David Friedman

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

January 25, 2012

Chairman Mary Nichols and Board Members
California Air Resources Board
Headquarters Building
1001 I Street
Sacramento, CA 95814

Re: Support for the package of amendments to the California Zero Emission Vehicle (ZEV) Program Regulations and areas for essential improvements

Dear Chairman Nichols and Members of the Board,

The Union of Concerned Scientists strongly supports the Air Resources Board's (ARB) efforts to strengthen the ZEV program through 2025. We also request essential improvements in both the 2009 through 2017 proposal and the 2018 through 2025 proposal to ensure that the program delivers on the significant benefits the ZEV program affords to California and those states adopting California's regulations and avoids any risk of large incentives for manufacturers participate in optional programs that lower the number of ZEVs.

California has led the nation and the world in protecting public health with clean car standards for more than 50 years. By adopting and strengthening the comprehensive Advanced Clean Cars proposals, the ARB will continue that legacy by driving innovation in automotive emissions performance for the next 14 years through the Low Emission Vehicle (LEV) III program and setting the pace of development of advanced clean car technology for the next 40 years by accelerating the electric car market through the ZEV and Clean Fuels Outlet (CFO) programs.

A look back at the last several years highlights the success of the ZEV program. According to data from the Initial Statement of Reasons (ISOR), all manufacturers are carrying excess ZEV credits as of September 2011. In other words, all manufactures have over-complied with the ZEV requirements. Most of the largest automakers have over-complied by significant amounts. As with the success of the LEV program to date, the success of the ZEV program reinforces the fact that automakers not only step up when the ARB raises the bar to help Californians, they do better than required and at a lower expense than ARB has estimated.

Now, as the ARB considers the most significant changes to the ZEV program in its 20 year history, it is essential that the board adopt the strongest possible ZEV program. As noted in the ISOR, significant reductions in smog-forming and particulate emissions are essential to protect Californian's health and welfare, the surest way to achieve this goal in the long term is to combine vehicles with no tailpipe emissions, such as battery and fuel cell electric vehicles, with increasing use of renewable electricity and hydrogen. California is already moving forward with the latter through the renewable electricity standard and a strong ZEV program will help ensure the former.

Further, to avoid the worst consequences of global warming, cars in California and the U.S. must produce 80-90 percent less global warming pollution than they do today.[1] Nearly all stakeholders, including government agencies, energy and climate experts, and even automakers, agree that large-scale commercialization of electric-drive vehicles is necessary to achieve long-term CO2 and oil reduction goals. Electric-drive cars cannot achieve this goal alone, but analysis by ARB, automakers, the International Energy Agency, the Natural Resources Defense Council, and the Union of Concerned Scientists, all show that a large majority of vehicles by 2040 must have significant electric-drive capability.[2]

As the ZEV ISOR indicates, because it takes about 15 years to turn over the fleet, meeting long term targets for reducing global warming pollution and protecting public health means that the ZEV program must help bring about a sustainable market for battery, fuel cell, and plug-in hybrid electric vehicles by 2025, about 15 years before the 2040 needs. We simply can't wait any longer.

Summary of Recommendations

Because of the urgency of the problems and the role electric cars can play in solving them, because of all of the strong indications in ARB's research that dramatic progress has occurred on ZEV technology, and because automakers are moving forward with more than 30 models of electric cars in the next few years, the ARB should adopt the staff ZEV proposal and feel very confident in directing staff to strengthen the program as follows:

- Strengthen the credit requirement by 30% in a manner similar to staff alternative B, but with a smaller increase between 2017 and 2018. This will significantly increase the chance of meeting California's long term climate and public health goals;
- Modify the ZEV travel provision to ensure other states get ZEVs before 2018;
- Establish a rigorous monitoring program for automakers to provide data to ARB on Type I.5x, Type IIx and BEVxs use so that ARB can adjust credits received or the criteria used to qualify as a BEVx based initial data on their real-world all-electric-miles versus gasoline miles.

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[1] California has adopted an economy-wide target of an 80 percent reduction below 1990 levels by 2050 (EXECUTIVE ORDER S-3-05, http://gov38.ca.gov/index.php?/print-version/executive-order/1861/). A recent McKinsey study for the European Union points to a need for a 95% reduction from on-road vehicles due to the difficulty of achieving reductions in industry (Exhibit 9 from Roadmap 2050: A Practical Guide to a Prosperous, Low-Carbon Europe, April 2010, www.roadmap2050.eu/attachments/files/Volume1_fullreport_PressPack.pdf).
[2] See ZEV ISOR Figure 1. Also, see Exhibit 6 from the 2010 McKinsey study, A Portfolio of Power-Trains for Europe, a Fact-Based Analysis: The Role of Battery Electric Vehicles, Plug-In Hybrids and Fuel Cell Electric Vehicles, that included participation from a wide variety of automakers and other industries (www.iphe.net/docs/Resources/Power_trains_for_Europe.pdf). And, see the International Energy Agency's 2011 report, Technology Roadmap Electric and Plug-In Hybrid Electric Vehicles, www.iea.org/papers/2011/EV_PHEV_Roadmap.pdf.

