Electric Vehicles Doug Hayhoe, September 2024

EVs compare well with ICE vehicles in convenience and cost, and their environmental impact is much better.

Our 2018 Chrysler Pacifica Hybrid was the perfect vehicle for COVID when we only drove 45 km a day, all on the battery. For longer trips, its gas-powered engine gave it a range of 750 km. But in 2024, we sold it and bought a Kia EV9. It's about the same size as the Pacifica, but its range is only 480 km as it's an all-electric vehicle.

This essay compares electric vehicles (EVs) with internal combustion engine vehicles (ICEs) in terms of charging, range, cost, and safety. Our responsibility as stewards of God's creation may be the most important reason to buy an electric car.

Charging and range

North Americans are more concerned about the inconvenience of charging an EV and their relatively limited range than the cost. But if you install a high-speed charger at your house, you can comfortably charge the car overnight. That's also when the cost of electricity is at the lowest.

If you live in a condo, as one of my EV friends does, you can collaborate with other EV owners there to work out a deal with the condo board to install individual chargers in the parking lot. The cost of the installation may be more than a house version, but the costs of electricity are very comparable since condominiums probably get a preferred bulk rate 24/7.

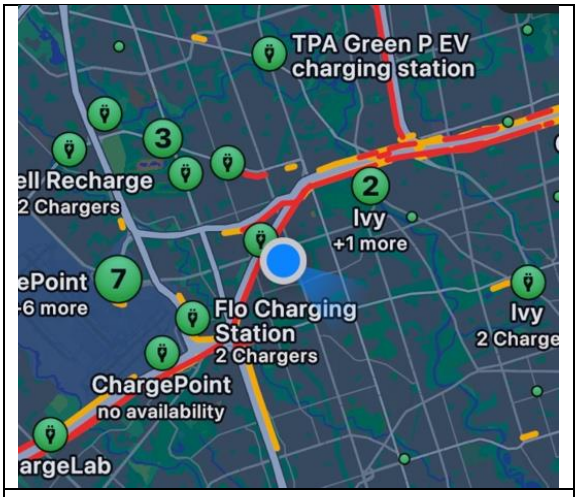

Figure 1 Charging stations within 5 or 10 minutes of my home in Toronto

When you're on the road it's usually easy to find charging stations close by (Figure 1). There are many apps, like *Charge Hub*, that identify locations of chargers of all types. Commercial charging stations may cost more than at home, but are useful for long-range trips.

A friend recently drove to Florida and back with his Tesla Y. It took 20-30 minutes to charge his car, which he did twice a day, at the Tesla supercharging stations. The Kia EV9 is larger, and has a bigger battery. Also, the charging stations it uses are slower than the Tesla supercharger. So, my charging times are approximately double that.

The range of most EVs is still a good deal less than that of comparable ICE vehicles. But in the city, the fuel economy of an ICE is much lower, while that of an EV actually improves. This is because EVs don't burn gas by idling. Also, whenever they are braked (or as soon as the foot is taken off the accelerator pedal), the battery is recharged by the same electric motor becoming a generator. This is called regenerative braking.

Winter, however, gives a downside to EVs. Their range is not nearly as good as in warm weather (Figure 2). There are two main reasons for this. First, batteries don't perform nearly as well in the cold "due to the reduced mobility of ions in the battery's electrolyte." Second, cabin heat is produced by battery power; while in ICE cars, the waste heat of the engine heats the cabin.

