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Disruptive Technologies in Transport Fuels

Extract – Commentary: The transition from ICVs to PHEVs and EVs by Daniel Kammen (Co-Director, Berkeley Institute of the Environment, and Founding Director, Renewable and Appropriate Energy Laboratory, RAEL) and Derek Lemoine (Energy and Resources Group, University of California, Berkeley)

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Electrified vehicles present novel solutions to three critical energy problems. First, the transportation sector is one of the world's largest sources of the greenhouse gases (GHGs) whose accumulation in the atmosphere drives global climate change. Electrified vehicles offer a means of adapting the electricity sector's multiple low-carbon fuel sources to the provision of transportation services.

Second, many large and powerful economies are net importers of petroleum, which highlights security concerns regarding supply and transit. If adopted in significant numbers, electrified vehicles could reduce vulnerability to disruptions in world oil markets.

Third, while better emission control regulations and technologies have improved air quality in the developed world, the problem is growing more acute in the developing world with rapid urbanization and expansion of automobile ownership. Electrified vehicles could reduce pollutant emissions and move them outside of urban centers.

While electrified vehicles can mitigate several longstanding and growing social problems, they also face obstacles. All-electric vehicles must overcome concerns about range, charging time, and charging infrastructure availability. By contrast, plug-in hybrid electric vehicles retain a gasoline (or biofuels) tank for use when the battery is sufficiently depleted. However, they still face two other problems common to all electrified vehicles: battery cost and battery durability. At current fuel costs in most nations, batteries add more to the vehicle cost than they eventually save through avoided fuel consumption, and there is much concern about how this expensive investment would hold up under real-world driving patterns and over the decade-or-more lifetime of a vehicle. Many companies are working on battery weight and cost, and many claim that costs would fall significantly with mass production. Concerns about battery durability may be assuaged by experience, by lowered costs that reduce the importance of battery failure, and by new business models that insulate the vehicle owner from the cost of battery failure. Because conventional vehicles lack the expensive battery investment and involve gasoline suppliers rather than electric utilities and charging system operators, the business models of conventional vehicles may not be the best fit for electrified vehicles. New business models may be able to shift some of the battery cost and risk from vehicles purchasers to companies better placed to mitigate the risk, better informed about the risk, and better able to capture residual value in stationary uses after batteries are no longer suited for more demanding transportation applications.

Just as business models may evolve as new vehicle technologies become competitive, so too the distribution of vehicle technologies in the fleet may change. The vehicle fleet has been largely divided between gasoline and diesel technologies. While the choice between gasoline-fueled and diesel-fueled light-duty vehicles often depends on regional policies and fuel prices, diesel technology's performance characteristics have made it the fuel of choice for long-haul freight. All-electric and plug-in hybrid technologies each have their own advantages and disadvantages relative to each other and to conventional vehicles. As these technologies develop, the vehicle fleet may pass through a period in which vehicle technologies end up sharing the market based on the applications and geographies in which they find their strongest relative advantage. Which companies profit from new vehicle technologies may depend not just on technological characteristics and business models but also on how those companies adapt and market the technologies to different portions of the larger vehicle market.

Finally, the benefits and the costs of new vehicle technologies are strongly dependent on the policy context. Purchase incentives such as tax credits or “feebates” (a self-financing system of fees and rebates that can be used to help shift buying habits—for example, high fees on high-carbon vehicle purchases, with rebates on low-carbon vehicle purchases) may provide an important push to the technologies' development and acceptance. However, other policies could limit the benefits of a pleasant surprise on the vehicle technology front. For instance, if the electricity sector's GHG emissions are capped, electrified vehicles could introduce an effectively zero-carbon fuel into transportation, but if transportation emissions also are included in a cap or are subject to a low-carbon fuel standard, then electrified vehicles may not provide any net climate benefit because their introduction may enable more use of higher-carbon transportation technologies. Lowering permit prices may be an important economic benefit, but it is not the same as the benefit of reducing GHG emissions. In the realm of energy security, if electrified vehicles produce tradable credits in a petroleum fuel-efficiency standard, they may not reduce societal petroleum consumption and, depending on the regulation's design, could even end up increasing it. Electrified vehicles promise to mitigate several important problems, but to do so they must avoid having their benefits offset by policies designed for a different technology mix.