
Lifetime Greenhouse Gas Emissions and Energy Impact of Current US Fleet

Kreider and Associates, LLC
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Background of study

- There is an unmistakable rise of fuel prices and a growing concern about global warming
 - This has led to much media attention about the effects of cars and trucks on the environment.
 - The motivation for this analysis is to better understand environmental and energy impacts of the construction and use of automobiles, pickup trucks, and sports utility vehicles.
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Objective of study

- The objective of this study is to conduct a simplified life cycle analysis (LCA) for the current light duty automobile and truck fleet in the US using open source, public domain data for all car companies.
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Overview

- This presentation describes the analysis methods and results of a simplified life cycle analysis for the current light duty automobile and truck fleet.
 - Impacts studied
 - greenhouse gas emissions
 - lifetime energy use
 - Purposely narrow scope
 - provides easy and transparent comparison of different vehicles
 - basic results not lost in simulation details
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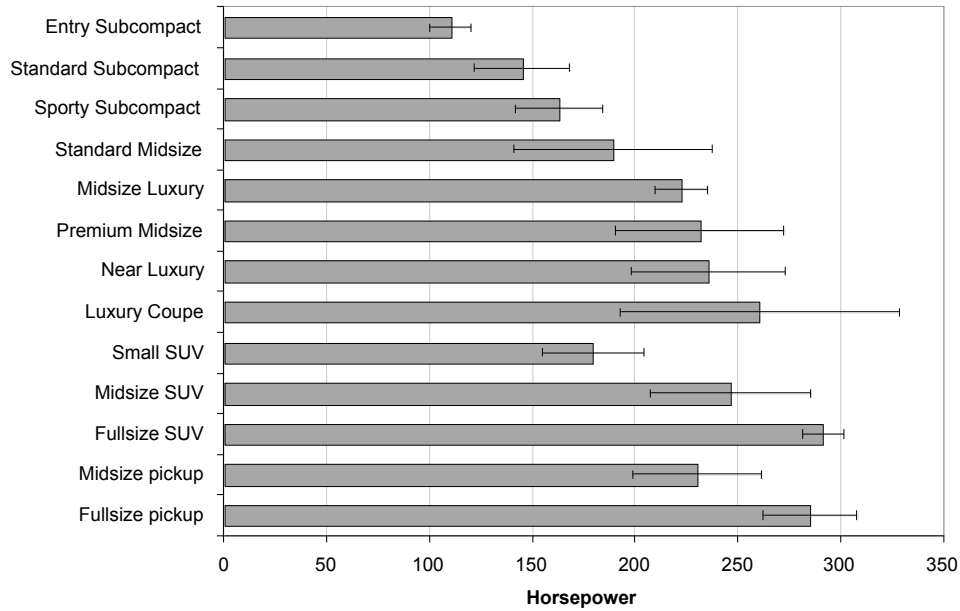
Database of current fleet

