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Resilience in Energy: Building Infrastructure Today for Tomorrow's Automotive Fuel

Concerns over our current energy supplies have led to an increasing focus on developing new transportation fuels. The drawbacks of our Nation's dependence on oil has made the need for a modernized energy infrastructure capable of powering our transportation sector with electricity from nuclear, coal, wind, solar, or hydro power sources abundantly clear. Policy makers must take steps now to encourage development of new power producing facilities and investments to improve the Nation's electric grid system. Doing both is necessary for the wide scale adoption of an electric powered auto fleet powered by American energy.

The United States is on the verge of a transportation fuel breakthrough. Spikes in fuel costs, concerns relating to national security, and worries over the environment have created a public outcry for increased automobile fuel efficiency as well as investment in alternative energy sources.[i] One possible solution is plug-in hybrid electric vehicles (PHEVs), which could help to move our transportation sector away from the unsustainable habit of consuming more than 14 million barrels of oil each day and sending $245 billon out of the country every year.[ii] Unfortunately, the United States is not yet fully equipped to take advantage of PHEV technology. Improvements to the nation's infrastructure need to be made. By developing a "smart" electric grid to better utilize electricity resources and building new energy production facilities, we can reduce our dependence on foreign oil and create new U.S. industry

PHEVs are quickly becoming a reality, although it is not yet apparent what impact their use will have. More than twelve years have passed since General Motors unveiled its groundbreaking EV1 electric car, but those vehicles require the use of battery technology that has yet to be developed in order for them to be viable.[iii] However, unlike the 1996 EV1s, PHEVs have caught the attention not only of the automakers, but also of government and private investors.

In August 2008, the United States Advanced Battery Consortium (USABC),[iv]with funding from the U.S. Department of Energy, announced that it had awarded an $8.2 million contract to Johnson Controls-Saft to focus on the

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development of lithium-ion battery systems for PHEVs and to validate the commercial feasibility of that technology for mass-market vehicles.[v] Similarly, in 2006, Johnson Controls-Saft began focusing on lithium-ion battery systems for hybrid electric vehicles (HEVs).[vi] Prior to this development, only lead-acid batteries—invented in 1859—were available to automakers, including GM with its EV1.[vii] The Johnson Controls-Saft technology had already been deployed in October 2008 for initial testing.[viii]

With new battery technology being developed and tested, all three major domestic automakers are planning to roll out PHEVs in the near term. Currently, Ford is testing a PHEV-installed Ford Escape model in several regions across the country.[ix] These early models are already capable of driving up to 30 miles at speeds up to 40 miles per hour.[x] Similarly, GM is testing its Chevrolet Volt, which will be capable of traveling 40 miles on battery power.[xi] Rather than rely only on its battery, the GM "E-Flex Drive System" will use a small internal combustion engine (ICE) to recharge its batteries beyond 40 miles, potentially using a number of different fuels.[xii] However, it will be able to charge its battery from a standard 110-volt household outlet when not in use. [xiii] Of the three domestic automakers, Chrysler leads the way in terms of distance per charge with the Dodge EV, a performance sports car, which claims a driving range of 150-200 miles per charge.[xiv] GM is planning to have the Volt in showrooms by late 2010, and Ford reportedly has similar plans for its PHEV.[xv] Chrysler plans to produce one of its electric-drive vehicles in 2010, but it has not reported if that will be the Dodge EV or a different HEV model.[xvi] In short, PHEVs will be available to the American public in 2010.

With the arrival of PHEVs beginning to appear inevitable, the question no longer appears to be how battery technology will advance to make them usable. Instead, the question has shifted to what the impact will be on the existing electrical grid when they arrive. Both individual states and the Federal government are working with utility companies to determine what the impact will be.[xvii] In addition to areas of dense population often considered to be the most appealing for PHEVs, such as New York City and southern California, analysis is proceeding nationwide.[xviii]

The impact of a wave of PHEV owners simply arriving at home after work and all plugging in their vehicles before going into their houses and then turning on all of their other electrical devices is daunting. Implementing effective charging strategies will be imperative in order

for PHEVs to offer consumers low-cost transportation with minimal greenhouse emissions.[xix] Without such a strategy, the significant increase in peak supply needed to power the PHEVs would likely result in a smaller decrease in overall emissions.[xx] While one solution could be strict charging regulations, the long-term solution appears to lie in *smart grid* technology.[xxi] *Smart grid* refers to a system of information technology and digital communications equipment overlaid on the power grid to give real-time information on factors like overall demand and current pricing.[xxii]

Once deployed, this infrastructure upgrade would allow PHEVs to communicate with the power grid in order to draw from it during times of low demand and potentially give back to it at times of peak usage.[xxiii] The technology would be used across the spectrum of consumer demand in order to allow consumers to tailor their usage to demand peaks and valleys throughout the day. PHEVs are expected to be a driving force in the market for this technology. Both the science and technology are currently available to form a nationwide network of not only charging stations, but also of integration with information such as where consumers are charging their vehicles.[xxiv] Because *smart grid* technology would be used throughout the grid, it would quickly become a part of everyday consumer life, allowing users to track all of their consumption.[xxv] Just as they might think twice about turning down the air conditioning during peak demand, they will be able to plan for charging their PHEVs.[xxvi] As the technology advances, PHEVs may be able to communicate directly with the grid in order to optimize their charging.[xxvii]

