



2014 IEPR Update Workshop Transportation – Benefits/Metrics



The Benefit-Cost Ratio

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Key Messages



- The metric formula and included benefits are extremely important
- When benefits and costs are kept constant, changing the formula effects the rankings of technologies
- All benefits including greenhouse gas (GHG) and criteria pollutant (VOC, NOx, PM) reductions, and petroleum displacement should be taken into account
- Private benefits, including fuel cost savings, should be considered

Review of Existing Metrics



- Existing metrics usually take into account only one pollutant (Note: Moyer does take into account two – NO_x and PM)
 - Dollars per ton of NO_x
 - Dollars per ton of PM
 - Dollars per tonne of GHG
 - Dollars per gallon of petroleum displaced
- The metrics above do not account for the aggregate benefit of some of the cleanest technologies including zero emission technologies
- The metrics also do not account of technologies that have associated lifecycle cost savings including reduced fueling and operation and maintenance costs

Benefit-Cost Ratio



- The benefit-cost ratio takes into account comprehensive societal benefits (GHG, criteria pollutant, petroleum displacement) and private operational cost savings with the numerator of ratio either be societal benefits or private benefits (e.g. fuel cost savings) and the denominator incremental costs including vehicle and infrastructure
- Societal benefits are monetized based on literature developed monetized health and environmental benefits (or displaced damages). Appendix slides includes the references and sources for monetized dollars per ton (or tonne) and dollars per gallon
- Private benefit-cost ratios greater than one mean lifecycle cost savings and societal benefits great than one mean monetized societal benefits are greater than the incremental costs
- A limitation of the benefit-cost metric is the magnitude of potential emissions for each technology

Quantitative Comparison Between Metrics



	\$/ton NOx	\$/ton PM	\$/ton (NOx + 20xPM)*	\$/ton GHG	Societal B-C Ratio	Private B-C Ratio	Total B-C Ratio
PHEV10 (A)	\$760,000	\$4,800,000	\$140,000	\$67	0.8	4.5	5.3
BEV (A)	\$1,000,000	\$6,100,000	\$190,000	\$130	0.5	1.6	2.0
e-Forklift - 19,000 lb	\$220,000	\$5,900,000	\$120,000	\$150	2.5	5.5	8.0
DPF - Class 8 Truck	-	\$12,000	\$8,900	-	1.3	0.0	1.3
CNG Bus (A)	\$360,000	\$4,600,000	\$140,000	\$41	4.3	4.7	9.0
Class 8 Hybrid	\$480,000	\$11,000,000	\$60,000	\$340	0.3	1.2	1.5
SCR	\$18,000	\$1,300,000	\$15,000	\$160	1.5	0.9	2.3

*Carl Moyer Program Formula

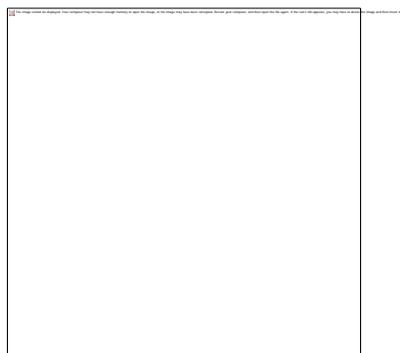
(A) CNG Bus, PHEV10 and BEV include federal incentives and funding

