

Plugged In

A GM Publication for Kids

Volume 1, Number 1

Out of This World

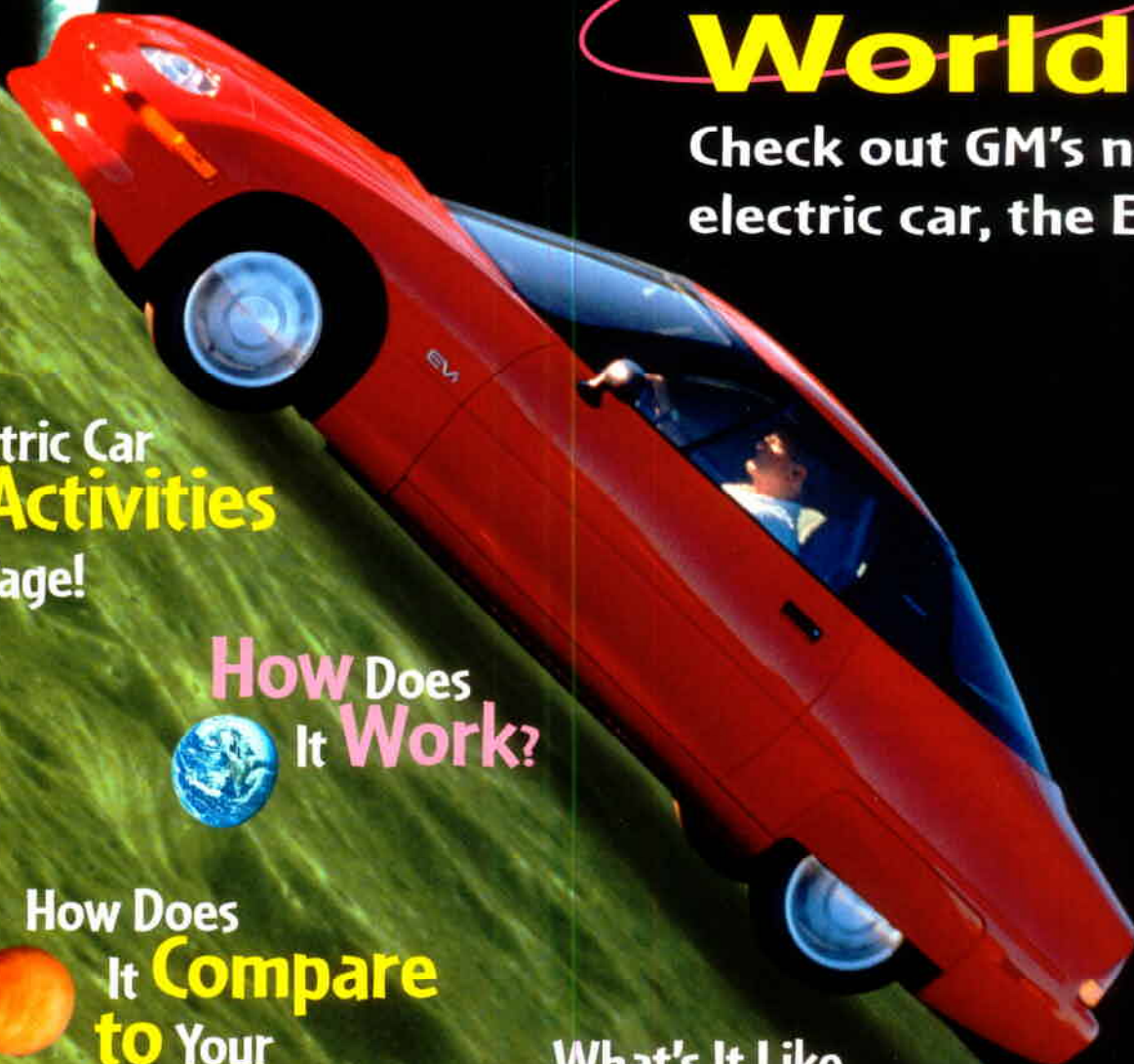
Check out GM's new electric car, the EV1

Electric Car
Activities
Page!

