) and 4-A9 (ozone-season NOx emissions) of the RIA, EPA compares two inventories of EGU precursor emissions: a) The inventories on which the benefits-per-ton estimates were based; and b) The projected inventories of EGU precursor emissions in the year 2020 that provide the baseline for the ESPS RIA.[18] EPA characterizes the two inventories as similar:

- Regarding the two inventories of SO2 emissions, EPA says: "The spatial distribution is relatively similar across states and thus the resulting benefit-per-ton would likely be similar." (page 4A-20)

- Regarding the two inventories of ozone-season NOx emissions, EPA says: "Base case emissions for … ozone-season NOx are also reasonably similar."

We view the results of a State-by-State comparison of the two inventories differently than does EPA. We believe the two figures provide evidence that the two inventories are rather different, not "relatively" or "reasonably" "similar" as EPA states.

[18] The benefit-per-ton estimates are based on a projected inventory of EGU precursor emissions in 2016 that does not reflect the substantial emissions reductions expected from MATS. The ESPS inventory of projected EGU emissions in 2020 does reflect the substantial emissions reductions expected from MATS.

We estimated the numerical values corresponding to the the heights shown in the bar graphs in Figures 4-A7 and 4-A9. We did so for all the States except for those with relatively short bars, and obtained the tables and results shown in Attachment 1. We then compared the two inventories (as best we could estimate them) and found:

- For SO2 emissions, the ESPS baseline inventory for 2020 totals 1.57 million tons, a total only about 40% as large as the 3.98 million total tons in the inventory providing the basis for EPA's benefits-per-ton estimates. EPA contends that the distribution of the two inventories across States is relatively similar and thus that the benefits-per-ton calculated for either of the two inventories would be similar. However, if the two inventories were distributed across States in a relatively similar manner, as EPA suggests, then most States should have an ESPS inventory of EGU SO2 emissions that is approximately 40% as large as the State's benefits-per-ton inventory of EGU SO2 emissions. We find to the contrary that most States do not have an ESPS inventory that is near 40% as large as the benefits-per-ton inventory. Only 12 of the 37 States for which we were able to develop estimates from Figure 4-A7 have an ESPS inventory that is within ± 25% of the 40% figure that would prevail if the two inventories were identically distributed across the States. 25 of the 37 States (68%) have an ESPS inventory that was either more than 25% larger or more than 25% smaller than 40% of the benefits-per-ton inventory.

- The same pattern of dissimilarity prevails for the two inventories of ozone-season NOx emissions. Total ozone-season NOx emissions in the ESPS inventory for the 43 States for which we were able to estimate the NOx data are about 74% of the total for the benefits-per ton inventory. Among the 43 States individually, though, only 18 have ESPS inventories that are within ± 25% of the 74% figure. 25 of the 43 States (58%) have an ESPS inventory that is either more than 25% larger or more than 25% smaller than the 74% average figure.

We conclude that the ESPS and the benefits-per-ton inventories are distributed rather differently across States, and that this suggests some likely inaccuracy in applying the benefits-per-ton values based upon one emissions inventory to the ESPS policy case where there is a different baseline emissions inventory. Further inaccuracy likely results from the second step we discussed previously: the inventory of emissions *reductions* for the ESPS policy further differs in character from the baseline inventory of emissions for the ESPS policy.

We have not found anywhere in the docket that EPA has provided a State-by-State estimate of the reductions in EGU precursor emissions expected from the proposed ESPS regulation. Thus, for the ESPS regulation we cannot directly test our supposition that the State-by-State distribution of precursor pollutant emissions reductions may differ in some meaningful manner from the State-by-State distribution of baseline emissions. However, the reduction in a State's CO2 emissions from EGUs that is required by the proposed regulation provides a rough indication of the degree to which that State's emissions of precursor pollutants will also be reduced by the regulation, and it is clear that the proposal requires States to reduce EGU CO2 emissions by widely varying percentages. The proposal requires the following CO2 emissions reductions by 2030:

- Reductions exceeding 70% for one State;
- Reductions between 50% and 70% for two States;
- Reductions between 40% and 50% for 7 States;
- Reductions between 30% and 40% for 20 States:
- Reductions between 20% and 30% for 11 States: and
- Reductions of less than 20% for 9 States plus the District of Columbia.

It seems likely that these widely varying required reductions in a State's CO2 emissions will result in similarly widely varying reductions in a State's precursor emissions.