- Eliminate or significantly modify the GHG-ZEV over-compliance provision to minimize the potential reduction in ZEVs. If the provision is not eliminated, we recommend that the ARB
  - Increase the amount of GHG over-compliance required to get ZEV credits (Currently an automaker would have to over-comply with GHG standards by just 1 percent to get a 40 percent reduction in ZEV requirements from 2018-2021. The cost to over-comply with GHG standards by 1% is $2,000 to $3,000 per electric car avoided. ARB estimates each electric car costs $10,000 to $15,000 in 2020. Even if the GHG over-compliance costs were double these values, the current proposal gives automakers a strong economic incentive to avoid selling electric cars),
  - Cap the potential reduction in ZEVs well below 40 percent, and
  - Make the following essential technical changes:
    - Ensure accurate accounting of GHG over-compliance by taking into account the net upstream emissions from electric cars used to over comply with GHG standards;
    - Reduce the uncertainty of the program by moving up the date for signing on to December 31, 2016 instead of May 1, 2018, which is after the program would be generating credits;
    - Monitor the use of the provision and report back on the losses in ZEVs and TZEVs due to the provision;
    - Clarify the intent of the provision as temporary and not inherently linking the ZEV and GHG programs.

We further recommend that the ARB direct the staff to revise the calculations of the costs and benefits of the ZEV program alone and within the context of state and federal greenhouse gas standards. ARB staff has done an impressive job in researching and analyzing key details on costs and benefits of the program. However, several key conservative assumptions were made and should be updated. Further, an analysis is required of the most likely scenario where the ZEV program moves forward and automakers adopt the option of complying with federal GHG standards instead of the LEV III-GHG program. Changing to at least some of the more realistic assumptions and analyzing the most likely scenario would indicate consumer costs that are a few hundred to several thousand dollars lower per car and benefits that are thousands of dollars higher per vehicle. Incorporating just some of these changes would raise the net lifetime savings for electric cars in 2025 to $5,000 to $10,000 compared to today's typical car. Specifically, we recommend the following:

- Adoption of an electricity price of significantly less than 15 cents per kWh for electricity to account for future accessibility of time of use rates and off-peak battery charging. We estimate that switching to 10 cents per kWh would increase lifetime savings for a battery electric car by as much as $2,000.

While 15 cents per kWh may represent a reasonable expected average, most battery charging is likely to happen off-peak, where electricity is significantly less expensive to produce. Efforts are already under way to increase availability of time of use rates for electric cars. To not assume much more extensive use of these lower rates significantly under values the fuel cost savings of the ZEV program. A lower hydrogen price should be adopted as well.

- Adoption of a higher gasoline price of $4.02 per gallon by 2025. Californians are regularly experiencing $4 per gallon gasoline today. We estimate that switching to $4.50 per gallon would increase lifetime savings for a battery or fuel cell electric car by more than $2,000.

With the inherent price volatility and increasing cost of oil as worldwide demand goes up with the economic recovery and as conventional supplies become harder and harder to access, remaining at $4 per gallon is unlikely at best.

- Adoption of an Indirect Cost Multiplier (ICM) of 1.33 for ZEV technologies, which staff have highlighted as the most likely case, but is not used in the analysis. ARB staff estimates that using an ICM of 1.33 would bring down battery and plug-in hybrid electric car costs by $1,000 to $3,000 per vehicle and fuel cell electric car costs by $200 to $1,500 per vehicle. Based on ARB data and UCS calculations, using the correct ICM would cut the cost of the ZEV program by nearly $2 billion, bringing it to $3 billion.

At a minimum, the ICM for battery electric and certain types of plug-in hybrid electric technologies should be reduced to the same level as that for fuel cell electric vehicles as they of similar complexity.

- Inclusion of an analysis of the costs associated with the ZEV program in the most likely scenario where automakers choose to comply with federal GHG standards in place of LEV III-GHG. We estimate that the incentives provided to electric cars in the federal GHG standards are about $3,000 to $6,000 per battery or fuel cell electric vehicle, depending on the year and the actual vehicle upstream emissions from 2018 through 2021, with significant incentives still available in 2022 through 2025 depending on how many electric cars automakers produce. Accounting for these incentives would further lower the cost of the ZEV program by about $1 billion, bringing it to $2 billion.

ARB has done excellent work in analyzing the costs associated with the ZEV program implemented in concert with the LEV III program, but has not looked at the case where automakers choose to use federal GHG compliance in place of LEV III-GHG. Under LEV III, ARB is expected to accept compliance with federal GHG regulations in place of LEV III-GHG. Unless key provisions in the federal GHG standards are altered, automakers will receive significant incentives for selling electric cars through a federal provision that excludes upstream emissions from producing electricity and hydrogen (qualifying pure electric cars as causing 0 grams per mile) and that can up to double the credit electric cars receive towards meeting federal GHG standards (credit multipliers from 1.5 to 2). Because these incentives are, appropriately, not included in the California LEV III program, they have not been accounted for in ARB staff estimates of the costs of the ZEV program.

