

CAN AN EV



DO THE JOB FOR ME?

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If you need to drive 80 to 125 miles (161 km) or more on a charge, the Toyota RAV4 EV is a good choice.

You're considering candidates for your next car, and you're intrigued by the idea of an electric vehicle (EV). You like the fact that they are clean, quiet, low maintenance, economical to operate, and petroleum free. But you're just not quite sure whether an EV can meet your needs.

Let's compare what you need and what you have to offer with what the car needs and what it has to offer, and see if we can make a match. We'll divide the subject into five general categories:

- Performance
- Driving Conditions
- Charging Infrastructure
- Mechanical Ability & Involvement
- Budget

Within each category, we'll look at several factors. If all or most EVs can handle an item, I'll call it a "Yes." If some EVs can handle it, but not others, or only up to a certain limit, it's a "Maybe." If no EVs (or very few) can deal with it, it's a "No." Some of these categories interact with each other, but by the time we're finished, we'll have the whole picture. You can use the accompanying table to follow along, and see where you fit in each category. So grab your pencil and let's find out how an EV scores for you.

Performance

This is the car's job description. For many people, range on a charge is of primary interest. A typical compact car conversion can travel 60 miles (97 km) or so before needing a charge, under good conditions. (We'll talk about bad conditions a little later.) A heavier vehicle might only get half that much. On the other hand, a high performance sports car conversion might get 80 miles (129 km) or up to 100 miles (161 km) on a charge—under good conditions.

Not a lot of options are available at the moment in commercially manufactured EVs, and many of them are

limited to California. The Toyota RAV4 EV, with its high end, nickel-metal-hydrate battery pack, claims 126 miles (203 km) on a charge. Micro cars, also known as city cars and neighborhood electric vehicles (NEVs), such as the Th!nk and the Gem get 30 to 50 miles (48–80 km) on a charge.

You need to determine your real life, daily range needs. The best way to do this is to keep a mileage log for at least a month. You also want to add some safety margin into your range capabilities in case of surprises.

If you need 30 miles (48 km) or less, even a city car or NEV could do the job for you. This is a definite “Yes.” If you need up to 60 miles (97 km) on a charge, most EVs will still be able do the job, so this is also a “Yes.” If you need 60 to 125 miles (97–201 km), this is a “Maybe.” Some EVs will do the job, under some conditions. More than 125 miles (201 km) is a “No.”

If you find that you have only an occasional day that exceeds the mileage of an EV, there are other alternatives. Do you have a second car you could use



A pickup conversion can make a good light-duty work vehicle.

for those longer mileage days? Would it be economical to use a taxi, public transportation, or a rental car for part or all of your mileage on those days, if they are infrequent?

If you regularly exceed the range of an EV, you can extend that range by plugging in and recharging at your destination. A full day’s recharge while at work will

An Electric Vehicle for You—Yes, No, or Maybe?

Item	Yes	Maybe	No
Range	< 30 miles: Almost any EV 30–60 miles: Most EVs	60–100 miles: Top conversions 80–125 miles: RAV4 EV	> 125 miles: Go hybrid
Speed & acceleration	25 mph, low acceleration: NEVs Up to 75 mph, good acceleration: Most conversions & factory EVs	Up to 90 mph, exceptional acceleration: High performance conversions	
Payload	2 passengers: NEVs & sports EVs 4 passengers & small cargo: Most conversions & factory EVs	Moderate cargo: EV pickups or VW vans	> 4 passengers, heavy cargo, or towing: Go biodiesel
Terrain	Flat to moderate hills	Lots of hills, very steep or long hills	Mountains: Go hybrid or biodiesel
Traffic	Light or smooth	Heavy stop-and-go	
Weather	Heat or rain	Moderate cold & snow	Severe cold: Go hybrid
Road conditions	Good paved: All EVs	Bumpy, dusty, gritty	Off-road or serious mud: Go biodiesel
Charging	Garage or outdoor	Apartment Off-site or off-grid	
Hands-on factor	Minor maintenance to build it yourself: Conversions	Drive it, plug it in, forget it: Factory EVs	
Budget	All ranges		

greatly increase your daily available range. If none of these options will meet your needs, you might want to look into the Toyota or Honda hybrids, which are high mileage, electric-assisted gas cars.

Two other related aspects of performance are speed and acceleration. Your needs will be determined by your local traffic conditions. On the low end, NEVs are limited to 25 mph (40 kph), but on the high end, a sporty EV conversion can reach 90+ mph (145 kph). Most fall in the midrange of 65 to 75 mph (105–121 kph). The top speed on the RAV4 EV is listed as 78 mph (126 kph).

Acceleration will vary from model to model. It's determined primarily by the current limit on the speed controller. Most full-fledged EVs can merge comfortably onto the freeway, and if you really need drag racer performance, it's available. In short, there is an EV out there to satisfy almost anyone's speed and acceleration needs. This is a "Yes."