We conclude thus that the inventory of precursor emission reductions from the proposed ESPS regulation will likely be rather different on a geographical (State-by-State) basis from the ESPS baseline inventory of precursor emissions, and that the baseline inventory of precursor emissions is also likely to be further different on a geographical basis from the inventory of EGU precursor emissions on which EPA's benefits-per-ton estimates were based. EPA's benefits-per-ton estimates were generated for a particular inventory of EGU precursor emissions, and they are not likely to be accurate when they are applied to a quite different (different geographically, as well as perhaps in other respects) inventory of EGU precursor emissions reductions. Furthermore, the benefits-per-ton approach is known to be additionally inaccurate with respect to situations involving nonlinear atmospheric chemistry and multi-pollutant interactions. EPA's results in assessing the impact of only some of these sources of inaccuracy when applying the benefits-per-ton approach to the MATS and CSAPR regulations suggested that the benefits-per-ton approach overestimated the benefits from reductions in precursor emissions by roughly 14 - 29%. The overestimation of benefits inherent in using the benefits-per-ton approach for the ESPS regulation might likely exceed this range. For a regulation as costly and important as the ESPS, EPA should consider simulating the geographic distribution of emissions reductions, atmospheric processes and population exposures using policy-specific, *de novo* atmospheric modeling, not the "short-cut" benefits-per-ton approach. EPA introduces needless inaccuracy and apparently some upward bias to the Agency's benefits estimates by relying on the benefits-per-ton approach.

Table 1: Comparison of Two EGU Emissions Inventories

1) The underlying inventory for EPA's average benefits-per-ton estimates; and

2) The baseline inventory for ESPS co-benefits analysis

	SO_2 (1,000 tons)		NOx (ozone season) (1,000 tons)	
	for Avg. Benefits/Ton	for ESPS RIA	for Avg. Benefits/Ton	for ESPS RIA
AK	80	30	11	18
AL	170	70	29.5	16.5
AZ	25	25	34.5	15.5
CA			7	9
CO	80	15	26	12.5
CT			1.5	3.5
FL	170	70	48	31
GA	90	30	17.5	17.5
IA	100	15	24	10
IL	165	40	20.5	17
IN	230	125	50.5	40.5
KS	120	15	13	13
KY	125	110	34.5	26
LA	85	15	15.5	10.5
MA			2	3.5
MD	35	10	8	7.5
ME			0.5	0.2
MI	170	120	32	32.5
MN	100	40	17	12
MO	175	180	25.5	25
MS	110	10	10	8.5
MT	15	15	12.5	7
NC	80	30	27	27.5
ND	120	20	38	32
NE	80	25	17.5	17
NJ			5	4.5
NM	15	20	34	7
NV			7.5	3.5
NY	35	10	8.5	9
OH	200	100	43	27.5
OK	140	20	27.5	24.5
OR	15	0	4	1
PA	155	70	52.5	45.5
SC	105	15	17	5.5
SD	30	10	7	5.5
TN	110	35	16	7
TX	420	140	73	71
UT	35	15	16	7
VA	45	10	15	12
WA	30	0	6	1.5
WI	80	15	20	8.5
WV	130	80	26	18
WY	105	20	37	21.5
Total	3,975	1,570	938	693.2

6. In the ESPS RIA, EPA has estimated the benefits-per-ton from reductions in precursor emissions from EGUs. But EPA has failed to estimate the "disbenefits-per-ton" to the extent that precursor emissions from sources other than EGUs will increase as a result of the proposed rule. EPA cannot ascribe positive value to the decreases in combustion-related emissions of $PM_{2.5}$ and ozone precursors from EGUs while failing to estimate negative value also for increases in precursor emissions from other source types.

EPA estimates monetized co-benefits from precursor emissions reductions at EGUs that will occur as States implement the four building blocks. We believe, though, that use of each of the four building blocks will result in at least some partly offsetting increases in precursor emissions, mostly from sources other than EGUs. EPA should account in the benefits analysis for the impacts of these emissions increases also. [19]

In the paragraphs below we suggest some examples of how use of each of the four building blocks can lead directly to increases in precursor emissions that EPA has not accounted for. We also expect some indirect or second-order increases in precursor emissions that we will also discuss. As the proposed regulation leads to changes in the relative prices of coal, natural gas and other sources of energy, usage of these and other fuels will change, with further likely increases in emissions from sources other than EGUs.

<u>1. Heat rate improvements</u>

- Emissions associated with manufacturing, transporting, constructing and installing the equipment that provides the heat rate improvements

<u>2. Shift electricity production from carbon-intensive EGUs to less carbon-intensive EGUs (e.g., NGCC units)</u>

- Increased or accelerated retirement of existing EGUs and replacement with new units will entail precursor emissions:
    - Associated with deconstructing existing units, including demolition, cleanup, scrappage, transportation, disposal, and materials recovery

[19] Note that in the criteria pollutant co-benefits analysis in the ESPS RIA, EPA has considered and analyzed only emissions from EGUs. EPA has applied benefits-per-ton figures only for EGUs, not for other sources types. And, EPA has applied these benefits-per-ton figures for EGUs largely, if not exclusively, to projected emissions *reductions* from EGUs and not to potential emissions *increases* from EGUs. It's not clear to us how EPA in the Agency's analysis accounts for EGU emissions in instances where use of a building block will entail some increase in precursor emissions from EGUs as well as some decrease (e.g., redispatch from a coal-fired EGU to a NGCC EGU where the increased use of the NGCC unit would entail some increase in emissions from this unit). EPA might perhaps estimate and include separately in the analysis both the emissions increase at the NGCC unit and the emissions decrease at the coal-fired unit; EPA might address instead the net emissions change across the two units, or EPA might address instead only the emissions reduction at the coal-fired unit.