This summary represents our top concerns. We will append added background on those concerns and a summary of our positions on other key changes in the proposal.

Conclusion

For more than 50 years, California has led the nation and the world when it came to reducing pollution from our cars and trucks. And, for more than 20 years, California's ZEV program has helped ensure long-term public health and consumer choice by accelerating the commercialization of the next generation of clean cars. Now, as California, the nation, and the world face a changing climate, continued unhealthy air, and significant economic costs linked to our dependence on oil, it is essential that the ARB adopt and strengthen the staff ZEV proposal. In doing so, ARB can help change daily commutes from part of the problem into part of the solution by giving consumers the chance to buy a different kind of car, one that is not captive to high gas prices or a tumultuous world oil market and that has the potential to truly deliver zero pollution. A strong ZEV program can do exactly that.

In closing, we want to commend staff, the Chair, and all others who have helped to deliver an impressive proposal backed by detailed research and analysis and a public process.

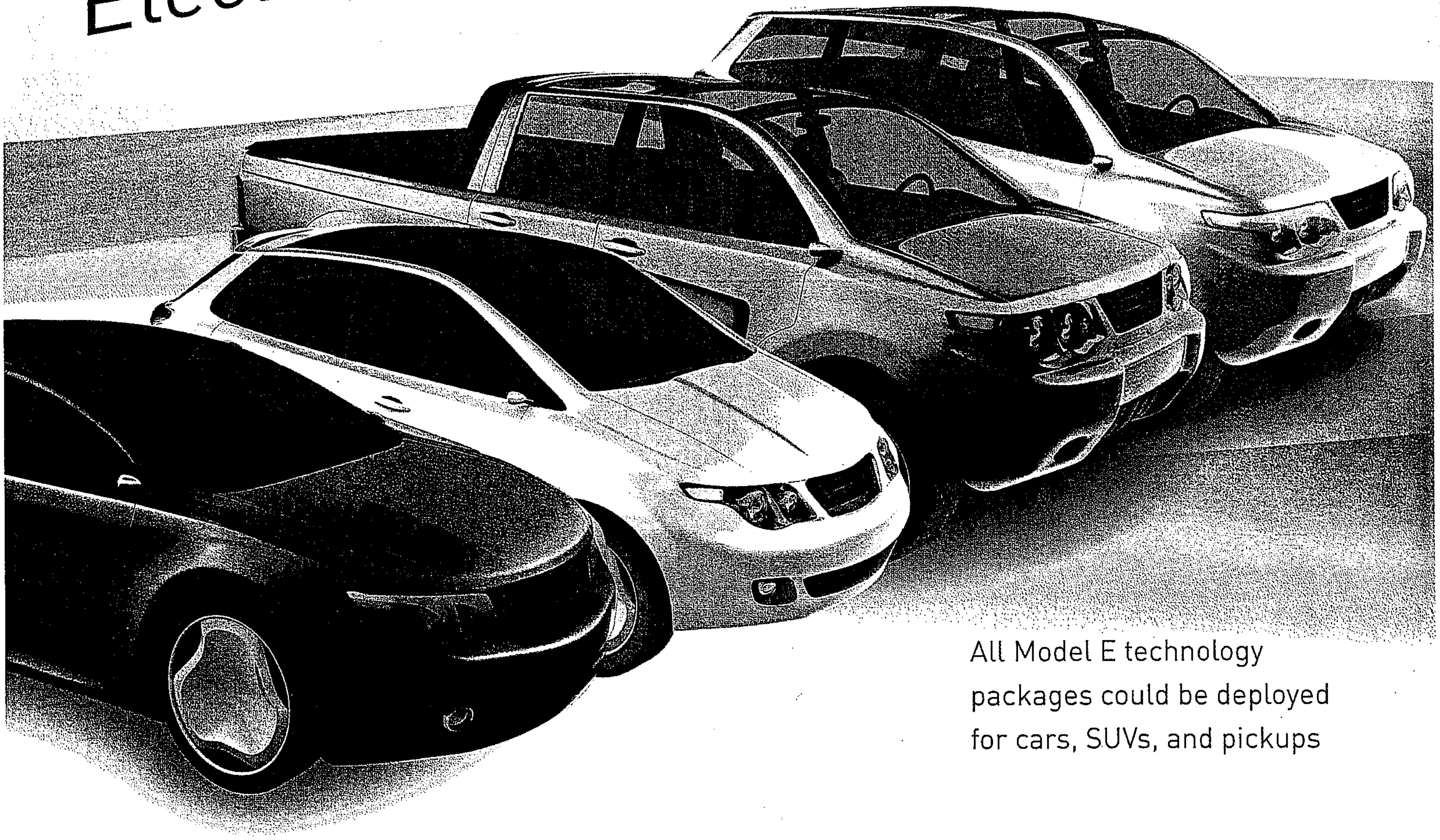
Sincerely,

David Friedman
Deputy Director and Senior Engineer
Union of Concerned Scientists

David Friedman

The UCS MODEL E

Electrifying America's Driving Experience



All Model E technology packages could be deployed for cars, SUVs, and pickups

One hundred years ago, Ford's Model T revolutionized the automobile industry. Now UCS engineers have created the Model E: a new line of electric-drive vehicle designs that could revolutionize tomorrow's driving experience.

