Cost Effectiveness of Alternative Diesel Fuel Options

Alternative Diesel Fuel Symposium

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Disclaimer

- This analysis does not necessarily represent the views of the California Energy Commission
- This analysis has not been approved or disapproved by the California Energy Commission

Presentation Overview

I Background

II Cost Effectiveness Analysis

III Discussion – Implications

IV Conclusion

Background

- Power Plant Siting
- Energy Efficiency Standards
- Energy Assessment
- Contingency Planning
- **Fuels / Resource Assessment**
- **Transportation - Alternative Fuels and Technologies**

Transportation Energy Policy Goals

- Reduce Petroleum Dependence
- Increase transportation efficiency and motor vehicle fuel economy
- Encourage market development that provides fuel choices
- Provide information on vehicle technology and fuel choices

Past Energy Commission Investments
(Technology R&D and Demonstrations)

Programs	Alternative Diesel Fuel (ADF) ($ millions)	Alternative Fueled Vehicles (AFV) ($ millions)
Clean Safe School Bus	0	100.0
Clean Fuel Infrastructure	0	5.3
Carl Moyer	0.65	4.3
Flexible Fueled Vehicle	0	42.0
Heavy-Duty Alternative Fuels	0	3.0
TETAP	0	3.0
Clean Diesel	0	2.2
Med-Duty CNG Demo	0	0.6
Efficient Vehicle Incentive	0	5.0
Electric Vehicle	0	4.2
Total	**$0.7**	**$169.6**

Need For Cost Effectiveness (C-E) Analysis

- Governmental programs need to gauge their relative effectiveness of investments
- Difficulty in comparing ADF to AFVs
- Emission differences between options continue to narrow
- Need a common yardstick to compare the relative effectiveness of options
- ADFs need to rationalize higher fuel prices for reducing petroleum and emissions

Cost-Effectiveness Limitations

- Is specific to the fleet evaluated, may not fully represent the technology
- Restricted to actual expenses - does not anticipate technology advancements or improved economics
- Snapshot of the dynamic transportation technologies
- Does not evaluate the potential benefits to California Fleets if each technology is expanded
- C-E analysis provides an analytical screening assessment of ADFs and AFVs

Cost Elements Considered

- Used California Fleets expenditures for 1999-2002
- Evaluated AFVs & ADF incremental expenses:
  - Vehicle capital price,
  - Infrastructure capital price,
  - Maintenance and
  - Fuel expenses

Cost Effectiveness Calculation

C-E = (annualized) ? vehicle + infrastructure + maintenance + fuel expenses

Capital Recovery Factor: 5%

Infrastructure Life : 20 years

Vehicle Life : 12-15 years

Cost-Effectiveness of ADFs vs AFVs

- Studied: 12 heavy-duty vehicle / technology options
- Evaluated: Petroleum, Particulate Matter and NOx reductions
- Compared AFVs: Propane, LNG, CNG, Diesel Hybrid to:
  – Biodiesel, Diesel Water Emulsion, Fischer-Tropsch Diesel (with and without a diesel soot filter)