How Does
It **Work?**

How Does
It **Compare**
to Your
Parents' Car?

What's It Like
to **Drive?**



Did You Know



DID YOU KNOW

that you can **set** your EV1 just **like** an **alarm clock**? You just tell the EV1 when you need to use it, and the car will wake itself up 15 minutes before you need to go. The EV1 will turn on the air conditioning or heater ahead of time, if it's too warm or too cold.

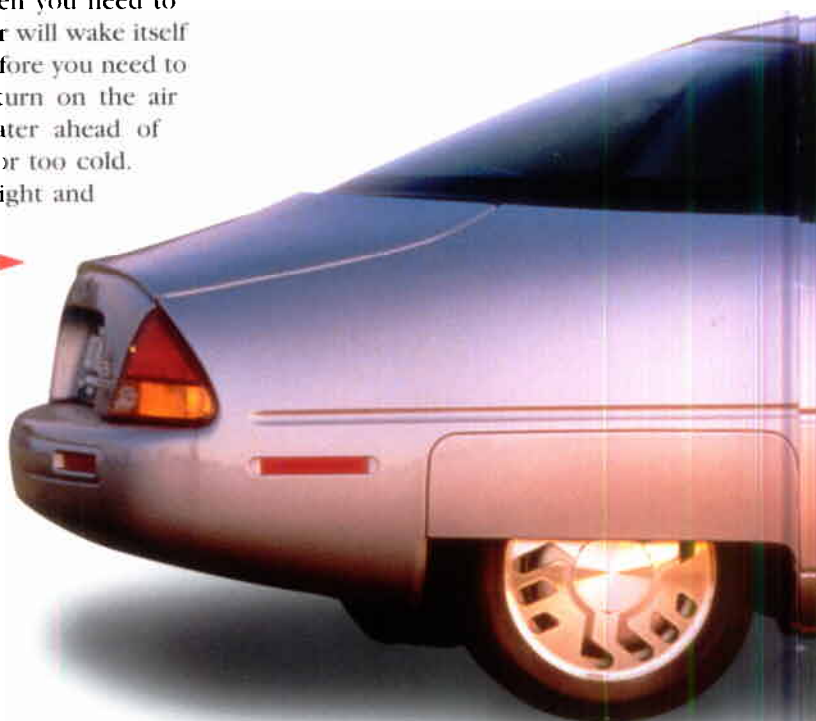
That way, it will be just right and ready to go when you are.



DID YOU KNOW

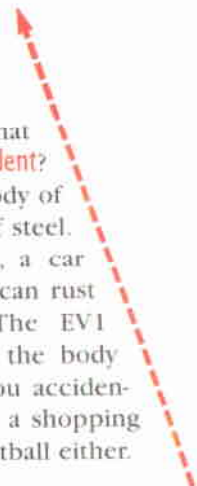
that **turning on** the EV1 is **like** starting up a **computer**? You don't use a key, as on traditional cars. Instead, you punch in a number on the car — like a password on a computer — and press the "Run" button.

The digital screens brighten up, and you're ready to go.



