



Technology to Increase CAFE

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Scope

- Analysis of 2003 Light Truck Rulemaking
 - see www.nhtsa.dot.gov/cars/rules/cape/rulemaking.htm
- Algorithm-Based Application of Technology
- Estimation of Benefits
- Costs vs. Benefits

Technology Assumptions (from NAS)

Technology	FC		Cost		Availability
	Low	High	Low	High	
Production-Intent Engine Technology					
Engine Friction Reduction	1.0%	5.0%	\$ 35	\$ 140	2002
Low Friction Lubricants	1.0%	1.0%	\$ 8	\$ 11	2002
Multi-Valve, Overhead Camshaft	2.0%	5.0%	\$105	\$ 140	2002
Variable Valve Timing	2.0%	3.0%	\$ 35	\$ 140	2002
Variable Valve Lift & Timing	1.0%	2.0%	\$ 70	\$ 210	2002
Cylinder Deactivation	3.0%	6.0%	\$112	\$ 252	2002
Engine Accessory Improvement	1.0%	2.0%	\$ 84	\$ 112	2002
Engine Supercharging & Downsizing	5.0%	7.0%	\$350	\$ 560	2002
Production-Intent Transmission					
5-Speed Automatic Transmission	2.0%	3.0%	\$ 70	\$ 154	2002
Continuously Variable Transmission	4.0%	8.0%	\$140	\$ 350	2002
Automatic Transmission w/ Aggressive	1.0%	3.0%	\$ 0	\$ 70	2002
6-Speed Automatic Transmission	1.0%	2.0%	\$140	\$ 280	2002
Production-Intent Vehicle Technology					
Aero Drag Reduction	1.0%	2.0%	\$ 0	\$ 140	2002
Improve Rolling Resistance	1.0%	1.5%	\$ 14	\$ 56	2002
Emerging Engine Technology					
Intake Valve Throttling	3.0%	6.0%	\$210	\$ 420	2007-2012
Camless Valve Actuation	5.0%	10.0	\$280	\$ 560	2007-2012
Variable Compression Ratio	2.0%	6.0%	\$210	\$ 490	2007-2012
Emerging Transmission Technology					
Automatic Shift Manual Transmission	3.0%	5.0%	\$ 70	\$ 280	2007-2012
Advanced CVTs	0.0%	2.0%	\$350	\$ 840	2007-2012
Emerging Vehicle Technology					
42 Volt Electrical Systems	1.0%	2.0%	\$ 70	\$ 280	2007-2012
Integrated Starter/Generator	4.0%	7.0%	\$210	\$ 350	2007-2012
Electric power Steering	1.5%	2.5%	\$105	\$ 150	2007-2012
Vehicle Weight Reduction	3.0%	4.0%	\$ 210	\$ 350	2007-2012

Optimization of Technology Application

“Cost Effectiveness”:

$$\frac{S_j \left[C_{ij} - \frac{k_{MY}}{1 - GAP} \left(\frac{1}{MPG_{i-1,j}} - \frac{1}{MPG_{i,j}} \right) \right]}{\Delta FINE}$$

