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The Role of Health Co-Benefits in EPA's Regulatory Impact Analyses

Scott Bloomberg

Vice President

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Insight in Economics™

Presentation Outline

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- Introduction
- Background on Health Co-Benefits
  - Role in the Regulatory Impact Analysis (RIA)
  - EPA's Methodology for Calculating Health Co-Benefits
- NERA's Analysis of Co-Benefits in the Proposed Clean Power Plan (CPP) RIA*

* The following analyses are based on information in the EPA's Proposed CPP RIA. While some numbers have changed in the final CPP RIA, the methods and approaches are identical, and thus conclusions apply equally to the Final CPP RIA.

Materials in this presentation were initially developed as part of a report for the Virginia Department of Environmental Quality (DEQ). The full report is available at: http://leg2.state.va.us/dls/h&sdocs.nsf/By+Year/SD152015/$file/SD15.pdf

Role in RIA: EPA Includes Health Co-Benefits as Part of its Net Benefits

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Summary of EPA Cost-Benefit Comparison in Proposed CPP's RIA (for Option 1 – State Implementation, billions of 2011$)

	2020	2025	2030
Climate Benefits (all mean SCC values)	$4.9 to $26	$7.6 to $37	$9.5 to 44
Air Pollution Health Co-Benefits (3%)	$17 to $40	$23 to $54	$27 to $62
Total Compliance Costs	$7.5	$5.5	$8.8

Source: Proposed CPP RIA, Tables ES-8 to ES-10. Air pollution co-benefits include ambient $PM_{2.5}$ and ozone changes . Climate benefits are for all 3 mean Social Cost of Carbon (SCC) values used in the RIA, for discount rates ranging from 2.5% to 5%; Co-Benefits are for the 3% discount rate, which is most consistent with discount rates for the SCC values.

EPA's estimated co-benefits are about as large as its estimated climate benefits, helping to justify that the proposed CPP's benefits will exceed its compliance costs

EPA's Methodology: The RIA for the Plan Uses a Simplified "Benefit-Per-Ton" Calculation

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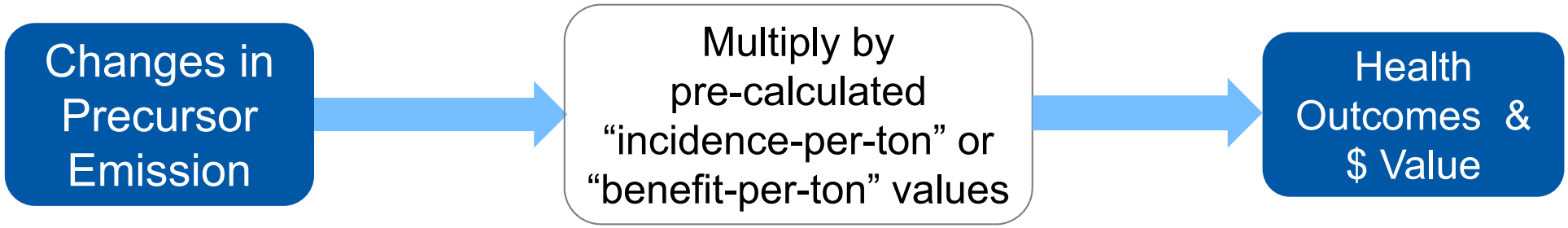
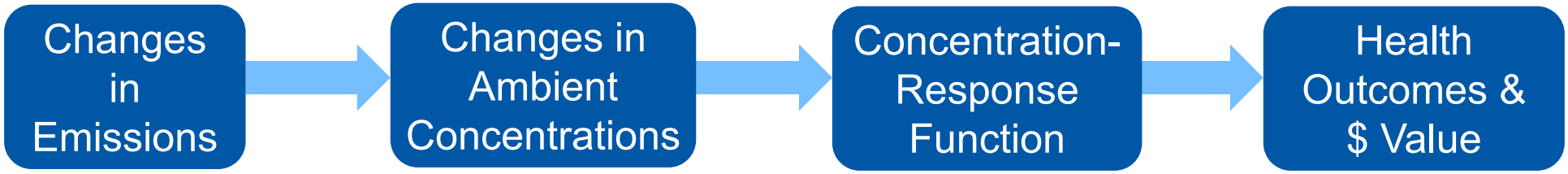
THE PROPOSED CPP RIA USES A SIMPLIFIED APPROACH:



INSTEAD OF (LOCATION, LOCATION, LOCATION):



e.g., using IPM model for EGU emissions

e.g., using CAMx or CMAQ models

Simple curve derived from epi studies; EPA applies using its BenMAP model

# of deaths, value of statistical life, morbidity

EPA's simplified approach removes all of the location-specific information. Why is location important?