These vehicles could help the United States cut smog-forming pollution dramatically, reduce global warming pollution 80 percent or more, and effectively end our oil addiction by 2050.

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

The future is starting now

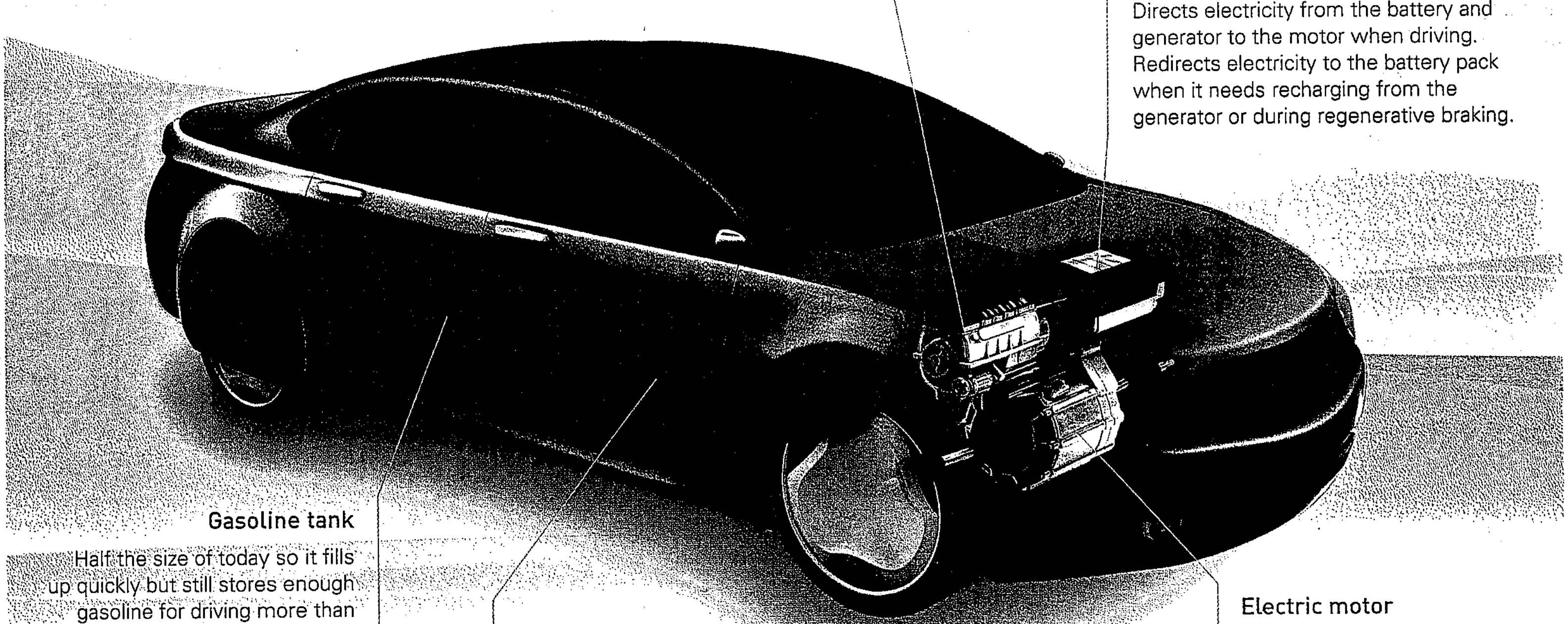
All Model E vehicles include advanced aerodynamic design featuring small cameras (instead of mirrors) and rear wheel covers, l that provide comfort and convenience without a large environmental footprint. Safety comes standard in the form of stronger m

Compact 4-cylinder engine/generator

High-efficiency gasoline engine connected to an efficient generator sends power to the electric motor and can recharge the batteries. Never idles, avoiding wasted fuel in stop-and-go traffic.

Power controller

Directs electricity from the battery and generator to the motor when driving. Redirects electricity to the battery pack when it needs recharging from the generator or during regenerative braking.



Gasoline tank

Half the size of today so it fills up quickly but still stores enough gasoline for driving more than 700 miles a week on one tank (with daily battery recharging).

Battery pack

Stores energy so you can drive up to 50 miles on electricity alone. Provides power for quick acceleration, passing, and merging. Recharges from the electric grid, engine/generator, or regenerative braking.

Electric motor

Delivers efficiency of around 90 percent during driving. Full torque available from rest for quick acceleration.

Model E Plug-in Hybrid Electric Vehicle (PHEV)

This vehicle delivers superior fuel economy on gasoline, plus full performance on electricity for up to 50 miles—more than the U.S. average of 30 miles a day. This cost-effective "series hybrid" relies exclusively on the electric motor to drive the wheels; the engine only turns on when the battery gets low.

Model E Fast Fact: The Model E PHEV will only deliver improved environmental performance over the Model E HEV if its batteries are recharged from electricity generated mainly from natural gas or renewable energy.