If the *smart grid* were deployed effectively, current estimates predict that between 43% and 73% of all the cars and trucks currently in use in the U.S. could be replaced with PHEVs without requiring any new power plants or transmissions lines to be put in place.[xxviii] This would be achieved by a more efficient use of current generation through the *smart grid*. The result would be that a 33-mile round-trip commute would cost approximately $.08.[xxix] Because of the offset from internal combustion to PHEVs, U.S. oil imports would fall by 52% and total carbon dioxide emissions would be reduced by 27%.[xxx]

In addition, the PHEV batteries would add new storage capacity that would enhance the stability of the *smart grid*.[xxxi] With batteries charging at optimal times through the use of the *smart grid*, they would also serve as an additional source of energy during times of peak demand. Rather

than needing to bring additional generation sources online, batteries could feed their excess into the grid. This process would support the recharging scheme available through the *smart grid*. Batteries would be available to respond to grid emergencies, such as by halting charging during a power outage.[xxxii]

One problem that has not been addressed is what to do for trips that extend beyond the roundtrip capacity of a single battery's charge. The relative lack of filling stations has hampered rates of adoption for other alternative fuels. For example, only 1200 natural gas fuel stations are in place in the U.S. compared to 180,000 gasoline stations.[xxxiii] Without the refueling infrastructure in place, PHEVs are not viable. The transition to PHEV use is obstructed by two basic factors: too few charging stations available and infrastructure that cannot support the increased demand for electricity.

Aside from people's homes and other locations where electrical outlets are available, PHEV drivers will need additional charging locations. The free market is already racing to fill that void. In two Bay Area cities, for example, innovators are starting to wire public spaces. Coulomb Technologies has installed operational charging stations in downtown San Jose, California.[xxxiv] Drivers sign up for a membership with the company and then use an issued card to access charging stations, which will eventually be available nationwide.[xxxv] In San Francisco, Better Place has an ambitious plan to install thousands of charging sites and battery-replacement stations throughout the city.[xxxvi] Following an example from cell phone providers, the company seeks to drive demand by providing the charging infrastructure.[xxxvii] Better Place has installed early versions of the charging stations in Israel, and plans to make them available in areas where people typically park their cars for extended periods of time, for example parking garages, malls, and movie theaters.[xxxviii] Estimates are that 100,000 to 200,000 charging locations would be required to handle 100,000 subscribers in the Bay Area, a number that should be profitable for Better Place.[xxxix] Similar efforts are underway by companies in other major cities.[xl]

However, once charging stations are established, an electrical grid that can support the demand needs to be built. While research is in progress to develop smart-charging hardware to moderate the time and pace of charging,[xli] the fact remains that the current electrical grid cannot handle the 100 million vehicles that are projected to be manufactured in the next 25 years.[xlii] In order to meet this demand, upgrades in infrastructure and technology support are necessary, perhaps

costing as much as one trillion dollars in investments. However, current data suggest that billions of dollars are now being lost by consumers annually because of a lack of access to low cost power.[xliii] Upgraded transmission and distribution lines are needed as well as the generation of additional power to meet the new demand.[xliv]

If motorists charge electric vehicles during peak demand hours, the U.S. will need 160 new power plants to meet the added demand.[xlv] If charging occurs during off-peak hours, the U.S. will still need to add as many as eight new power plants[xlvi] because the current grid can manage only approximately 70% of would-be demand with charging during off-peak hours.[xlvii] Even with *smart grid* technology, total demand cannot be met with current electricity generation sources. As demand moves into peak hours, the number of needed sources increases. This includes all sources, including the dirtiest technology currently in use.

The most viable sources for the required new energy will likely come from one of the two sources that provide most electricity today: coal and nuclear power, at approximately 50% and 20%, respectively.[xlviii] Even the most optimistic projections of growth from renewable sources cannot support the projected demand for new power.[xlix] Coal plants with carbon capture and storage have not yet proven to be functional.[l] Currently, the outlook for research and development spending in the energy sector is bleak, especially in the generation side of the industry.[li] Spending on new research and development on energy production is less than half of what it was in the 1970s.[lii]

Currently there are 20 license applications pending with the Nuclear Regulatory Commission for new nuclear plants.[liii] Because of delays, these plants may not be built even if approved, because the existing government loan guarantees may no longer cover the cost of construction unless Congress acts to increase funding.[liv] No new nuclear plant has been successfully ordered since 1977.

PHEVs will be on the market by late 2010. However, the infrastructure that will be needed to support them is years away from becoming reality. Private companies and individual cities are working to install charging points, but the grid behind those stations is unprepared to handle the new demand, and new power plants are needed to feed it. To date, those facilities are not on their way.

Steps to build resilience in energy transportation:

- Further incentivize for the installment of smart electric grid technologies to improve the capability and deployment of PHEVs. Doing so will broaden the portfolio of resources utilized by the transportation sector, reducing U.S. reliance on foreign sources of energy and enhancing U.S. energy resilience.
- Encourage states to continue de-coupling, incentivizing utilities to accept and utilize smart meters on residential homes and businesses. While merely a component of the *smart grid*, meters possess the same advanced energy consumption monitoring capability.
- Task the Department of Energy to serve as the bridge between utilities and the auto manufacturers to ensure that their investments are compatible with the future deployment of plug-in hybrid-electric vehicles.

ENDNOTES

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