Policy Report March 2007

PLUGGING INTO THE GRID

How Plug-In Hybrid-Electric Vehicles Can Help Break America's Oil Addiction and Slow Global Warming

by Joseph Romm and Peter Fox-Penner

There is a growing consensus that America's dependence on oil constitutes a triple threat to its national security, its economic vitality, and its environmental health. But agreement breaks down on the question of how, exactly, the country can best achieve dramatic, near-term reductions in oil consumption. We believe that the greatest potential for transformative change may lie in the emerging technology of plug-in hybrid-electric vehicles (PHEVs), which could become widely available in the United States in five to 10 years if government takes a few smart steps to help spur their commercialization.

Like conventional hybrid-electric vehicles, plug-in hybrids save fuel by using small internal combustion engines in combination with electric motors. But while conventional hybrids charge their batteries with kinetic energy and power generated by their own internal combustion engines, plug-in hybrids, as the name suggests, have cords that can be plugged into standard, 120-volt electrical outlets.

That design—constituting a partial merger of the transportation and electricity sectors—can produce dramatic reductions in gasoline consumption. Equipped with more powerful battery packs than conventional hybrids, plug-in hybrids can travel the first 20 miles or more on battery power alone, without ever firing up their internal combustion engines. That is farther than the average round-trip commute. After that, they can switch to a conventional hybrid-electric operating mode. In all-around driving, plug-ins could thus get between 80 m.p.g. and 160 m.p.g., compared to about 45 m.p.g. for today's Toyota Prius. The gasoline savings could be even greater if plug-ins were designed to run on biofuels; they could travel 500 miles on a gallon of gasoline blended with five gallons of ethanol.

Even beyond the possible reductions in oil consumption, plug-ins also offer a compounded benefit in their ability to sharply reduce carbon dioxide emissions and thus slow global warming. The beauty is in the increased reliance on the electricity grid, which can concentrate the environmental impact of driving upstream in a few thousand electrical power plants instead of downstream in a hundred million motor vehicles. That puts

Joseph Romm is a senior fellow at the Center for American Progress and author of the new book, Hell and High Water: Global Warming—The Solution and The Politics. Peter Fox-Penner is the chair of The Brattle Group, an economic consultancy, and of the Environmental Alliance, a nonprofit voter education group. Both are former senior officials at the U.S. Department of Energy.

"One person with a belief is a social power equal to ninety-nine who have only interests."
—John Stuart Mill

The Progressive Policy Institute

The Progressive Policy Institute is a catalyst for political change and renewal. Its mission is to modernize progressive politics and governance for the 21st century. Moving beyond the left-right debates of the last century, PPI is a prolific source of the Third Way thinking that is reshaping politics both in the United States and around the world.

The PPI invents new ways to advance enduring progressive principles: equal opportunity, mutual responsibility, civic enterprise, public sector reform, national strength, and collective security. Its "progressive market strategy" embraces economic innovation, fiscal discipline, and open markets, while also equipping working families with new tools for success. Its signature policy blueprints include national service, community policing, and a social compact that requires and rewards work; new public schools based on accountability, choice, and customization; a networked government that uses information technology to break down bureaucratic barriers; pollution trading markets and other steps toward a clean energy economy; a citizen-centered approach to universal health care; and a progressive internationalism that commits America's strength to the defense of liberal democracy.

Rejecting tired dogmas, PPI brings a spirit of radical pragmatism and experimentation to the challenge of restoring our collective problem-solving capacities—and thereby reviving public confidence in what progressive governance can accomplish.

progressive policy institute ppi

www.ppionline.org

The Progressive Policy Institute is a project of the Third Way Foundation.

the environmental policy focus squarely on reducing greenhouse gas emissions from the power sector, where there is the greatest opportunity to make high-volume progress.