Why is Location Important?
Reason #1

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- Under EPA's approach, the reduction of a ton emitted upwind of NYC is assumed to have the same benefit as the reduction of a ton emitted upwind of the Atlantic Ocean, or of a rural location

Numerical Example using BenMAP:

Using mortality risk function for lower $/ton value (Krewski *et al.*),
… Reduce ambient $PM_{2.5}$ by 1 μg/m^3,
… Estimate benefit in 2 locations of same area (144 sq km):

➔ *56-fold difference in benefit per unit pollutant change:*

Rural (Blacksburg, VA):	1.26 deaths per year
Urban (Manhattan, NYC):	70.98 deaths per year

*The benefit-per-ton approach would assign the **same** value to both locations*

Why is Location Important?
Reason #2

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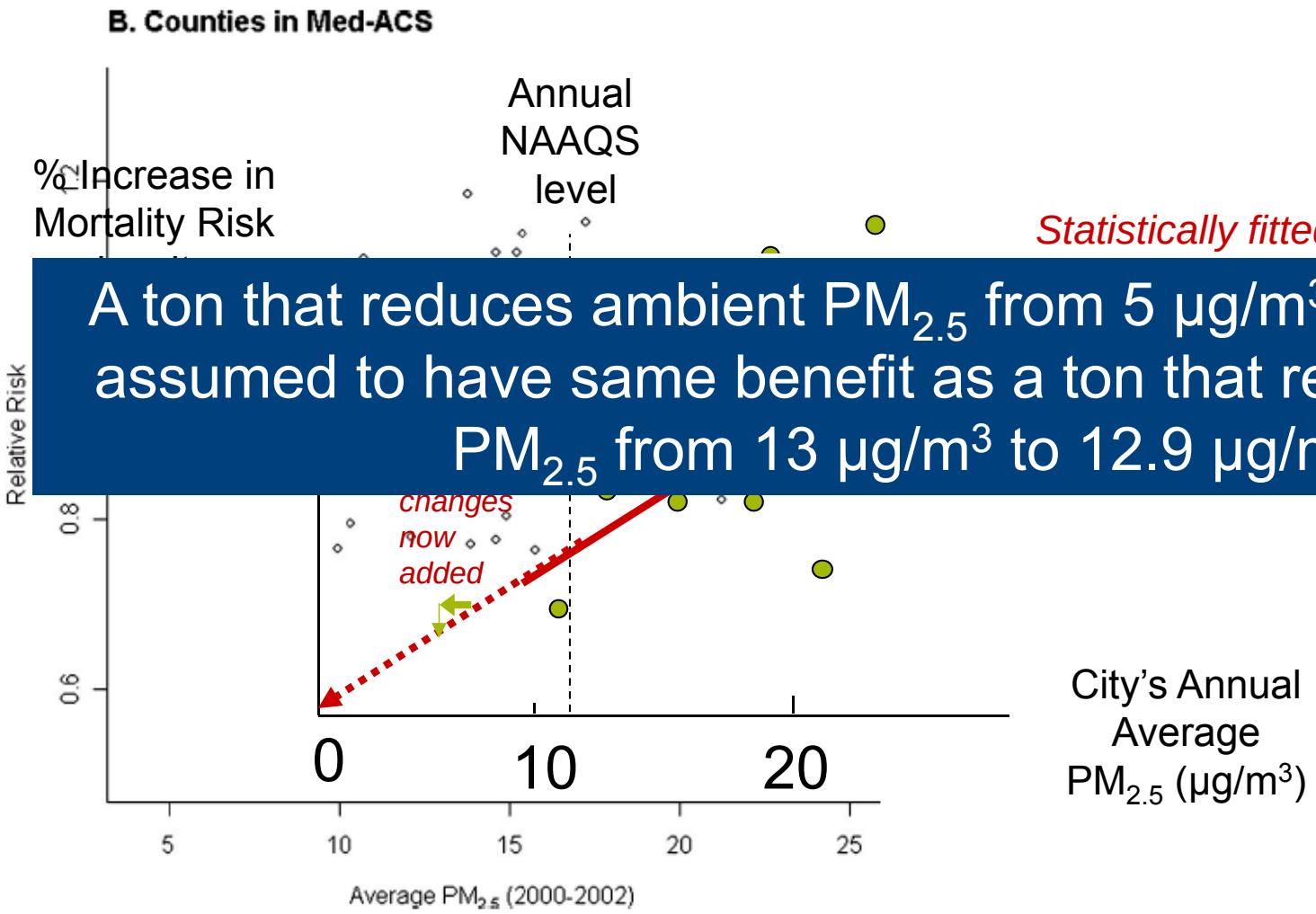
ILLUSTRATIVE DATA