A final part of the vehicle's job description is payload capacity. How many passengers, or how much cargo, do you need to carry? Sporty EVs and NEVs may only carry two people and a small amount of cargo. Most compact conversions can carry four people, and many have substantial trunk space as well. Vehicles designed to carry more than four people are generally too heavy to be good candidates for conversion. Up to four people and a few groceries is a "Yes." Very few EVs can carry more than four people comfortably, so we'll call that a "No."

Light pickup trucks can be good conversions. They can carry loads for short distances, but be aware that heavy cargo will diminish speed, acceleration, and range. Older, air-cooled VW vans can make good conversions, but the newer, water-cooled Vanagons and minivans by other manufacturers are generally too heavy.

More cargo than a few bags of groceries is a "Maybe." It depends on the EV in question, how heavy your cargo is, how far you need to take it, and under what conditions. Serious cargo hauling on a regular basis, or towing, is a "No." If you need to carry a lot of people or a lot of cargo regularly, you might want to investigate a truck or minivan that runs on biodiesel instead of an EV.

Driving Conditions

This is the environment in which the car must do its job. We mentioned in the previous section that conditions affect range. The most significant factor here is terrain. As you might guess, flat roads are best, but a few gently rolling hills or freeway overpasses are not a problem. This is a "Yes." If your drive is moderately hilly, most full-fledged EVs (not NEVs) will still be able to handle it, but it will reduce your range. For most people, this will still

be a "Yes." If you have a lot of hills, or some very steep ones, it can cut your range in half. This moves into the "Maybe" area. Mountain passes and EVs are generally incompatible, a definite "No."

If you have very steep hills, or very long continuous grades, these will reduce your speed as well as range. Some EVs will be able to handle some of these situations, while others will not. If hills are a significant part of your driving, you should consult in detail with the EV seller, or someone who has knowledge about the kind of EV you are considering. This falls into the "Maybe" range.

The next biggest factor is probably traffic flow. Light traffic, or traffic that flows smoothly, is clearly a "Yes." Just as stop-and-go driving is hard on gas mileage, it's also hard on an EV's range. Every time you tap the brakes, you are wasting momentum that you spent amp-hours to achieve.

You can compensate somewhat for this kind of traffic with your choice of route and your driving style. But if you are stuck doing a lot of this, you will need to adjust the car's expected range downward. Whether or not the EV can still do the job for you will depend on how far you need to go, and how many other negative factors (such as the aforementioned hills) you have to deal with. It's a "Maybe."

After traffic, the most common concern is weather. A hot climate may mean you need an EV with heavy duty components or additional cooling. It might mean that you need to water your batteries more often. (We'll talk more about that later.) But EVs tend to like hot climates better than cold ones, so this should not be a problem. Call it a "Yes."

EVs can work perfectly well in places that get real winters. Electric heating systems can draw from the battery pack. However, cold reduces range—directly by lowering battery capacity and indirectly if you have passenger heat drawing from the batteries. So this might affect your choice of which EV to get.

How much range you lose will depend on how cold the batteries get, and how much you use the heater. It could be as little as 10 percent, or as high as 50 percent. Driving and charging daily will help keep battery temperatures warm and the driving range high.

Fully enclosed battery boxes, possibly insulated or heated, will be a plus. Usually, battery boxes are only heated while the car is charging, using commercial battery heating blankets made for heavy diesel trucks. The heaters are plugged into an external AC source so they do not drain the battery pack. The pack itself is a

substantial heat sink, and once warmed, it will hold its heat well, particularly if the boxes are insulated.

If you live in a severely cold climate, an EV is probably not for you. As with hills, if cold is a significant issue for you, consult with someone knowledgeable about EVs. Mild to moderate winters are a “Maybe,” depending on your other factors. Severe winters are a “No.”

Rain and snow are not deal breakers. EVs don't short circuit in the rain, but it's not advisable to ford deep puddles that will immerse components. Slippery roads will require a little more care, since EVs are heavier than comparable gas cars. Also, crunching through inches of snow will reduce range. Mere rain is a “Yes.” Snow is a “Maybe.”

Finally, the condition of the road itself is relevant. A potholed dirt or gravel road will reduce range, and components (especially the motor) should be shielded from excessive dust and road grit. EVs are not recommended as off-road vehicles. Good paved roads are a “Yes.” Lumpy or dusty and gritty roads are a “Maybe.” Off-roading or serious mud is generally a “No.” (Note: there is a small electric utility vehicle called the Gorilla, which resembles an ATV more than a passenger vehicle. I am not including it in this blanket prohibition.)

Charging Infrastructure

The ideal situation is a dedicated electrical outlet for charging inside your garage—a definite “Yes.” If you buy a factory EV like the RAV4 EV with its special offboard 240 VAC charger, this arrangement is essential.

For conversions, outdoor charging can work. One woman, who had no garage or driveway, trenched across the yard, laid conduit, and installed a weatherproof outlet next to the curb. This is still a “Yes.”