Assumptions & Finding

Heavy-Duty Vehicles	Incremental Vehicle Price	Infrastructure price/100 HD vehicles & price/300 LD vehicles)	Baseline Fuel Economy	Alternative Fuel Economy	Operational Expenses Relative to Baseline ($/mile)	Fuel Expense Only Relative to Baseline ($/gallon)	Vehicle Life	Infrastructure Life	Annual Miles (Thousand miles)	Petroleum Reduction %	NOx Emission Reduction [4.0 g/bhp-hr baseline] (%)	Particulate Matter Reduction [Assumes 0.085 g/bhp-hr avg 0.05 for transit bus] (%)
LNG Waste Management San Diego	$35,000	$1,266,666	4.0	4.0	0.2**		12	20	45	100%	50%	0.03g/hp - 65%
LNG Transit Bus (OCTA)	$40,000	$2,200,000	5.0	5.0	0.2**		12	20	45	100%	50%	.01g/hp - 80%
LNG Class-8 Dual-Fuel (Harris Ranch)	$33,000	$640,000	8.0	8.0	0.2**		10	20	100	65%	50%	0.1g/hp - (15%)
CNG School Bus (Tehachapi)	$29,269	$2,840,000	5.0	5.0	0.17**		15	20	18	100%	50%	.02g/hp - 80%
CNG Transit Bus (Averaged)	$49,500	$2,686,100	3.9	3.0	0.17**		15	20	43	100%	50%	.01g/hp - 80%
Propane (LA DOT)	$16,000	$20,000	4.0	2.5	0.01	-0.45	15	20	40	100%	63%	95%
Diesel Hybrid Transit Bus (NYTA)	$103,000	$0	4.0	6.0	0	0	12	20	43	33%	50%	95%
Diesel Truck (DPF & 15-ppm S)	$6,000	$50,000	8.0	8.0	0	0.05	12	20	100	0%	3%	95%
Projected Fischer-Tropsch (DPF)	$6,000	$50,000	6.0	6.0	0	0.30	12	20	100	100%	10%	95%
Projected Fischer-Tropsch	$0	$50,000	6.0	6.0	0	0.30	12	20	N/A	100%	8%	30%
Diesel Water Emulsion	$0	$50,000	6.0	5.1	0	0.25	12	20	N/A	5%	16%	64%
Biodiesel B20	$0	$50,000	6.0	5.9	0	0.20	12	20	N/A	20%	-2%	22%

** includes fuel cost

Fig. 1.

