

improvements relative to reductions from ground-level mobile sources. For example, mobile source tailpipe emissions are located in urban areas at ground level (with limited dispersal) while electric utilities emit NO<sub>x</sub> from "tall stacks" located in rural (remote) locations with substantial geographic dispersal (Letter to Don Arbuckle, Deputy Administrator, OIRA from Tom Gibson, Associate Administrator, Office of Policy, Economics and Innovation, EPA, May 16, 2002.) There remain considerable uncertainties with the development of these estimates. The discussion below outlines the various EPA analyses serving as the basis for the NO<sub>x</sub> benefit transfer values presented above and discusses the uncertainties that attend these estimates.

Analysis of recent EPA rules yield several estimates for the NO<sub>x</sub> benefits per ton from electric utility sources. (See the Regulatory Impact Analyses for the "NO<sub>x</sub> SIP Call" and the Section 126 rules, available on the Web at <http://www.epa.gov/ttn/ecas/ecoguid.html>. In addition, see Memo to NSR Docket from Bryan Hubbell, Senior Economist, Innovative Strategies and Economics Group, EPA.) Based on these studies, the upper end of the range for the benefits of NO<sub>x</sub> reductions from stationary sources (electric utilities) is \$2500 per ton. These studies also developed estimates for the benefits associated with reductions in SO<sub>2</sub> from electric utilities. Based on an analysis outlined in a June 20, 2001 EPA memo to the file, "Benefits Associated with Electricity Generating Emissions Reductions Realized Under the NSR Program," we used \$7300 per ton SO<sub>2</sub> emissions for the 1992 EPA Acid Rain rule.

For mobile sources, EPA recently published the final Tier 2/Gasoline Sulfur rule RIA (EPA, 1999) and Heavy Duty Engine/Diesel Fuel RIA (EPA, 2000). For the Tier 2 rule, which affects light-duty vehicles, NO<sub>x</sub> reductions account for around 90 percent of PM precursor emissions and 86 percent of ozone precursor emissions. Based on the final Tier 2/Gasoline Sulfur RIA, EPA estimates that NO<sub>x</sub> reductions will yield benefits of \$4,900/ton (1996\$). EPA believes this analysis provides a more appropriate source for the NO<sub>x</sub> benefit transfer value for mobile sources. (Letter from Tom Gibson, pp. B2 and B3, May 16, 2002.) Additional details on the Tier 2 benefits analysis are available in the Tier 2/Sulfur Final Rulemaking RIA, available on the Web at <http://www.epa.gov/oms/fuels.htm>.

The Heavy Duty Engine/Diesel Fuel benefits analysis examined the impacts in 2030 of reducing SO<sub>2</sub> emissions by 141,000 tons and NO<sub>x</sub> emissions by 2,750 thousand tons, as well as a 109,000 ton reduction in direct PM emissions. Based on this analysis, EPA estimates a value for NO<sub>x</sub> reductions of \$10,200/ton in 2030. (Letter from Tom Gibson, p. B3, May 16, 2002.) Complete details of the emissions, air quality, and benefits modeling conducted for the HD Engine/Diesel Fuel Rule can be found at <http://www.epa.gov/otaq/diesel.htm> and <http://www.epa.gov/ttn/ecas/regdata/tsdhdv8.pdf>. Because the Heavy Duty Engine/Diesel Fuel estimate includes an adjustment for income growth out to 2030

and involves reductions in several PM-related pollutants, OIRA has adopted a value of \$4900 per ton from EPA's analysis of the Tier 2 rule as a benefits transfer value for reductions in NO<sub>x</sub> emissions from mobile sources.

Reductions in the risk of premature mortality dominate the benefits estimates in all of these analyses. The size of the mortality risk estimates from the underlying epidemiological studies, the serious nature of the effect itself, and the high monetary value ascribed to prolonging life make mortality risk reduction the most important health endpoint quantified in these analyses.<sup>12</sup> Because of the importance of this endpoint and the considerable uncertainty among economists and policymakers as to the appropriate way to value reductions in mortality risks, EPA has developed alternative estimates for its "Clear Skies" legislation that show the potential importance of some of the underlying assumptions. (See "Human Health and Environmental Benefit Achieved by the Clear Skies Initiative" at <http://www.epa.gov/clearskies>.) OIRA has used this analysis to identify an alternative estimate of the benefits from NO<sub>x</sub> reductions. In its Clear Skies analysis, EPA presented alternative benefits estimates of \$14 billion and \$96 billion per year in 2020, or a difference in the estimates of roughly a factor of seven.<sup>13</sup> Using this ratio, an alternative estimate of the benefits of NO<sub>x</sub> reductions from stationary sources would be \$350 per ton from stationary sources and \$700 per ton from mobile sources.

