

Plug-In Hybrid Electric Vehicles

Reducing Greenhouse Gas Emissions and Oil Dependence

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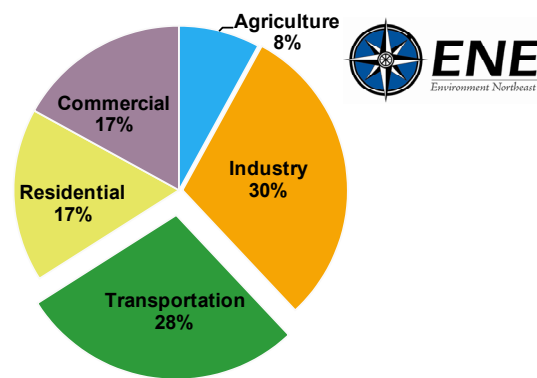
What is a PHEV? Plug-in hybrid electric vehicles (PHEV) are an evolution from today's hybrid vehicles, such as the Toyota Prius.

Today's hybrid relies principally on a gasoline engine assisted by an electric motor. The electric motor can start and accelerate to low speeds without engaging the gasoline engine, and assist at higher speeds when extra power is needed. The battery pack is charged exclusively from the car's internal combustion engine and regenerative braking.

The PHEV of tomorrow runs principally on an electric motor that is assisted, when needed, by a gasoline engine. The PHEV has a larger battery pack that is charged through regenerative braking and/or from a household outlet. For longer drives, PHEVs have an advantage over pure battery electric vehicles (BEVs) because PHEV drivers don't have to worry about running out of electricity. When the battery runs low, PHEVs operate like conventional hybrids and use the gasoline engine and regenerative braking to drive the car and charge the battery. Because they have both gasoline and electric drive systems, PHEVs can also have smaller, less expensive battery packs than BEVs. Custom-made PHEVs are on the road today in small numbers, but major manufacturers claim that mass produced PHEVs will be sold in dealerships starting in 2010.

Background

PHEVs play an important role in a mix of strategies that can help address climate change and reduce our dependence on foreign oil. The transportation sector is now the second largest source of U.S. greenhouse gas (GHG) emissions - contributing 28% and growing. In the northeast states, the transportation sector accounts for nearly 40% of all GHG emissions. Improving vehicle fuel economy and reducing vehicle miles traveled are other critical pieces of any transportation strategy. Ultimately, the task of significantly reducing



U.S. Greenhouse Gas Emissions by Sector

Source: Pew Center on Global Climate Change

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Environment Northeast is a nonprofit organization that researches and advocates innovative policies that tackle our environmental challenges while promoting sustainable economic development. ENE is at the forefront of state and regional efforts to combat global warming with solutions that promote clean energy, clean air and healthy forests.

GHGs from the transportation sector requires switching to cleaner fuels, such as electricity and low carbon biofuels.

PHEVs use cleaner energy

supply. PHEVs charged on New England grid will reduce greenhouse gases and other air pollutants.

The size of the GHG savings possible from switching to PHEVs depends largely on the mix of fuels and power plants used to generate the electricity that charges the vehicle. As shown in Figure 1,

operating a vehicle charged on the New England electric power grid emits two-thirds less CO₂ emissions per mile than running an average car on the road in 2005 when using conventional gasoline.¹ This is true even when factoring in emissions from the production and transmission of the electricity used to charge the vehicle.²

PHEVs are more efficient. Just as hybrids represented a major leap in fuel efficiency over conventional gasoline vehicles, PHEVs may be able to double the gas mileage of the first generation of hybrids. One reason that PHEVs can attain such improvements in fuel economy over internal combustion engines is that they make far more efficient use of energy. The “thermal efficiency”