A ton that reduces ambient $PM_{2.5}$ from 5 µg/m³ to 4.9 µg/m³ is assumed to have same benefit as a ton that reduces ambient $PM_{2.5}$ from 13 µg/m³ to 12.9 µg/m³

City's Annual Average $PM_{2.5}$ (µg/m³)

Source: Eftim *et al. 2008.*
"Fine Particulate Matter and Mortality – A Comparison of the Six-Cities and American Cancer Society Cohorts with a Medicare Cohort"
Epidemiology 19(2):209-216

Comparison of SO_2 Reduction Locations to Ambient $PM_{2.5}$ Concentrations (EPA 2020 Projection)

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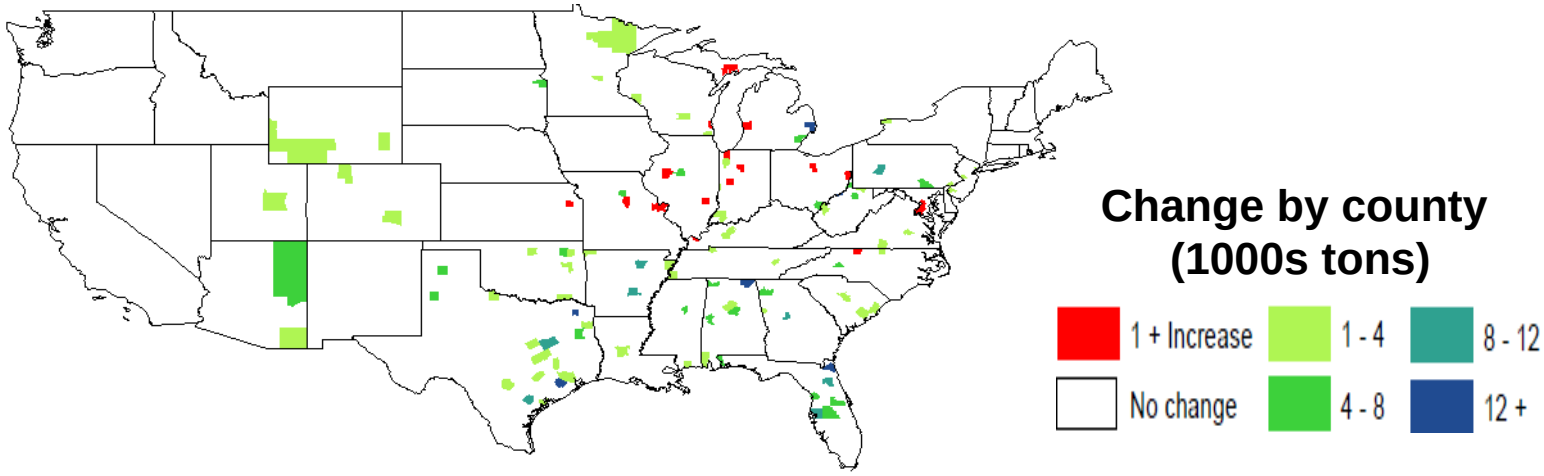
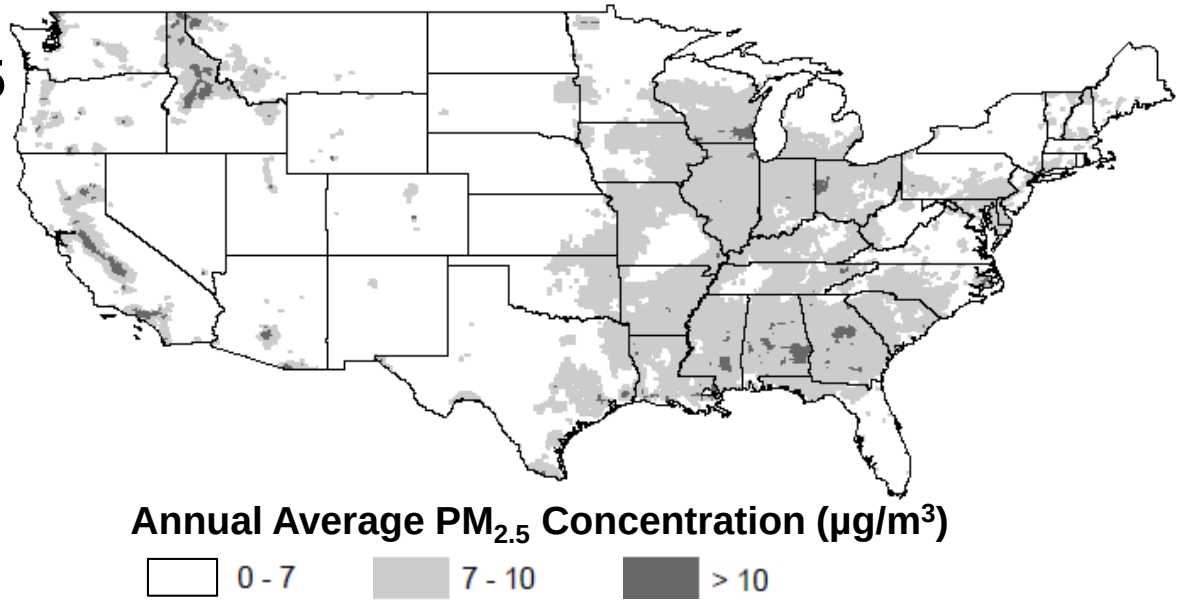
SO_2