    - Associated with manufacturing, transporting and constructing new units.
    - Associated with constructing and maintaining transmission lines to the new units.

<u>3. Shift electricity production from carbon-intensive EGUs to low- or zero-carbon EGUs (e.g., renewable, hydro, nuclear units)</u>

- Increased or accelerated retirement of existing EGUs and replacement with new units will entail precursor emissions:
    - Associated with deconstructing existing units, including demolition, cleanup, scrappage, transportation, disposal, and materials recovery
    - Associated with manufacturing, transporting and constructing new units.
    - Associated with constructing and maintaining transmission lines to the new units.
- Combustion emissions from new or existing but more intensively used biomass and RDF units

<u>4. Demand-side energy efficiency measures that reduce the amount of generation required</u>

- Combustion emissions due to marginal shift from electric to gas-fired appliances -- space heating, water heating, clothes driers, ranges, cooktops, etc.
- Emissions associated with manufacture, transportation and installation of residential, commercial and industrial energy efficiency equipment, including, e.g., insulation, energy-efficient windows, controls, more efficient lighting.
- Emissions from Increased or accelerated retirement of energy-inefficient equipment and replacement with new, more efficient equipment (e.g., boilers, heat pumps, air conditioners, lighting).

More generally, the shifts in relative prices for energy from different sources that will result from the proposed ESPS regulation will cause some second-order increases in precursor emissions throughout the economy. EPA projects in 2030 as a result of the proposed regulation that the retail price of electricity will increase by a little more than 3%, the price of natural gas will be unchanged, and the delivered price of coal will decrease by more than 18%. Effects such as the following will occur:

- Electric vehicles will become marginally less attractive relative to conventional-fueled and LPG- or CNG-fueled vehicles. On-road vehicle emissions may increase.
- Cement producers will shift to use more coal and less natural gas. Their emissions will increase.

- Electricity-intensive manufacturing industries such as steel, aluminum, chemicals and pulp and paper may shift to using less electricity generated off-site and combusting more fuels on-site (natural gas, biomass, perhaps coal in some cases).

- Gas-powered equipment and appliances will become relatively more attractive than electric-powered, with precursor emissions thus shifting from EGUs to users' locations.

These examples all represent ways in which precursor emissions from sources other than EGUs may increase as a result of the proposed rule. It is not appropriate for EPA to value only the decreases in combustion-related emissions of $PM_{2.5}$ and ozone precursors from EGUs while failing to account also for increases in precursor emissions from other source types.

7. 98% of EPA's estimated co-benefits involve avoided premature mortality. These estimated mortality benefits would decline sharply, perhaps by as much as 95%, if the Agency were to improve the analysis by estimating and valuing "statistical life-years gained" rather than "statistical lives saved"

Most premature mortalities that EPA contends could be avoided as a result of a reduced $PM_{2.5}$ and ozone concentrations would occur among older populations with many fewer average years of life expectancy remaining than the populations that have been assessed in the studies from which EPA draws the Agency's estimated value of a statistical life (VSL). EPA chooses the Agency's VSL by reference mostly to studies that have evaluated the wage premium paid to workers in hazardous occupations. When deaths occur in these occupations, the deaths usually cut the life expectancy of the deceased worker by 20, 30, 40, or even 50 or more years. In contrast, EPA finds that the premature mortality that the Agency believes may result from exposure to $PM_{2.5}$ and ozone occurs mostly among individuals with many fewer years of life expectancy remaining. In the 2012 RIA for the fine particle NAAQS, for example, EPA projects that half of the premature mortality that may be avoided due to the proposed standard would occur among populations of age 75 to 99. We believe it is inappropriate for EPA to value the statistical lives at risk from $PM_{2.5}$ air pollution -- for populations for whom the potential loss in life expectancy is usually small -- by reference to studies on wholly different populations where deaths involve much greater loss in life expectancy.

In the benefits-per-ton calculations for estimating co-benefits, EPA estimates the value of avoided mortality by multiplying the projected number of *statistical deaths avoided* due to the proposed rule by the Agency's (we believe wrongly) chosen VSL. A better approach for monetizing the benefits of avoiding premature mortality would be for EPA to estimate the number of *life-years gained* as a result of the regulation and then multiply by the value of a statistical life-year (VSLY). This alternative approach has been recommended for regulatory analysis by the Office of Management and Budget, it has been used occasionally in the past by EPA, it is often used by other Federal agencies and by other countries, and it is the preferred practice in valuing mortality benefits in the United Kingdom and for the World Bank. Depending on the particular VSLY that is chosen, this different approach to valuation would reduce the monetized benefits that EPA estimates for the proposed ESPS regulation by between 47% and 95%.