In reality, it is unlikely that the current U.S. vehicle fleet could ever be entirely replaced by PHEVs, for the simple reason that it would be impractical for some drivers to plug in with any regularity—people who live in urban or dense, inner-suburban areas and have no access to off-street parking, for example. For them, it might make more sense to have a conventional hybrid, or a "flex-fuel" car that can run on biofuel. But PHEVs can certainly work for enough people to make a substantial dent in America's gasoline needs.

At the moment, the market for plug-in hybrids is still in its infancy. The first commercial model, the Mercedes-Benz Hybrid Sprinter van, is available in Europe. In the United States, there are only after-market conversion kits available to turn conventional hybrids like the Toyota Prius and the Ford Escape into plug-ins (voiding their warranties). But the future looks brighter. Toyota, already the leader in gasoline-electric hybrid technology, announced in July 2006 that it would begin developing plug-in hybrids. Shortly thereafter, Google's new philanthropic arm, Google.org, announced plans to back development of an ultra-fuel-efficient plug-in hybrid car engine that runs on ethanol, electricity, and gasoline. More recently, GM pledged to build a plug-in hybrid.

Several lingering challenges must be overcome before the oil- and climate-saving potential of plug-in technology can be realized. The larger and more complicated batteries in plug-ins make them considerably more expensive than conventional hybrids. In addition, their ability to help reduce greenhouse gas emissions depends entirely on the power sources that feed the electricity grid. If the electricity used to power plug-ins comes from relatively CO_2-free sources such as wind, solar, or nuclear power, then plug-ins can be considerably cleaner than conventional hybrids. But if the electricity comes from traditional coal-fired power plants, then plug-in hybrids are no cleaner from a climate perspective than today's conventional hybrids.

Given the tremendous promise of plug-in hybrid technology, there is a strong policy case to be made for accelerating its development. But there is an equally strong case to be made that government should refrain from picking technological winners. (Plug-in hybrids may look more promising than any other technology right now, but that could obviously change.) So what is the right role for government? The answer is that it should focus its regulatory authority on achieving the broad policy outcomes that are unquestionably in the public interest—that is, reducing carbon dioxide emissions and oil consumption—but let markets determine which technologies are best able to deliver results. Government can certainly play a catalytic role in spurring the development of specific technologies, as long as it maintains a technologically-neutral posture by keeping its efforts diversified. Indeed, that is its current approach. There are existing programs to promote plug-in hybrid-electric vehicles, along with tax credits for consumer purchases of conventional hybrid-electric vehicles, subsidies for homegrown biofuels, and federally funded research projects to develop hydrogen fuel cells, among other things.

With those principles in mind, PPI proposes a three-part policy agenda that will effectively spur the development of plug-in hybrids, along with other new transportation technologies:

- Establish a mandatory national cap on carbon dioxide and other greenhouse gas emissions;
- Reform federal fuel economy standards to increase pressure on carmakers to produce high-mileage, low-emission vehicles of all types; and
- Partner with the private sector to leap technological barriers related to such things as battery cost and performance.

Plug-In Hybrids vs. Other Gasoline-Saving Alternatives

To better understand the promise of plug-ins, it is helpful to first know how they stack up against the alternatives in the growing global race to build cleaner, cheaper, more fuel-efficient cars. Here is a brief overview of the competition:

Conventional Hybrid-Electric Vehicles

The highest-profile alternative vehicles on the road today are conventional hybrid-electric vehicles (HEVs), sales of which have skyrocketed 80 percent since 2000 as gas prices have nearly doubled.[1] Conventional hybrids save gasoline by converting energy usually lost during braking into electricity, which is stored in an onboard battery that powers an electric motor to assist a gasoline-powered engine. But HEVs still rely on gasoline, and their fuel efficiency varies depending on whether the stored battery power is used by the vehicles in lieu of gasoline or as a way to beef up horsepower.