If you live in an apartment, you need to have an assigned parking space that you can rely on, and a cooperative apartment manager who will allow you to install the necessary outlet. Investigate this and get it in writing before you commit to the EV. Mark this one “Maybe.”

As we mentioned in the first section, some people will need a daytime recharge at work to get enough range. For a factory EV like the RAV4 EV, you will have to locate a factory charging station. For a conversion, you only need a normal, household, 120 VAC outlet. If you snoop around, you may find that such an outlet already exists at work, and all you need is permission to use it. Another “Maybe.”

Finally, if you are off-grid, you will need to be sure that your renewable energy system has enough capacity to

do the job, at the time of day when you need to charge. Most EVs are driven by day and charged by night. On the grid, this represents surplus capacity time. But for an off-grid, solar-electric system, this is when you are operating on your household battery bank.

The RAV4 EV would not be an option here, with its 240 VAC charger, unless your system uses stacked inverters or a transformer for 240 VAC output. Conversions can be charged off-grid with the right system and planning. The most common chargers take 120 VAC input at 15 to 20 amps. The charge starts out at a high current and tapers automatically. A typical conversion uses about 0.4 KWH per mile under good conditions. If you have any of the adverse conditions mentioned above, adjust this number upward, but probably no more than 0.7 or 0.8 KWH, worst case. With this information and the mileage you expect to drive, you can calculate how much juice your car will need to recharge. Off-grid charging is also a “Maybe.”

Mechanical Ability & Involvement

This is the “hands-on factor.” There are two parts to it. The first is acquiring the car. On one end of the scale, you can walk into a Toyota dealership and buy an RAV4 EV without ever getting your hands dirty. On the other end of the scale, you can buy a donor chassis and a drive system and build the car yourself. In between these extremes are the options of having a conversion built for you by a mechanic, or by a school auto shop class, or simply buying a used conversion that's already built. There are EVs for every level, so they are all “Yes.”

The second part is maintenance. A factory EV requires very little care, and you have the dealership to take care of this for you. This is a definite “Yes.” A conversion requires a little more attention, although much less than a gas car. But you cannot afford to skip that little bit that it does need—battery maintenance. If you don't pay attention to it, you will murder your battery pack.

If you have flooded, lead-acid batteries, as most conversions do, they will need to be checked periodically for equal voltage across the pack, as well as for fluid levels and clean, tight connections. It is recommended to do this once a month for at least the first six months. In hot climates, you may need to continue at this rate. In milder climates, you may find that the batteries only need attention every two months or so.

Sealed batteries, which are less common, don't need watering. However, they do require a special charging profile, with individual regulators on each battery in the series string. These regulators monitor each individual battery's state of charge, and drop them out of the charging circuit when they reach full charge to prevent

overcharging. This is important with sealed batteries because they will vent if overcharged, but there is no way to replace the lost electrolyte, so this shortens the battery's life. If abused, sealed batteries are easy to kill. They are used mostly by serious EV performance geeks.

If you are the type who wants to just drive it, plug it in, and forget about it, you should stay away from the sealed batteries unless you get a factory EV with them. That sounds counterintuitive, but experience shows that the people who are successful with these batteries are the ones who monitor them a lot and are very careful about their charge/discharge profile. One NEV manufacturer switched to flooded batteries for their standard pack, with sealed only as an option, because customers were destroying the sealed packs by abuse and neglect.

With flooded batteries, if you tend to procrastinate and avoid simple chores like battery watering, you should make arrangements with a local mechanic to do the battery service for you, much like an oil change. Then follow up with your mechanic faithfully. If you can't do that, you'd better stick to factory EVs. Battery service is a "Maybe," depending on your ability to carry it out religiously.

Budget

As with many of the other topics we've discussed, there is a range of options. On the high end is a factory EV. The RAV4 EV's sticker price is US\$42,510. Various federal, state, and local incentives can knock about 25 to 30 percent off that number, but it still is not cheap.

In the midrange, you can have a conversion built for you for US\$15,000 or so. Lower down on the scale, you can build your own for US\$6,000 to \$10,000. Finally, you can shop on the Internet for a used EV. These will run from a US\$1,000 fixer-upper with dead batteries to a US\$15,000 or \$20,000 custom, high performance EV in good running condition. Overall, the EV is a "Yes" for any budget level.

Does the EV Get the Job?

As you can see from reviewing this list and the table, only a few circumstances make an EV totally unsuitable. Some situations are clearly well-suited to an EV. Others will suit some EVs but not all.

Compare your needs and circumstances with those we've talked about here. If you don't have any of the "Absolutely No" conditions, take a look at the "Maybes." Too many marginal conditions can stack up and become a "No." But if you only have a few iffy conditions, there is probably an EV that will do the job. A lot of people are surprised to discover, if they really get down to specifics, that the final answer is "Yes!"

Access

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