$PM_{2.5}$



Source: NERA mapping of EPA's Input files for benefits analysis in 2012 $PM_{2.5}$ NAAQS RIA – 2020 projection under attainment of annual $PM_{2.5}$ NAAQS of 12 µg/m^3; NOX reductions have similar pattern

97-98% of Plan's Co-Reductions Occur in Areas with $PM_{2.5} \leq 10\ \mu g/m^3$

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2025 SO_2 Emission Changes in Plan RIA (Thousands of Tons)

County-Level 2020 $PM_{2.5}$ Concentration	SO_2 Reductions	SO_2 Increases	Net SO_2 Reductions	% of Net SO_2 Reductions
$\leq 7\ \mu g/m^3$	190	19	171	**40%**
> 7 and $\leq 10\ \mu g/m^3$	292	49	243	**57%**
$> 10\ \mu g/m^3$	10	2	8	2%
No County Information	5	2	3	1%
Total	497	72	425	

98% of NO_X Reductions occur at concentrations less than or equal to $10\ \mu g/m^3$

Almost all $PM_{2.5}$ co-reductions are in areas expected to attain even a potentially future tightened $PM_{2.5}$ NAAQS

EPA's Approach to Health Co-Benefits Raises Significant Credibility Issues

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- Almost all of the Plan's co-reductions occur in areas well below current and likely future NAAQS levels
- EPA evaluates the same epidemiological evidence to set NAAQS at a level to protect the public health with an adequate margin of safety
- By attributing health benefits for reductions of $PM_{2.5}$ concentrations below the NAAQS level, EPA is effectively assuming an equal probability of public health risks below the standard as above it
- Risk estimates calculated below a NAAQS, using extrapolations of epidemiological evidence are inherently of a much lower degree of credibility/confidence
- ….and my analyses have demonstrated that almost all of the proposed CPP's health co-benefits lie well within this low-credibility range

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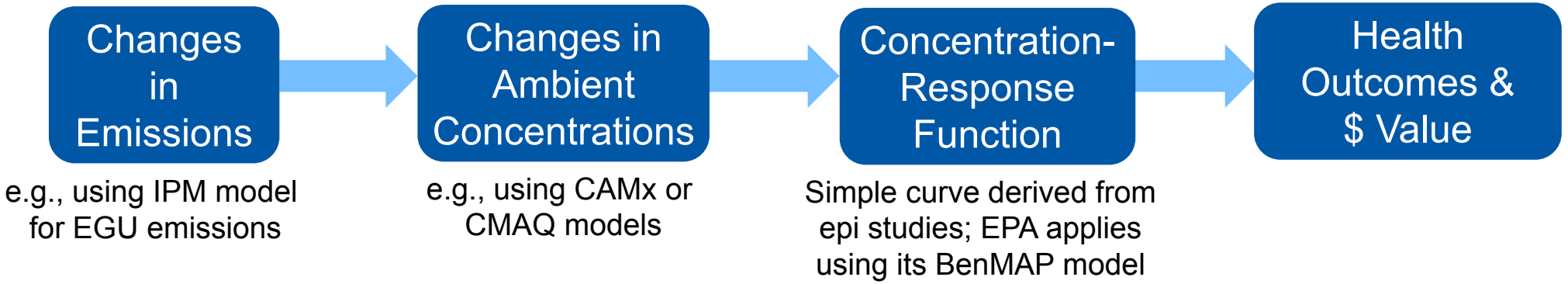
Appendix