Electric Vehicles

To some degree, the emergence of both gasoline-electric and plug-in hybrids may be understood as a response to California's brief, unsuccessful flirtation with purely electric vehicles (EVs) in the 1990s. The state required manufacturers to make a percentage of their fleets electric vehicles. The cars, which were virtually silent and produced no direct tailpipe emissions, were wildly popular with the small segment of California drivers who leased them while they were available. The one knock against them was that they had a limited range of about 60 miles per charge, making them practical only for routine, in-town driving. Manufacturers contested the state's mandate in court, however, and that first generation of EVs was eventually recalled and destroyed.

More recently, a new generation of upstart electric carmakers, such as Silicon Valley's Tesla Motors, have begun building electric cars with greater range and horsepower. Tesla's inaugural souped-up Roadster, introduced in 2006, accelerates from zero to 60 miles per hour in four seconds, travels 250 miles on a charge, and costs about 1 cent per mile to operate.[2] But with a $100,000 price tag and production volumes currently limited to about 100 cars at a time, this next-generation EV remains an unattainable option for most Americans.

Biofuels

Another way to reduce gasoline consumption is to use alternative biofuels, such as ethanol made from corn. Already, about 5 million U.S. vehicles are capable of running on biofuel blends—either gasoline mixed with ethanol, or petroleum-based diesel mixed with biodiesel—and U.S. automakers have pledged to double their annual production of these so-called "flex-fuel" models to 2 million vehicles per year by 2010. That could help displace more than 3.5 billion gallons of gasoline consumption per year.[3]

While vehicles that run on biofuel blends can stretch oil supplies, today's biofuels cannot replace oil entirely for several reasons: First, it is doubtful that the United States has enough arable land to grow corn in quantities sufficient to produce enough of the currently available type of ethanol for its entire vehicle fleet. Second, it takes a lot of energy and natural resources to grow those crops—including oil, fertilizer, and water. Third, today's biofuel blends do not contain as much energy as pure gasoline. Although the type of ethanol that is available today is an important bridge technology, there is greater potential in a new generation of biofuels made from fast-growing switch grass and other plants that typically do not serve as food for humans or livestock. That topic will be explored in greater detail in a companion paper to this report.

Diesel

Standard diesel fuel has also received new attention of late, since diesel engines get better mileage than gasoline engines. Honda, for example, has announced that it will begin selling a new diesel model in 2009 that will be clean enough to comply with California's tough emissions standards, while getting 30 percent better mileage than equivalent gasoline-powered vehicles. In the past, diesel engines have earned a bad reputation for being loud and producing a lot of soot, while diesel fuel itself has been available at fewer pumps than gasoline. If a new generation of more efficient diesel engines can overcome that old reputation, the result would be not just an expanded market for standard diesel fuel but also an expanded market for biodiesel, since all new and recent model-year diesel engines can run on it, too.

Hydrogen

And then there is hydrogen: No alternative vehicle technology has been the subject of quite as much hype. President Bush unveiled a $1.2 billion Hydrogen Fuel Initiative in his 2003 State of the Union address. California Gov. Arnold Schwarzenegger has been another vocal proponent. But the infrastructure and safety challenges associated with using hydrogen fuel cells to produce electricity will make it a highly impractical vehicle technology for decades, and perhaps forever.[4] Also, the process of generating, delivering, and utilizing hydrogen from zero-carbon electricity sources is three to four times less efficient than simply using those sources to power the electricity grid and then charging a vehicle's battery directly by plugging it into an electrical outlet.[5] If practical onboard batteries can be designed for vehicles, then electricity is certain to be a far more viable alternative "fuel" than hydrogen.

The Implications of Plugging Into the Grid

The electric current needed to charge a PHEV could easily be supplied by a single circuit in a typical home; the power requirement would be roughly equivalent to what is needed to operate a large room air conditioner or a hair dryer. And from the consumer's point of view, plugging in a PHEV will be no more complicated than plugging in any other appliance, tool, or electronic device.