DID YOU KNOW

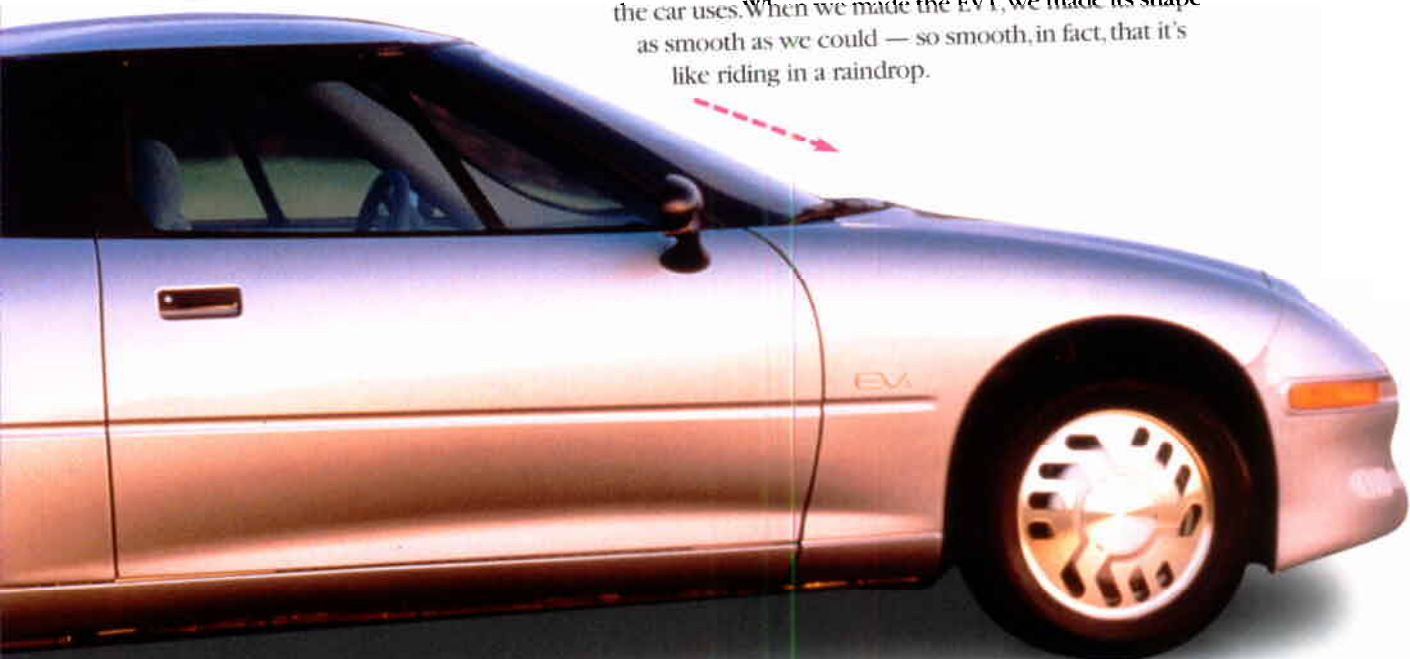
that the EV1 **won't rust** or **dent**? That's because the body of the car isn't made of steel. Just like a bicycle, a car with a steel body can rust after a while. The EV1 won't ever. And the body won't dent if you accidentally hit it with a shopping cart or a basketball either.



DID YOU KNOW that the EV1 isn't built like a regular car? Many of its parts are held together with what is called "structural adhesive bonding." That's really just a complicated way of saying "glue." That's right, a lot of the EV1 is put together with super strong glue like that used in jet planes.



DID YOU KNOW that the EV1 can slip through the air easier than any other car in the world? The easier it is to move through the wind, the less energy the car uses. When we made the EV1, we made its shape as smooth as we could — so smooth, in fact, that it's like riding in a raindrop.



DID YOU KNOW that because the EV1 is an electric car it uses batteries instead of a gas-powered engine? Just like a portable CD player or radio-control toy car. That means the EV1 is a zero emission vehicle.



DID YOU KNOW the 26 batteries that run the EV1 put out a lot of power? It's enough power to run thousands of handheld video games all at once.

