

## **Appendix 5A: Stylized Version of the Script Used for Discussions with Senior EPA Officials**

Thank you for agreeing to participate in this U.S. Environmental Protection Agency (EPA)-sponsored project on the presentation of risk, cost, and benefit information to high-level decisionmakers at EPA. As you may know, a 2002 National Research Council (NRC) study recommended that EPA incorporate greater information about the uncertainties associated with risk, cost, and benefit information into the regulatory decision framework. Most recently, the Office of Management and Budget (OMB) has mandated the use of formal uncertainty analysis in regulatory impact analyses (RIAs) for extremely large rules—those with annual economic impacts in excess of \$1 billion.

While part of the Resources for the Future (RFF) study is quite technical, we are here today to get your ideas on the most useful way of presenting the results to senior decisionmakers. Our approach is to display the results of a case study on the basis of a hypothetical rule change—namely, further tightening the nitrogen oxides (NO<sub>x</sub>) standard starting around 2020. After providing you some background information on NO<sub>x</sub>, we will present estimates of the risks, costs, and benefits of the hypothetical rule along with some alternative visual ways of conveying the uncertainties associated with these estimates. We will ask you to react to these different formats, and then we will also ask you a series of broader questions about the whole area of uncertainty analysis. On the basis of your responses and those of other senior decisionmakers, we will prepare a summary report for EPA without identifying individual responses.

As you know, NO<sub>x</sub> is an air pollutant of concern because it contributes to the formation of fine particles, including particulate matter smaller than 2.5 microns (PM<sub>2.5</sub>) and ozone. PM<sub>2.5</sub> has been linked to premature mortality, chronic bronchitis, heart attacks, and respiratory problems. Ozone causes changes in lung function and respiratory symptoms and aggravates asthma and other respiratory conditions. Recently published studies suggest that ozone may also contribute to premature mortality. Nitrogen deposition also has broad-scale ecological impacts, but they are also excluded from the analysis because we are focusing on health impacts.

Recent regulatory actions affecting mobile and stationary sources are projected to reduce NO<sub>x</sub> emissions substantially by 2018—to roughly 40–50% below 2001 levels. In the electric power sector, which contributes almost one-quarter of total NO<sub>x</sub> emissions,

EPA estimates that after full implementation of the Clean Air Interstate Rule (CAIR), total emissions will still be about 2.4 million tons per year in 2018–2020.

In terms of health impacts, EPA's so-called best estimates of the effects of the CAIR rule—which includes major sulfur dioxide (SO<sub>2</sub>) and NO<sub>x</sub> reductions—are that premature mortality would be reduced by 17,000 deaths per year and that 22,000 nonfatal heart attacks, 12,300 hospital admissions, and 1.7 million lost work days would be avoided. Although EPA has not officially broken out the NO<sub>x</sub> component of those reductions, about 10% is probably attributable to NO<sub>x</sub>. Overall, EPA estimates that by 2015, the annual benefits of the rule will be about \$100 billion per year—more than 25 times the estimated costs—mostly in the form of reduced mortality.

Our hypothetical regulatory option involves further NO<sub>x</sub> reductions in the power sector—probably the most cost-effective source of such reductions—starting in 2020. As noted, annual emissions from the electric power sector are projected to be about 2.4 million tons in 2020. Our most stringent option involves reducing NO<sub>x</sub> by another 900,000 tons, or about 40% below the expected baseline. Our intermediate option involves emission reductions of about half that level, or about 20% below baseline.

It is important to note that with some minor differences, we rely on standard EPA assumptions about both the health effects and control costs. Yet even within this framework, many uncertain factors figure into the estimation of risks, costs, and benefits. For example, there are uncertainties about dose–response functions, the size and spatial distribution of the affected population in the future, the expected change in future natural gas prices, and other factors. There are also uncertainties about the economic valuation of mortality and morbidity effects. The results we will show you focus on the uncertainties in all these factors and how they could affect the overall estimates.

