How to Improve Gas Mileage 25% to 50%

By Glenn Weinreb

SUMMARY: Small electric motors and small batteries can improve vehicle gasoline mileage at relatively little cost.

There are four primary types of automobiles: Gas Vehicle (ICEV), Hybrid (HEV), Plugin Hybrid (PHEV), and Electric Vehicle (EV).

The term "hybrid" refers to a vehicle that has both a gasoline engine *and* an electric motor; and there are two types of hybrid. The more costly type is called "Plugin Hybrid" (PHEV) and the less costly type is called "Hybrid" (HEV). This is confusing, since both use the term "hybrid".

The Plugin variety supports driving 20 to 50 miles exclusively on electricity, and allows one to charge with a wall outlet. The less costly variety is designed to recover energy while braking, and is designed to run on electricity *only* while coasting; not while accelerating. Subsequently, the less costly type's electric motor and battery are tiny since they provide relatively little power, for little money.

The below table (LINK http://www.ma2life.org/g/pic/ev_kill_car/rav4_models.png) summarizes the Toyota RAV4 Gas, Hybrid (HEV, no plug) and Plugin Hybrid (PHEV).

Model	Type	Car Cost ($ MSRP)	Mileage (MPG)	Gas Motor (HP)	Electric Motor HP	Electric Only Miles	Gas + Elect (HP)	Battery (kWh)	Weight (LBs)
2022 Toyota RAV4 LE AWD (Gas)	Gas	$27,925	30	203		0	203	0	3,490
2022 Toyota RAV4 Hybrid LE AWD (HEV)	HEV, Hybrid (no plug)	$29,075	40	203	16	0	219	1.6	3,690
2022 Toyota RAV4 Prime SE AWD (Plugin)	PHEV, Plugin Hybrid	$39,800		203	99	42	302	18.1	4,235

Figure 1: Comparison of Toyota RAV4 Gas, HEV and EV.

The RAV4 HEV only cost $1.2K more than the RAV4 Gas, and it gets 33% better gas mileage (30MPG vs. 40MPG). The additional $1.2K pays for a small motor and small battery that provides some power while coasting, and recovers energy while braking.

Alternatively, the initial cost of the RAV4 Plugin Hybrid is $12K more than the RAV4 Gas, and this additional cost pays for a moderately sized battery and electric motor that supports driving 42miles exclusively on electricity. Its electric motor is 6-times larger, and its battery is 11-times larger, than that in the Hybrid (HEV, no plug).

If one typically drives less than 40 miles each day, they can charge a Plugin Hybrid at night and run on electricity during the day; and revert to gas when they drive further. In contrast, Electric Vehicles (not Plugin Hybrid) entail range anxiety (worry about charging) and inconvenience (wait while charging). Plugin Hybrid does not have these burdens, since gas can kick in, when electricity kicks out.

The HEV Miracle

The *electric* motor size is typically 200HP in an EV, 100HP in a Plugin Hybrid, and 16HP in an HEV. And the battery size is typically 64kWh in an EV, 18kWh in a Plugin Hybrid, and 2kWh in an HEV.

One might consider the HEV unappealing due to its diminutive battery and electric motor. However, these small sizes are misleading. The HEV is a miracle since one saves money *and* reduces CO_2 when they buy an HEV instead of a Gas Car. In other words, buyers are paid to reduce CO_2, and decarbonization cost ($/t$CO_2$) is negative.

Now let's look at a specific case. The initial cost of the Toyota Camry HEV (LINK https://cars.usnews.com/cars-trucks/toyota/camry-hybrid/2022/specs/camry-hybrid-hybrid-le-cvt-(natl)-422092) sedan is $2K more than the Camry Gas (LINK https://cars.usnews.com/cars-trucks/toyota/camry/2022/specs/camry-le-auto-(natl)-422196); however, lifetime gasoline costs are $6.5K less due to better gas mileage, as shown in the below table (LINK http://www.ma2life.org/g/pic/ev_kill_car/camry_rav4.png). The situation with the Toyota RAV4 (LINK https://cars.usnews.com/cars-trucks/toyota/rav4-hybrid/2022/specs/rav4-hybrid-hybrid-le-awd-(natl)-424494) sport utility vehicle is similar.

Model	Type	Gas Mileage (MPG)	Battery (kWh)	Car Cost ($ MSRP)	Gas Lifetime Cost ($)	Car+Gas Lifetime Cost ($)	Car+Gas Cost per mile ($/mile)	Lifetime Emissions (tCO_2/life)
2022 Toyota Camry LE (Gas)	Gas Sedan	34	n/a	$25,395	$18,507	$43,902	$0.22	67.8
2022 Toyota Camry Hybrid LE CVT (HEV)	HEV, Hybrid (no plug)	52	1.6	$27,480	$11,923	$39,403	$0.20	43.7
	Difference	19		$2,085	-$6,584	-$4,499	-$0.02	-24.1
		55%		8%	-36%	-10%	-10%	-36%
2022 Toyota RAV4 LE AWD (Gas)	Gas SUV	30	n/a	$27,925	$20,667	$48,592	$0.24	75.7
2022 Toyota RAV4 Hybrid LE AWD (HEV)	HEV, Hybrid (no plug)	40	1.6	$29,075	$15,500	$44,575	$0.22	56.8
	Difference	10		$1,150	-$5,167	-$4,017	-$0.02	-18.9
		33%		4%	-25%	-8%	-8%	-25%

**Conditions: $3.1/gal gas (US 2021), $0.14/kWh electricity (US 2021), 14 years x 14.3K mi/yr = 200K lifetime miles, replace EV battery once.*

Figure 2: Comparison of Toyota Camry Gas vs. EV and Toyota RAV4 Gas vs. EV.