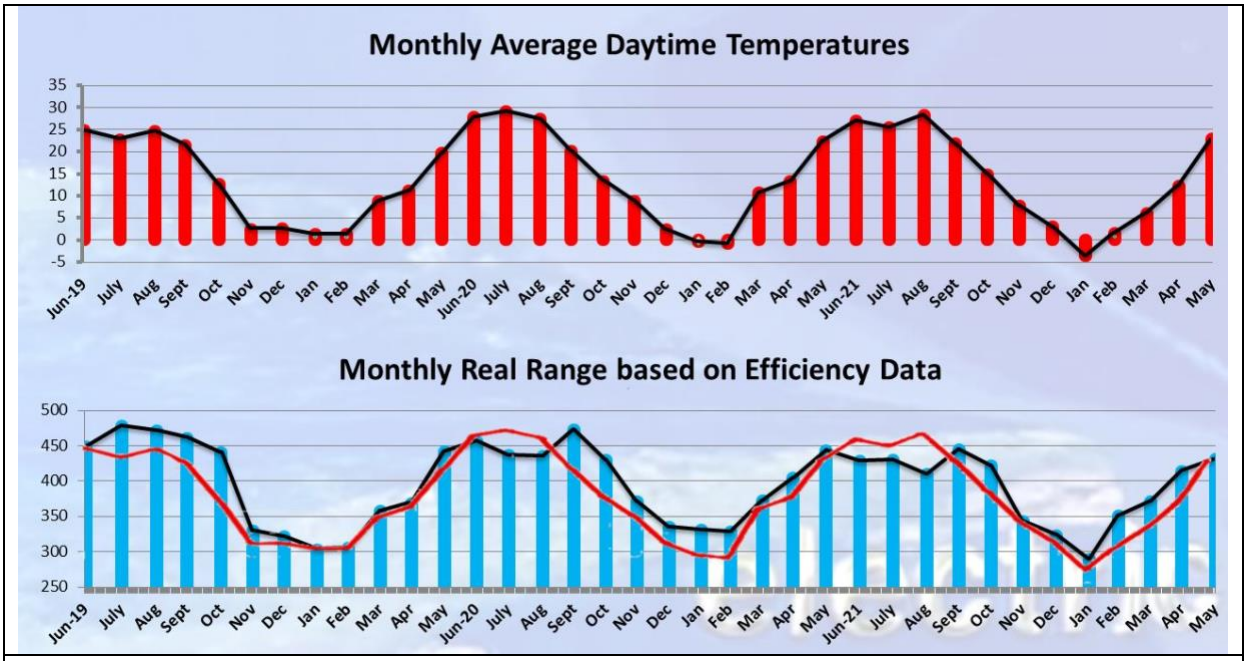

Figure 2 The top chart plots the monthly average temperature in Toronto over three years, while the bottom chart plots the average range of the Kia Soul EV in km over the three years (with the average temperature superimposed in red). Notice how closely they compare (Geoff Day, used by permission)

Cost

Let's compare the all-electric Kia EV9 with the gas-powered Kia Telluride, two almost identical cars. If you choose two other very similar EV and ICE vehicles, the results should be similar.

Initial cost: A new EV9 starts at $10,000 CAD more than the Telluride. But there is a $5000 rebate for EVs, before Ontario's 13% tax is added. So, the extra cost is only $5650 more. If you install a driveway charger, as I did, that may cost $1350. So, your initial EV cost is $7000 more.

Fuel cost: The Telluride has an average fuel economy of 11.9 L/100 km. At the current cost of $1.57 per Litre for gasoline in Toronto, this comes to $18.68 CAD per 100 km. If you drive 25,000 km per year, that will be $4,670. The electricity cost in Toronto for charging the EV9, on the other hand, is only 20% of this (see the Appendix). So, it will save you $3,736 per year (80% of $4670) and you can pay off the extra purchase cost of $7000 in two years. If you drive 15,000 km a year, you can pay it off in three years. (Of course, EVs don't yet pay for road construction.) A friend pointed out that if you drive your EV for ten years, the savings in fuel cost might recoup up to 50% of the cost of the car. At least they would help with any repairs incurred.

Insurance and service costs: Auto insurance for the EV may cost more, as EVs are often more expensive to replace or repair when accidents occur. But insurance rates depend on many factors. And service costs will be less, as EVs require no oil change or lubrication, and often there are no routine service visits. One friend only paid $140 per year, for several years, to service his EV.

Depreciation: In their early years, EVs lost value more quickly than CEs, partly because their range was so small. But today's EVs have better batteries and longer ranges, and they may hold their value as much as ICEs.

Safety

When a cousin who is a fire chief saw my Kia EV9, he noted that fires in EVs are more difficult to put out than those in ICEs (see here). The fire burns from section to section of the battery, through the entire car. A recent report from AutoinsuranceEZ, however, said EVs had 60 times fewer fires per 100,000 sales than ICE vehicles. And my cousin said he might still buy an EV!

Another safety issue with EVs was their risk to pedestrians, because they are so quiet, according to a recent report. But the data for this was from the UK a decade ago. And the research has been questioned as to whether it has any significance for us today. In the past few years, laws have been passed to mandate at least 30 dB of sound to be produced, and a louder sound for reversing.

Efficiency and environmental impact

ICEs have a theoretical efficiency of only 50%, compared with 100% for EVs with regenerative brakes. ICEs also have up to 2,000 moving parts, while EVs only have 18 moving parts (Figure 3). In fact, the total conversion efficiency of fuel energy into kinetic energy for ICE vehicles – "power to wheels" – is only 16% to 25%. Whereas for EVs it is 86% to 90%.

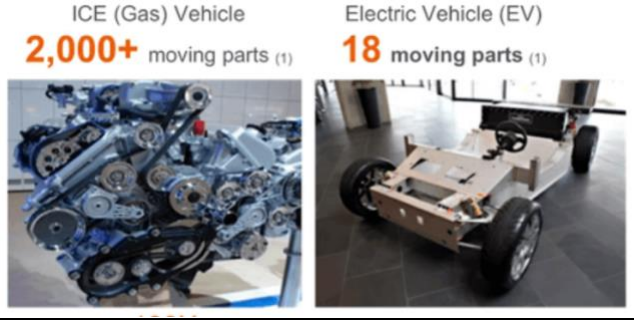

Figure 3 Moving parts in an ICE versus EV automobile

The biggest advantage of the EV over the ICE car may be its environmental impact. Cars and vans account for 10% of the global CO_2 production, although the total transportation sector, including airplanes, trains, and trucks, accounts for double this amount. This is a main driver of climate change, one of our most serious threats (see my essay *The Science of Climate Change*).