Specifications: Model Year 2025 PHEV Family Car*

EPA Fuel Economy on Gasoline/Electricity	45 miles per gallon/33 kilowatt-hours per 100 miles	Global Warming Pollution on Gasoline	200 grams per mile
Range on Full Tank/Battery	350 miles/50 miles	Global Warming Pollution on Electricity	Nearly zero to 290 grams per mile depending on electricity source
Price Premium vs. 2025 Conventional Gasoline Model	$7,300	Smog-Forming Pollution	Zero to 0.02 gram per mile (but full impact depends on electric grid)

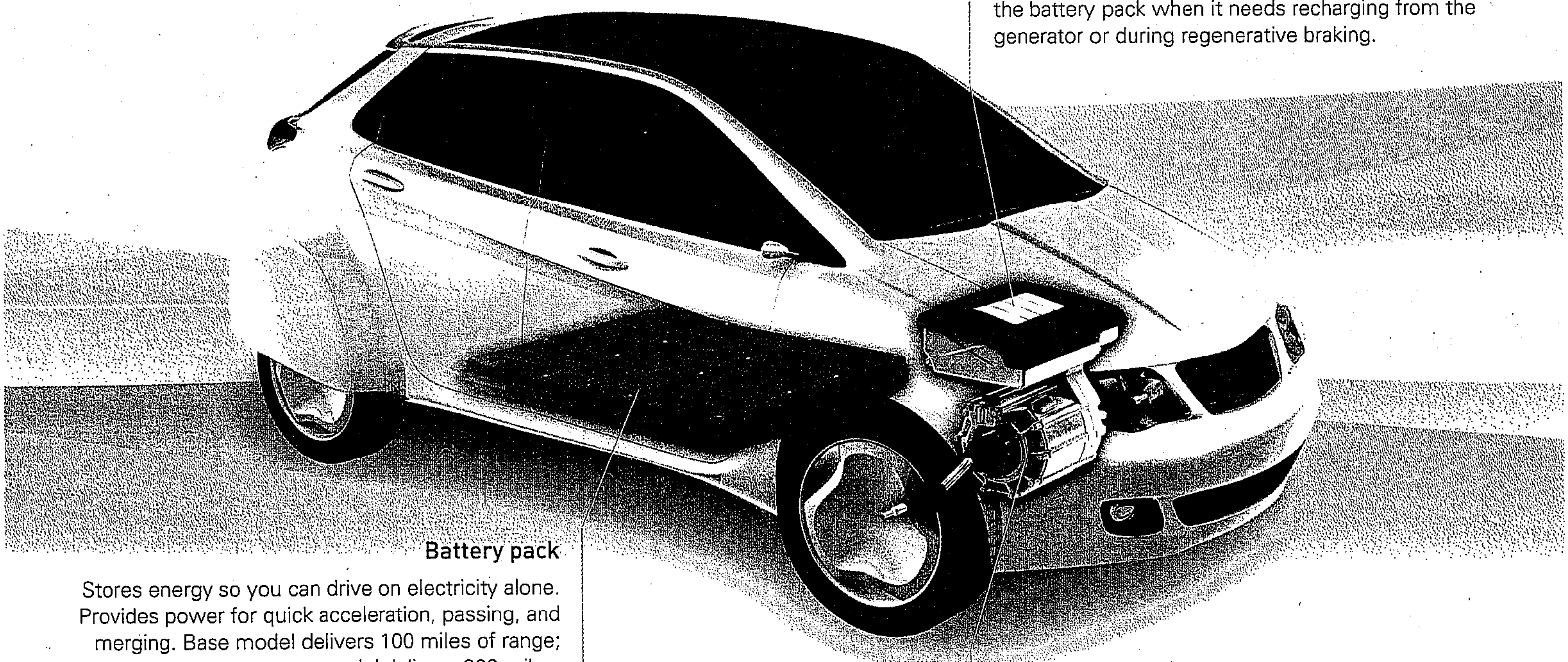
* Fuel economy, range, and global warming pollution are estimated for real-world driving conditions (similar to what is displayed on a new vehicle's window sticke

for electric vehicles

olling resistance tires, clean and efficient heating and air conditioning systems, and other efficient accessories
als, roll cage, air bags, advanced seat belts, and electronic stability control to help avoid accidents.

Power controller

Directs electricity from the battery and generator to the motor when driving. Redirects electricity to the battery pack when it needs recharging from the generator or during regenerative braking.



Battery pack

Stores energy so you can drive on electricity alone. Provides power for quick acceleration, passing, and merging. Base model delivers 100 miles of range; extra-range model delivers 200 miles.

Electric motor

Delivers efficiency of around 90 percent during driving. Full torque available from rest for quick acceleration.

Model E Battery Electric Vehicle (BEV)

No more gas stations: this all-electric car can be driven 100 miles or 200 miles for a higher-priced version before needing to be recharged at a wall-mounted charger in your garage or a public charging station. With nightly charging, 100 all-electric miles will cover most people's daily driving needs.

Model E Fast Fact: Today's typical BEV running on electricity generated from natural gas would have the same carbon footprint as a gasoline vehicle getting 60 to 70 miles per gallon (mpg). Using electricity generated from coal is equivalent to getting only 30 to 35 mpg.