In estimating the monetized value of the premature mortality that EPA projects will be avoided due to the proposed ESPS regulation, the Agency values each avoided premature death at $6.3 million (in year 2000 dollars) or at $10.1 million in 2030 (in 2011 dollars, after increasing the VSL to reflect projected growth in real income between now and 2030).[20] EPA projects that the proposed ESPS regulation would avoid between 2,800 premature deaths per year in 2030 (based mostly on a lower-estimate exposure-response function for $PM_{2.5}$ drawn from Krewski, et al. 2009), and 6,650 premature deaths per year (based mostly on an upper-estimate exposure-response function drawn from Lepeule, et al. 2012). After multiplying these numbers of avoided premature deaths by the estimated $10.1 million value of a statistical life, EPA estimates mortality benefits in 2030 at about $28 to $73 billion per year.[21] These estimated mortality benefits account for about 98% of the total monetized benefits that EPA estimates for the proposed NAAQS.

EPA might alternatively have estimated the monetized value of the Agency's projected reduction in risk of premature mortality by calculating the number of life-years that would be saved or extended rather than the number of premature deaths avoided, and then by multiplying by the value of a statistical life-year (VSLY) rather than by the value of a statistical life (VSL). The VSLY approach would yield lower, and perhaps much lower, estimated benefits for the proposed rule than the VSL approach that EPA has applied.

There has been extensive discussion in recent years about whether VSL or VSLY may be the preferred metric to use in valuing health benefits, about which particular values for each might be assumed for regulatory analysis, and about the degree to which these values may vary with the age of the individuals receiving the health benefit and other characteristics of the risk reduction. We offer several comments:

- The Office of Management and Budget suggests in Circular A-4 and in its "best practices" guidance for regulatory agency analyses pursuant to Executive Order 12866, that agencies present benefits estimates showing both statistical lives saved and statistical life-years saved.[22] EPA has not done so.

- EPA's $6.3 million (in year 2000 dollars) or $10.1 million (in 2030 in year 2011 dollars) VSL figure derives ultimately from the Agency's analysis of twenty-six studies published between 1974 and 1991 that estimated the values that various populations placed on

[20] This VSL value chosen for this analysis is arguably too high. Many researchers have estimated values lower than this. For several years beginning in 2004, EPA's air office used a value about 10% lower than this based on the results derived from three meta-analyses of VSL that were completed subsequent to EPA's adoption of the $6.3 million figure in 2000. OMB in Circular A-4 suggests that the great majority of VSL estimates have been between $1 and $10 million. In addition to choosing a single value for the VSL that is perhaps too high, EPA has failed in the ESPS RIA to portray the very wide range of uncertainty about what the VSL may be.

[21] 95% of these mortality benefits stem from reductions in $PM_{2.5}$ concentrations. 5% stem from reductions in ozone concentrations. EPA subsequently discounts these estimated benefits somewhat to reflect an assumed "cessation lag". EPA presumes that the mortality rate will not decline immediately to its new level following a reduction in ambient $PM_{2.5}$ concentrations; instead there will be some lag in this adjustment process. EPA discounts the raw benefit values shown above to reflect the delay in realizing these benefits.

[22] U.S. Office of Management and Budget. Circular A-4. September 17, 2003.

reductions in mortality risks. Twenty-one of the studies were wage-risk studies in which researchers had estimated the value of mortality risk reduction by examining the degree to which workers receive higher wages for performing more hazardous jobs. Five of the studies used other techniques. In general, the average age of the populations included in the 21 wage-risk studies is in the mid- to late-thirties. The occupationally-related fatalities that occurred among these populations and that the studies were evaluating might each entail an average of twenty to forty years of lost life expectancy. In contrast, most of the statistical deaths that EPA believes can be avoided by regulations like the proposed ESPS occur among older populations with fewer years of life expectancy remaining.[23] In our view, it is inappropriate for EPA to value the premature fatalities avoided by this proposed regulation at the same VSL as has been derived from a set of studies where each avoided premature fatality involves many more years of life expectancy. OMB suggests in Circular A-4:

> "… when there are significant differences between the effect on life expectancy for the population affected by a particular health risk and the populations studied in the labor market studies, they prefer to adopt a VSLY approach to reflect those differences. You should consider providing estimates of both VSL and VSLY…" (page 30)

If EPA were to value mortality benefits for the proposed ESPS regulation using the VSLY approach, the results would depend upon the specific figure the Agency would choose for VSLY. A variety of VSLY estimates have been developed. For example:

- Aldy and Viscusi (2008) estimate a VSLY that varies with age. In one formulation, the VSLY is about $175,000 for workers in their late teens, then rises steadily to peak at $375,000 for workers in their late 40s, then declines rather sharply to near $100,000 at age 62.[24] In another formulation the VSLY is about $50,000 lower than the first for individuals up to their mid-40s, but continues to rise to about $400,000 at age 54, then declines modestly to just below $350,000 at age 62.