Clearly, other uncertainties exist that we do not consider in our analysis. For example, further research could increase (or decrease) our concern about ozone mortality effects. Alternatively, new lower-cost NO<sub>x</sub> control technologies may become available. Although uncertainties undoubtedly exist with respect to the costs of the regulation, we have not included them in the analysis for this presentation.

Consistent with the OMB requirements, our presentation today focuses primarily on estimated costs and benefits of alternative regulatory options. However, as noted, uncertainty can also be presented in terms of physical effects, such as mortality and

morbidity. At the end of this presentation, we will seek your views on the usefulness of presenting uncertainty information for physical effects as well as monetized values of benefits.

## **Text for Table 5A-1**

Now that you have an understanding of the approach we are pursuing, I want to show you an initial table for one of the options. This table presents the best estimate for the net benefits of the stringent NO<sub>x</sub> policy in 2025, along with a 90% confidence interval. On the basis of our modeling assumptions, this means that there is a 90% chance that the net benefits will fall between these two numbers. The numbers are uncertain for the reasons outlined above (i.e., questions about dose–response functions, the size of the affected population, the valuation of human health effects, and other factors). We can compare this with similar information for the other policy (also shown in Table 5A-1).

Looking at this information, how would you choose between the options? Do you feel you have enough information to make a decision?

**Table 5A-1. Comparison of Alternative Policy Options for Post-CAIR Rule: Net Benefits in 2025 (Millions of Dollars Annually)**

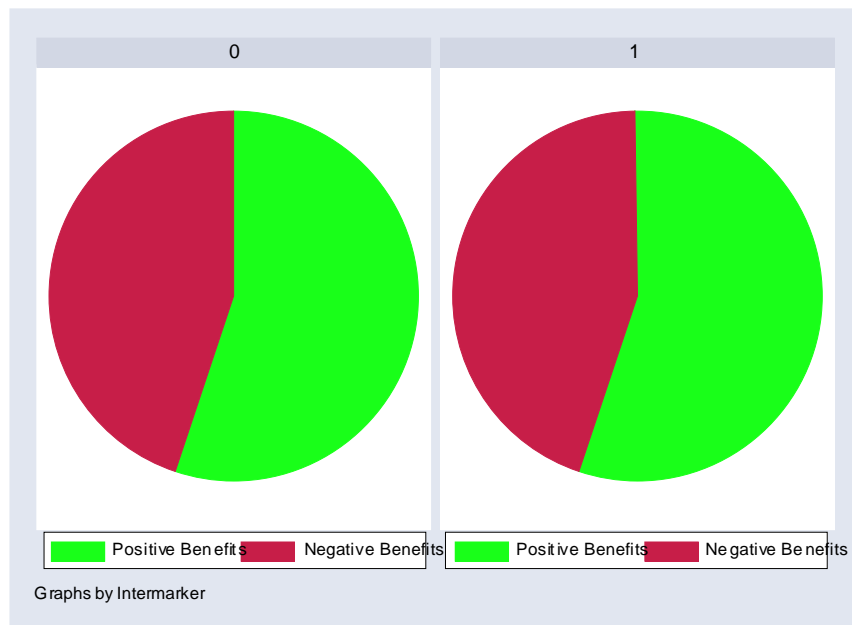
<i>NO<sub>x</sub> Standard</i>	<i>Mean</i>	<i>25th Percentile</i>	<i>75th Percentile</i>
Stringent	11.2	-307.5	296.2
Intermediate	9.6	-165.7	170.9

## Text for Figure 5A-1

This simple pie chart shows the probabilities that net benefits are above zero for each of the two options. The area highlighted in green represents the probabilities that net benefits are above zero. The probability that each policy will produce net benefits is virtually identical, as you can see from this graph.

The information here is somewhat limited, but do you find it helpful as a way of focusing your attention on the probabilities? In combination with the simple tabular information, does this chart add any value? Please explain. Does it change your decision?