Gas-powered cars also emit "volatile organic compounds, hydrocarbons, carbon monoxide, ozone, lead, and various oxides of nitrogen." Also, their brakes release much more brake dust. For when you take your foot off the accelerator in an EV, the electric motor switches to become a generator, and you hardly have to use the brake. EVs can often be driven using one pedal only.

Objections to the Environmental Impact Argument

People point out that the mining of the rare earth minerals used in Lithium-ion batteries, such as cobalt and nickel, can damage the environment. The Wall Street Journal notes, however, that the Chinese have developed a way of refining cobalt and nickel out of industrial waste. And in the U.S., there are companies such as *Ascend Elements*, which is "an independent manufacturer of advanced battery materials using valuable elements reclaimed from spent lithium-ion batteries."

Another objection is that *the production process* of an electric car and its battery may produce more CO_2 than that produced by an ICE vehicle. But MIT's *Climate Portal* has looked into this, and concluded that, in the end, battery-driven cars have less impact on the environment. (For additional recent reports on this topic, see *Scientific American* and *The Conversation*.)

A further objection is this: Canada may have ambitious time-lines for moving us all into EVs. But does it have realistic time-lines for increasing electrical production from utilities powered by non-fossil fuel sources to support this? (See here for an overview of Canada's energy sector.)

Many people not yet convinced by the environmental impact argument, such as a nephew of mine, still enjoy their EVs for other reasons. He has bought Teslas for 12 years now, because "they are fast, nimble, and quiet." But I still hope to persuade him that, in the long run, they are also better for the environment than ICE vehicles!

Conclusion

In terms of convenience and cost, EVs and ICE vehicles may be about even. But many people are seriously concerned about the greater damage that ICE vehicles cause the environment. They love this wonderful Earth that we live on, and want to see it remain the same for future generations, including their children and grandchildren. And they see the purchase of an electric car, as well as other lifestyle changes, as one way to save it.

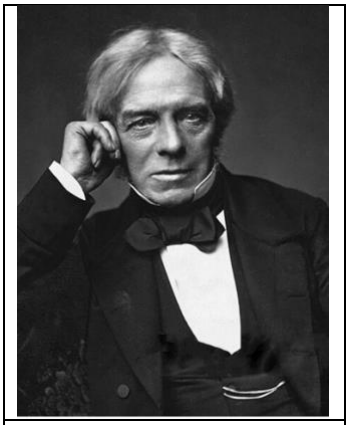

Figure 4 Michael Faraday, photo in the public domain

But if you're a Christian, you have a further motivation. The Bible has many references to the stewardship responsibility God has given us, with respect to our natural resources. The famous scientist who invented the electric motor and electric generator 200 years ago, Michael Faraday (Figure 4), was a faithful Christian who was very concerned about the environment.

I hope that you will seriously consider buying an electric car, if you need a vehicle, even though there are many other ways you can reduce your impact on the environment.

Other resources

For recent articles comparing EVs with ICE vehicles, from the *New York Times,* see here and EVs with hybrids see here. For a recent article on fires caused by making Lithium-ion batteries, from the *Wall Street Journal*, see here. My own research suggests that this may be exaggerated.

References

Geoff Day, former technology consultant for the Toronto District School Board, kept track of the range of his Kia Soul EV from 2019-2022. He found that the "it simply follows temperature and the average given by the OEM [original equipment manufacturer] is a very real annual average with better than average range between April and November and poorer than average range November to April - something quite different to learn to reap the benefits of driving an EV!"

Appendix: Fuel costs for a comparable Kia EV vs Kia ICE vehicle per 100 km

The fuel economy of a new Kia Telluride, for city/highway driving, is 11.9 L/100 km. At $1.57 per L for gasoline, **driving a 100 km will cost $18.68.** The range of our Kia EV9 Land is 480 km for 100 kwh battery. So 100 km needs 20.8 kwh. Each kwh costs 0.146 on my residential charger or 0.172 cents on my friend's condo charger. Thus, **driving 100 km will cost $3.04** (20.8 x $0.146) or $3.6 (20.8 x $0.172). This is 16% to 20% as much as the Kia Telluride's $18.68

The cost at charging stations is higher than with your home charger. You will pay $0.50 per kwh at a Petro Canada station ($0.50/min at 100 kw). Some EV stations charge as much as $0.70 per kwh. Obviously, having a home charger is the way to go, unless you are on the road all the time.