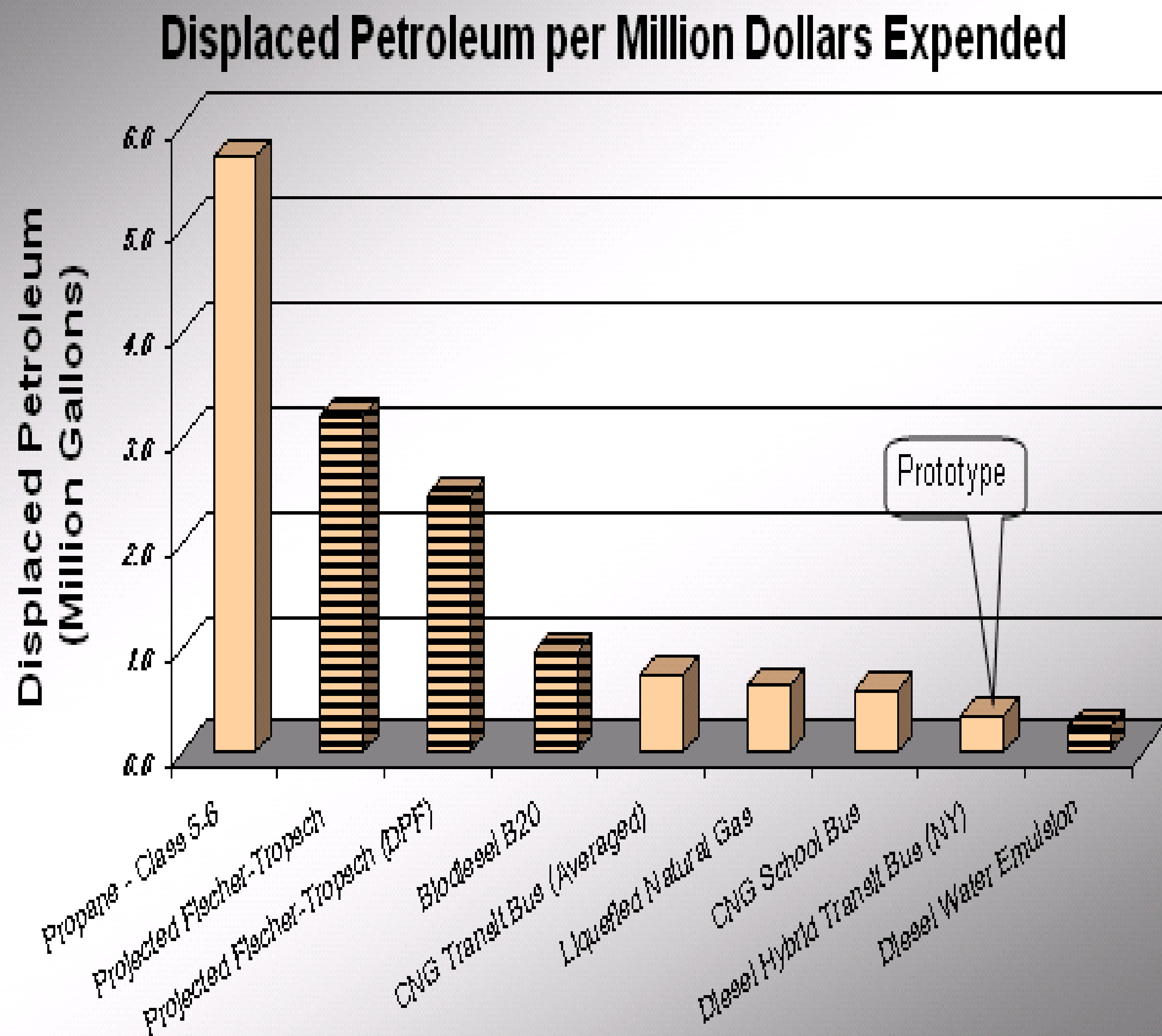

Displaced Petroleum per Million Dollars Expended
Displaced Petroleum (Million Gallons)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Prototype
Propane - Class 5-6
Projected Fischer-Tropsch
Projected Fischer-Tropsch (DPF)
Biodiesel B20
CNG Transit Bus (Averaged)
Liquefied Natural Gas
CNG School Bus
Diesel Hybrid Transit Bus (NY)
Diesel Water Emulsion

Fig. 2 Lifetime NOx Reduction per Million Dollars Expended

(in 1999-2002)