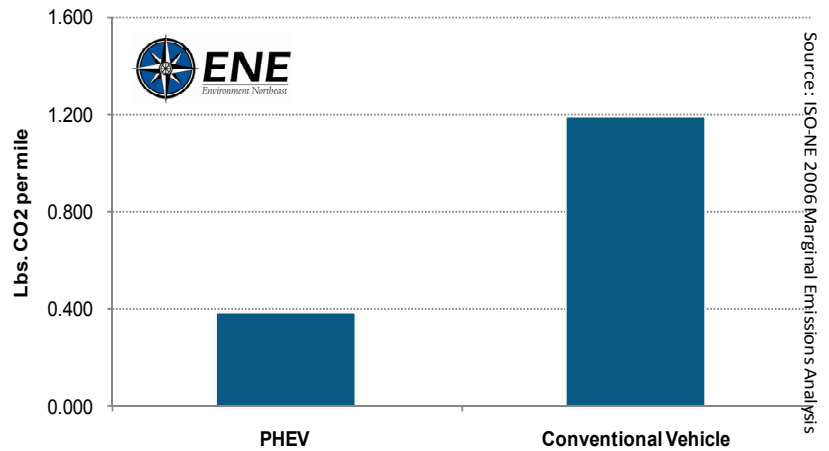


Figure 1: CO₂ Emissions per Mile

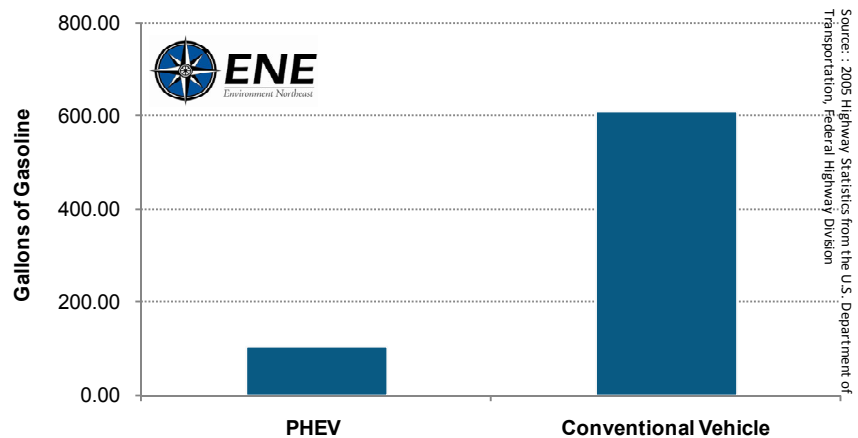


Figure 2: Annual Gas Consumption

¹ ENE assumes here that all vehicles travel 12,000 miles per year. The average combined mpg for all U.S. cars and light trucks on the road today is 19.8 mpg. (Source: 2005 Highway Statistics from the U.S. Department of Transportation, Federal Highway Division). We assume PHEV electrical efficiency is 3.2 mi/kWh (based on analysis of PHEVs in California), and PHEV fuel efficiency is 40.7 mpg, and we further assume 66% of the PHEV miles are driven using stored grid energy. Electrical efficiency may be lower in cold-weather states. (Source of assumptions: EPRI/NRDC, 2008. Environmental Assessment of Plug-in Hybrid Electric Vehicles, available from <http://my.epri.com/portal/server.pt?open=514&objID=223132&mode=2>).

² The source of the data on emissions from generators in New England is the New England Independent System Operator - New England. September 2008. *2006 New England Marginal Emission Rate Analysis*.

of an internal combustion engine – its ability to convert fuel to useful work – is roughly 20%. Electric engines are very efficient because they don't produce much heat, and most of the energy is converted into forward motion.³

The average U.S. light-duty vehicle on the road today gets about 19.8 miles per gallon (mpg). Figure 2 compares annual gasoline consumption of a conventional vehicle and a PHEV, assuming that a PHEV will achieve 40.7 mpg and each vehicle travels 12,000 miles per year.⁴ Switching to a PHEV would save a consumer 411 gallons of gas per year, or about \$1,024 (if gasoline costs \$2.49/gallon).

What does this mean for the northeast? ENE analyzed the potential benefits of various levels of PHEV market saturation in 11 northeastern states.⁵ Figure 3 show the reduction in GHG emissions that could be realized if 5%, 10%, 20% or 60% of the Northeast's light-duty vehicle fleet switched from conventional vehicles to PHEVs. Avoided CO₂ emissions range from 7 million metric tons of CO₂ (MMT_{CO₂}) to 85 MMT_{CO₂}.⁶