When they have widely penetrated the auto market—which would be long after they become widely available, probably not for another 10 or 15 years—PHEVs will represent the largest new source of demand for electric power since air conditioning became common in the 1960s. But all that new demand will not exceed the grid's capacity, because drivers will typically charge their PHEVs when they are home for the night, during off-peak hours.

Eventually, drivers will likely be able to plug in during the day at other locations, such as offices and malls, as the expanding market for PHEVs drives infrastructure improvements in parking garages and some curbsides. Still, until the number of PHEVs in use becomes very large, the aggregate demand of the vehicles on power supplies will not be anywhere near large enough to pose a supply problem for the electric industry. One recent study, focused on California, concluded that "millions of PHEVs could be economically charging at even peak hours on most days."[6] One hundred thousand PHEVs charging simultaneously in one metropolitan area would require one additional 220-megawatt power plant, less than half the size of a conventional central power plant and also smaller than several recent wind farms. Since the demand created by PHEVs will grow slowly as fleet and then individual sales grow, the power industry will have plenty of time to plan for this new load, while still meeting environmental commitments and other needs.

In fact, rather than constituting an unbearable load that breaks the back of the electricity industry, PHEVs may eventually be able to help stabilize the electricity grid by serving as distributed reserve-capacity storage systems. For one thing, because PHEVs will have large batteries, they will be ideal for storing the intermittent power produced by wind and solar generators. For another thing, as Amory Lovins, Willett Kempton, and others have pointed out, with some modifications to PHEVs and the electricity grid, power companies could remotely discharge batteries of plugged-in vehicles during peak periods-paying vehicle owners for the privilege.

Many issues remain to be resolved before such "grid management services" from PHEVs would make sense. Foremost, PHEVs numbers would need to rise to a point where storage and load balancing functions would be economically viable. Then, some infrastructure improvements would need to be made to permit plugging in at the workplace and most likely, accompanying changes in zoning, permitting, and applicable building and safety standards. To provide plug-in owners with a financial incentive to release power stored in their cars back to the grid, cars would require transformers, meters, control circuits, and additional safety gear. Nonetheless, these are additional reasons why PHEVs represent very important elements in a clean, efficient energy industry of the future.

What is Holding PHEVs Back?

The biggest obstacles that manufacturers face in bringing PHEVs to market are battery cost and performance.

Presently, conventional gasoline-electric hybrids cost, on average, about $4,000 more than cars that run on gasoline alone. Batteries account for half of that premium. If plug-in hybrids were mass-produced, their comparatively higher battery cost would add another $2,000 to $3,000 to the cost of a conventional hybrid, according to the Electric Power Research Institute (EPRI).

The future promises greater economies of scale, however. Toyota and Honda have announced the goal of reducing the incremental cost of conventional hybrids by 50 percent in the near-term. Toyota alone plans to offer hybrid versions of almost all its models and sell a million hybrid vehicles a year worldwide during the next decade. The benefits of that thrust are already apparent. From 1997 to 2004, for example, the price tag for the nickel metal hydride batteries used in conventional hybrids dropped by half, as did their weight.

The same scale economies would apply to plug-in hybrids if they are manufactured in high volumes. In fact, falling costs are even more likely for PHEVs than conventional hybrids because the more powerful electric motors in PHEVs allow for significant downsizing of their gasoline engines and other related mechanical systems.

As battery advances and scale economies kick in, PHEVs batteries made from nickel metal hydride or lithium ion ultimately are predicted to drop to $3,000 or less while providing enough energy for range of 20 miles (and possibly more). In time, engineers are expected to extend the operational lifetimes of these batteries to more than 15 years and 150,000 miles.

Even before those benchmarks are reached, lower fuel bills will partially offset PHEVs' higher initial price. How much lower will drivers' fuel bills be? A conventional 25-mile-per-gallon car costs about 12 cents a mile to operate at current gasoline prices. Most of today's conventional hybrids cost in the range of 8-to-10 cents a mile (although the very best, like the Prius, do somewhat better). A plug-in hybrid, when it is running on battery mode, would likely cost about 3 cents a mile to operate, based on current average residential electricity prices of 8 cents a kilowatt-hour.