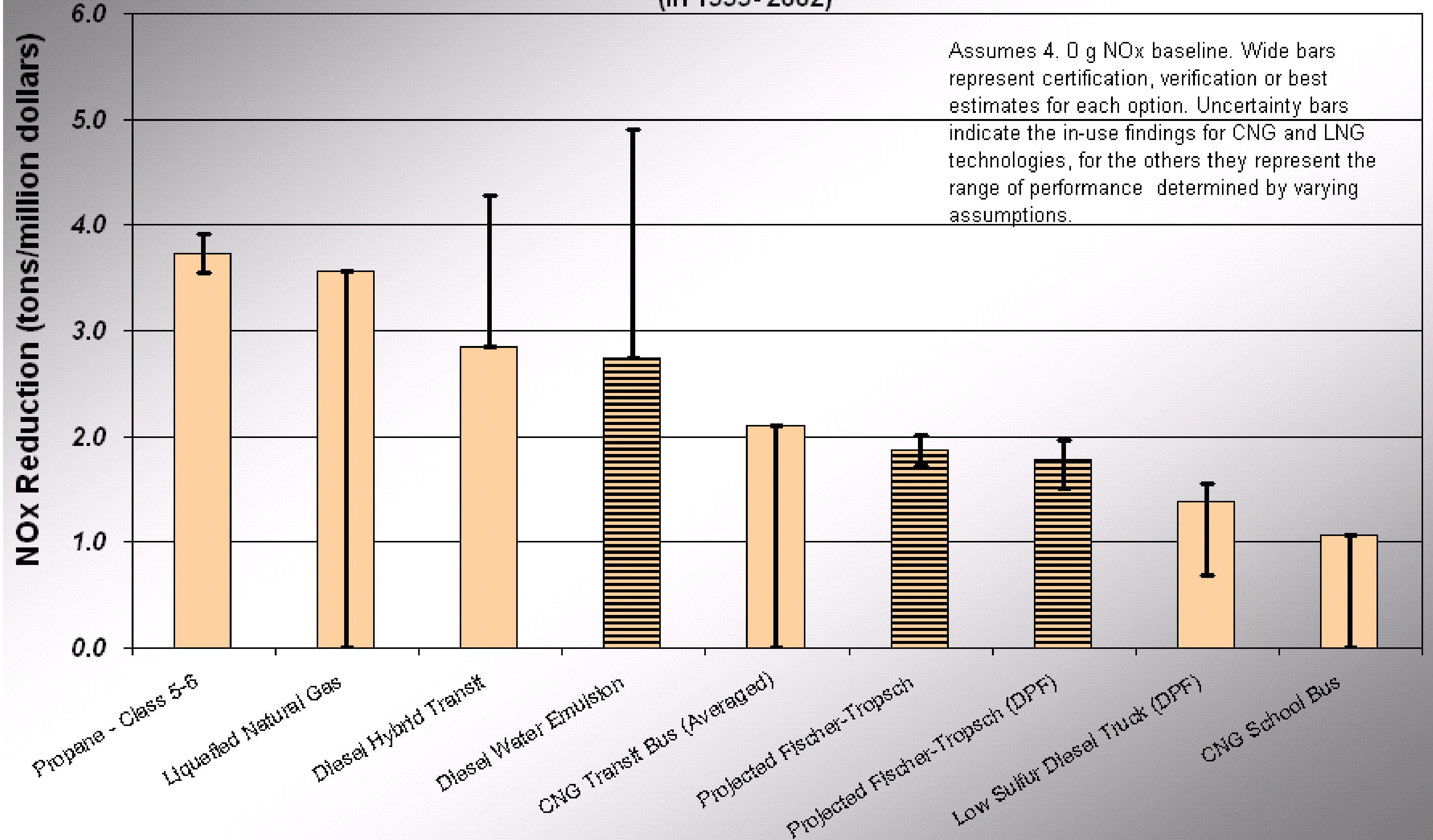


Fig. 3. Particulate Matter and Toxics Reduction per Million Dollars Expended