HOW the EV1 WORKS

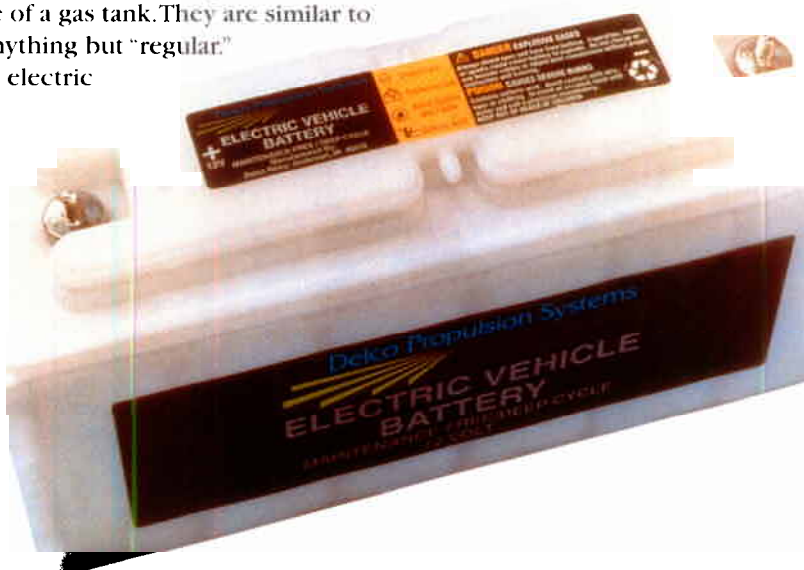


INDUCTIVE CHARGING. When the batteries in the EV1 finally do need to be recharged, it's easy and fast. Drivers won't plug the car in like you do a TV or a computer. Instead of a plug, the EV1 uses a paddle that looks sort of like a Ping-Pong paddle. The paddle doesn't have any metal on it, so you can even charge your EV1 in the rain without getting shocked. (Keep in mind, normal electric appliances should always be kept away from water.) It's called Magne Charge and is not only safe, but also fast. There's a full-size recharger that goes right into the garage and can recharge the

EV1's batteries in two to three hours. That's one of the things that makes the EV1 so easy and convenient to own: You can recharge the batteries right at home while you sleep.

A smaller recharger, called the convenience charger, is also included with the EV1. It takes longer to work, but fits in the trunk, so you can recharge the batteries wherever you want.

BATTERIES. Since the EV1 is an electric car, all of its power is stored in its 26 batteries. The batteries take the place of a gas tank. They are similar to regular car batteries, but they are anything but "regular." They were designed specifically for electric vehicles. They're designed to produce energy over a longer period. And they can be recharged many more times. The liquid in the batteries (called electrolyte) is held inside absorbent pads — like sponges. If the car is ever in an accident, the electrolyte won't leak out.



PROPULSION SYSTEM.

The only car ever to drive on the moon, the Lunar Rover, was an electric car. In many ways the EV1 is more like the moon car than regular cars. For instance, both use electric motors to power them. The EV1's motor, called a traction system, makes a powerful 137 horsepower. That's enough to go from 0 to 60 miles per hour in less than 9 seconds. In other words, it's neck-and-neck with the BMW 318i. For all of that power, the EV1 motor is also quiet, lightweight and small. And one of the best things about the motor is that it has zero emissions, and there's never any old engine oil to change or dispose of. The little bit of oil in the EV1 is there for life. That's one of the ways that the EV1 is so nice to our planet. It uses energy in a clean and efficient way, which is very good news for the environment. And the motor never needs a tune up, which will save an owner time and money.



STRUCTURE.

Like the skeleton in your body, cars also have skeletons called space frames. Instead of being made of bones, though, they're usually made from steel. Because the EV1 needs to be as lightweight as possible, aluminum is used instead. At 290 pounds, the EV1 skeleton is only about the

weight of two teenagers. Your skeleton must be strong, so it doesn't bend or break when you bump into something. The EV1 is the same way. Its frame was designed to be both lightweight and strong.

WHEELS AND TIRES.

You might not think there's too much engineers can change about wheels and tires, but, like most other parts of the EV1, they are special too. To keep the EV1 rolling along efficiently, special tires are filled with more air than average tires. How does that help the EV1? Think of a basketball. When it's filled with air, it will roll farther and bounce higher than when it's flat. Even more special is that if one of the tires is damaged, a sealant (sort of like chewing gum) inside the tire can plug up the hole. And, just in case, if one of the tires does start to lose air, a light on the dashboard will tell the driver to check tire pressures.