Ambient Pollutant Risks Combine Air Quality Model Projections with Epidemiologically-Based Risk Functions



- Air quality modeling determines how location-specific emissions changes translate into location-specific ambient pollutant concentration changes
- Concentration-response functions are used to determine health risk levels – by location
  - Concentration-response relationships are usually derived from population-scale statistical associations of health endpoints and pollutant levels (epidemiological studies)
  - Many analyst judgments are implicit in choosing to create a C-R function for the risk calculations from a statistical association

The Basis for the Benefits-per-Ton Factors

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- Derived in an earlier analysis (Fann *et al.*, 2012) of national $PM_{2.5}$ due to total national emissions
  - Estimated effect on total ambient $PM_{2.5}$ of *all* emissions from a sector were used to estimate air pollutant health effects due to that sector & divided by total tons from each sector (for each separate precursor type)
  - Later re-computed to disaggregate to 3 U.S. regions
- Similar (less well documented) analysis later done for ozone
  - Ozone co-benefits are in the Plan's RIA, but account for only 4% to 8% of the Plan's total co-benefits estimates

Resulting co-benefits estimates lack locational specificity (e.g., level of air quality and population density)

Examples of Benefit-Per-Ton Values Used in Plan RIA

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Benefit-Per-Ton Values for $PM_{2.5}$ Precursor Emissions in 2025 from Electric Generating Units
(2025 Emissions, 3% Discount Rate, 2011$/ton)

Region	SO_2	NO_X (as $PM_{2.5}$)
East	$44,000 to $98,000	$7,200 to $16,000
West	$8,800 to $20,000	$1,300 to $2,900
California	$180,000 to $410,000	$19,000 to $42,000

- Vast majority of value – and determinant of the range – is mortality risk
  - There is an associated range of "deaths-per-ton" used in the RIA
- The ranges of values above reflect two different $PM_{2.5}$ epidemiological studies for mortality risk (*i.e.*, Krewski *et al.* and Lepeule *et al*.) and no other forms of uncertainty
- All location-specific concerns are lost

Illustration of $PM_{2.5}$ Mortality Calculation in the Plan's RIA

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Changes in Precursor Emissions → Deaths-per-Ton Value(*) → Avoided Deaths (**)

	2025
SO_2 Base Case	1,515
SO_2 Policy Case	1,090
SO_2 Reductions	**425**
NO_X Base Case	1,587
NO_X Policy Case	1,151
NO_X Reductions	**436**
PM Base Case	209
PM Policy Case	145
PM Reductions	**63**

Source: Plan RIA, Table ES-2

Avoided $PM_{2.5}$-Related Deaths	**2025**
Low Estimate (Krewski *et al.*, 2009)	2,400
High Estimate (Lepeule *et al.*, 2012)	5,400

Source: Plan RIA, Table 4-17

(*) Deaths-per-ton are reported in Tables 4A-5 to 7 (for $PM_{2.5}$) and 11-13 (for ozone) of Plan RIA.

(**) Actual calculations are by region; majority of Plan's reductions & health outcomes are in East.

Relationship Between Incidence and Monetized Benefits

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Avoided $PM_{2.5}$-Related Deaths × Value of Statistical Life = $PM_{2.5}$ Mortality Co-Benefits

Avoided Deaths	2025
Low Estimate (Krewski *et al.*, 2009)	2,400
High Estimate (Lepeule *et al.*, 2012)	5,400

Source: Plan RIA, Table 4-17

2025 VSL (Millions of 2011$)
$10.1

Source: Plan RIA, p. 4-22

Total $PM_{2.5}$ Co-Benefits(*) (2011$)	2025
Low Estimate (Krewski *et al.*, 2009)	$23 billion
High Estimate (Lepeule *et al.*, 2012)	$50 billion

Source: Plan RIA, Table 4-14, excluding ozone co-benefits

(*) Table includes $PM_{2.5}$ morbidity benefits as well as the $PM_{2.5}$ mortality co-benefits; $PM_{2.5}$ mortality is up to 99% of total $PM_{2.5}$ co-benefits (per Fann *et al.*, 2012). Values calculated differ from table due to rounding at each step in Plan RIA reporting.