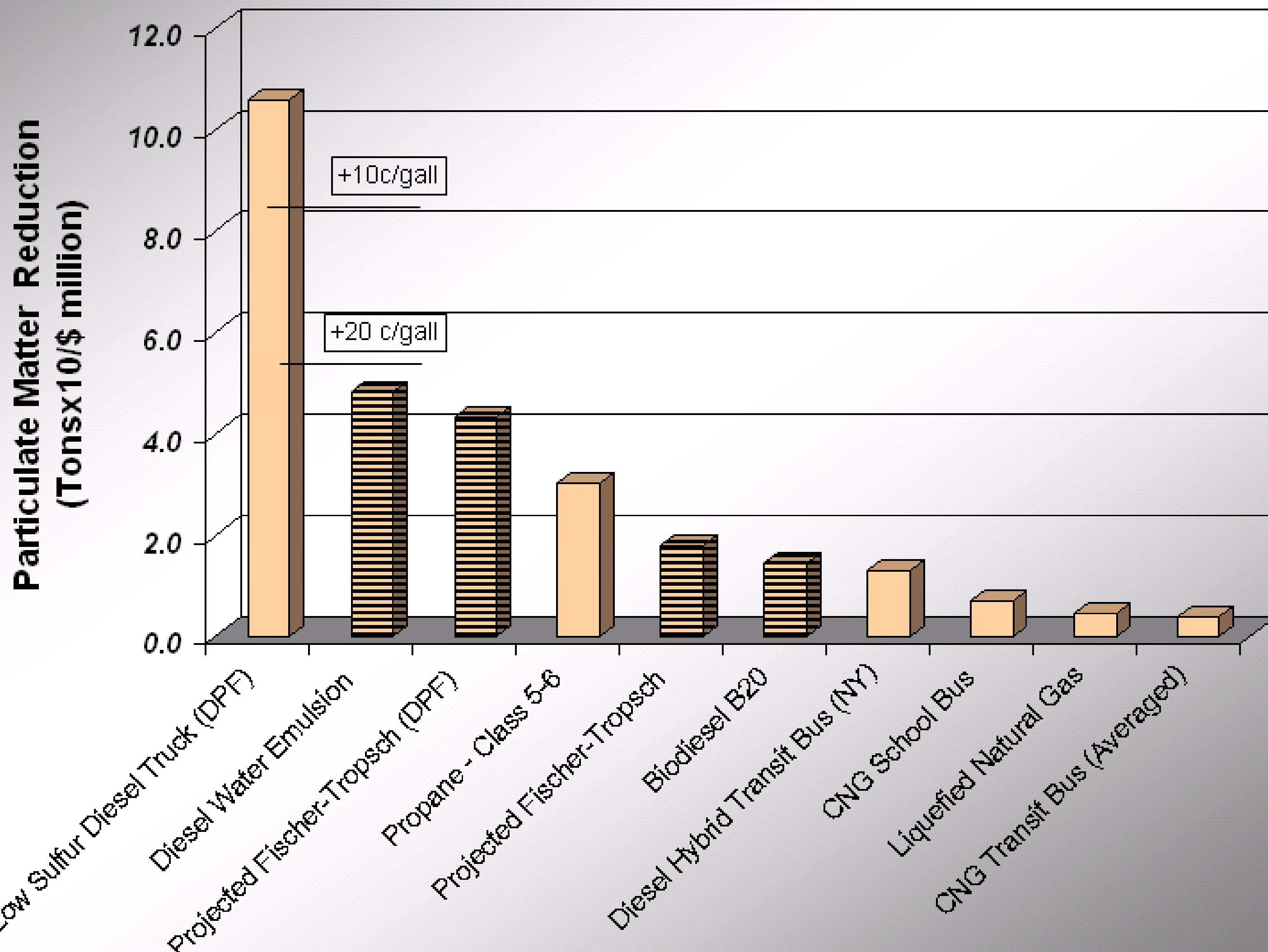


Fig. 4

Visualization of the Aggregate Reductions - Equally Weighting Petroleum, NOx and PM Reductions