**Figure 5A-1.**

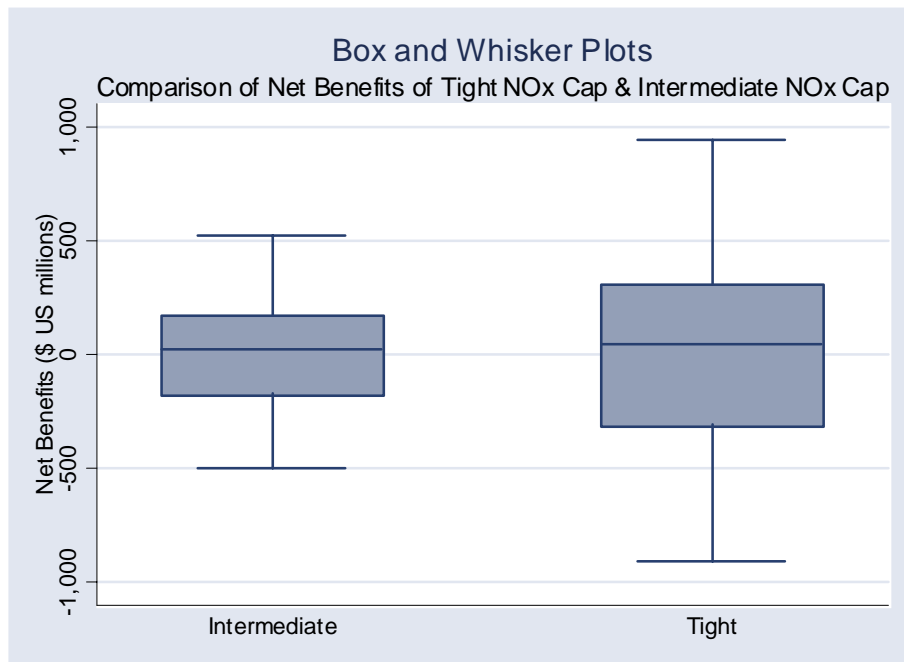


## Text for Figure 5A-2

Now I would like to show you the same information presented in a slightly different format. This is known as a box-and-whisker plot; you may be familiar with this kind of presentation. We present the same two different policy options as above. Here the median is labeled on the graph. The box represents the middle 50% of the distribution, and the ends of the “whiskers” delineate our minimum and maximum estimates. Thus, the chart breaks the distribution into quartiles.

As you can see, the graph demonstrates that both options have similar median expected net benefits, but the tighter standard generates a wider range of potential outcomes. Compared with the table, how well does this sort of graphic convey the issue to you? How does it affect your decision?

Figure 5A-2.