In reality, just as most vehicle purchases are motivated by complex non-economic factors, people tend to buy hybrids for the "environmental" and "oil independence" features, without considering paybacks. Nevertheless, at present, hybrid prices—when the currently available federal tax credits for hybrids are factored in[7]—payback can take several years, assuming that one assigns no value to benefits such as increased range. As oil prices continue to climb as a result of growing global demand and finite supply, the payback for PHEVs may be faster than the payback for conventional hybrids, when total lifetime cost of ownership is considered.

Policies to Promote Plug-In Hybrids

Federal policies to promote PHEVs should be a part of a comprehensive strategy for addressing the twin energy policy imperatives of halting global climate change and oil dependence. As with all federal energy and environmental policies, federal actions should leverage advanced policies already in place in many states and municipalities, as well as many decades of public and private research, design, and development efforts on the part of companies, academia, and national laboratories.

In that spirit, PPI proposes a three-part agenda:

Curb Carbon Dioxide and Other Greenhouse Gas Emissions

When operating in electric-only mode, plug-in vehicles have no tailpipe emissions. But the ability of plug-in hybrids to reduce greenhouse gas emissions depends in part on the mix of fuels used to generate electricity. The climate impact of plug-in vehicles in California, where renewables and nuclear power account for 45 percent of power generation, is considerably lower than in Eastern portions of the country, which rely heavily on conventional coal. A recent study found that a plug-in hybrid operating in electric-only mode in California would reduce CO_2 emissions relative to a conventional hybrid by one-third, whereas the difference would be negligible in more coal-intensive parts of the United States.[8]

Thus, in order to realize the full environmental potential of PHEVs, Congress should establish an economy-wide cap on greenhouse gas emissions through a flexible, market-based "cap-and-trade" system that allows companies to buy and sell emissions allowances. Limiting America's carbon dioxide and other greenhouse gas emissions in that way would help kick America's oil habit by giving carmakers a financial incentive to build cars and trucks that use less oil and gas. It would also kick start a robust national market for alternative biofuels and ensure that electricity producers power America's grid—and, by extension, PHEVs—with "clean coal" technologies, natural gas, and zero-emission sources like nuclear, wind, biomass, and solar power.

Lawmakers can create a national cap-and-trade system for greenhouse gas emissions either in one fell swoop, or in steps: They could start with the electricity sector, which produces 40 percent of the nation's greenhouse gas emissions, and then fold in the rest of the U.S. economy, including the transportation sector, with a tailpipe emissions trading system for vehicle manufacturers.[9]

Under a national cap-and-trade system, all significant carbon-reducing transport technologies should be eligible for greenhouse gas emissions permits. PHEVs could provide manufacturers with a one-time carbon credit in the range of $750 per car.

Reform Federal Fuel Economy Standards

It is time for the United States to implement stronger automobile efficiency standards. Since Congress first created this system of Corporate Average Fuel Economy (CAFE) standards in 1975, the share of new vehicles classified as light trucks (including SUVs, minivans, and pickups) has shot up from 20 percent of sales to more than one-half of the market. As a result of all this, U.S. automobiles and passenger trucks are responsible for nearly one-half of all greenhouse gases emitted by passenger vehicles globally.[10]

Advanced programs of fleet-wide standards have been designed that continue to allow for vehicle choice and that increase passenger safety.[11] Properly designed, mileage standards will accelerate the adoption of PHEVs and other fuel-saving vehicles while saving critical quantities of oil and carbon across the automotive market.

Unfortunately, measures to raise the standard remain gridlocked in Congress. One way to break the stalemate is for lawmakers to gradually replace stalled CAFE standards with a tailpipe emissions trading system that is integrated into a national cap-and-trade system for carbon dioxide and other greenhouse gases.