And, because it's easier to roll something light than something heavy, the EV1's wheels are made of aluminum instead of steel.



KEYPAD.

There are two keypads on the EV1: one on the outside that unlocks the doors and one on the

inside that allows a driver to turn the car on. It's these keypads that mean a driver will never have to worry about losing his keys. Almost all the controls and buttons that a driver needs are also on the console. That means the controls for everything from opening and closing the power windows to playing your favorite song on the CD player are all easy to find, right under the driver's hand.

CUTAWAY

THE PEOPLE INSIDE the EVI are kept safe in many ways. But how about **THE PEOPLE OUTSIDE?** To keep others safe, the EVI comes with a pedestrian warning system. Because the EVI is so quiet, there's not much noise for a pedestrian to hear, so the driver can activate the warning, which will make a sound and flash the headlights. That helps ensure people can tell the EVI is coming. The warning sounds automatically anytime the EVI backs up.

THE GLASS for the windshield is made of very high-tech materials. When it's a sunny day, one that could make the car too hot, the solar glass windshield keeps a lot of the heat from getting inside. In cold weather, the special windshield heats up to keep mist and snow off the glass.

The EVI's **DAYTIME RUNNING LAMPS** are the turn-signal lamps and stay on whenever the car is on. Like in all other new GM cars, the daytime running lamps help keep drivers and passengers safe by making sure everyone can see you and the EVI coming.



THE ANTENNA

for the EVI's stereo, which comes with tape deck and CD player, is hidden inside the roof. It doesn't get in the way as the EVI slices through the air.

One of the many things the EVI **DOESN'T HAVE** is an **EXHAUST SYSTEM**. The EVI is electric, so it doesn't have an exhaust system. That not only means that there are zero emissions, but that the EVI can also be driven around the factory as it's being built.

Unlike most cars, the EVI has **REGENERATIVE BRAKING**. It's pretty complicated, but what it does is partially recharge the car's batteries when the driver uses the brakes, by turning the EVI's motor into a generator. Another neat feature is the rear brakes. They work with their own electric motors to move one part of the brakes (the linings) against another to help stop the car.

To make the EVI as light as possible, **THE SEAT FRAMES** are made of a special, ultralight metal called magnesium. The inside of the steering wheel is also made from a ring of magnesium. That way, both parts save weight and are strong at the same time.



by Greg Wilson, age 12

An Electrifying

BIG WHOOOP

What it's like to ride in the EV1

My ride in the EV1 begins at the GM Advanced Technology Vehicle Center in Michigan, where electric cars and trucks are designed and engineered. As we walk through a room on the way to the car, I see EV1's self-sealing, puncture-resistant tires (it doesn't have a spare tire) and the all-aluminum body. I also notice a robot that tests the switches inside and lots of battery packs, including some new ones that will give EV1 a longer driving range than it has today. Earlier, in the lobby, I tried out a demonstrator of the charging system and discovered that EV1 has an Inductively Coupled Charging System (which means that the charging is done magnetically so you can't hurt yourself). You just stick a plastic-covered paddle in a slot in the nose and the car gets a full charge in about three hours.

I'm beginning to get charged up about actually getting inside an electric car. The one we're going to take turns out to be red.

Once we're inside the small, two-seat car and buckled up, Dad tells me the five-number code to start it. Then I press "run," but there's no engine noise. I only know it's running because the single digital display monitor (there are not any gauges at all) lights up with a display of a speedometer, the gears, and the battery's current range. When we back out of the garage, there's a beeper going so people can tell you're backing up.

Since my dad works for a car magazine, he drives a lot of different cars, and I ride in them. The EV1 is quieter than most cars, virtually silent except for a muted, whining hum which has different pitches, depending on your speed. When you speed up, the pitch is high, and the opposite is also true. It sounds like a cross between a remote-control car and a hedge clipper. When we get out to the main road, Dad hits the accelerator and the car surges smoothly to 50 mph without any gearshift bumps. It's neat! The car has an AM/FM stereo and a CD player. The side windows have defogging vents, the rear window has a defroster, and there's a heater and air conditioner.

