



1994 Ford Ranger – EV Conversion

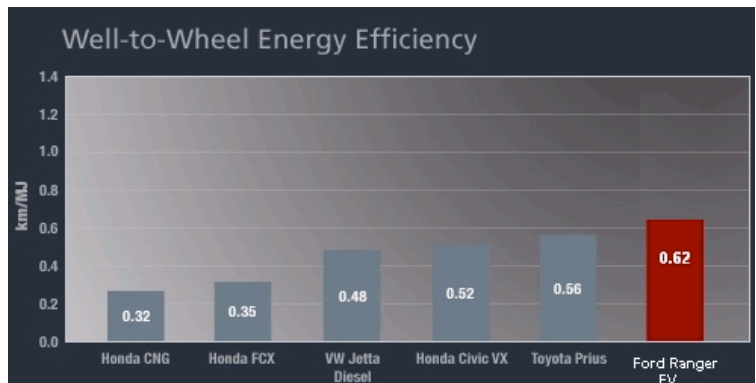


Q: Can I charge a plug-in car with solar or wind power?
A: Yes. The cleaner the power the cleaner the car. Using solar PV or wind power at your home or business makes even more sense with a plug-in car. The investment pays off faster, and the car becomes truly zero-emission.

Q: Isn't hydrogen the solution?
A: No. Hydrogen fuel cell cars are 4X less efficient than battery EVs if the hydrogen is produced from electricity. It's 1.4X less efficient if made from natural gas. Transporting and storing hydrogen is a big challenge. With plug-in cars, the infrastructure is already in place - the electric grid.

Q: How does the Ford Ranger EV conversion stack up to other fuel efficient vehicles that are currently available?
A: We conducted a "well-to-wheel" accounting for several efficiency standards and emissions of several types of high-efficiency cars, including an estimate for the Ford Ranger EV conversion.

Here is what we found: The Ford Ranger EV conversion beats gasoline, diesel, CNG and hydrogen fuel cell powered vehicles and surpasses the well-to-wheel efficiency of the top (*mass produced*) hybrid car – the Toyota Prius – while generating less carbon dioxide. Compare the Ford Ranger EV conversion against other hybrid vehicles and the results are better still. This is very impressive considering the Ford Ranger EV conversion is a truck, not a car. It also weighs almost 400 lbs. more than the Toyota Prius, has poor aerodynamics and is not equipped with advanced regenerative braking.



Fuel Efficiency by Type

Example Car	Technology	Source Fuel	Well-to-Station Efficiency	Vehicle Mileage	Vehicle Efficiency	Well-to-Wheel Efficiency
Ford Ranger EV	Electric	Natural Gas	54.2%	206.4 Wh/km	1.15 km/MJ	0.622 km/MJ
Toyota Prius	Hybrid (Gas/Electric)	Crude Oil	81.7%	55 mpg	0.68 km/MJ	0.556 km/MJ
Honda Civic VX	Gasoline Engine	Crude Oil	81.7%	51 mpg	0.63 km/MJ	0.515 km/MJ
VW Jetta Diesel	Diesel Engine	Crude Oil	90.1%	50 mpg	0.53 km/MJ	0.478 km/MJ
Honda FCX	Hydrogen Fuel Cell	Natural Gas	61.0%	64 m/kg	0.57 km/MJ	0.348 km/MJ
Honda CNG	Natural Gas Engine	Natural Gas	86.0%	35 mpg	0.37 km/MJ	0.318 km/MJ

Sources:
 • Density of gasoline: Pocket Ref, 3rd Edition, 2002, Thomas Glover, Page 690
 • Exhaust Emissions From Natural Gas Vehicles by NyLund & Lawson, page 27
 • www.fuelefficiency.gov

• Well-to-Tank Energy Use and Greenhouse Gas Emissions of Transportation Fuels – North American Analysis, June 2001, by General Motors Corp., Argonne National Library, BP, ExxonMobil, and Shell, Vol. 3, Page 42
 • Ibid, Page 33
 • Well-to-Tank Energy Use and Greenhouse Gas Emissions of Transportation Fuels – North American Analysis, June 2001, by General Motors Corp., Argonne National Library, BP, ExxonMobil, and Shell, Vol. 3, Page 59
 • Well-to-Wheel Studies, Heating Values, and the Energy Conservation Principles, 29 October 2003, Ulf Bossel

PURPOSE-BUILT VEHICLE

Base Vehicle: 1994 Ford Ranger
 VIN: **1FTCR10U2RUD05744**
 Gross Vehicle Weight: 4,360 lbs.
 Seatbelt Positions: two
 Standard Features:
 AM/FM Radio
 Air Conditioning
 Rear Wheel Drive
 Rack & Pinion Steering
 ABS Brakes
 Four Wheel Disc Brakes
 Standard 4-speed Transmission
 Windshield Wiper (delay)
 Truck Bed Liner
 Inertia Switch – cuts power to contactor in a front-end collision