As with national cap-and-trade proposals that would cover energy producers, factories, and other big emitters, a tailpipe trading system would give automakers a profit motive to produce cars and trucks that keep CO_2 emissions under set limits. Companies whose fleets miss the mark could buy credits from other sources (any company covered in the trading system, not just other automakers), or pay into a fund that could be used to spur innovation further.[12]

A third option is to provide federal financial assistance to U.S. vehicle manufacturers in exchange for stronger mileage standards. For instance, the "Health Care for Hybrids" proposal from Sen. Barack Obama (D-Ill.) and Rep. Jay Inslee (D-Wash.) recognizes that U.S. automakers have legacy costs that should be honored, such as healthcare and pension commitments. Congress could consider striking a bargain with manufacturers to help with these costs in exchange for commitments to build cars and light trucks that get much better mileage than today's models.

Partner with the Private Sector to Leap Lingering Technical Barriers

The primary challenge manufacturers face with PHEVs involves battery cost and performance. To further the development of PHEVs, the federal government should partner with the private sector to help solve these technological issues and identify any other problems that may exist. To refine and promote the technology, the federal government also could promote, coordinate, and help fund PHEV demonstration and integration projects, ensuring that key equipment suppliers, vehicle manufacturers, fleet owners, real estate developers, and the electric utility industry cooperate to speed the introduction of PHEVs. Much of this is already stated federal policy—the key is to ensure adequate funding and prompt implementation.[13]

Financial assistance to prime the pump of the PHEV market will be important—such as offsets for some of the up-front costs of early models—until economies of scale kick in. But this is the area that is least ready for policymaking now (apart from the existing tax credits for conventional hybrids). Yet even though PHEVs will not be widely available for several years, getting some tax credits for actual PHEV purchasers by 2010 could help jump-start commercial production.

In addition, there are many innovative financing and first-cost reduction policies that may be as (or more) important than tax credits. One such approach is the Plug-In Partners consortium, which is essentially taking advance orders for PHEVs now, well before they are in production. The consortium—which includes about 100 public power utilities, state and local governments, and public interest organizations—takes "soft buy order" pledges from the owners of public and private vehicle fleets who agree to purchase a certain number of PHEVs as soon as manufacturers meet a set of delivery targets. With a recent pledge from the city of Chicago and an order of 2,000 vehicles from Minnesota, Plug-In Partners has now reached the 6,000 vehicle mark.

The electric utility industry also has a very critical role to play in implementing PHEVs. Electric utilities will be both the providers of electricity and the purchasers of stored power from PHEVs. The rates at which these services are provided should be market-determined, but it is possible that utilities could play an effective role in financing PHEV batteries through customer assistance programs. To reduce the dominant risk factor for individual and fleet buyers—battery lifetime—the government should encourage pilot programs for utilities to own and lease or independently warranty PHEV batteries, and to buy back older batteries that are appropriate for second-life applications in stationery facilities.

Through its participation in research, design, and development at every level, and through other market-leading programs such as Plug-In Partners, the electricity industry must be a full partner in the development of this technology. Utilities must also plan with their regulators or customer-owners for a rate and policy framework that enables the PHEV market to thrive without jeopardizing other important activities in the industry. This will require state-by-state and company-by-company planning, ratemaking, marketing, and distribution engineering policies that facilitate this large future market.

Conclusion

There is widespread agreement that America needs to substantially reduce its petroleum consumption and curtail its carbon dioxide emissions. The question is, how? We believe the best answer is to merge a substantial part of the transportation sector onto the electricity grid, and make sure that the grid's power sources are as clean as possible. Plug-in hybrid-electric vehicles represent the most practical technology for doing that in the near- to mid-term. Our vision is that in 10 to 15 years, most new cars sold in the United States will be either plug-in or conventional hybrids capable of running on biofuels.