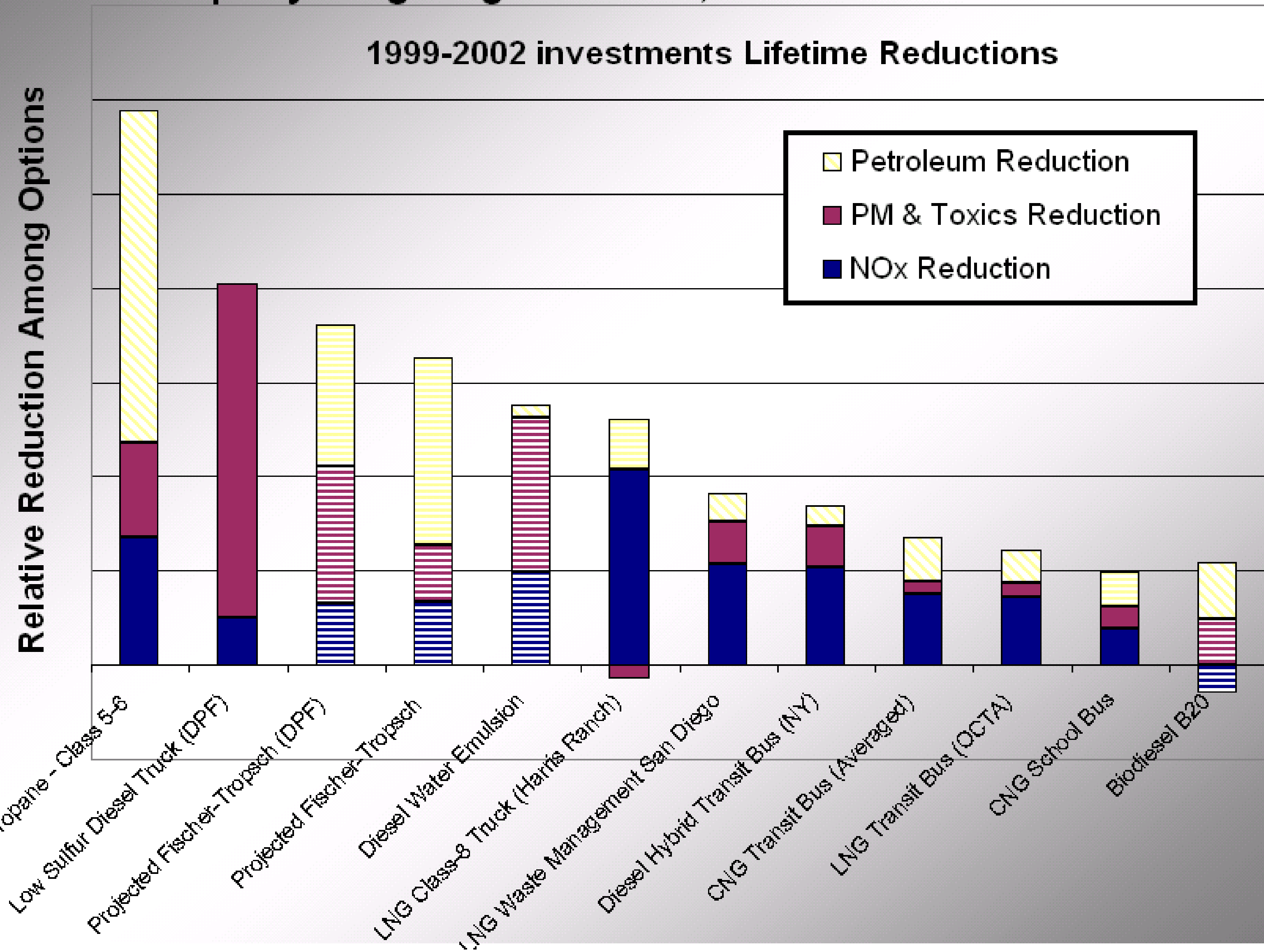
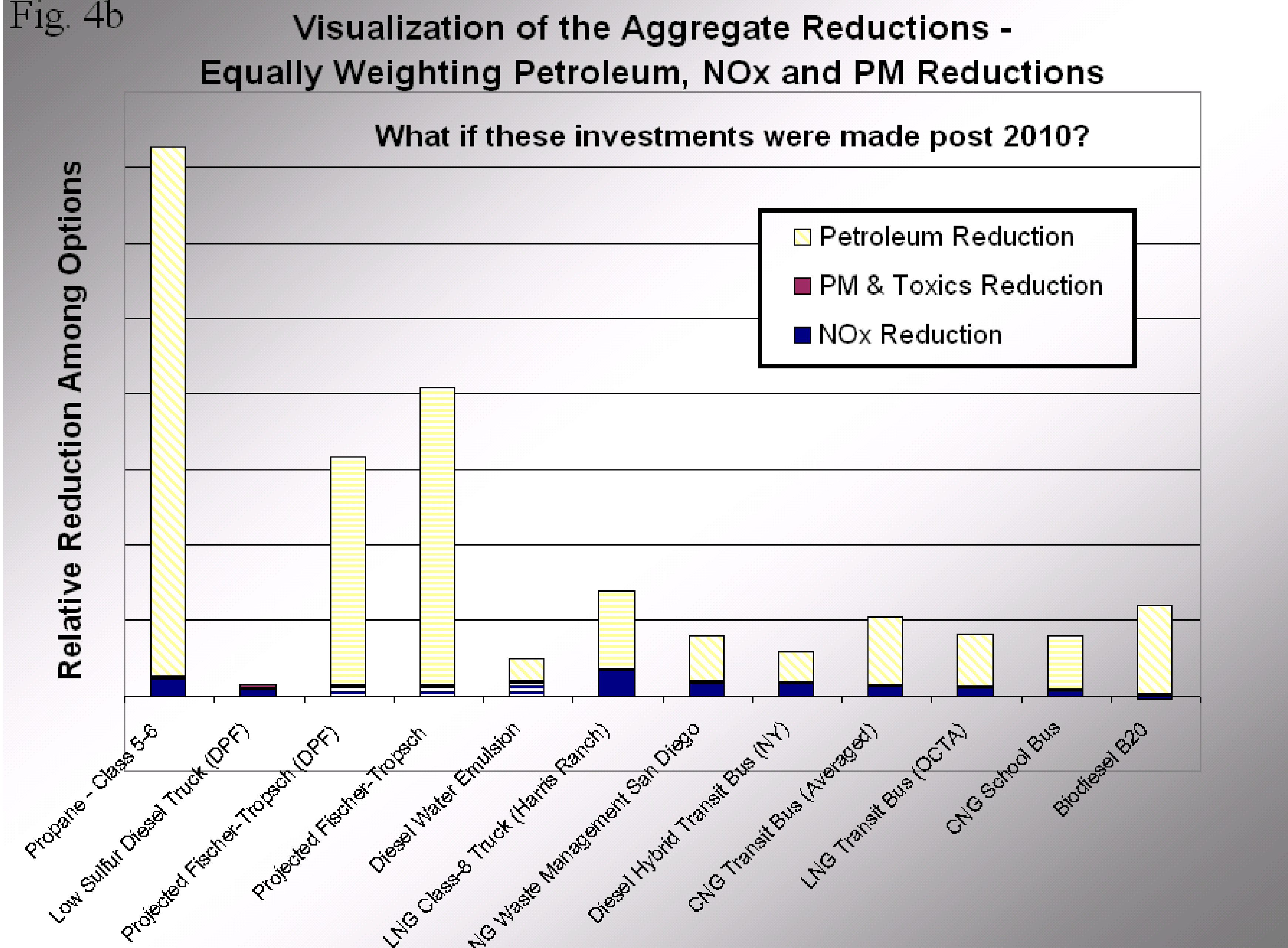