OIRA recognizes that there are potential problems and significant uncertainties that are inherent in any benefits analysis based on

<sup>12</sup> There are several key assumptions underlying the benefit estimates for reductions in NO<sub>x</sub> emissions, including:

1. Inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis. While no definitive studies have yet established any of several potential biological mechanisms for such effects, the weight of the available epidemiological evidence supports an assumption of causality.

2. All fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because fine particles from power plant emissions are chemically different from directly emitted fine particles from both mobile sources and other industrial facilities, but no clear scientific grounds exist for supporting differential effects estimates by particle type.

3. The concentration-response function for fine particles is approximately linear within the range of outdoor concentrations under policy consideration. Thus, the estimates include health benefits from reducing fine particles in both attainment and non-attainment regions.

4. The forecasts for future emissions and associated air quality modeling are valid.

5. The valuation of the estimated reduction in mortality risk is largely taken from studies of the tradeoff associated with the willingness to accept risk in the labor market.

<sup>13</sup> The difference between the estimates reflects several assumptions, including differences in the estimation and valuation of mortality risk and the valuation of a reduction in the incidence of chronic bronchitis.

\$/ton benefit transfer techniques. The extent of these problems and the degree of uncertainty depends on the divergence between the policy situation being studied and the basic scenario providing the benefits transfer estimate. Examples of other factors include sources of emissions, meteorology, transport of emissions, initial pollutant concentrations, population density, and population demographics, such as the proportion of elderly and children and baseline incidence rates for health effects. Because of the uncertainties associated with benefits transfer, OIRA decided not to include three mobile source rules that are projected to achieve substantial reductions in SO<sub>2</sub> and PM emissions that OIRA included in previous years in the monetized estimates presented in Tables 5 and 6 of the 2002 Report.<sup>14</sup>

#### *Adjustment for Differences in Time Frame Across These Analyses*

Agency estimates of benefits and costs cover widely varying time periods. The differences in the time frames used for the various rules evaluated generally reflect the specific characteristics of individual rules such as expected capital depreciation periods or time to full realization of benefits. In order to allow us to provide an aggregate estimate of benefits and costs, we developed benefit and cost time streams for each of the rules. Where agency analyses provide annual or annualized estimates of benefits and costs, we used these estimates in developing streams of benefits and costs over time. Where the agency estimate provided only annual benefits and costs for specific years, we used a linear interpolation to represent benefits and costs in the intervening years.<sup>15</sup>

#### *Further Caveats*

In order for comparisons or aggregation to be meaningful, benefit and cost estimates should correctly account for all substantial effects of regulatory actions, including potentially offsetting effects, which may or may not be reflected in the available data. We have not made any changes to agency monetized estimates. To the extent that agencies have adopted different monetized values for effects—for example, different values for a statistical life or different discounting methods—these differences remain embedded in the tables. Any comparison or aggregation across rules should also consider a number of factors which our presentation does not address. For example, these analyses may adopt different baselines in terms of the regulations and controls already in place. In addition, the analyses for these rules may well treat uncertainty in different ways. In some cases,

<sup>14</sup> These are: Municipal Waste Combustors (1995), Emission Standards for New Locomotives (1997) and Emission Standards for Non-Road Diesel Engines (1998).

<sup>15</sup> In other words, if hypothetically we had costs of \$200 million in 2000 and \$400 million in 2020, we would assume costs would be \$250 million in 2005, \$300 million in 2010, and so forth. For example, for the Regional Haze rule, EPA provided only an estimate of benefits and costs in 2015. To develop benefit and cost streams, we used a linear extrapolation of benefits and costs beginning in 2009 and scaling up to the reported 2015 estimates.