NERA Has Identified Locations of Plan's Co-Reductions (as of 2025)

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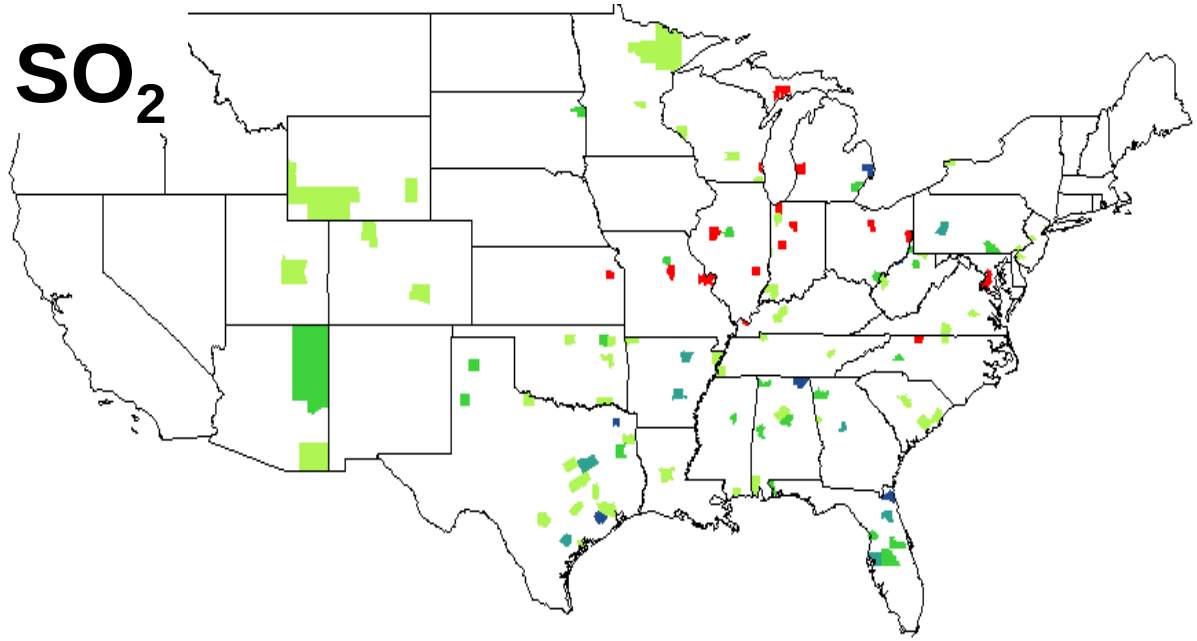
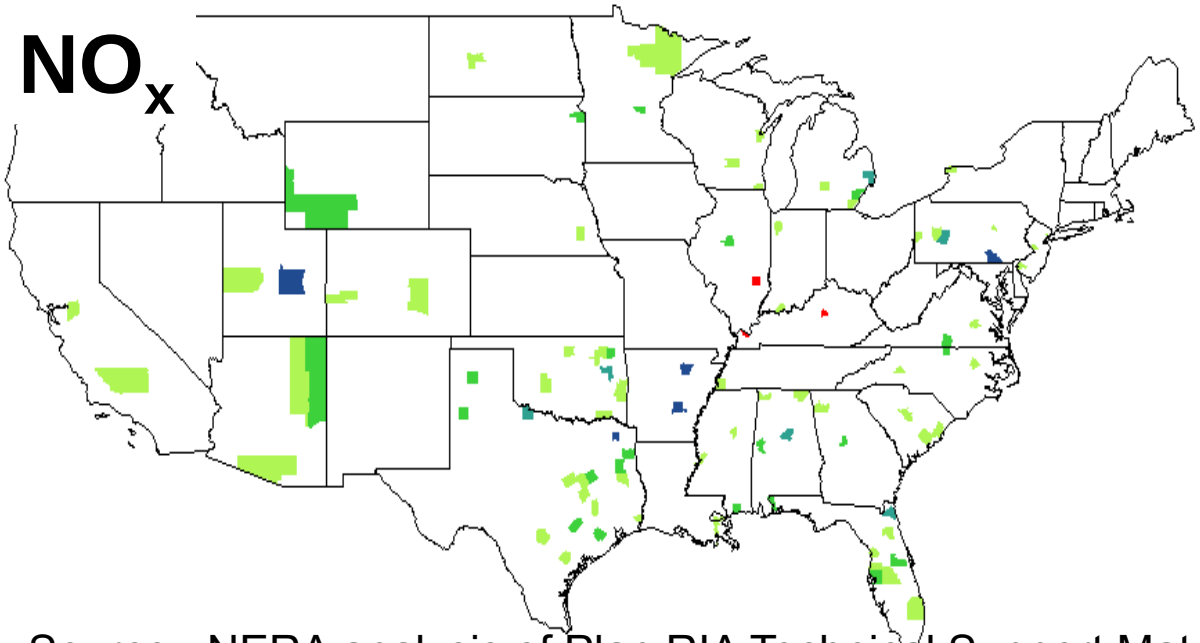
SO_2