Fig. 4b


Visualization of the Aggregate Reductions -
Equally Weighting Petroleum, NOx and PM Reductions
What if these investments were made post 2010?
Petroleum Reduction
PM & Toxics Reduction
NOx Reduction
Relative Reduction Among Options
Propane - Class 5-6
Low Sulfur Diesel Truck (DPF)
Projected Fischer-Tropsch (DPF)
Projected Fischer-Tropsch
Diesel Water Emulsion
LNG Class-8 Truck (Harris Ranch)
LNG Waste Management San Diego
Diesel Hybrid Transit Bus (NY)
CNG Transit Bus (Averaged)
LNG Transit Bus (OCTA)
CNG School Bus
Biodiesel B20

Findings

- Propane, ULSD & Diesel Particulate filters investments provide the most cost-effective environmental benefits
- FTD and biodiesel are cost-effective petroleum & particulate matter reduction options
- Generally the least capital intensive fuel technologies are associated with the highest cost-effectiveness: Propane, ULSD, FTD
- Most expensive technologies: CNG & LNG had the lowest C-E performance

Findings Continued

- Regarding NOx Reduction: LNG & Propane performed well
- Diesel Water Emulsions environmental benefits are cost-effective with AFV's.
- Biodiesel's overall cost-effectiveness ranking improves post 2010
- Capital intensive fuel systems cost-effectiveness performance degrades post 2010

Conclusion

- Cost-Effectiveness Analysis is a basic screening tool, provides a simple comparison of options
- Alternative Diesel Fuels provide relatively cost-effective: petroleum, particulate matter and NOx reductions

Conclusion

- As emission standards are tightened ADFs maintain and improve their relative benefits compared to traditional AFVs