

## REPLACING FOREIGN OIL WITH ELECTRIC VEHICLES

A UniStar Issue Brief



The iconic electric vehicle (EV) is a classic example of a single, elegant solution to multiple problems. By fueling our light vehicle fleet with electricity, we can reduce our dependence on foreign oil, enhancing both national security and our balance of trade. Furthermore, by generating the electricity for this fleet with clean nuclear energy instead of fossil fueled power plants, we obtain substantial environmental benefits by reducing green house gas emissions and other unhealthy air pollution. Accomplishing such a transformational change in the United States transportation culture, demands a long-term energy policy that commits to electrification of our light vehicle fleet and to clean, reliable electrical generation, such as new nuclear, to support that fleet. The government must support research and development in battery and electric drive technologies, build public charging infrastructure, incentivize purchase of EVs, and support the market through direct purchase of EV fleets.

### ELECTRIC VEHICLES TODAY

There are several general classifications of EVs that have important distinctions. The most common EV on the road today is the hybrid electric vehicle (HEV). HEVs have both an internal combustion engine (ICE) and an electric motor. Batteries to power the electric motor are charged by reversing the electric motor during braking. HEVs are not plugged in to a source of electricity to recharge. The high fuel mileage obtained by HEVs results from smaller engines, lighter weight, improved aerodynamics, and the part-time electric drive. The actual 100 percent electric range obtained from a fully charged battery in an HEV is very small, approximately 10 to 20 miles.

Plug-in hybrid electric vehicles (PHEVs) were introduced to the U.S. market in late 2010 and early 2011. These vehicles have larger batteries that can be recharged by plugging them into an electrical source. The 100 percent electric range of PHEVs is nominally sized for a typical one-day round trip (i.e., 40 to 60

miles). The ICE is retained in this design as an additional drive motor or a so-called “range extender” for use when the battery can no longer power the drive train. A typical fuel mileage can not be calculated for PHEVs because the proportion of electric motor to ICE drive times is the key factor and will vary widely among driving applications.

The final principal class of EVs is the battery powered electric vehicle (BEV), which has no ICE and is 100 percent electric powered. BEVs have the greatest potential environmental benefits. The only BEV available for sale in the U.S. prior to 2010 was the Tesla Sportster, which has a range of more than 200 miles, but sells for over \$100,000 and costs \$40,000 to replace the battery.<sup>1</sup> Other manufacturers introduced BEVs to the market in late 2010 and early 2011, with claims for vehicle ranges from 60 to 100 miles.

## EV/PHEV/BEV Offerings in the U.S.

Number of Manufacturers		
YEAR	HEV/PHEV	BEV
2010 <sup>1</sup>	12	1
2011 <sup>1</sup>	14	3
2015 <sup>2</sup>	20	46

<sup>1</sup> U.S. DOE Alternative Fuels Data Center

<sup>2</sup> Plug-In America Vehicle Tracker Projection (not all may be offered in the U.S.)

## POTENTIAL

There are about 250 million passenger cars and light duty trucks in the United States. Together they account for approximately 41 percent of our petroleum consumption, nearly 8.6 million barrels per day.<sup>2</sup>

This number happens to coincide within a few percent of the amount of oil imported by the U.S. from all foreign countries except Mexico and Canada. The sizeable role of light vehicles in the overall consumption of petroleum makes this sector an obvious opportunity for prioritization in strategies to reduce oil consumption. Furthermore, the driving habits of the American public mean that about 85 percent of these vehicles are driven less than 40 miles per day.<sup>3</sup> This average range requirement makes possible the design of a variety of EVs that are pragmatic for a significant number of Americans even with today's limited battery technology.