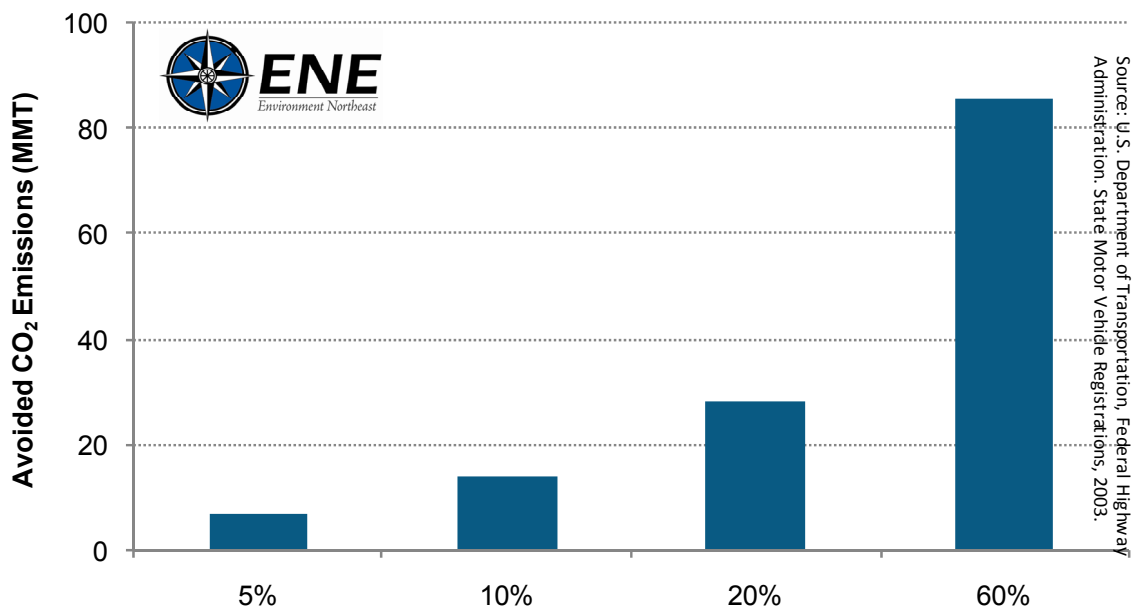


Figure 3: Percent of PHEVs in the Northeastern Light Duty Vehicle Fleet

³ The most efficient combined cycle natural gas power plants generate electricity at nearly 60% efficiency.

⁴ Actual avoided emissions is likely to be lower than shown here because new federal efficiency (CAFÉ) standards will require new vehicles sold in the U.S. to achieve higher gas mileage than the average vehicle on the road today.

⁵ The 11 northeastern states are: CT, DE, MA, MD, ME, NH, NJ, NY, RI, PA, and VT.

⁶ Emissions rates based on ISO-NE, Inc. 2008. 2006 New England Marginal Emission Rate Analysis.

The Figure 4 shows what the northeast would save in gallons of gasoline and dollars if drivers switched to PHEVs. Drivers could reduce their annual consumption of gasoline by 607 million gallons in the low-adoption scenario and by 7,290 million gallons in the high-adoption scenario. This translates into cost savings of between \$1,513 million and \$18,154 million per year, assuming a price of \$2.49/gallon.

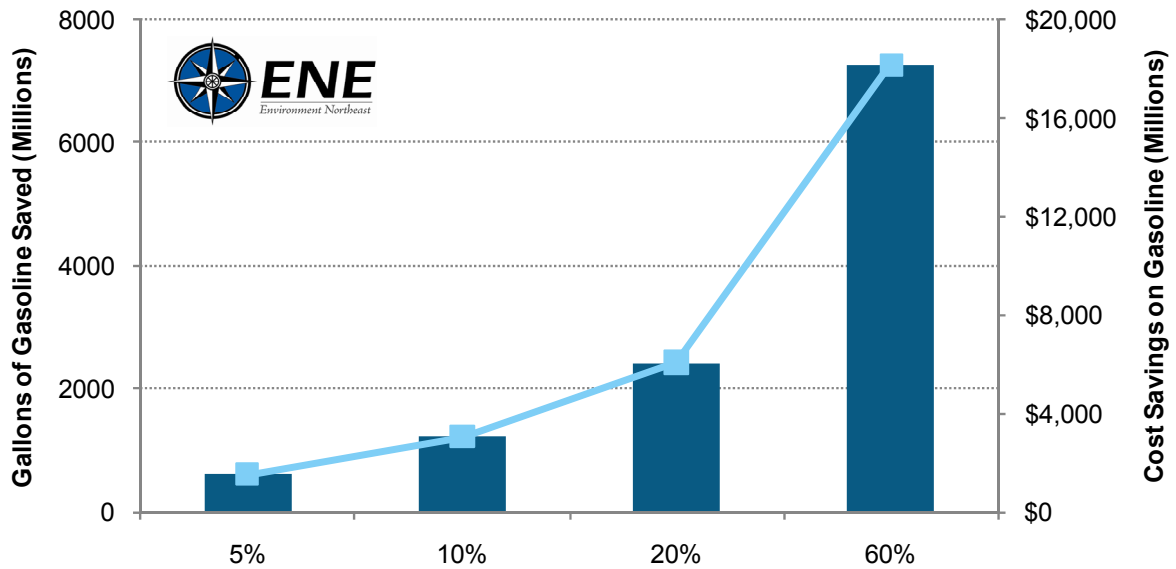


Figure 4: Percent of PHEVs in the Northeastern Light Duty Vehicle Fleet

Source: U.S. Department of Transportation, Federal Highway Administration. State Motor Vehicle Registrations, 2003. , assuming gasoline price of \$2.46/gallon

For More Information:

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