Ranking Comparison Between Metrics



Ranking	\$/ton NOX	\$/ton PM	\$/ton GHG	\$/ton (NOx + 20xPM)*	Societal B-C Ratio	Private B-C Ratio	Total B-C Ratio
1	Bobtail TRU	DPF	TSE - S	Bob - TRU	Bob - TRU	TSE - S	TSE - S
2	TSE - Shorepower	Bob - TRU	Bob - TRU	TSE - S	TSE - S	F - 19k lb	Bob - TRU
3	TSE - Idleaire	TSE - S	TSE - Idle	TSE - Idle	TSE - Idle	Bob - TRU	CNG Bus
4	Semi TRU	TSE - Idle	CNG Bus	DPF	CNG Bus	F - 8k lb	TSE - Idle
5	SCR	SCR	PHEV10	Semi TRU	F - 19k lb	CNG Bus	F - 19k lb
6	Forklift - 8,000 lb	Semi TRU	Semi TRU	SCR	F - 8k lb	PHEV10	F - 8k lb
7	Forklift - 19,800 lb	CNG Bus	F - 8k lb	C-8 Hybrid	SCR	TSE - Idleaire	PHEV10
8	CNG Bus	PHEV10	BEV	F - 8k lb	Semi TRU	PHEV40	Semi TRU
9	Class 8 Hybrid	PHEV40	F - 19k lb	F - 19k lb	DPF	BEV	SCR
10	PHEV10	F - 8k lb	SCR	PHEV10	PHEV10	Semi TRU	PHEV40
11	PHEV40	F - 19k lb	PHEV40	CNG Bus	BEV	C-8 Hybrid	BEV
12	BEV	BEV	C-8 Hybrid	PHEV40	PHEV40	SCR	C-8 Hybrid
13	Class 6 Hybrid	C-8 Hybrid	CNG Sedan	C-6 Hybrid	C-8 Hybrid	C-3 Hybrid	DPF
14	Class 3 Hybrid	C-6 Hybrid	C-3 Hybrid	BEV	CNG Sedan	CNG Sedan	C-3 Hybrid
15	CNG Sedan	C-3 Hybrid	C-6 Hybrid	C-3 Hybrid	C-3 Hybrid	C-6 Hybrid	CNG Sedan
16	DPF - Class 8 Truck	CNG Sedan	DPF	CNG Sedan	C-6 Hybrid	DPF	C-6 Hybrid

*Carl Moyer Program Formula



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Appendix – Values for All Technologies



	\$/ton NOx	\$/ton PM	\$/ton (NOx + 20*PM)	\$/ton GHG	Societal B-C Ratio	Private B-C Ratio	Total B-C Ratio
DPF -Class 8 Truck	-	\$12,000	\$8,900	-	1.3	0.0	1.3
CNG Sedan	\$4,700,000	\$370,000,000,000,000	\$3,300,000	\$460	0.2	0.7	0.9
CNG Bus	\$360,000	\$4,600,000	\$140,000	\$41	4.3	4.7	9.0
Forklift - 8,000 lb	\$120,000	\$5,700,000	\$71,000	\$100	1.5	5.2	6.6
Forklift - 19,800 lb	\$220,000	\$5,900,000	\$120,000	\$150	2.5	5.5	8.0
TSE - Shorepower	\$2,600	\$300,000	\$2,600	\$18	8.8	12.7	21.5
TSE - Idleaire	\$3,000	\$350,000	\$3,000	\$21	5.3	3.5	8.8
PHEV10	\$760,000	\$4,800,000	\$140,000	\$67	0.8	4.5	5.3
PHEV40	\$960,000	\$5,700,000	\$180,000	\$160	0.5	1.8	2.2
BEV	\$1,000,000	\$6,100,000	\$190,000	\$130	0.5	1.6	2.0
Semi TRU	\$8,000	\$2,700,000	\$9,000	\$73	1.3	1.5	2.7
Bobtail TRU	\$1,500	\$240,000	\$1,600	\$21	10.2	5.2	15.3
SCR	\$18,000	\$1,300,000	\$15,000	\$160	1.5	0.9	2.3
Class 3 Hybrid	\$3,700,000	\$1,600,000,000	\$790,000	\$480	0.1	0.8	0.9
Class 6 Hybrid	\$1,400,000	\$36,000,000	\$180,000	\$830	0.1	0.5	0.6
Class 8 Hybrid	\$480,000	\$11,000,000	\$60,000	\$340	0.3	1.2	1.5

*Carl Moyer Program Formula

Appendix – Monetized Benefits Sources



■ Petroleum Displacement

- Leiby, P. Estimating the Energy Security Benefits of Reduced U.S. Oil Imports, ORNL/TM-2007/028, March 2008
- EPA RFS Annual Rulemaking, Updated Energy Security Benefits, 2012. EPA-HQ-OAR-2010-0133-0252, Available online at: <http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2010-0133-0252>

■ GHG

- Interagency Working Group on Social Cost of Carbon. 2010. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. February. United States Government. <http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf>
- Interagency Working Group on Social Cost of Carbon. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, United States Government, May 2013.

■ NO_x, VOC, PM

- Diesel Emissions Quantifier Health Benefits Methodology, EPA, EPA-420-B-10-034, August 2010. Available online: <http://www.epa.gov/cleandiesel/documents/420b10034.pdf>
- EPA/HNTSA, Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA-420-D-11-901, November 2011.