Quantifying the Health Benefits and Economic Value of Diesel Particulate Matter Control Measures

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Air Resources Board

California Environmental Protection Agency

Thank you, Ms. Witherspoon. Good morning, Dr. Lloyd and members of the Board.

This morning's presentation focuses on the methodology ARB staff uses to calculate the health benefits and economic value of diesel particulate matter control measures.

Methodology Development & Uses

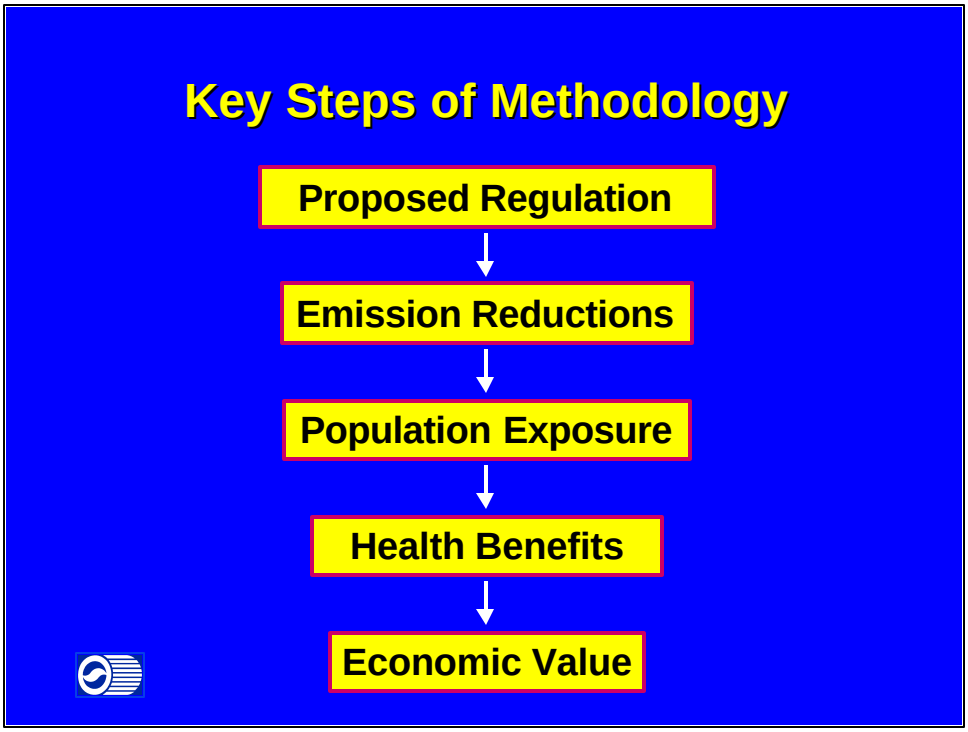
- Developed and used by U.S. EPA
  - Benefit-to-cost ratio of Clean Air Act:
    - $40 to $1 from 1970 to 1990
    - $4 to $1 from 1990 to 2010
  - Diesel regulatory impact analysis
- Used by ARB for State PM ambient air quality standards
- Endorsed by National Academy of Sciences, World Health Organization, and others

The methodology dates back to the 1980's, when U.S. EPA first developed it to analyze the impact of regulations designed to reduce air pollution.

EPA used the methodology to estimate the benefits and costs of the Clean Air Act. They estimated that from 1970 to 1990, the benefit-to-cost ratio was 40 dollars of benefits to every dollar of control. From 1990 to 2010, the ratio is 4 to 1.

Recently, EPA has used it to analyze the impact of their proposed rule for non-road diesel engines.

ARB used this methodology to support the proposed PM10 and PM2.5 ambient air quality standards in 2002. Also, the methods are endorsed by the National Academy of Sciences, the World Health Organization, World Bank, US A.I.D. and other agencies.



This slide shows the steps involved in the methodology.

With a proposed regulation, emission reductions and air quality improvements are combined with population data to estimate reductions in population exposures to air pollutants.

Health benefits that would result from these reductions are then calculated based on concentration-response information from health studies.

