Science You Can Use

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Dear Science: I'm thinking about buying an electric car, but there are so many issues to consider I don't know where to start. Advice? -- Buck R.

Dear Buck: You are right to view this as a complicated decision. There are many different kinds of "electric" cars, and they can have different strengths and weaknesses relative to your interests.

Your question has two levels: (a) environmental reasons for buying an electric car, and (b) how to choose among specific cars that are currently on the market. Let's look at these in turn.

Environmental reasons for buying an electric car. Globally, fossil-fuel-powered internal-combustion-engine (ICE) automobiles are one of the two largest human-produced sources of carbon dioxide (CO_2), a major greenhouse gas. The governments of most countries, the scientific community, and much of the informed general public agree that to help mitigate the climate disasters caused by excess CO_2 in the atmosphere, the major fossil-fuel-burning countries (primarily the US and China) must, over the next 30 years, shift almost all automobile propulsion technology to non-CO_2-producing energy sources (wind-, solar-, hydro-, and nuclear-based electrical energy generation). A DoE study (David Gohlke and Yan Zhou, Argonne National Laboratory, *Assessment of Light-Duty Plug-In Electric Vehicles in the United States, 2010-2018*, 2019, https://publications.anl.gov/anlpubs/2019/03/151081.pdf), in particular, shows that the total-system CO_2 production of an *all-electric* vehicle (see (4) below for a definition) fleet would produce only about *half* as much CO_2 as a 30-mpg ICE fleet would. There is no known auto-propulsion technology whose CO_2 emission is nearly as low as that of all-electrics. Shifting the fleet to all-electrics will require both the US and China to approximately double the electrical production and distribution capacity they had as of 2021.

Choosing among the specific cars on the market. In a column on a piece of paper, list the specific vehicles you would consider buying. Let's call this list "vehicle options". It's informative to organize vehicle options under the following general propulsion-technology categories:

1. Internal combustion engine
2. Hybrid. A hybrid car uses a gasoline-powered engine to charge large batteries. These batteries, in turn, provide electrical energy to power electrical motors that propel the car.
3. Hybrid with an all-electric mode (also called plug-in hybrid (PHEV)). In addition to operating like (2), PHEVs can operate in an all-electric mode for a short distance (50 miles or less between rechargings)
4. All-electric (also called a battery-electric vehicle (BEV)). A BEV runs on power derived from batteries, which have to be recharged. Most BEVs available today have a range between charges of 50 to 250 miles between charges.

5. Fuel-cell powered. This kind of vehicle catalytically combines hydrogen (typically stored as a high-pressure gas), and oxygen from the air to produce electricity, which in turn drives electric motors on the vehicle.

In a horizontal row across the top of paper, write a list of vehicle properties that might make a difference in your decision to buy them. Let's call this list "measures of merit". Here is an example list of "measures of merit" (as of 25 July 2021, subject to change):

a. Cost to purchase. New hybrid vehicles cost about the same as new ICE vehicles.
b. Cost to operate.
c. Range between energy-"refuelings". An ICE car can typically travel about 500 miles between fill-ups; several BEVs have a maximum range of less than 100 miles. The most expensive BEVs have a range of about 250 miles.
d. Availability of energy sources along the routes you typically drive. You can buy gasoline "almost anywhere". E-85 is available at a fewer than 20% of gas stations. Charging stations (for BEVs and PHEVs) are scarce in rural areas. Fuel-cell stations are extremely rare. If you drive less than about 50 miles per day, you can charge BEV or PHEV overnight using a special charging circuit in your house.
e. Availability of competent maintenance facilities on routes you drive. For hybrid and BEV cars, most of this competence is concentrated in dealers who sell such cars.
f. Passenger capacity
g. Cargo capacity
h. How much experience the manufacturer of a vehicle has with the vehicle's propulsion technology. If you don't want your car to be an "experiment", buy one that is produced by a manufacturer that has more than one year of experience with the car's propulsion technology.

Next, for each vehicle-option/measure-of-merit combination, place a "+" sign wherever you think that particular vehicle has that measure-of-merit, or a "-" sign where you think that particular vehicle does not have that measure of merit.

Finally, for each vehicle count the number of plus and the number of minus signs. Subtract the number of minus signs from the number of plus signs and write that result to right of the rightmost measure-of-merit column header. Let's call this result the "vehicle-option score". The vehicle with the highest score is likely to be the vehicle that you think is overall best for your interests.

For more information, see
https://afdc.energy.gov/fuels/electricity_research.html#:~:text=Electric%20Vehicle%20Research%20and%20Development%20The%20U.S.%20Department,performance%20of%20electric-drive%20vehicles.%20Environmental%20and%20Market%20Analysis .

Jack Horner is a systems engineer. Thanks to Gennie and Richard Barrett for suggesting this topic.