Specifications: Model Year 2025 BEV Compact Car*

EPA Fuel Economy on Electricity	30 kilowatt-hours per 100 miles	Global Warming Pollution on Electricity	Nearly zero to 260 grams per mile depending on electricity source
Range on Full Battery	100 miles	Smog-Forming Pollution	Zero from the tailpipe (but the full impact depends on the electric grid)
Price Premium vs. 2025 Conventional Gasoline Model	$6,800		

'alues are for the vehicle and powertrain combination shown; for information on other combinations, go to *www.ucsusa.org/Model-E*.

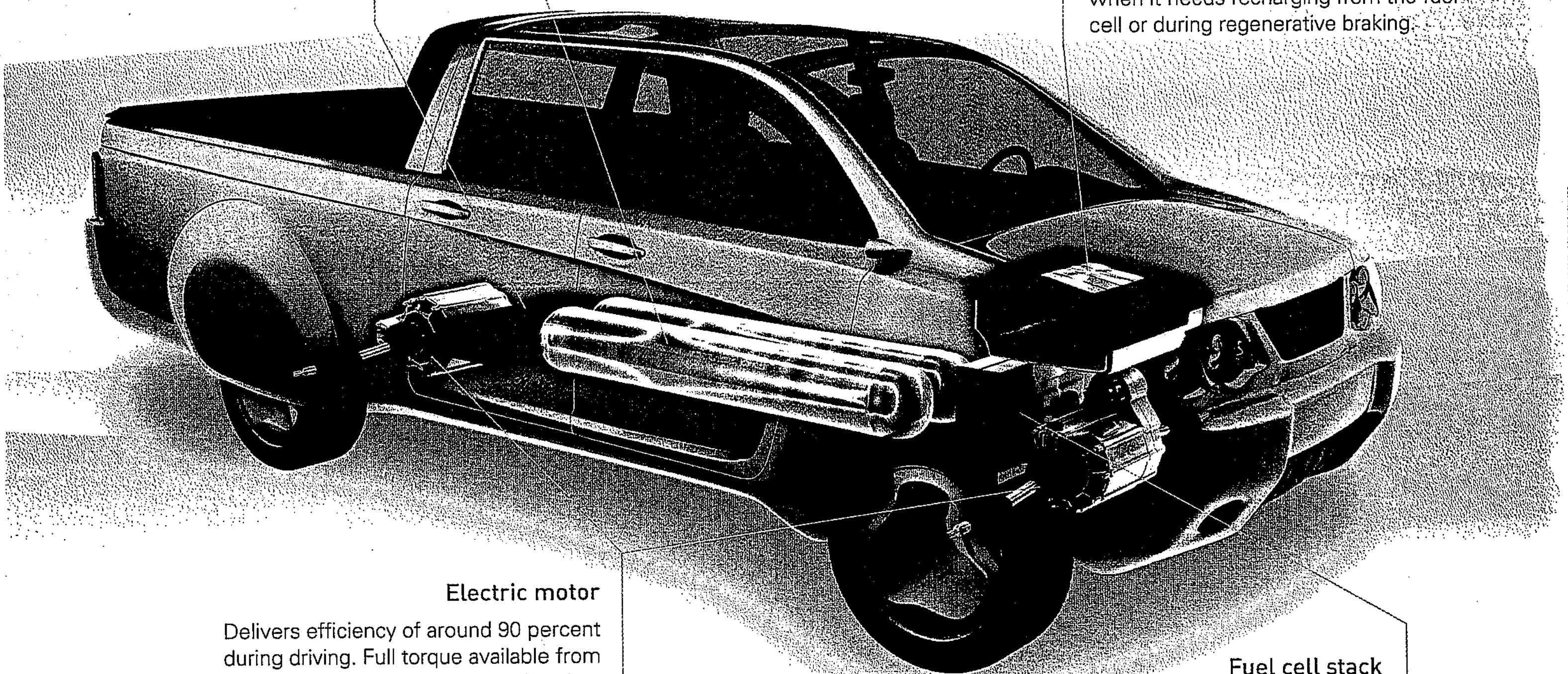
Advanced electrified drivetrain technologies are already entering the market, but they face many barriers that limit their potential. UCS engineers have created the Model E designs you see throughout this brochure to illustrate what that potential could mean for drivers in 2025. We also answer several common questions about these technologies, and highlight some of the steps needed to help them succeed.

To see more, go to the Model E Resource Center at *www.ucsusa.org/Model-E.*

Battery pack
Provides power for quick acceleration, passing, and merging. Recharges from fuel cell or during regenerative braking.

Hydrogen storage tanks
Stores enough hydrogen for 400 miles of driving on electricity alone. Fills to full capacity about as fast as today's gasoline tanks, with no smell or leaks.

Power controller
Directs electricity from the fuel cell and battery pack to the motor when driving. Redirects electricity to the battery pack when it needs recharging from the fuel cell or during regenerative braking.



Electric motor
Delivers efficiency of around 90 percent during driving. Full torque available from rest for quick acceleration.