Performance Statistics

Acceleration: 0-60 mph in ~30-seconds
 Max Speed: < 70 mph
 Torque: 116 ft. / lbs.
 Horse Power: ~70
 Driving Cycle Range: ~60.0 miles
 Energy Used: 20.0 kWh
 Cost for Full Charge: \$2.80
 Cost per mile: 4.6¢/mile
 Gasoline Gallons Equivalency (GGE): 100 mpg
 Time to Recharge: 10 hrs.
 Max AC Charge Current: 25 Amps
 Charger Input Voltage: 120 Volts AC

BATTERY

Manufacturer / model: Interstate / U2200
 Type: Flooded Pb-Acid (6-Volt)
 Number of Batteries: 24
 Total Weight of Packs: 1,512 lbs.
 Pack Locations: Underhood / Underbody
 Nominal System Voltage: 144 V
 Nominal Capacity – each battery: 232 Ah @ 20-hrs.
 Battery System Energy Capacity: 33 kWh
 Battery Warranty: 2-year Warranty (first year is free replacement / 2nd year is prorated)

DC Electric Drive System Components

Motor Manufacturer / model: Warp 9 / 00-08219
 Contactor Manufacturer / model: Albright / SW200
 Onboard Charger Manufacturer / model: Zivan / E7 PC



Out With The Old

In With The New

Fuel Efficiency Comparison - Before & After :

1994 Ford Ranger equipped with Gasoline Engine

MPG rating: **17 MPG**

Cost to drive 60-miles w/ gasoline @ \$2.20 per gal.: **\$7.77**

Cost to operate per mile w/ gasoline @ \$2.20 per gal.: **13¢ / mile**

1994 Ford Ranger EV Conversion

Gasoline Gallons Equivalency (GGE) MPG: **100 mpg**

Energy Cost to drive 60-miles: **\$2.80**

Energy Cost to operate per mile: **4.6¢ / mile**

Fuel Cost Savings Improvement: **63%**

CO2 Emission Reduction: **72%**



The City of Tallahassee is promoting energy conservation and efficiency through its Energy Smart Plus (e+) programs. This electric truck innovation is another example of the City's organizational efforts to move toward energy independence and fossil fuel replacement - while our Energy Smart Plus programs are intended to help individual customers save energy and save money.

FAQ's

Q: Why did the City Of Tallahassee convert this vehicle to an electric plug-in and what is their plan for the future?

A: As part of the City Of Tallahassee's Green initiatives, we are constantly looking for ways to reduce dependence on foreign oil and reduce our carbon footprint, while at the same time maintaining fiscal responsibility. Due to age and escalating repair costs, the 1994 Ford Ranger recently reached the end of its service life. Rather than purchase a new gasoline-powered truck, the vehicle was converted to full electric. The City has determined that old vehicles can be converted to full electric for less than the purchase price of a new replacement vehicle. Doing so will save money in the front end and the efficiency of the conversion vehicle will save money over the life of operation. The conversion process "permanently" removes an old internal combustion engine vehicle from our roads and replaces it with an ultra-clean energy efficient vehicle. Maintenance costs for electric vehicles are also lower. The electric vehicle has very few moving parts, whereas the gasoline-powered vehicle has hundreds of moving parts. More moving parts means more maintenance costs. The gasoline-powered vehicle requires a wide range of maintenance, from frequent oil changes, filter replacements, periodic tune ups, and exhaust system repairs, to the less frequent component replacement, such as the water pump, fuel pump, alternator, etc.

The City is already in the process of converting five (5) additional vehicles to full electric and we plan to convert more as vehicles are retired from service. Operating a fleet of electric vehicles will position the City to take advantage of renewable energy technology such as solar-PV and wind and create a pathway for a carbon neutral fleet.

Q: Will the City of Tallahassee's electricity grid be able to handle plug-in vehicles?

A: Yes. Plug-in vehicles will typically be plugged in at night – during off-peak hours. The City's existing off-peak grid capacity is more than sufficient to power a fleet of electric vehicles. In fact, having more electric vehicles plugged in at night would help to "smooth-out" power demand and could lead to increased power generation efficiency.

Q: Can this vehicle be plugged into an ordinary 120 VAC electrical outlet?

A: Yes. Plugging in literally takes less than 5 seconds of your time. There is no going out of your way to a gas station and jockeying for a pump. The vehicle can be charged anywhere there is an electric outlet.



Q: Aren't all those batteries full of toxic chemicals and metals that will just end up in a landfill?

A: Not at all. Every car on the road is equipped with a lead-acid battery. Even with its low value as scrap, the recycling rate for lead-acid batteries is about 98% in the U.S. The recycling of lead-acid batteries is a well establish practice in the automotive maintenance / repair industry.

Q: How often do you have to replace the batteries?

A: We estimate the batteries will have to be replaced every 5-years.