Some people might think about EV1 only going 80 mph and 90 miles on a single charge, and say, "Big whoop." But EV1 is only the *FIRST* modern electric car that is, well, a real car and not a golf cart. So "big whoop" this: The first car you own might be an electric car, and EV1 is the pioneer that is leading the way.

BACK TO THE FUTURE

Even though

the EV1 from GM is a brand new car that makes history itself, this is not the first time electric cars have been driven around. It's not even the first time that GM has made electric cars. Here are some of the things that have happened through history that have led up to the EV1:



1912-16 Electric cars have been around almost as long as cars have. Between 1912 and 1916, the **GM Truck Company** built 682 electric trucks. In the early 1900s, 38 percent of American cars were electric. Back then electric cars were often advertised as being cleaner, quieter and cheaper to use than their gas-burning cousins. That doesn't sound much different from today.

1964-87 Several GM cars were converted and tested as electric vehicles. From **Chevrolet Corvairs** in 1964 to **GMC vans** in 1965 and **Chevrolet Chevettes** from 1977 to 1980, GM has experimented with many different kinds of batteries and motors. All the while, GM engineers learned more about the best and safest ways to make electric cars perform.

1969-72 GM engineers helped build a series of **Lunar Rover** electric vehicles. The electric buggy was used by Apollo astronauts for driving on the moon. The Rovers had four electric motors — one for each wheel — and four-wheel steering. Three of the Lunar Rovers are still parked up on the moon.



1987 The **Sunracer solar-powered race car** won the 1987 Solar Challenge in Australia (solar-powered cars use sunlight to charge their batteries). The car came in two and a half days ahead of any other vehicle, and it taught GM engineers a lot about what an electric car needs to perform well.



1990 At the Los Angeles Auto Show, GM showed an electric car called **the Impact**. It looked very similar to the EV1. Three months after the show, GM created a group that could change the Impact into a production car. That car became the EV1.

1994 A special version of **the Impact** electric car drove 183.822 miles per hour on a race track in Texas. That was the fastest that any electric-powered vehicle had been driven — ever.

1994-96 More than 700 people around the country got to test drive **the Impact** to see how the new electric cars worked on a day-to-day basis.

1995 An electric **Chevrolet S-series pickup truck** was built. The truck uses a motor similar to the one in the EV1. It will be available to fleet customers and will be used mostly as a delivery vehicle.

DECEMBER 5, 1996

The first day customers could drive away in their very own **EV1, leased at Saturn dealers**. There are 26 dealerships in Los Angeles, San Diego, Phoenix and Tucson where people can order an EV1 to drive every day on the street.

ACTIVITIES

WORD SEARCH

All the words on the right relate to the EVI. They are either parts of the car or types of energy that make it run. Your job is to find them in the box of letters on the left. They can be horizontal, vertical or diagonal, so it's not easy. But just like engineers looking for new solutions to car problems, you must first find every word before you can move on to the next challenge.

1. BATTERY
2. CHARGER
3. CURRENT
4. ELECTRICITY
5. ENERGY
6. EVI
7. LEAD ACID
8. POWER
9. PROPULSION
10. RANGE
11. VOLTAGE
12. ZERO EMISSIONS

