School Bus Emission Reduction in New York City

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Considered Retrofit Options

• Diesel Oxidation Catalyst (DOC)
  – $2000 base cost, 3 hour install

• Passive Diesel Particulate Filter (PDPF)
  – $9000 base cost, 8 hour install

• Active Diesel Particulate Filter (ADPF)
  – $16000 base cost, 16 hour install

• 2008 Model Year Replacement
Cost of Replacement

• Cost = Used Bus Market Value – Scrap Value
• Scrap value of $700 for short, $1000 for long
• Used bus market values obtained from 100’s of bus prices collected from public and private sellers
Used Bus Prices by Model Year and Size

\[ y = 7E-153e^{0.1802x} \]
\[ R^2 = 0.9449 \]

\[ y = 4E-139e^{0.1642x} \]
\[ R^2 = 0.8017 \]
School Bus Usage

• MOBILE6.2 standard of 9939 miles/year for school buses was used
• Additionally, 15 min of idle time/school day was included
• Expected life of 19 years, 1 remaining year for those older than 19
Emission Rates

- All emission rates are obtained from EPA MOBILE6.2 software
- Distinct PM2.5, CO, NOx, VOC g/mile and g/hr idle rates for each model year
- Gaseous idle emission rates are computed using EPA recommended 2.5mph speed
- % reductions from each retrofit from EPA verified technology list
PM2.5 Reduction Cost Effectiveness for Large Buses

grams of PM2.5 reduced/\$ vs. Model Year

- 0 to DOC
- 0 to PDPF
- 0 to ADPF
- 0 to new 2008

Model Year:
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
- 2010
PM2.5 Reduction Cost Effectiveness for Large Buses

grams of PM2.5 reduced/\$ vs. Model Year

- 0 to DOC
- 0 to PDPF
- 0 to ADPF
- 0 to new 2008

Model Year:
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
- 2010
PM2.5 Reduction Cost Effectiveness for Large Buses

grams of PM2.5 reduced/$

- 0 to DOC
- 0 to PDPF
- 0 to ADPF
- 0 to new 2008

Model Year

CO Reduction Cost Effectiveness for Large Buses

Model Year

grams of CO reduced/$

0 to DOC
0 to PDPF
0 to ADPF
0 to new 2008
Trends in Cost Effectiveness

• Replacing the oldest buses is by far the most cost effective way to reduce all emissions
• For PM2.5, VOC, CO, and NOx, it is more cost effective to replace a pre-1991 bus than retrofit
• For PM2.5, VOC and CO, it is more cost effective to retrofit a post-1996 bus than replace
• Most cost efficient 1991-1996 strategy depends on bus size and priority of pollutants
Fleet Assumptions

• Limited information on past retrofits from meetings with planners, other sources
• PDPFs only possible on Staten Island
• MOBILE6.2 national average age distribution
• Resulting fleet is similar to NYC fleet in many ways, but is likely quite different in others
Cost vs. PM2.5 Fraction Reduction

Replace Model Year
1984-1993 Buses (even those with DOC)

Add Retrofits, Swap Retrofits, Retire Newer Buses
Thank You

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