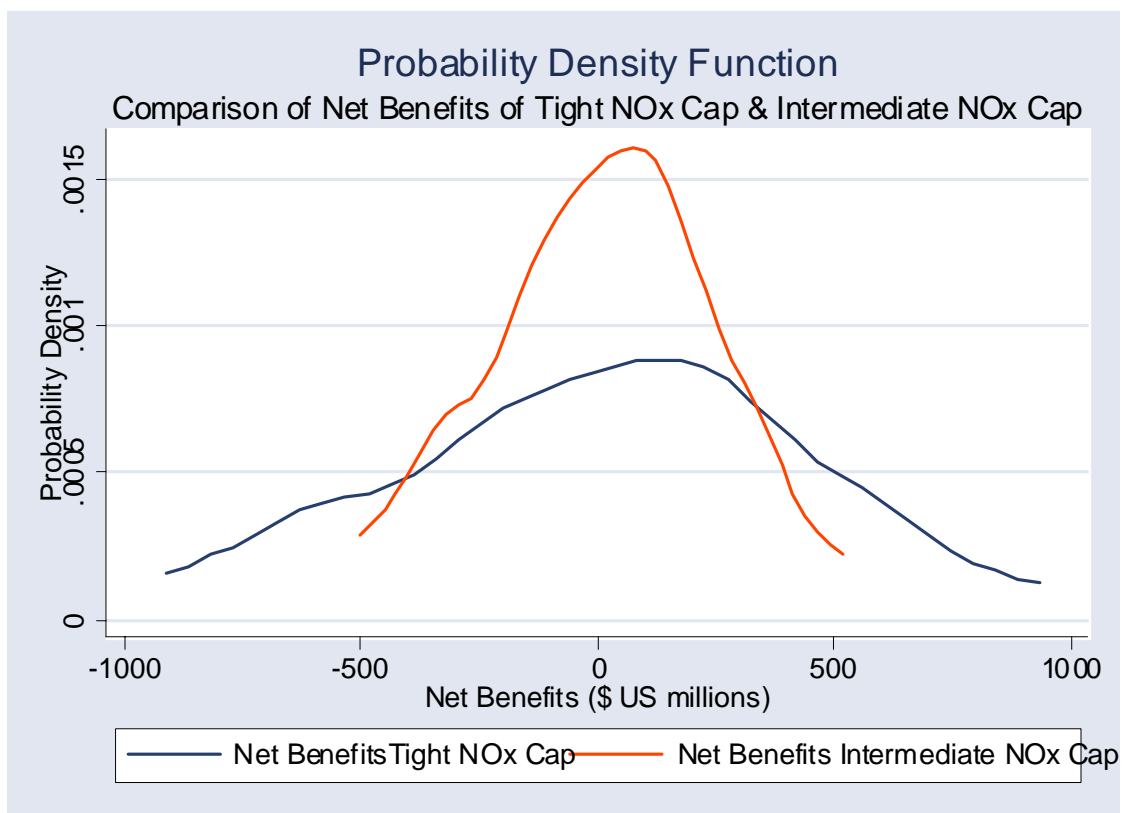


### Text for Figure 5A-3

Here is more detailed graphic that conveys more information. It is a probability density functions (PDF) of our estimates of the net benefits of the two policies. Along the horizontal axis are the values of our net benefit estimates. The vertical axis shows the relative probability of each of these results occurring. For both policies, the highest probabilities are around the midpoints, but, as we saw above, the tighter policy has a wider distribution. In other words, the central tendency for both policies is the same, but the tighter policy has a higher potential for both much larger net costs and much larger net benefits.

How do rate this graphic in terms of clarity and amount of information provided? How does it affect your decision?

Figure 5A-3.