- To perform life cycle assessment analyses of automobiles it is necessary to obtain
 - the mass of each vehicle, used for upstream and downstream emission and energy estimates
 - the fuel efficiency, used to calculate the emissions due to use of the vehicle.
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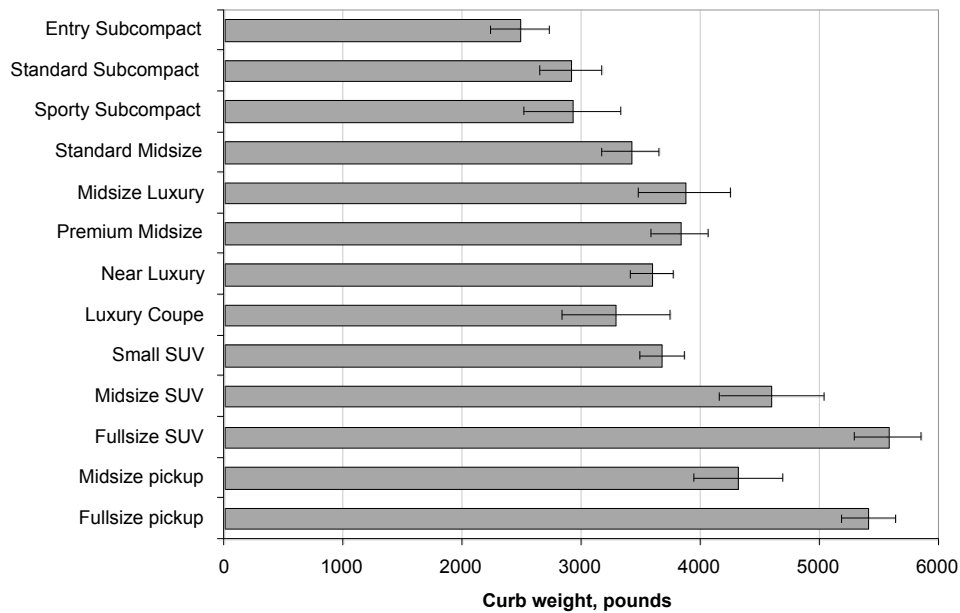
Data sources

- Data were derived from Consumer's Union's (CU) Consumer Reports road tests and from published EPA values.
 - Some discrepancies between these two required data adjustments
 - EPA Equivalent Test Weight versus CU published curb weight
 - EPA city and highway mileage estimates versus CU results
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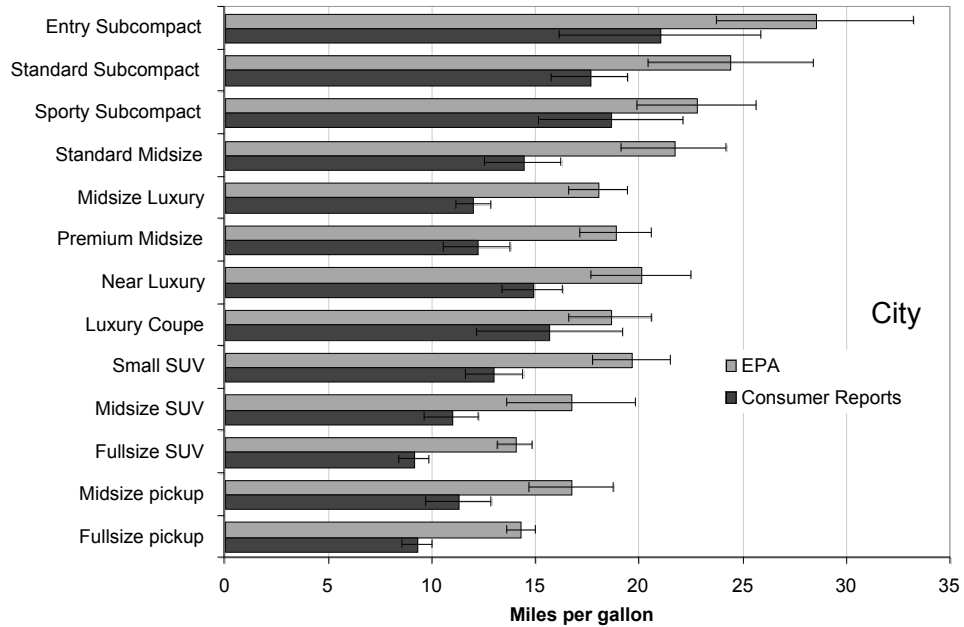
Comparison of EPA and CU values