G	X	Z	I	N	D	G	C	U	R	R	E	N	T	Q
O	L	Y	E	V	I	K	C	I	G	X	E	W	O	P
D	C	H	A	R	G	E	R	D	G	A	O	K	P	T
N	T	V	X	I	O	N	T	L	F	C	V	Z	R	T
Y	P	V	D	I	L	E	A	D	A	C	I	D	O	G
T	P	O	W	E	R	R	M	H	H	V	E	T	P	J
Q	G	L	I	U	I	G	H	I	S	S	D	O	U	L
B	A	T	T	E	R	Y	O	B	S	W	I	J	L	L
T	T	A	T	U	S	A	S	S	I	S	P	E	S	I
E	L	G	G	Y	K	X	N	G	O	D	I	I	I	Q
F	R	E	I	R	G	O	O	G	E	I	C	O	O	L
K	S	U	W	V	B	I	W	A	E	Z	T	P	N	M
Z	E	L	E	C	T	R	I	C	I	T	Y	Q	K	S
P	A	Z	Y	R	I	H	D	B	M	O	E	W	C	X

WORD SCRAMBLE

The words on the left are all mixed up so they don't make sense anymore. Your job is to unscramble them. You can check your answers on the right. (No peeking!)

1. CHANERMAGGE
2. RECETLIC
3. CEVHEIL
4. LOVTS
5. CHRERGAE
6. WEHLGITHIGT
7. VERMNTIOINN
8. ZONEO
9. TYBARTE KACP

ELECTRIC
VEHICLE
BATTERY PACK
OZONE
LIGHTWEIGHT
RECHARGE
ENVIRONMENT
MAGNECHARGE
VOLTS

WEB SITES

The Internet is like an electronic highway where information and pictures zoom all over the world in the form of electricity. While you can't drive the EVI on that kind of highway, you can find a lot of information about electric cars and the environment. Here are a few pit stops you might want to make:

- <http://www.gmev.com/index.htm> – GM's official EVI homepage.
- <http://www.saturncars.com/index.html> – More EVI information from its seller.
- <http://www.bedison.com/resident/kidspace/index.htm> – Where electricity came from.
- <http://www.halcyon.com/sciclub/kidproj1.html> – Good ideas for science projects.
- <http://www.azc.com/client/enn2/kcscience.htm> – Lasers, electricity, illusions and more at Kid City Science.
- <http://www.evaa.org/> – Electric car news, library and events.
- <http://www.epri.com/csg/trans/overview.html> – Information on electric transportation.
- <http://www.ott.doe.gov/office/office.html> – U.S. Department of Energy site.
- <http://fly.hiwaay.net/~palmer/motor.html> – How to build an electric motor.
- <http://www.calstart.org/> – Information on transportation technology.
- <http://scat.ev.hawaii.edu:80/home.html> – Southern Coalition for Advanced Transportation (SCAT).

QUESTION and ANSWER

Questions by Sean Wilson, age 14

How fast can it go, anyway?

The EV1 is limited to a top speed of 80 mph, which is faster than the speed limit in almost any state in the country. The car could go faster, but the faster you drive, the more energy you use. A special prototype went much faster, breaking the electric car world record for top speed at 183.8 mph in 1994.

What is being done to increase the driving range of future models?

The first and biggest improvement in driving range will come with the new batteries (nickel metal hydride). They should be able to last longer on one charge and be more powerful for better performance. The batteries may be the big improvement, but every time engineers look at the EV1 and try new things, they keep finding ways to make the car a little lighter, faster and more aerodynamic. Stay tuned, there's more cool stuff to come.

How come I need the inductive charger? Why can't I just plug the car into a wall anywhere I want to go?

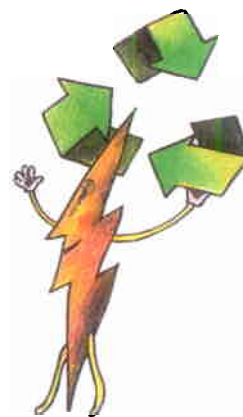
Engineers made the inductive charging system for two main reasons: safety and weight savings. They wanted people to be able to recharge the car whether it was sunny or raining. Most appliances with metal plugs cannot touch water. But with the Magne Charge system, there are no metal parts on the paddle. It is also tough: you could freeze it, bang it, even drive over it with the car and the paddle shouldn't break.

The Magne Charge system also saves a lot of weight for the car because you don't have to carry around a heavy charger with it everywhere it goes.