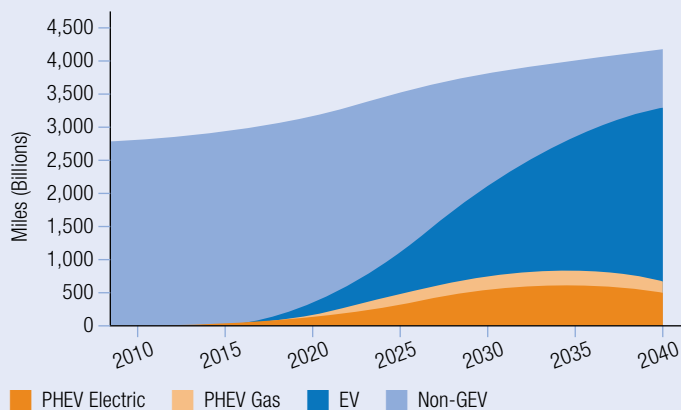
President Obama has stated a goal of 1 million EVs on American roads by 2015.<sup>4</sup> Although in itself ambitious, this is really only a tentative first step and would replace only a small fraction of the U.S. light vehicle fleet. Furthermore, it is the fraction of vehicle miles that are electric-driven that is important, not simply the fraction of electric vehicles in the fleet. Large numbers of PHEVs driving on their gas engines won't help much. Only a much bolder, long range plan can hope to have a significant impact on oil consumption in the U.S.

The Electrification Roadmap published in 2009 by Electrification Coalition outlines such a plan. The goal set in the Roadmap is for 75 percent of the vehicle miles traveled in the United States to be electric miles by 2040.<sup>5</sup> This has the potential to reduce the petroleum consumption by the U.S. light vehicle fleet to less than 2 million barrels per day. Based on today's electricity generation mix, this would also reduce carbon emissions by about 600 million tons per year. The Electrification Coalition lays out a detailed plan and justification for electrification of the majority of the U.S. personal transportation system, covering the interactions with electrical generation and the distribution grid, the economy, national security, and environmental protection. If achieved, the societal benefits are huge.

## BENEFITS OF ELECTRIFICATION

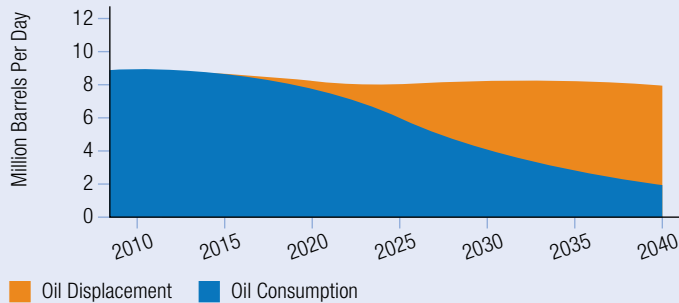
Electrification on the massive scale envisioned will have enormous benefits on many levels. By reducing our consumption of oil and gasoline, we will be able to substantially reduce imports of foreign oil, especially from countries that are generally hostile to American interests or our way of life. The purchase of foreign oil represents the greatest continuous transfer of American wealth overseas (\$350 billion in 2008<sup>6</sup>). Reducing our purchases of foreign oil will immediately improve our balance of trade.

## Vehicle Miles Traveled



Source: "Electrification Roadmap" Nov. 2009, The Electrification Coalition

## Expected Light-Duty Vehicle Oil Abatement



Source: "Electrification Roadmap" Nov. 2009, The Electrification Coalition

The development of grid-enabled electric vehicles (GEVs) will provide opportunities to enhance electrical grid stability and provide backup storage for renewable sources. GEVs are vehicles that can interact intelligently and in real-time with the grid. They will charge when there is surplus electricity on the grid, draw no power when demand is high, and even surrender some charge back to the grid during periods of excess demand or low generation by renewables.

## CHALLENGES OF ELECTRIFICATION

Battery technology is the key to acceptance of the EV by the American public as a practical alternative to their existing automobile. Battery systems must have adequate range, long life, safety, and insensitivity to charging rate, over-charging, partial charging, or running until dead. The designs must envision a closed-loop battery ecosystem, with reprocessing of active materials and reuse of housings. Intermediate uses of batteries with insufficient capacity to run cars but sufficient capacity for stationary uses such as backup emergency power might be included.