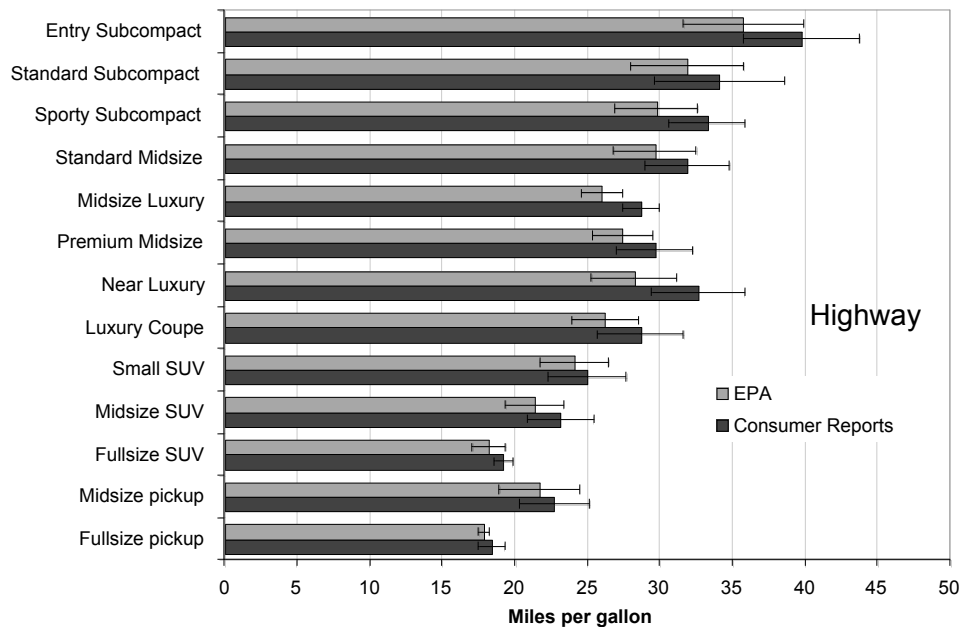
Comparison of EPA and CU values



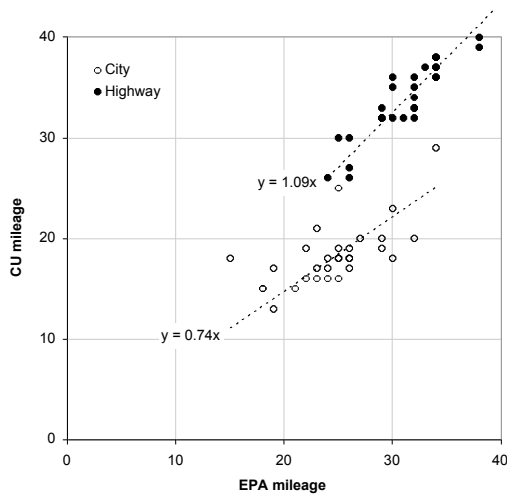
Comparison of EPA and CU values



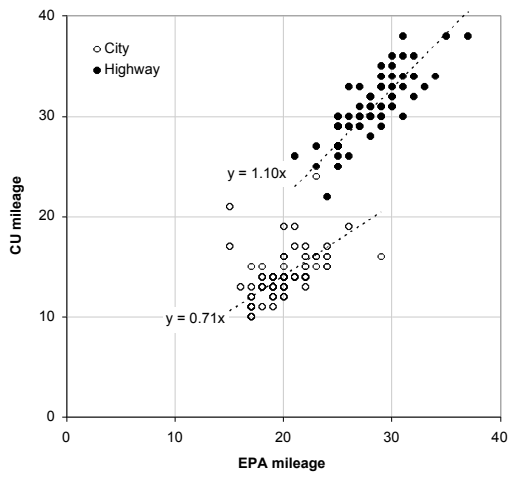
Comparison of EPA and CU values



Comparison of EPA and CU values

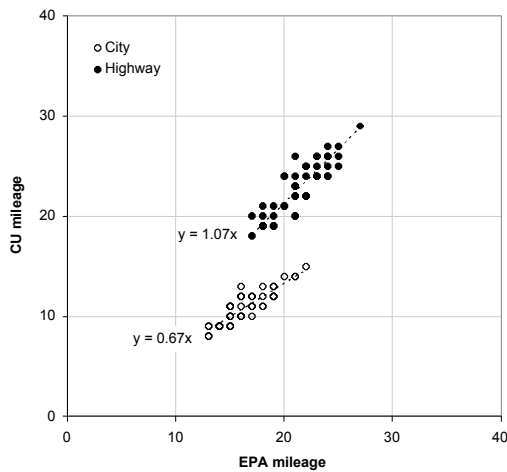


All compacts

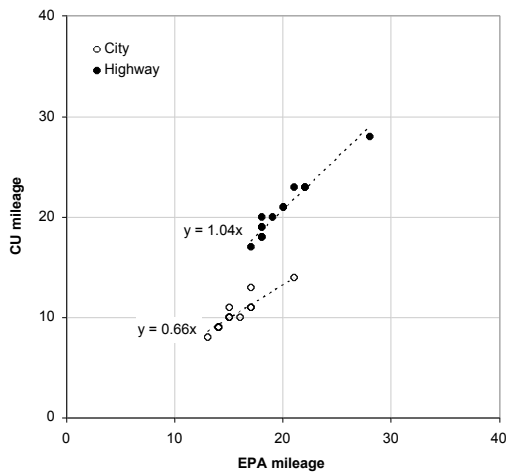


All sedans

Comparison of EPA and CU values

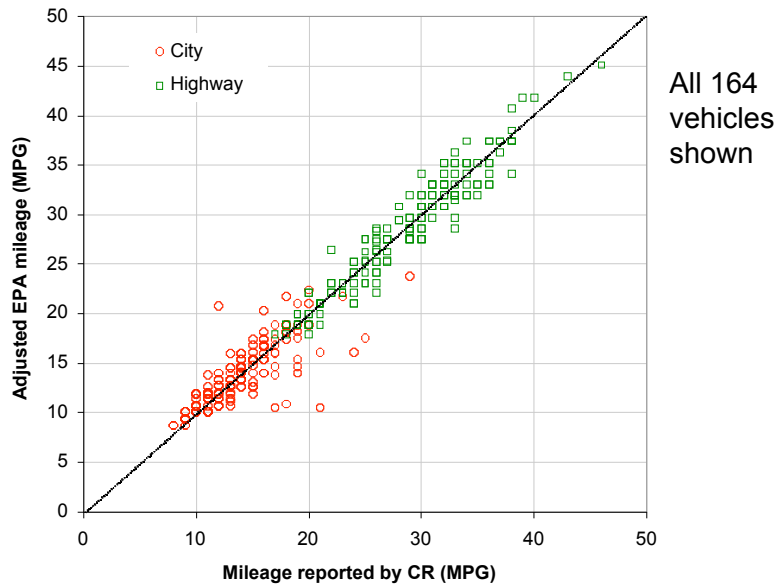


All SUVs



All pickups

Adjusted EPA and CU mileage



Summary of database vehicle categories

1171 total vehicles representing 422 makes and models

Size/Category	Number	Weight	Rated power	City mileage	Highway mileage
Entry Subcompact	20	2534	112	20	39
Standard Subcompact	105	2979	163	17	34
Sporty Subcompact	46	3002	169	16	33
Standard Midsize	148	3432	205	15	32
Near Luxury	108	3662	237	14	30
Premium Midsize	42	3880	247	13	29
Midsize Luxury	55	3875	270	13	28
Luxury Coupe	108	3557	312	12	27
Prestige Luxury	31	4566	407	10	24
Small Van	25	4372	204	12	26
Small SUV	88	3620	178	13	26
Midsize SUV	163	4621	250	11	22
Full-size SUV	66	5493	307	9	19
Midsize pickup	91	4113	209	12	23
Full-size pickup	75	5364	279	10	20