- The Food and Drug Administration (FDA) typically uses four different VSLY estimates for sensitivity analyses, ranging from about $100,000 at the low end (based usually on estimates in the health economics literature) to about $500,000 at the high end (based on a VSL value and then estimating the corresponding

[23] EPA does not provide information in the ESPS RIA on the age or life expectancy of the individuals who avoid premature death as a result of the proposed regulation. In the $PM_{2.5}$ NAAQS RIA, however, EPA observes that about half of the avoided premature deaths for that regulation which also focused heavily or exclusively on $PM_{2.5}$ would have occurred in populations age 75-99, and the average number of life years gained per premature fatality avoided would have been about 16.

[24] Aldy and Viscusi, 2008. Aldy, J. E. and W. K. Viscusi (2008), 'Adjusting the value of a statistical life for age and cohort effects'. *Review of Economics and Statistics*. 90(3), 573–581.

discounted value of the additional life years gained with the avoided premature deaths) (Robinson, 2007).[25] See FDA (2011) for a recent example.[26]

- EPA often prepared VSLY estimates from about 1997 through 2003, when the "senior discount" controversy erupted after EPA used VSL values indicating that older individuals are willing to pay less for life-saving interventions than younger adults (Robinson 2007). One of EPA's VSLY values was $293,000 in 1990 dollars, used for the Clean Air Act Prospective Analysis (EPA 1999).

- First Great Britain (DEFRA 2004) and then the European Union (NEEDS 2006) conducted major contingent valuation surveys to develop an independent estimate of VSLY -- not derived by assuming a VSL value as a starting point -- that is intended to be used broadly in a variety of policy contexts.[27] The EU ultimately in 2006 recommended a VSLY value of 40,000 euros for general use in benefit-cost analyses (NEEDS 2006).[28] Many European nations now value mortality benefits by using both the VSL and the VSLY approaches, with the VSL approach almost always providing a higher estimate of benefits (note that the European choice of VSL is usually less than EPA's VSL) and the VSLY approach, based on the 40,000 € figure, providing a much lower estimate (OECD, 2011).[29] The United Kingdom uses the VSLY approach preferentially.

- The Australian Office of Best Practice Regulation provides guidance to other Australian Federal government agencies on procedures to apply in preparing cost-benefit analyses in Regulation Impact Statements. The Office recommends use of a VSLY of 151,000 AUD, roughly equivalent to U.S. $130,000 (OBPR 2008).[30]

Any of these various VSLY estimates, if EPA were to use them, would lead to lower estimates of $PM_{2.5}$ mortality benefits than those EPA calculates in the ESPS RIA.[31] Assuming that the

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[25] Robinson, 2007. Lisa A. Robinson. How U.S. Government Agencies Value Mortality Risk Reductions. *Review of Environmental Economics and Policy*. Volume 1, issue 2, summer 2007, pp. 283-299.

[26] FDA, 2011. U.S. Department of Health and Human Services, Food and Drug Administration. Food Labeling: Calorie Labeling of Articles of Food in Vending Machines NPRM. Preliminary Regulatory Impact Analysis. March, 2011.

[27] DEFRA, 2004. Department for Environment, Food, and Rural Affairs, United Kingdom. Valuation of Health Benefits Associated with Air Pollution. Final Report. May, 2004. NEEDS, 2006. New Energy Externalities Developments for Sustainability. Brigitte Desaigues, et al. Final Report on the Monetary Valuation of Mortality and Morbidity Risks from Air Pollution. September 26, 2006.

[28] 40,000 euros at 2006 exchange rates is equivalent to approximately $50,000 in 2006 dollars.

[29] OECD, 2011. Organization for Economic Co-operation and Development, Environment Directorate, Environmental Policy Committee. Valuing Mortality Risk Reductions in Regulatory Analysis of Environmental, Health and Transport Policies: Policy Implications. ENV/EPOC/WPIEEP(2011)8/FINAL. 17 June, 2011.

[30] OBPR, 2008. Australian Government, Department of Finance and Deregulation, Office of Best Practice Regulation. Best Practice Regulation Guidance Note: Value of Statistical Life. November, 2008.

[31] We are not seriously suggesting that EPA use any of the VSLY figures that have been developed for foreign populations. We cite the foreign VSLY estimates only to show how they compare with estimates for U.S. populations, and to indicate the frequency with which foreign governments have chosen to value mortality risk

average premature fatality avoided due to the proposed ESPS regulation will result in 16 additional life years, as EPA estimated in the $PM_{2.5}$ NAAQS RIA, the VSLY would need to be $802,000 at a 3% discount rate or $1,074,000 at a 7% discount rate in order to yield a present value of benefits equal to EPA's assumed VSL of $10.1 million.[32] Assuming a 7% discount rate and the *highest* of the VSLY values cited above ($500,000, the high end of FDA's range), EPA's mortality benefits calculated in the ESPS RIA using a VSL of $10.1 million would decline by 53% if EPA were to switch to the (we think more appropriate) VSLY approach. Assuming instead a 7% discount rate and the *lowest* of the VSLY values cited above (40,000 € or $50,000, the European Union's recommended value for general application), EPA's mortality benefits calculated in the RIA using a VSL of $10.1 million would decline by more than 95% if EPA were to switch to the VSLY approach.[33]

8. EPA has not clearly defined the baseline for the ESPS RIA, nor has EPA justified whatever the chosen baseline is. The benefits, co-benefits and costs that EPA estimates for the proposed regulation are importantly dependent on whatever EPA has defined the baseline to be. Absent a clear statement of what the baseline is for the analysis and why it was chosen, the RIA is incomplete and very difficult for the public to review.