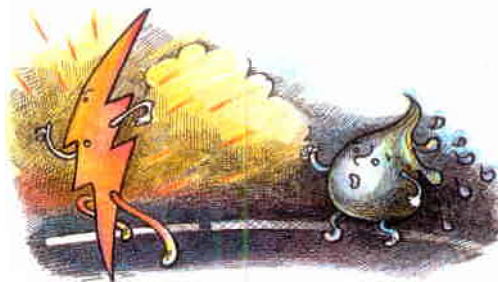
Are the components recyclable? How long will the car last?

The car itself will last about as long as any other car. The batteries in the EV1 need to be replaced about every three years. And when the time comes to replace them, the old ones are 98% recyclable. The high-tech plastic body panels of the car are made with advanced composite material. Then when the car's life is finally over, there are recycling procedures in place to reuse the plastics.



Why won't the EV1 run as well in cold weather?

Today's cars — including the EV1 — run less efficiently in cold weather. Temperature has a direct effect on the performance of lead-acid batteries like the ones in the EV1. That's because the rate of chemical reactions changes when it is hot or cold. A battery being used on a 32-degree Fahrenheit winter day will only operate at 70% of its capacity. And a battery being used on a 110-degree hot summer day will work at 110% of its capacity. The best temperature for batteries is 78 degrees Fahrenheit. Engineers are working hard to make batteries that are not so sensitive to temperature.



How expensive is charging the EV1 compared to the price of gas to drive the same distance?

The EV1 is cheaper to run than a gasoline car. A full charge should only cost an owner a dollar in electricity. Most of the time, it costs about one or two pennies to run an EV1 for a mile, and an average gasoline-powered car costs about 4 to 5 cents per mile, and that's just for the gas. That may not sound like much, but over a whole year, and many miles, you could save a lot of money. Running an EV1 for a year only costs about as much as it does to run a refrigerator for a year.

WHAT'S coming UP

HYBRIDS.

A hybrid is what you get when you put two different things together. Just as a mule is a hybrid of one parent that's a horse and one that's a donkey, a hybrid car



has two different kinds of "parents." Hybrid cars use batteries like an electric car, and an engine like regular cars. Many experts think that the future of cars might be in hybrid vehicles. They use a very small, efficient engine and very powerful batteries. When a driver needs a lot of power, the engine and the batteries work together to give the car plenty of muscle.

make a car go up to twice as far on one charge. An experimental car drove 373 miles on one charge using NiMH batteries. That's more than many gasoline-powered cars can go on a tank of gas.

While NiMH batteries are not common in electric vehicles yet, they are already being used in some laptop computers and other appliances. Many electric vehicles have been tested with them, including GM's own EV1.

By now, you've read about what makes the EV1 special. You've seen pictures of the new, cutting-edge technology that makes the car run so well. But, just like any other technology, there's always a need to try a little harder — to make things lighter, faster, more powerful and easier to use. These are a few of the things that GM engineers are working on for the future:

CHEVROLET S10 ELECTRIC PICKUP.

Cars aren't the only vehicle that can be electric. GM is making



an S10 Electric Pickup truck that runs on electric power instead of gasoline. The truck will be sold starting in 1997 to companies that have fleets of many vehicles.

The pickup will be almost as fast as the EV1 and able to go about 60 miles on one charge.

Electric vehicles are great for fleet use because they are perfect commuter cars. In other words, people drive them on short trips around town in a day. Electrics like the S10 are also good for companies that have fleets, because it only costs about a penny a mile to run them. Regular gasoline cars cost about four or five cents per mile.

NICKEL METAL HYDRIDE (NiMH) BATTERIES.

The real heart of any electric car is its batteries. Making a better kind of battery will improve the car's performance more than any other thing. The EV1's 26 lead-acid batteries provide plenty of power, but there are new batteries on the way. One of the most promising is called the NiMH battery. It uses different kinds of metal for about two times more energy. This will