Fuel cell stack
Converts hydrogen and air into electricity. Two to three times more efficient than today's gasoline engines. Sends electricity to the electric motor to drive the vehicle and to the batteries for recharging.

Model E Fuel Cell Electric Vehicle (FCEV)

This all-electric car never needs to be recharged from the electric grid. The internal combustion engine has been replaced by a hydrogen-powered fuel cell supplemented by a small battery; when you step on the accelerator pedal, the fuel cell generates electricity while emitting only water.

Model E Fast Fact: Separating hydrogen from fossil fuels will contribute to global warming because it leaves behind heat-trapping carbon. Using renewable energy to separate hydrogen from water is better for the environment—as long as the water is not in short supply.

Specifications: Model Year 2025 FCEV Pickup Truck*

EPA Fuel Economy on Hydrogen	42 miles per kilogram	Global Warming Pollution on Hydrogen	Nearly zero to 390 grams per mile depending on hydrogen source
Range on Full Tank	400 miles	Smog-Forming Pollution	Zero from the tailpipe (but the full impact depends on the hydrogen source)
Price Premium vs. 2025 Conventional Gasoline Model	$8,400		

UCS engineers have bridged the gap between the technology of today and the vehicles of the future with a hybrid electric vehicle that far surpasses the fuel economy and emissions performance of today's hybrids. All the Model E technology packages described in this brochure could be deployed for cars, SUVs, and pickups.

Gasoline tank

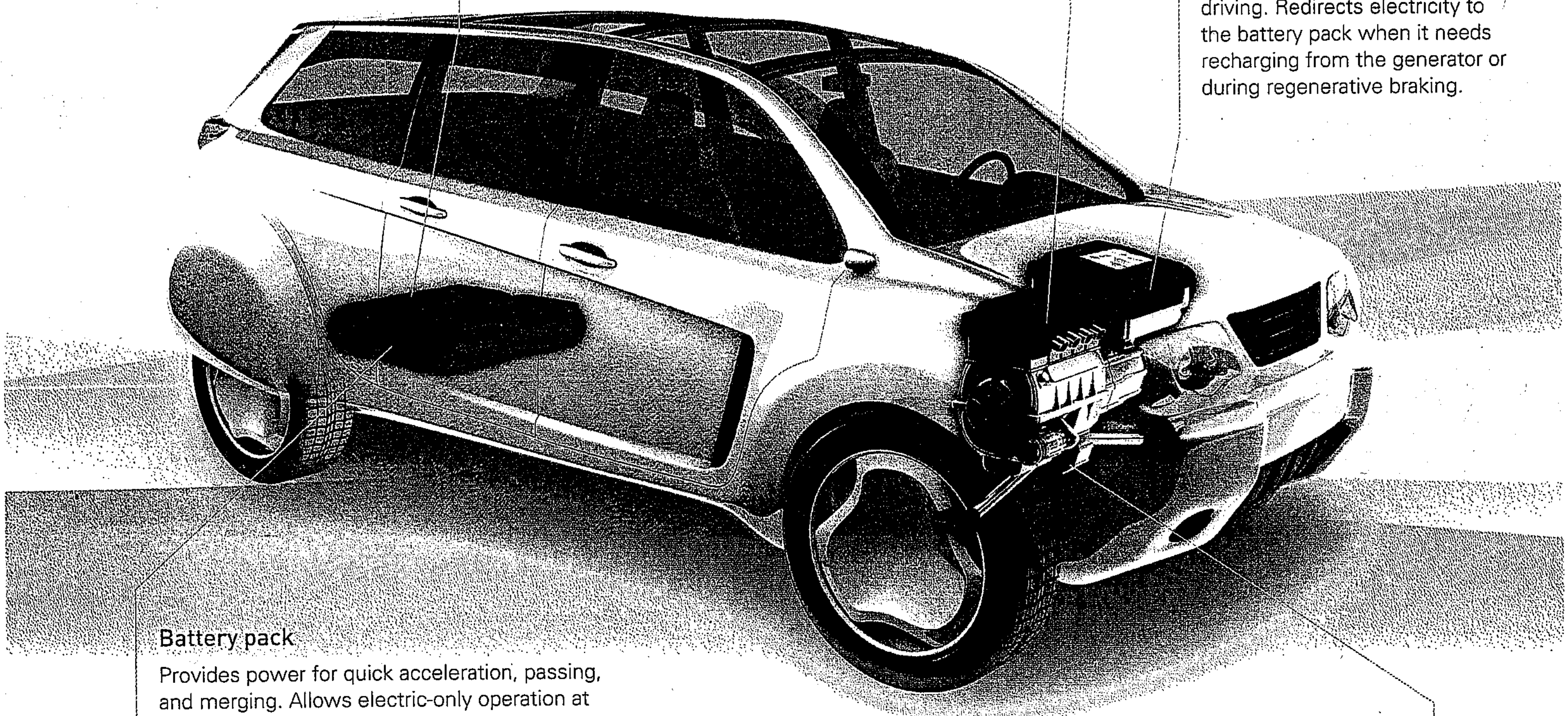
Half-size tank delivers the same range as today with quicker fill-ups. Optional full-size tank delivers twice today's driving range with fewer trips to the pump.