S_j = sales of vehicle j

C_{ij} = cost to apply technology i to vehicle j

GAP = onroad FE gap

MPG = fuel economy

$\Delta FINE$ = decrease in CAFE fines

$SURV_v$ = survival rate at vintage v

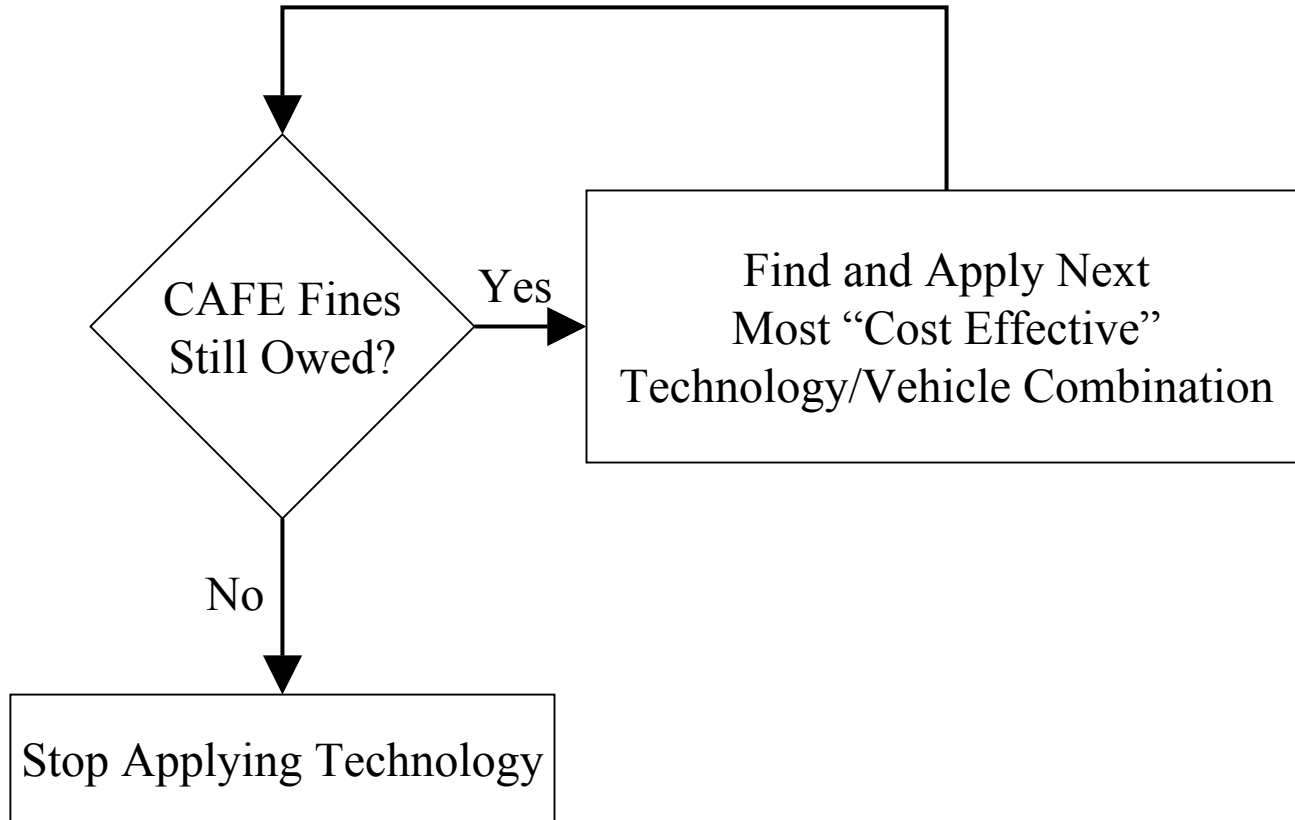
M_v = annual driving at vintage v

P = fuel price

r_b = discount rate

$$k_{MY} = \sum_{v=0}^{v=PB} \frac{SURV_v M_v P_{b,MY+v}}{(1 + r_b)^{v+0.5}}$$

Basic Logic



Estimated CAFE Levels

	<u>MY 2005</u>				<u>MY 2006</u>				<u>MY 2007</u>			
	<u>Base</u>	<u>20.7</u>	<u>21.0</u>	<u>Δ</u>	<u>Base</u>	<u>20.7</u>	<u>21.6</u>	<u>Δ</u>	<u>Base</u>	<u>20.7</u>	<u>22.2</u>	<u>Δ</u>
Toyota	22.12	22.12	22.12	-	22.13	22.13	22.13	-	22.13	22.13	22.23	0.11
GM	20.37	20.70	21.03	0.33	20.44	20.70	21.63	0.93	20.63	20.82	22.21	1.39
DaimlerChrysler	21.32	21.32	21.32	-	21.53	21.53	21.60	0.07	22.24	22.24	22.27	0.03
Ford	20.79	20.79	21.00	0.21	21.12	21.12	21.68	0.56	21.40	21.40	22.20	0.81
Nissan	20.81	20.81	21.01	0.20	20.81	20.81	21.64	0.83	20.81	20.81	22.21	1.40
Isuzu	21.12	21.12	21.12	-	21.12	21.12	21.60	0.48	21.12	21.12	22.20	1.08
BMW	21.77	21.77	21.77	-	21.77	21.77	21.77	-	21.77	21.77	22.22	0.44
Suzuki	22.01	22.01	22.01	-	22.01	22.01	22.01	-	22.01	22.01	22.20	0.19
Honda	24.85	24.85	24.85	-	24.85	24.85	24.85	-	24.85	24.85	24.85	-
Kia	19.55	20.84	21.07	0.23	19.55	20.84	22.13	1.28	19.55	20.84	22.70	1.86
Hyundai	25.02	25.02	25.02	-	25.02	25.02	25.02	-	25.02	25.02	25.02	-
Volkswagen	16.68	17.42	17.42	-	16.68	17.82	17.82	-	16.68	21.30	21.61	0.31
Porsche	13.21	13.21	13.21	-	13.21	15.95	15.95	-	13.21	15.95	15.95	-
Subaru	22.48	22.48	22.48	-	22.48	22.48	22.48	-	22.48	22.48	22.48	-
Avg.	21.03	21.13	21.29	0.16	21.05	21.31	21.78	0.47	21.05	21.60	22.31	0.71