Finally, the economic value of these reductions are estimated.

Exposure

- Methods
  - air quality measurements: to estimate current exposure
  - air quality models: to estimate future exposure
- Results (statewide annual average)
  - all PM2.5 (2000): 18 $\mu g/m^3$
  - diesel PM (2000): 1.8 $\mu g/m^3$

The first step in the methodology is to quantify the population exposures to air pollution.

Existing air quality measurements are used to estimate current levels of human exposure. Future reduced exposure levels, expected from implementation of the proposed control measures, are calculated with air quality models.

Using air quality measurements, staff estimated the statewide population-weighted annual average concentration of PM2.5 to be 18 $\mu g/m^3$ in the year 2000. Using air quality models, staff estimated diesel PM concentration to be 1.8 $\mu g/m^3$.

Health Impacts

- **Concentration-response functions from 12 epidemiological studies**
  (supported by hundreds of others)
  - **14 health endpoints: mortality & morbidity**
  - **for mortality: 50 cities; 300,000 individuals**
- **Results on a statewide annual basis**
  - **~6,500 deaths avoided by achieving PM2.5 ambient annual standard of 12 $\mu g/m^3$**
  - **~2,000 deaths associated with 1.8 $\mu g/m^3$ in diesel PM2.5 concentration**

With a given set of exposure changes, the next step is to relate these changes to impacts on health.

For PM impacts, we rely on 12 epidemiological studies which provide concentration-response functions for 14 adverse health endpoints. A concentration-response function relates changes in exposure levels to changes in health endpoints.

In the case of mortality associated with PM exposure, health information was analyzed for 300,000 individuals from 50 cities in the United States.

When ARB staff reviewed the PM standards, we estimated that on a statewide basis, about 6,500 premature deaths would be avoided per year if the PM2.5 ambient standard were achieved -- reducing the average statewide level from 18 $\mu g/m^3$ to 12 $\mu g/m^3$. For diesel PM, about 2,000 deaths are associated with exposure of 1.8 $\mu g/m^3$, assuming that the toxicity of diesel PM is at least equal to that of ambient PM2.5.

The uncertainty associated with these mortality estimates is on the order of 50%.

Economic Value

- U.S. EPA uses $6.3 million as value of a life
  - Derived from 26 studies measuring an individual's willingness to pay to reduce a given mortality risk
- Results for annual mortality
  - all PM2.5: $41 billion
  - diesel PM: $13 billion

The final step in our methodology is to estimate the economic value of the control measure.

In its benefit/cost analysis based on year 2000 dollars, US EPA values a life at $6.3 million. This estimate was based on 26 peer-reviewed studies that measure an individual's willingness to pay to obtain a small change in the risk of mortality.

When we applied this value to the mortality estimate presented in the previous slide, the economic value of attaining the PM2.5 standard is about $41 billion annually. For diesel PM, the value is $13 billion annually.

Diesel ATCM Health Benefits

- Mortality for stationary engines Airborne Toxic Control Measure
  - 120 deaths reduced between 2005 & 2020
  - benefit-to-cost ratio: $20-$28 to every $1 of control
- Methods based on best science and economic information
- Methodology peer-reviewed and widely used

Based on the previously discussed methodology, staff assessed the health impact of the proposed ATCM for stationary engines. Staff estimated the proposed rule, when fully implemented, would result in approximately 120 fewer premature deaths from year 2005 to 2020, with a range of 60 to 180 fewer deaths. This health benefit would result from the estimated 1,700 ton reduction in diesel PM2.5 during the period 2005 to 2020.

The benefit-to-cost ratio for this regulation is about 20 to 28 dollars of health benefit for every dollar of control. This calculation shows us that the regulation is cost-effective in terms of furthering the goals of the Diesel PM Risk Reduction Plan.

As we've discussed today, the methodology for calculating health benefits and economic value of diesel PM control measures is based on the best scientific and economic information available. It has been used in numerous applications by other agencies and has been published in peer-reviewed journals.

This concludes my presentation. I will be happy to answer any of your questions. Thank you for your attention.