How much in the way of heat rate improvements, redispatch, fuel switching, additional renewables, demand-side energy efficiency (DSEE) improvements and other measures (i.e., the four building blocks) that EPA envisions as needed to meet the proposed standards would occur in the future anyway, without the ESPS regulation? How much credit for health co-benefits can EPA claim in the RIA if much of the emissions reductions projected by EPA from the four building blocks in order to meet the proposed standards would occur even if the regulation were not promulgated?

As in any RIA, EPA for the ESPS RIA must: 1) define a "baseline" (what the world is projected to look like absent the proposed regulation); 2) Predict what regulated entities will do to comply with the regulation; 3) Estimate what the world will then look like with the regulation (after the regulated entities take the predicted actions); and 4) Calculate costs and benefits based on the differences between (3) and (1). In effect, the costs and benefits that the Agency estimates are a function of both the prediction about what the baseline will look like and the prediction about what the with-regulation world will look like. In the case of the ESPS proposal, if one expects much activity across the four building blocks to occur as a matter of course in the future (i.e., in

reductions in VSLY terms.

[32] Note that individuals will discount the value of an additional year of life in the future relative to an additional year of life at present. Discounting means that the present value of 16 years of extended life, such as EPA might estimate would result on average for each premature mortality avoided due to the proposed rule, is not simply 16 times the VSLY. At a 3% discount rate, the present value of 16 years of extended life is equal to 12.6 times the VSLY, while at a 7% discount rate the present value of 16 years of extended life is equal to only 9.4 times the VSLY.

[33] If the VSLY at a 7% discount rate needs to be $1,074,000 in order to yield a present value for 16 years of life extended that equals EPA's chosen VSL of $10.1 million, then a VSLY of $50,000 would yield only 4.7% as much mortality benefits for the 16 years of life extended as does EPA's VSL of $10.1 million ($50,000 ÷ $1,074,000 = 0.047). Estimated mortality benefits would decline by 95.3%.

the baseline), then not much additional effort will be required to meet the proposed regulatory targets, and benefits and costs as estimated in the RIA should be relatively low.

For this particular rule and RIA, a major analytical problem that EPA faces is that it's very difficult to define the baseline and there will be large uncertainty around whatever baseline is defined. For most rules, EPA plausibly defines the baseline as identical or similar to the current state of the world. This approach doesn't work for this rule, since a) Compliance with this rule is not projected to occur until the period 2020 – 2030, and that time frame provides a long period during which things can change from their present configuration; and b) there is substantial momentum for change already – redispatch and fuel switching are occurring, energy efficiency upgrades are occurring, renewables are increasing, etc. So, for this rule and RIA, EPA has the difficult task of defining a baseline some 10+ years in the future that probably should look substantially different from the present.

How EPA chooses to define the baseline in 2020 -2030 will affect the conclusions from the ESPS RIA. If EPA chooses to define a future baseline that has included much progress on the four building blocks between now and 2020 - 2030 by both utilities and consumers, then little further effort will be needed to achieve the proposed regulatory targets and both benefits and costs will be low. Or conversely, if EPA chooses to define a baseline that includes little progress between now and then, meeting the regulatory targets will require much effort and benefits and costs will be much higher.

However, another line of argument could suggest that defining the baseline for this RIA may not be so important. A key issue in any RIA is whether net benefits are positive -- do benefits exceed costs, and if so by how much? But if costs and benefits both go up or down in tandem with the choice of baseline, then one might expect that net benefits would be much less affected by the choice of baseline than either costs or benefits alone would be affected.

For the proposed ESPS regulation in particular, we disagree with this argument to the effect that defining the baseline will have relatively little impact on net benefits. To the contrary, the choice of baseline here will have a major effect on the estimated net benefits for the rule as well as on costs and benefits individually.