The practical expressions of battery technology to the consumer are vehicle range and cost, two very important possible deal breakers. Americans are very comfortable with the 300 mile range of modern ICE cars and they are fully confident that there will always be a gas station within reach of that last quarter of a tank. BEVs must improve on their current 100 mile range and the charging infrastructure must approximate existing levels of range confidence to achieve success on the scale envisioned.

### Range Anxiety—The fear that your electric car will run out of juice before you get "there"!

- This concern is not relieved by general assurances that a BEV with a 100-mile range will easily handle a 40-mile daily commute.
- Americans love their freedom and flexibility. They want to know they can handle the unanticipated extra miles.
- To be acceptable, BEVs must match the perception of freedom embodied in the modern automobile.

## Benefits of Vehicle Electrification

- Electric miles are cheaper than current oil miles (cheapest when charged by nuclear generated electricity)
- Electric miles reduce oil imports
- Electric miles reduce health effects and premature deaths due to air pollution (\$50 billion to \$80 billion/year according to the FHA)
- Electric miles are cleaner and quieter, improving the urban environment
- Electric miles are carbon dioxide free when supported by nuclear and renewables
- Electric miles may reduce overseas defense cost
- Electric miles will boost the economy, if pursued as a national strategy

The instability of oil supplies and prices is a constant threat to American industry. The RAND Corporation has estimated that the U.S. military spends between \$67.5 billion and \$83 billion annually to decrease this vulnerability.<sup>7</sup>

Another direct benefit from burning less oil comes in the form of decreased air emissions. Decreases in smog producing pollutants will have both health and economic benefits in locales vulnerable to smog formation. Reductions in carbon dioxide will aid in forestalling the effects of climate change, especially if the electricity used to charge EVs comes from clean sources.

Proactive tax policies and incentives have the potential to release huge economic benefits by facilitating a string of new industries to build and maintain EVs. Building on this industrial infrastructure, the U.S. could again become the preeminent auto manufacturer in a new EV economy.

Neither can battery technology burden EVs with a significant cost penalty. Purchasers today must contend with an approximate 25 percent price penalty relative to a comparable ICE. In addition, the battery system may only have a 125,000 mile life and cost \$10,000 to \$15,000 to replace.<sup>8</sup> This will rapidly reduce the retained value of a used BEV, another factor in the cost of ownership. While Americans generally support the concept of electric vehicles, that support falls off dramatically when a cost premium is attached to the EV. Polls show a 50 percent decline in support, when EVs cost only \$5,000 more than a comparable ICE car.<sup>9</sup>

Finally, the mix of generating assets will determine the environmental benefits to be derived from the EV fleet. If the electricity used to charge EVs comes from fossil fueled power plants, a lot of the clean air benefits of electrification of the fleet will be lost. Building new clean generation, especially new baseload nuclear facilities, will obtain the maximum benefits from an EV fleet.

## GETTING TO A CLEANER FUTURE

Of course, there are a lot of external forces acting on a plan of this scale. Early adopters of BEVs will not be very cost-sensitive. However, Government incentives, subsidies, and mandates will be required to help successfully market those same BEVs to the cost-sensitive average consumer. Government will also have a role in financing R&D into battery systems and electric drive trains, and establishing public charging infrastructure. Private

EV fleets with private charging infrastructure must be encouraged to complement public systems.

The most important prerequisite is that the individual elements of government support and policy be seen as strategic components of a long-term, bipartisan commitment to an electric vehicle future. The commitment must be flexible in its details, but irrevocable in its goals. And it must be paired with a similar irrevocable commitment to a future of clean, reliable electricity, based on new nuclear generation and other clean sources.

Uncertainty is the real enemy of both vehicle electrification and clean electricity. True commitment, backed by real long-term programs, will encourage investment. The potential economic benefits are huge and the opportunities for entrepreneurs and investors varied and plentiful. We can rekindle manufacturing, become the world leader in EV technology, increase exports of manufactured goods and decrease imports of oil.

With a national commitment to electrification we can also simultaneously improve national security and become substantially energy independent in a clean and sustainable manner. All of this is possible. We need only the national political will to commit.



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