Compact 4-cylinder engine

High-efficiency gasoline engine can drive the wheels, run a generator to recharge the batteries, or turn itself off to avoid wasting fuel in stop-and-go traffic or when the electric motor alone can drive the vehicle.

Power controller

Directs electricity from the battery and generator to the motor when driving. Redirects electricity to the battery pack when it needs recharging from the generator or during regenerative braking.



Battery pack

Provides power for quick acceleration, passing, and merging. Allows electric-only operation at lower speeds. Recharges from onboard generator powered by the engine or regenerative braking.

Power split device

Combined transmission, motor, and motor/generator enables the engine to operate at the most efficient speeds. Disconnects the engine and generator from the powertrain so the electric motor alone can drive the vehicle at low speeds or during highway cruising.

Model E Hybrid Electric Vehicle (HEV)

This combination gasoline-electric system delivers more than double the fuel economy of today's cars via a "full hybrid" drivetrain: in stop-and-go city traffic, the electric motor provides power to the wheels; on the highway, a high-efficiency, downsized gasoline engine provides the power. When extra power is needed during acceleration, the engine and motor join forces for peak performance.

Model E Fast Fact: Automakers still have far more they can do with hybrid technology. The UCS Hybrid Scorecard (see *www.hybridcenter.org*) revealed that only 13 of the 34 hybrids on the U.S. market in 2011 lowered global warming emissions more than 25 percent compared with their conventional counterparts. The Model E HEV would deliver better than a 50 percent reduction.

Specifications: Model Year 2025 HEV Crossover*

EPA Fuel Economy on Gasoline	44 miles per gallon	Global Warming Pollution on Gasoline	200 grams per mile
Range	400 miles	Smog-Forming Pollution	0.02 gram per mile (1/8th today's average car)
Price Premium vs. 2025 Conventional Gasoline Model	$2,000		

* Fuel economy, range, and global warming pollution are estimated for real-world driving conditions (similar to what is displayed on a new vehicle's window sticker). All values are for the vehicle and powertrain combination shown; for information on other combinations, go to *www.ucsusa.org/Model-E*.

Questions about an electrified future? Model E engineers have the answers

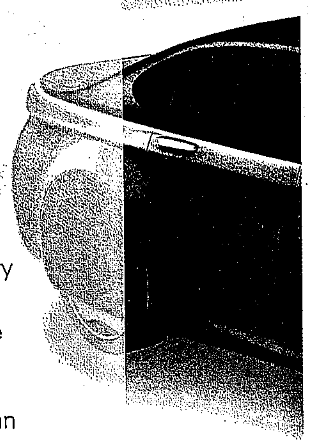
Q. How could these different technologies benefit the environment?

A. Electric-drive vehicles have the potential to dramatically reduce the global warming, smog-forming, and toxic pollution produced by cars and trucks. However, 70 percent of U.S. electricity today is generated from fossil fuels—primarily coal and natural gas—that produce the same kind of pollution as gasoline. An electric-drive vehicle recharged with electricity generated from coal will have a carbon footprint only slightly better than the average gasoline vehicle, and hydrogen generated from coal is no better. Recharging with electricity (or hydrogen) generated from natural gas, however, results in a carbon footprint better than a good hybrid today, and renewable sources of electricity and hydrogen (wind, sun, and low-carbon biomass) result in nearly zero emissions.

Q. Will an electric-drive vehicle be fun to drive? How will it handle?

A. Electric-drive vehicles can deliver great acceleration, especially from a stop, and improved handling over today's gasoline cars. One of the benefits of using an electric motor is that it provides maximum torque (the force applied to turn the wheels and move the car) even when the car is just getting started. Electric motors can also deliver very high torque over short periods of time, providing good acceleration on the highway. Improved handling is possible because, unlike a gasoline engine and transmission whose size and shape dictate their placement under the hood, an electric drivetrain gives automakers the flexibility to create a lower center of gravity and near-ideal weight distribution.

Q. Is there a clear winner among electric-drive technologies?



A. No. Over the past 40 years, each of our last eight presidents has acknowledged the need to curb U.S. oil dependence, but shifted financial and policy support from one promising energy technology to another—making it difficult for industry and venture capitalists to make long-term investments. Developing a new fleet of clean vehicles will take time, and success depends on creating an opportunity for many technologies, not focusing on one "winner" that changes every few years. Policy makers must accept the fact that the typical two- to four-year political cycle is too short to deliver big results, and that we must invest in a portfolio of technologies with some risk if we are to succeed.

Considering that our nation has relied on one basic engine technology and one fuel for more than a century, and that it will take a few more decades to end this reliance, the switch to electric-drive vehicles may feel more like evolution than a revolution. But it is high time we face the challenges of climate change and America's oil dependence by moving our transportation system into the twenty-first century.

For more questions, answers, and information go to the Model E Resource Center at *www.ucsusa.org/Model-E*.

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

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Citizens and Scientists for Environmental Solutions

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