Electricity producers and distributors and residential, industrial and commercial consumers currently have available to them a vast array of opportunities to improve heat rates, redispatch, switch fuels, deploy renewables, and/or improve efficiency and conserve energy. Imagine rank-ordering these opportunities in terms of decreasing cost-effectiveness with regard to CO_2 emissions. At the top of the rank order, some of the best possible efficiency measures may generate economic returns to the initiator sufficient to cover their costs and the resulting CO_2 reductions are "free" or even profitable; other measures may be moderately cost-effective in yielding emission reductions at a reasonable cost per ton; and other measures at the low end of the rank order would cost a very large amount per ton of CO_2 emissions abated. How far down this cost-effectiveness list EPA assumes the nation will have gone in the baseline by 2020-2030 will determine what set of opportunities remains available at that point for compliance with the regulation. Does EPA assume that the highly cost-effective measures are "used up" before 2020 in the baseline, thus leaving only high cost/low effectiveness measures available for regulatory compliance, thus causing the RIA to show a poor ratio of benefits to costs for the proposed regulation? Or might EPA define the baseline in an opposite manner, assuming for the baseline that various market barriers will prevent the private and public sectors from implementing many of the cost-effective energy efficiency opportunities, thus leaving many of them as available to be induced (profitably!) by the proposed regulatory intervention. In short, we believe that perhaps the most important respect in which EPA defines the baseline -- at least in terms of the conclusions that are reached in the RIA -- is in projecting what portion of the cost-effective energy efficiency opportunities that are thought to exist now will still be available and not be "used up" by the time when regulatory compliance will begin to occur.

How much opportunity for energy efficiency and fuel switching exists now, how many of these opportunities will be "used up" between now and 2020-2030, and what will the remaining opportunity set then look like at this future time are all important elements of EPA's decision about how to portray the baseline for the ESPS RIA.

Unfortunately, given the importance of the baseline definition to the conclusions of the RIA, it is not at all easy to review, understand and critique how EPA has chosen to define the baseline for this analysis.

First, nowhere in the RIA does EPA explicitly state what the Agency has defined the baseline to be. In many RIAs EPA includes a section detailing the specific changes from the present that are assumed to be included in the baseline, but not for this RIA. In some other RIAs (those for NAAQS revisions, for example, which pose somewhat similar issues as the ESPS insofar as compliance dates are far in the future and much can happen between now and then) -- but again not for this RIA -- EPA explicitly defines the assumed baseline in part by providing detailed emissions projections for each source or each type of source for the future year being analyzed.[34] In the ESPS RIA, though, EPA never clearly states what the baseline assumptions for 2020, 2025, or 2030 are, nor does the Agency even list the data elements that are addressed in the baseline. We expect in defining the baseline for this sort of analysis that EPA would need to address issues such as which of the electricity generating units (EGUs) that now exist will be on-line in these future years and which will not, which new EGUs are assumed to be brought on line

[34] In the RIA for the 2012 revisions to the PM NAAQS, for example, EPA provided great detail on how the Agency developed the baseline emission projections for the year 2020 for the various precursor pollutants for each source category. For non-EGU point sources, for example, EPA: 1) began with the emission estimates for each source in Version 2 of the 2008 National Emissions Inventory; then 2) estimated the reductions in emissions that would occur between 2008 and 2020 due to each of many adopted-but-not-yet-fully-implemented regulations, SIPs, consent decrees, and other requirements; then 3) projected additional changes in emissions due to an assumed relationship between emissions for the sector and projected growth in economic output from the sector (in the case of non-EGU point sources EPA assumed there would be zero growth in this sector's emissions with future growth in economic output); and finally 4) projected baseline emissions in 2020 for each source as the result from steps 1, 2 and 3.

during this period, and the efficiency (heat rate), costs of power generation, emissions and opportunities for heat rate improvements from each. And, if the RIA is to provide a reasonably careful and thorough analysis of the impacts of the proposed regulation, we believe when defining a baseline that EPA would likely need to include projections regarding many more dimensions of how the world in 2020 - 2030 will look in the absence of the regulation, for example:

- Projections regarding the installed capacity for various renewable power sources and for nuclear power. In order to make these projections in a credible manner, we presume that EPA would need to have considered the full range of factors that significantly affect the demand and supply for renewables and nuclear energy, including, for example the likely prices for competing fossil energy sources and the existence and level of governmental requirements or subsidies for renewable energy sources.

- Projections regarding the opportunities for demand-side energy efficiency (DSEE) and the degree to which DSEE measures will have been implemented. In particular, EPA should reflect in the baseline the Agency's judgment about whether, by 2020, all of the DSEE measures that can pay for themselves -- i.e., all the measures that it's reasonable to assume would be implemented by individuals acting in their self-interest -- will have been implemented in the baseline. Or does EPA leave many cost-effective DSEE measures as not yet implemented in the baseline, thus making them available as low cost or even profitable actions that regulated entities can implement when complying with the proposed ESPS regulation?

EPA provides virtually no information in the ESPS RIA about what the assumed baseline is, which topics it covers, and whether the baseline is defined in sufficient depth and breadth to address issues that we believe to be important such as those listed above. We presume that at least some information on what EPA's baseline assumptions are may be available somewhere in the documentation and/or model runs of the Integrated Planning Model (IPM) that EPA uses to simulate the power sector for the ESPS RIA, but these are likely not easy materials to review. EPA is quite remiss in not providing a chapter in the ESPS RIA that describes what the chosen baseline is.