NO_x



- Locations of SO_2 and NO_x are similar because Plan's co-reductions are entirely due to unit generation changes
- Some locations have increased precursors

Change by county (1000s tons)

1 + Increase	1 - 4	8 - 12
No change	4 - 8	12 +

Source: NERA analysis of Plan RIA Technical Support Materials – IPM Parsed Files

Comparison of Reduction Locations to Projected Ozone Levels in 2025

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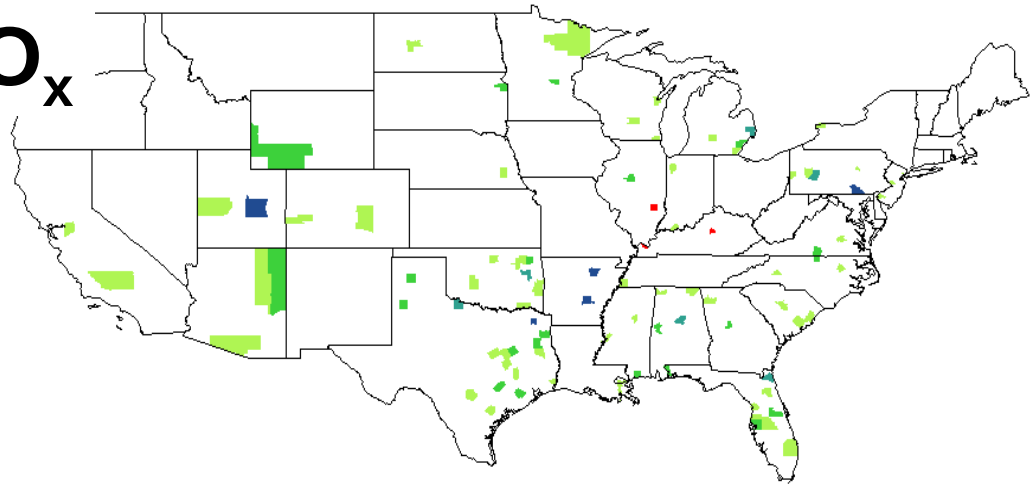
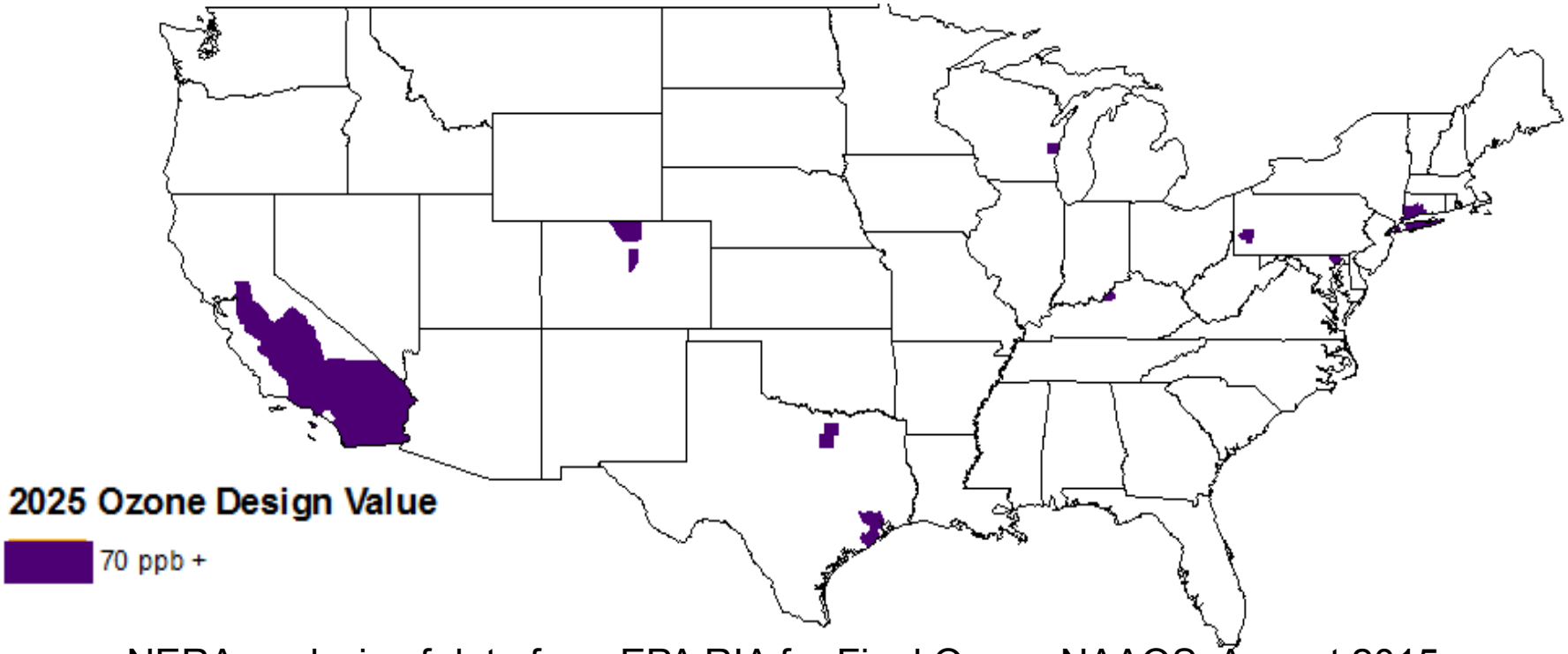
NO_x