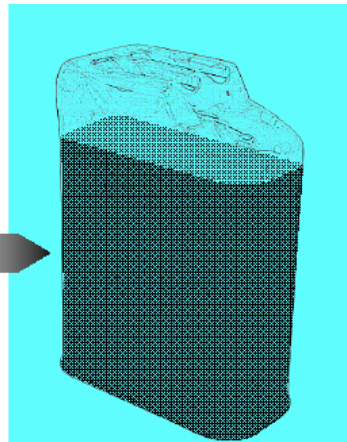
Basic calculations

- Total gallons of gasoline based on 126,000 lifetime miles and a 45% highway / 55% city driving cycle
 - Lifetime energy found from materials, assembly, use, and recycling
 - Well-to-wheel CO_{2,eq} found from carbon content of gasoline plus releases from upstream (refining) activities
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Mass of carbon in regular gasoline



1 gallon of gasoline weighs about 6.15 pounds



85.5% of the weight - about 5.25 pounds - is carbon

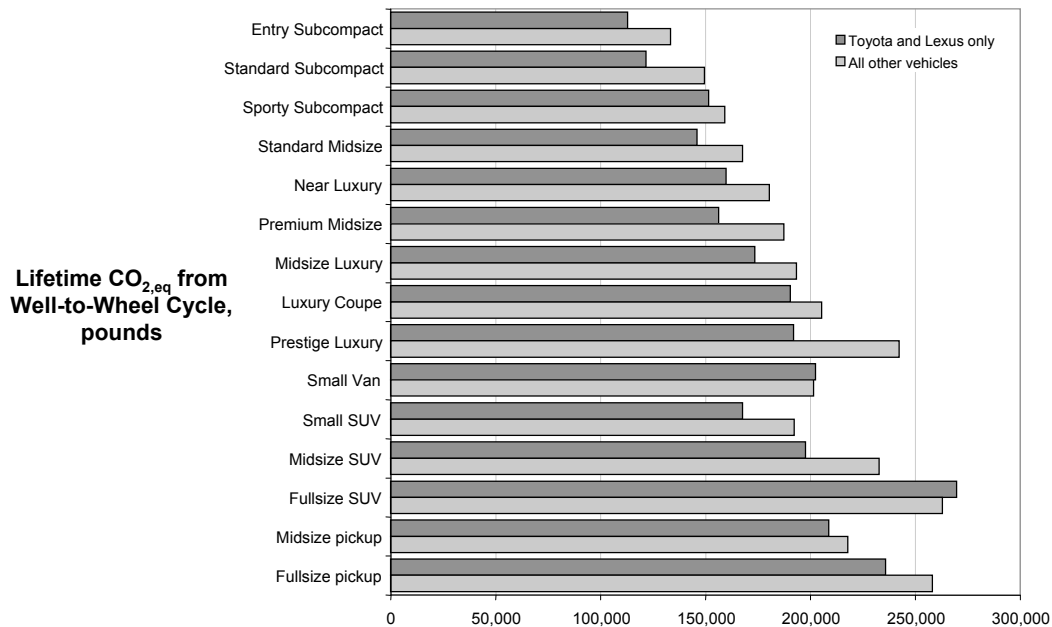
A typical car releases its weight in carbon every year