Estimated Cost (RPE) Increases (\$/Vehicle)

	<u>MY 2005</u>			<u>MY 2006</u>			<u>MY 2007</u>		
	<u>20.7</u>	<u>21.0</u>	<u>Δ</u>	<u>20.7</u>	<u>21.6</u>	<u>Δ</u>	<u>20.7</u>	<u>22.2</u>	<u>Δ</u>
Toyota	-	-	-	-	-	-	-	5	5
GM	42	91	49	29	172	144	21	251	229
DaimlerChrysler	-	-	-	-	4	4	-	1	1
Ford	-	30	30	-	84	84	-	116	116
Nissan	-	18	18	-	96	96	-	215	215
Isuzu	-	-	-	-	45	45	-	123	123
BMW	-	-	-	-	-	-	-	40	40
Suzuki	-	-	-	-	-	-	-	8	8
Honda	-	-	-	-	-	-	-	-	-
Kia	181	230	49	181	463	282	181	597	415
Hyundai	-	-	-	-	-	-	-	-	-
Volkswagen	331	331	-	385	385	-	1,224	1,326	102
Porsche	-	-	-	1,033	1,033	-	1,033	1,033	-
Subaru	-	-	-	-	-	-	-	-	-
Avg.	14	36	22	13	80	67	15	121	106

Total Estimated Cost Increases (\$m)

	MY 2005			MY 2006			MY 2007			MY 2005 - 2007		
	20.7	21.0	Δ	20.7	21.6	Δ	20.7	22.2	Δ	20.7	22.2	Δ
Toyota	-	-	-	-	-	-	-	5	5	-	5	5
GM	81	177	96	56	341	284	43	504	461	181	1,021	841
DaimlerChrysler	-	-	-	-	7	7	-	3	3	-	10	10
Ford	-	63	63	-	179	179	-	253	253	-	495	495
Nissan	-	6	6	-	35	35	-	80	80	-	122	122
Isuzu	-	-	-	-	6	6	-	16	16	-	21	21
BMW	-	-	-	-	-	-	-	3	3	-	3	3
Suzuki	-	-	-	-	-	-	-	0	0	-	0	0
Honda	-	-	-	-	-	-	-	-	-	-	-	-
Kia	16	21	4	17	43	26	17	56	39	50	120	70
Hyundai	-	-	-	-	-	-	-	-	-	-	-	-
Volkswagen	11	11	-	14	14	-	45	49	4	70	74	4
Porsche	-	-	-	16	16	-	16	16	-	32	32	-
Subaru	-	-	-	-	-	-	-	-	-	-	-	-
Total	109	279	170	103	641	537	121	984	862	333	1,903	1,570

Estimation of Benefits: Key Assumptions

- Private Fuel Savings: AEO2003 **pretax** fuel prices
- Oil Import Externalities: \$0.083 per gallon
- Rebound Effect: 20%
- Cons. Surplus from Add'l. Travel: $0.5(\Delta\text{VMT})(\Delta\text{cpm})$
- Add'l Congestion, Accidents, and Noise: \$0.062 per mile
- Criteria Emissions: MOBILE6.2, GREET; \$/ton from OMB
- Increase Driving Range: \$20.50 per hour of refueling avoided
- Discount Rate: 7%

Social Benefits

Present Value of Lifetime Social Benefits (Costs)
(Millions of \$2000)

Category	MY 2005	MY 2006	MY 2007
Fuel Savings	\$263.9	\$779.7	\$1,160.8
Reduced Oil Import Externalities	18.5	54.7	81.3
Reduced Criteria Pollutant Emission	2.4	8.0	12.7
Consumer Surplus from Rebound Effect Driving	0.3	2.9	6.3
Increased Refueling Range	20.5	60.3	89.6
External Costs from Rebound Effect Driving (Congestion, Crashes, and Noise)	-87.4	-261.1	-395.6
Total	\$218.2	\$644.5	\$955.2

Costs vs. Benefits

Incremental Total Cost Benefit Analysis
Over the Lifetime of the Fleet
(In Millions of Year 2000 Dollars)

	Costs	Benefits	Net Benefits
MY 2005	\$170	\$218	\$48
MY 2006	\$537	\$645	\$108
MY 2007	\$862	\$955	\$93

More Information

CAFE Program Information

<http://www.nhtsa.dot.gov/cars/rules/cafe>

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