In the near-term, the nation's electricity grid can easily handle a substantial increase in the number of plug-in vehicles. As their numbers grow, the power industry will have plenty of time to plan for increased electricity demand. In fact, with some minor infrastructure improvements, plug-in vehicles may be able to play a valuable role as reserve power supplies for the rest of the grid during demand spikes. Meanwhile, powering the transportation sector with electricity instead of oil will concentrate the environmental impact of driving on a few hundred electricity plants instead of millions of vehicle tailpipes. That will allow the country to curtail its carbon dioxide emissions in big, efficient steps, instead of small ones.

Acknowledgments

The authors would like to thank the following individuals for their help with this paper: Willett Kempton, University of Delaware Graduate College of Marine Studies; Rick Tempchin, EEI, Director of Electric Transportation; Edward Kjaer, Southern California Edison, Director of the Electric Transportation Division; Felix Kramer, Calcars.org; Walter Short, NREL, Principal Policy Analyst and Group Manager; and Terry Penney, NREL, Technology Manager, FreedomCAR and Vehicle Technologies. All errors and views remain those of the authors.

Notes

[1] Lemoine, D., D. Kammen, A. Farrell, " Effects of Plug-In Hybrid Electric Vehicles in California Energy Markets," submitted to, The Energy Journal, 2006.
[2] See: *http:www.teslamotors.com*.
[3] Green Car Congress. "U.S. Automakers Plan to Double Output of Biofuel Vehicles by 2010," June 28, 2006, *http://www.greencarcongress.com/2006/06/us_automakers_p.html.*
[4] Romm, Joseph, J., The Hype About Hydrogen: Fact and Fiction in the Race to Save the Climate, Island Press, 2004.
[5] Romm, Joseph J., and A.A. Frank, "Hybrid Vehicles Gain Traction," Scientific American, April 2006, *http://sciam.com/article.cfm?chanID=sa006&articleID=0008B248-256B-1417-A41383414B7FFE9F*
[6] Lemoine, D., D. Kammen, A. Farrell, " Effects of Plug-In Hybrid Electric Vehicles in California Energy Markets," submitted to, The Energy Journal, 2006, p. 8.
[7] Hybrid vehicles purchased after 2005 are eligible for federal tax credits of up to $3,400. See *http://www.fueleconomy.gov/feg/tax_hybrid_new.shtml.* As commercial plug-in vehicles become available, we expect that additional favorable tax credits and local and corporate employee-benefit credits will apply to them.
[8] Kleisch, J. and T. Langer, "Plug-In Hybrids: An Environmental and Economic Performance Outlook," American Council for an Energy Efficient Economy, September 2006, Report No. TW61, p.7.
[9] Mazurek, Jan, "Toward a Post-Oil Economy," in With All Our Might, ed. Will Marshall, Rowman & Littlefield, 2006.
[10] DeCicco, J. and F. Fung, "Global Warming on the Road: The Climate Impact of America's Automobiles." Washington, D.C.: Environmental Defense, June 2006., *http://www.environmentaldefense.org/article.cfm?contentid=5300&linkID=200*.
[11] See "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards," (Board of Energy and Environmental Systems, Transportation Research Board, National Research Council, 2002), p. 113.
[12] Mazurek, Jan, "Toward a Post-Oil Economy," op. cit.
[13] This year's requested budget for the Department of Energy Vehicle Technologies program was an extremely modest $14 million, a request that was fully supported by the electric utility industry. (*http://www.eei.org/newsroom/press_releases/060517.htm*)

First-Class Mail
U.S. Postage Paid
Permit 244
Washington, DC

Find this and other policy reports at **www.PPIONLINE.org**, *the official website of the Progressive Policy Institute.*

Now on PPIonline.org:

- ❒ The Global Climate Change Marketplace: Moving Forward Without the United States
  David J. Hayes
- ❒ The Promise of Biofuels: A Homegrown Approach to Breaking America's Oil Addiction
  David J. Hayes, Roger Ballentine, and Jan Mazurek

***If you would prefer to receive future reports via email, please contact the PPI Publications Department at* publications@ppionline.org.**