Results for fuel use and GHG emissions

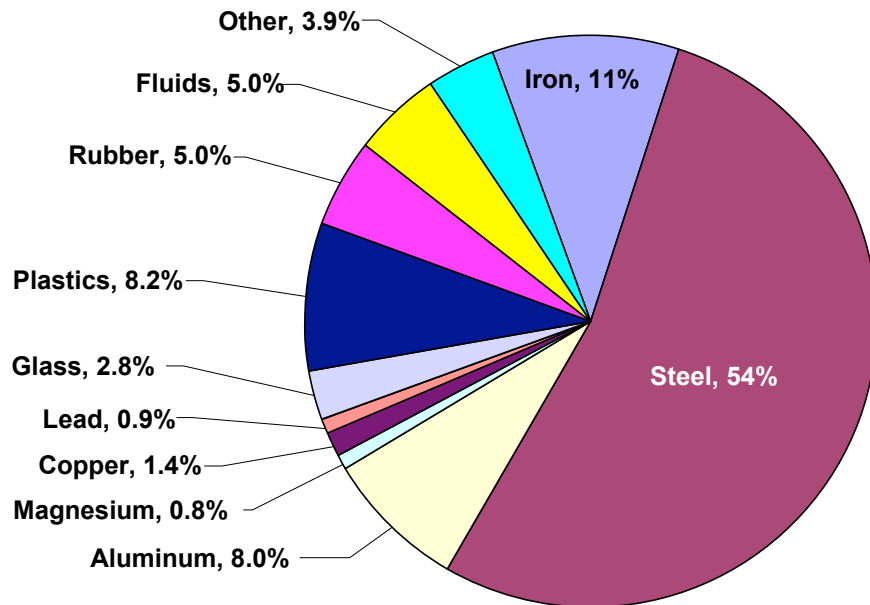
	Toyota and Lexus only		All others	
	<i>Lifetime fuel</i>	<i>W-to-W CO_{2eq}</i>	<i>Lifetime fuel</i>	<i>W-to-W CO_{2eq}</i>
Entry Subcompact	4.3	110	5.1	130
Standard Subcompact	4.7	119	5.8	146
Sporty Subcompact	5.8	148	6.1	155
Standard Midsize	5.6	142	6.4	164
Near Luxury	6.1	156	6.9	176
Premium Midsize	6.0	152	7.2	183
Midsize Luxury	6.7	169	7.4	189
Luxury Coupe	7.3	186	7.9	200
Prestige Luxury	7.4	187	9.3	236
Small Van	8.0	202	7.9	202
Small SUV	6.6	168	7.6	192
Midsize SUV	7.8	198	9.2	233
Full-size SUV	10.6	270	10.4	263
Midsize pickup	8.2	209	8.6	218
Full-size pickup	9.3	236	10.2	258