Q: What happens when the batteries run out of power?

A: You charge them back up. At the end of a workday, the vehicle will be plugged in and a majority of the re-charge time will occur during the night during off peak hours.

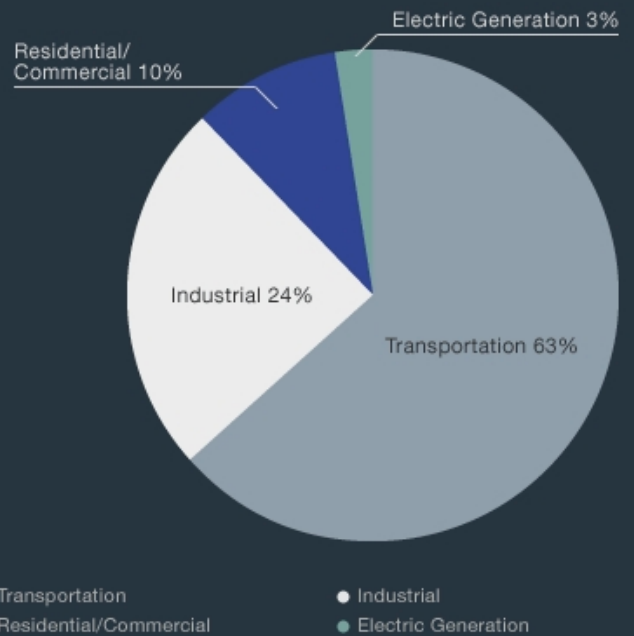
Q: How much better is the fuel efficiency of this conversion EV as compared to when the vehicle was operated with gasoline?

A: The original 1994 Ford Ranger pick-up truck achieved ~17 mpg "fuel efficiency" when it was powered with petroleum gasoline via the ICE. This means the truck consumed 3.53-gallons of gasoline in order to travel 60-miles. With gasoline priced @ \$2.20 per gallon, the total cost for fuel = \$7.77. The conversion EV uses 20kWh of energy to travel 60-miles and achieves a 100 mpg GGE. With electricity, the total cost for fuel (electricity) = \$2.80. This equates to a 63% fuel cost savings improvement.

Q: What about CO2 emissions?

A: The EV conversion results in 72% less CO2 emissions as compared to when the vehicle operated with gasoline. The EV conversion does not have a tail pipe so it does not "directly" emit CO2 while in operation. The City's electric utility produces electricity via the combustion of natural gas and it is there at the power plants where the CO2 emissions are counted.

U.S. Oil Demand by Sector, 2004



Source:
*Annual Energy Review, Tables 5.12a and 5.12b

Transportation accounts for ~63% of U.S. oil demand. By switching to electric vehicles and re-charging them during off-peak hours, we can dramatically reduce our dependence on foreign oil. The City produces electricity primarily through the combustion of clean burning natural gas – a domestically produced fuel. By switching to electric plug-in vehicles, the City can shift transportation fuel demand from foreign oil to clean domestic energy sources.

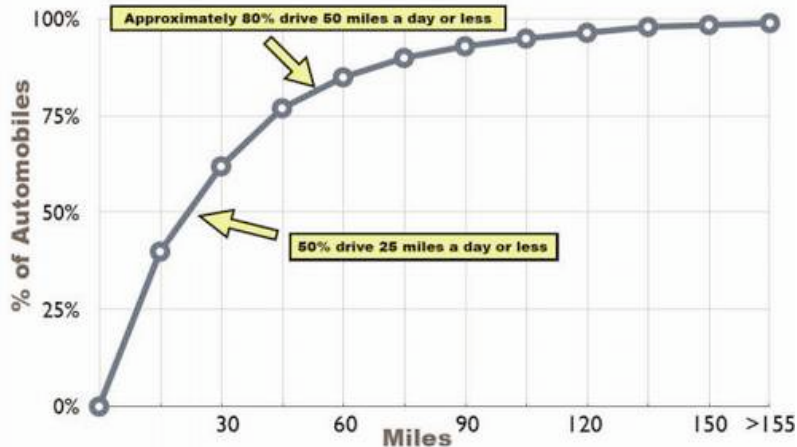
Q: This vehicle can only go 60-miles between charges. Is that far enough for a typical workday?

A: Yes. Most of the small trucks in the City's fleet travel less than 60-miles in a typical workday.

Q: This vehicle seems to be practical for use in a fleet application. Would this EV be practical for the average citizen?

A: Yes. Most people, when educated as to the benefits of driving with electricity, will be well served by a car with a range of 60 miles. Approximately 80% of daily driving is well under 50 miles. Any long distance travel can be accomplished with a second car or by renting a car.

Personal Vehicle Miles Driven Daily



Source: U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Survey (NPTS), Volpe National Transportation Systems Center, Cambridge, MA, 1999. Nationwide Personal Transportation Survey 1990