The Gas vs. HEV comparison at Honda Corporation is similar to that at Toyota. The Honda CR-V (LINK https://cars.usnews.com/cars-trucks/honda/cr-v-hybrid/2022/specs/cr-v-hybrid-ex-awd-424801) sport utility vehicle and the Honda Accord (LINK https://cars.usnews.com/cars-trucks/honda/accord-hybrid/2022/specs/accord-

hybrid-hybrid-sedan-425170) sedan have HEV models with lower lifetime costs than their Gas counterparts, as noted in the below table (LINK http://www.ma2life.org/g/pic/ev_kill_car/accord_crv.png).

Model	Type	Gas Mileage (MPG)	Battery (kWh)	Car Cost ($ MSRP)	Gas Lifetime Cost ($)	Car+Gas Lifetime Cost ($)	Car+Gas Cost per mile ($/mile)	Lifetime Emissions (tCO_2/life)
2022 Honda Accord Gas, LX 1.5T CVT	Gas Sedan	34	n/a	$26,120	$18,235	$44,355	$0.22	66.8
2022 Honda Accord Hybrid (no plug) Sedan	HEV, Hybrid (no plug)	48	1.3	$27,320	$13,053	$40,373	$0.20	47.8
	Difference:	14		$1,200	-$5,183	-$3,983	-$0.02	-19.0
		40%		5%	-28%	-9%	-9%	-28%
2022 Honda CR-V Gas, EX AWD	Gas SUV	30	n/a	$30,410	$21,017	$51,427	$0.26	77.0
2022 Honda CR-V Hybrid (no plug), EX AWD	HEV, Hybrid (no plug)	38	1.4	$31,610	$16,533	$48,143	$0.24	60.6
	Difference:	8		$1,200	-$4,484	-$3,284	-$0.02	-16.4
		27%		4%	-21%	-6%	-6%	-21%
**Conditions: $3.1/gal gas (US 2021), $0.14/kWh electricity (US 2021), 14 years x 14.3K mi/yr = 200K lifetime miles, replace EV battery once.*								

Figure 3: Comparison of Honda Accord Gas vs. EV and Honda CR-V Gas vs. EV.

The NREL transportation webpage (LINK https://atb.nrel.gov/transportation/2020/data) as of June 2022 does not reflect the above situation since their data is based on older 2013 to 2020 studies (LINK https://atb.nrel.gov/transportation/2020/literature_context), and they look at average car instead of comparing different versions of the same model. For example, the initial cost of their average HEV is $5K greater than that of their average Gas Car, and this is not consistent with the cases described above.

HEV Needs a Name Change

HEV is not very popular, in part, due to an unattractive battery and electricity motor size. Also, the term "Hybrid" (HEV) is too easily confused with "Plugin Hybrid" (PHEV). It sounds like one has a plug, and the other does not. However, the plug is not the primary difference. The primary difference is the larger motor and battery for significantly more money.

If HEV was relabeled to "Electricity Assist" (EA), it could be positioned as a $1K to $2K accessory that improves gas mileage by 25% to 50%, with a 1 to 3 year payback period. And then it would *not* be compared with the Plugin Hybrid. In other words, HEV needs a name change.

Kill the Car

If lawmakers wanted buyers to favor Cars with Electronic Assist, to reduce CO_2, they could transfer money from non-EA buyers to EA buyers. For example, if the ratio of non-EA buyers to EA buyers was 4-to-1, gov't could collect $500 from non-EA buyers and transfer $2,000 to EA buyers (4 x $500). If the initial price of the EA vehicle with rebate

was lower than the non-EA vehicle, consumers would be more inclined to favor EA. Subsequently, one could kill the car, where "car" is defined as a Gas Vehicle without EA. This might be accepted politically since it would not increase federal tax, it would not increase the federal deficit, it would not subsidize a more costly solution, and it would reduce CO_2.

Alternatively, gov't could kill the car without EA by requiring better gas mileage.

For more information on how to reduce CO_2 from vehicles, see:

- *Are We Ready for a Swappable EV Battery?* (LINK https://www.eetimes.com/are-we-ready-for-a-swappable-ev-battery/)
- *The Dirty Little Secret of Electric Vehicles* (LINK https://www.eetimes.com/the-dirty-little-secret-of-electric-vehicles/)
- *Car Costs and CO_2 are Complicated* (LINK https://www.eetimes.com/car-costs-and-co2-are-complicated/)

Mr. Weinreb is the Director of The Manhattan 2 Project and has published over 30 articles (LINK http://www.ma2life.org/g/aspencore-climate-change-solutions.pdf) *on how to tackle climate change.*