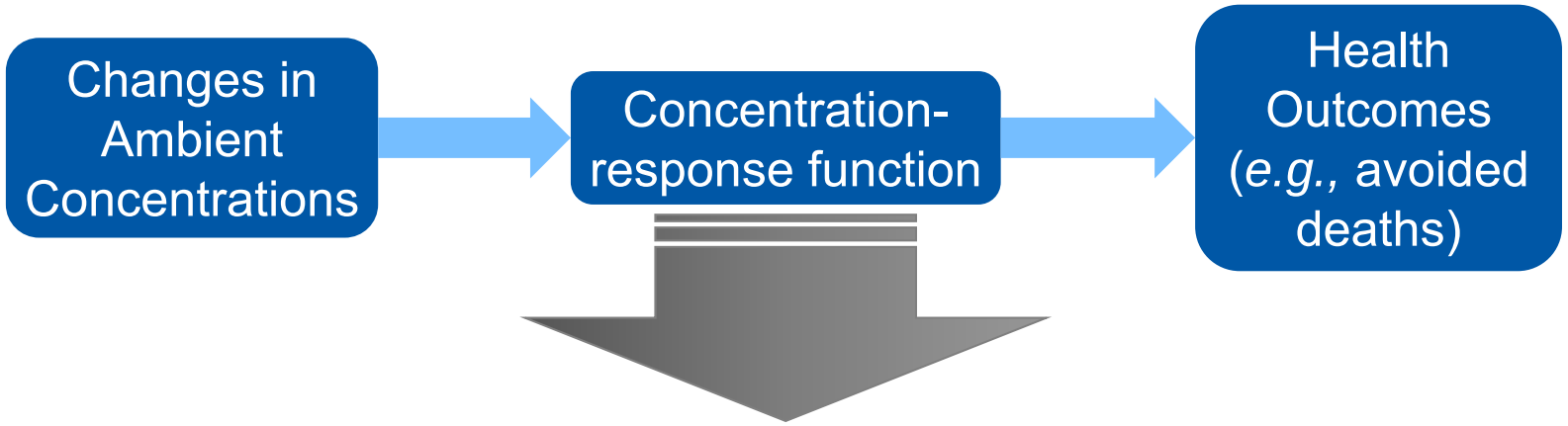


Some overlap, but most NO_x co-reductions are in areas projected to be already attaining the new ozone NAAQS by 2025



Source: NERA analysis of data from EPA RIA for Final Ozone NAAQS, August 2015 –mapping of 2025 ozone design values by county for Base Case (i.e., before any reduction due to the Plan)

Risks Estimated at Low Ambient Levels Have Limited Credibility Because They Are Out-of-Sample Extrapolations



- Are based on concentration-response functions derived from statistical (epidemiological) associations
  - These studies are based on historically higher pollutant levels
- The benefit-per-ton estimates assume risks from a unit of pollutant at a very low concentration has same magnitude as risk from exposure to much higher concentrations
  - This extrapolation ignores potential thresholds outside of the range of epidemiological data on which risk function is estimated