fuel use in 1000 gallons, lifetime greenhouse gas emissions in 1000 lbs

Results for GHG emissions



Material composition fractions

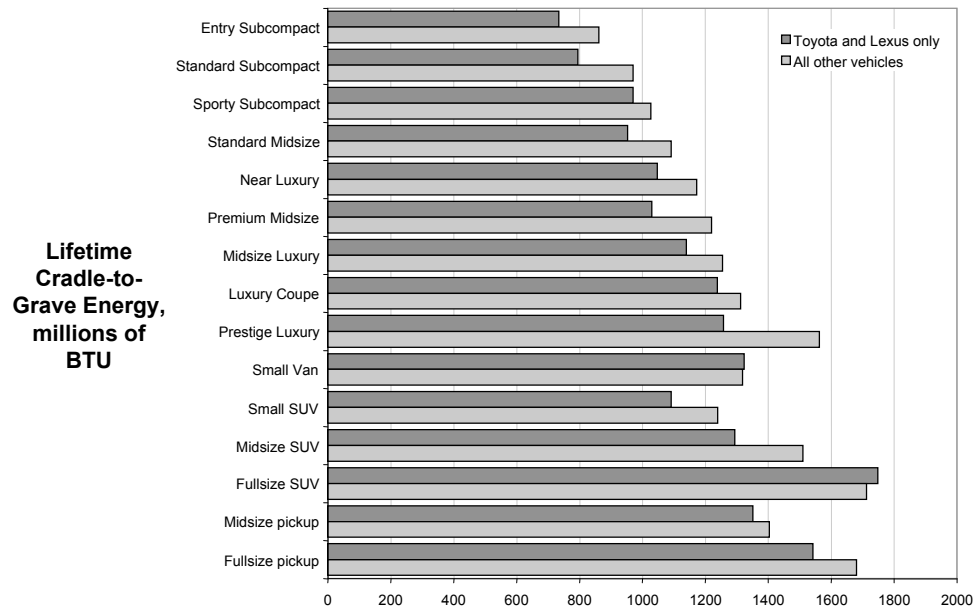


Results from energy analysis

Size/Category	Toyota and Lexus only				All others			
	Materials energy	Assembly energy	Use energy	Recycling energy	Materials energy	Assembly energy	Use energy	Recycling energy
Entry Subcompact	65	11	639	4	72	12	755	4
Std Subcompact	72	12	689	4	83	14	847	5
Sporty Subcompact	75	13	858	4	84	15	900	5
Standard Midsize	87	15	826	5	96	17	949	6
Near Luxury	98	17	904	6	102	18	1021	6
Premium Midsize	100	17	884	6	108	19	1059	6
Midsize Luxury	109	19	981	6	107	19	1094	6
Luxury Coupe	108	19	1078	6	99	17	1161	6
Prestige Luxury	117	20	1085	7	127	22	1370	7
Small Van	122	21	1174	7	121	21	1169	7
Small SUV	97	17	973	6	101	17	1115	6
Midsize SUV	120	21	1147	7	129	22	1351	8
Full-size SUV	150	26	1564	9	153	26	1525	9
Midsize pickup	114	20	1211	7	114	20	1263	7
Full-size pickup	141	24	1368	8	149	26	1497	9

Energy values given in millions of BTU

Total Cradle-to-grave energy use



Comparison with CNW results

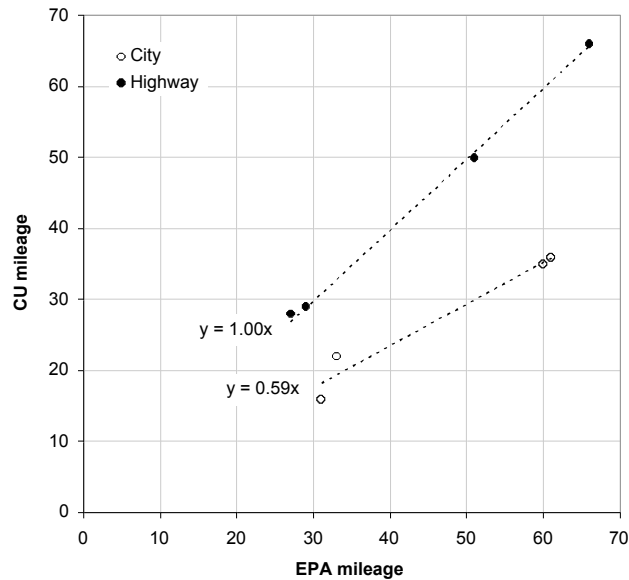
Numbers shown for Honda Civic

Stage	Fraction of total energy	
	This report	CNW
Materials	8%	13%
Assembly	1%	14%
Driving	90%	59%
Recycling	0.5%	15%

Hybrid vehicles

Comparison of EPA and CU mileage estimates

Four vehicles total



Comparison of Toyota Prius

Lifetime $CO_{2,eq}$ for fuel use and related upstream activities

Size/Category	Weight (lb)	HP	City MPG	Highway MPG	Lifetime fuel (gal)	lifetime $CO_{2,eq}$ (lb)
Standard Subcompact	2979	163	18	34	5690	144,410
Standard Midsize	3432	205	15	32	6384	162,033
Prius hybrid	2950	110	35	51	3069	77,906

Stage and total energy in millions of BTU

Size/Category	Materials	Assembly	Use	Recycling	Total
Standard Subcompact	83	14	838	5	939
Standard Midsize	95	16	940	6	1057
Prius hybrid	90	15	452	6	563

All hybrid stages except Use have multiplier to account for batteries

Comparison of Highlander hybrid

Lifetime CO_{2,eq} for fuel use and related upstream activities

Size/Category	Weight (lb)	HP	City MPG	Highway MPG	Lifetime fuel (gal)	lifetime CO _{2,eq} (lb)
Midsized SUV	4621	250	11	22	9020	229,000
Highlander hybrid	4430	268	18	27	5890	149,000

Stage and total energy in millions of BTU

Size/Category	Materials	Assembly	Use	Recycling	Total
Midsized SUV	128	22	1327	8	1485
Highlander hybrid	127	22	822	8	978

All hybrid stages except Use have multiplier to account for batteries