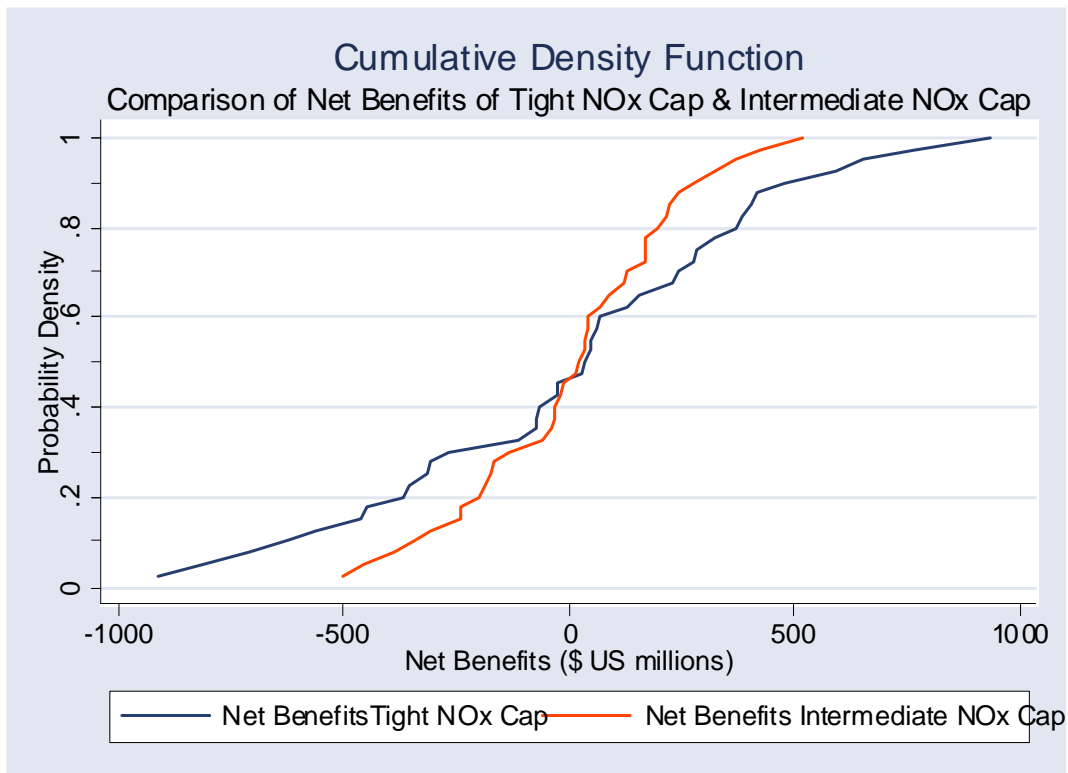


## Text for Figure 5A-4

A graphic similar to the PDF is the cumulative density function (CDF). It shows the probability that the value is below each level along the horizontal axis. So, for example, we can see that for both policies, there is about a 50% chance that net benefits are negative and a 50% chance they are positive. For the stringent policy, there is about a 10% net benefits are less than -\$500 million dollars a year but an equivalent probability that the policy generates more than \$500 million in net benefits.

This graph highlights the chance that net benefits will be over or under a certain value; do you find this informative? How does it affect your decision?

Figure 5A-4.

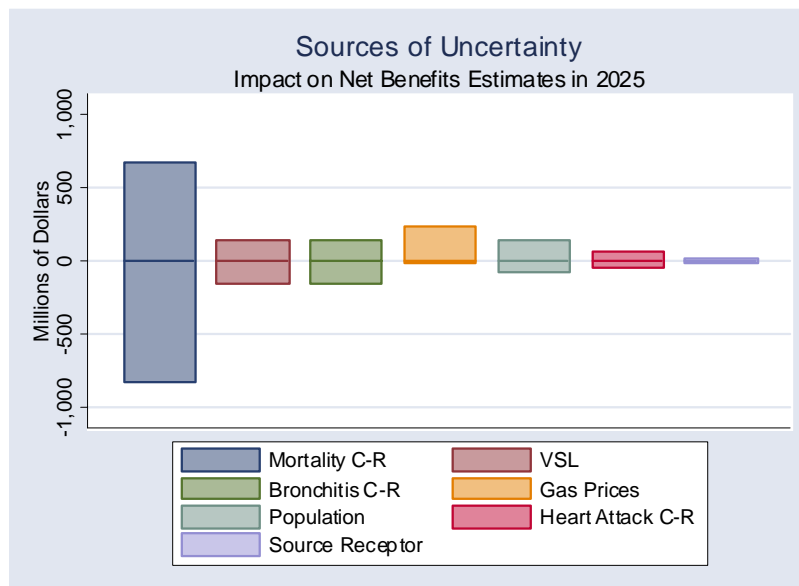


## Text for Figure 5A-5

The preceding presentations have focused solely on the uncertainty around the net benefits. Now we would like to show you a graph that demonstrates some of the drivers of the uncertainty. This graph shows the impacts on the final net benefits estimation from the uncertainties associated with the different factors.

As you can see, uncertainty about the mortality concentration–response function has by far the largest impact on the net benefits estimate. Is this information useful to you? How does it affect your thinking?

Figure 5A-5.



## Review of Graphics and Policy Options

Now, thinking about what you have seen—two policies with mean benefits close to zero, but with different spreads—would you choose the same policy as before? What were the reasons that guided your choice?

## **Additional Thoughts on Uncertainty**

First, is this of interest to you at all or would you just rather get point estimates? In general, how interested are you in this issue?

We have presented only a small sliver of the uncertainty that is involved in an analysis of this type. By necessity, the presentation has to be streamlined, and as a consequence, a decisionmaker like yourself would have to rely on staff to make judgment calls as to what to include and what to leave out. Are you comfortable relying on staff to make the judgments about the uncertainty analysis? Are there steps you would like to take to increase your level of confidence in staff decisions?

Thank you for your help on this project.