Second, EPA provides no information to help the reader in judging whether the manner in which the Agency has chosen to define the baseline is reasonable. EPA has not explained in any document that we have been able to find why the Agency defines the baseline as it has. EPA has not discussed any possible alternative definitions of the baseline, nor has the Agency discussed strengths or weaknesses or misgivings about the Agency's chosen definition. The reader of the RIA and other regulatory support materials is left completely on his own to judge whether EPA's baseline is realistic or not. The range of subject matter expertise that the reader must possess in order to evaluate the chosen baseline is very wide -- one must know not only about status and trends regarding coal and gas-fired power plants, but also about renewable energy sources, about prices and supply/demand issues for coal, gas, nuclear and renewables, about opportunities for increased efficiency in all forms of power production, about progress and prospects for further efficiency improvements in residential, industrial and commercial energy use, about the workings of existing credit and allowance programs, and more. It would quite helpful if EPA were to provide the reader of the RIA with information about all these topics and to explain why the Agency chose to make the specific projections for each that have been included in the baseline.

In sum, the definition of the baseline for the ESPS regulatory impact analysis is very important in affecting the benefits, costs and net benefits that are estimated for the proposed rule. Unfortunately, in the RIA EPA fails even to present the baseline that has been assumed for the analysis, much less going further to explain or justify the particular choices that have been made in defining the baseline. EPA's failure in the RIA to address the baseline violates the requirements laid out in the RIA guidance manuals issued by each of OAQPS, EPA and OMB:

> "[OAQPS] analysts should: … clearly describe the assumptions underlying the specification of the baseline … and the reasons why the chosen specification is appropriate." (*OAQPS Economic Analysis Resource Document*, April 1999)

> "In specifying the baseline, analysts should employ the following guiding principles … : 1) Clearly specify the current and future state of relevant economic variables, the environmental problem that the regulation addresses and the regulatory approach being considered; 2) Identify all required parameters for the analysis; … 4) Clearly identify all assumptions made in specifying the baseline conditions; … 7) Detail all aspects of the baseline specification that are uncertain …" (National Center for Environmental Economics, U.S. EPA. *Guidelines for Preparing Economic Analyses*, December, 2010)

> "The baseline represents the agency's best assessment of what the world would be like absent the action. To specify the baseline, the agency may need to consider a wide range of factors and should incorporate the agency's best forecast of how the world will change in the future, with particular attention to factors that affect the expected benefits and costs of the rule. For example, population growth, economic growth, and the evolution of the relevant markets should all be taken into account. … The analysis should focus on benefits and costs that accrue to citizens and residents of the United States." (Office of Information and Regulatory Affairs, U.S. Office of Management and Budget. *Regulatory Impact Analysis: A Primer*)

> "You should also discuss the reasonableness of the baseline[s] used in the … analyses. For each baseline you use, you should identify the key uncertainties in your forecast." (OMB. *Circular A-4*. September, 2003)

9. EPA overestimates the climate benefits of the proposed ESPS regulation.

We have directed our critique on benefits issues to EPA's estimated co-benefits involving criteria air pollutants. In our review, we have not addressed EPA's estimated climate/CO_2

benefits. In this final section of this paper, we very quickly reiterate and summarize the recent comments on EPA's estimated climate benefits that were provided by a large coalition of industry groups in response to OMB's invitation for public comments on the Administration's "social cost of carbon" (SCC) estimates.[35]

EPA estimates climate benefits for the ESPS proposal by applying the estimated "social cost of carbon" to the volume of CO_2 emissions that the Agency projects will be abated. The industry coalition provided the following criticisms of the SCC estimates:

- There has been a lack of transparency and peer review in the process by which the estimates were generated.
- The IWG should supplement the record to provide all of the data, models, assumptions and analyses relied on to arrive at the SCC estimates and should allow the public a reasonable opportunity to review and comment on the supplemented record.
- The SCC estimates reflect an inadequate treatment of uncertainty, including particularly the inappropriate recognition of divergent model assessments and failure to represent central as opposed to high end estimates.
- The modeling does not provide an acceptable range of accuracy for use in policymaking.
- The SCC estimates should reflect only domestic rather than worldwide values. When the SCC estimates are to be used in benefit-cost analyses for U.S. regulations where the costs that are estimated are those borne by U.S. industries and consumers, it is not appropriate to count benefits that will be accrued by populations outside the U.S. that will not incur any of the estimated costs of the regulation. It is not appropriate to estimate benefits across a much different population than that for which costs are estimated.
- The modeling overestimates the probability of extreme events.
- The SCC estimates do not accurately characterize the damage functions included in the models.
- The choice of discount rates for the analysis is very important, has not been subjected to peer review, and the particular rates that have been chosen diverge from OMB guidance.
- The SCC estimates are projected for excessively long model time horizons, far beyond those for which the IPCC, for example, provides projections of climate impacts.

[35] Comments of the American Chemistry Council and 18 other industry groups on the Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order No. 12866; Docket ID OMB-OMB-2013-0007; filed on February 26, 2014.