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An electric plan for energy resilience

The fastest way to reduce America's dependence on oil imports is to convert petroleum-driven miles to electric ones by retrofitting the SUVs and pick-ups now on the road with rechargeable batteries. Here's how.

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McKinsey&Company

Every president since Richard Nixon has vowed to reduce the United States' dependence on foreign oil. None has succeeded. Imports—and thus America's vulnerability to disruptions—have increased to where now they supply two-thirds of consumption. As former Secretary of State George Schultz asked: "How many more times must we be hit on the head by a two-by-four before we do something decisive about this acute problem?"

Our aim should not be total independence from foreign sources of petroleum. That is neither practical nor necessary in a world of interdependent economies. Instead, the objective should be developing a sufficient degree of resilience against disruptions in imports. Think of resilience as the ability to absorb a significant disruption, bigger than what could be managed by drawing down the strategic oil reserve.

Our resilience can be strengthened by increasing diversity in the sources of our energy. Commercial, industrial, and home users of oil can already use other sources of energy. By contrast, transportation is totally dependent on petroleum. This is the root cause of our vulnerability.

Our goal should be to increase the diversity of energy sources in *transportation*. The best alternative to oil? Electricity. The means? Convert petroleum-driven miles to electric ones.

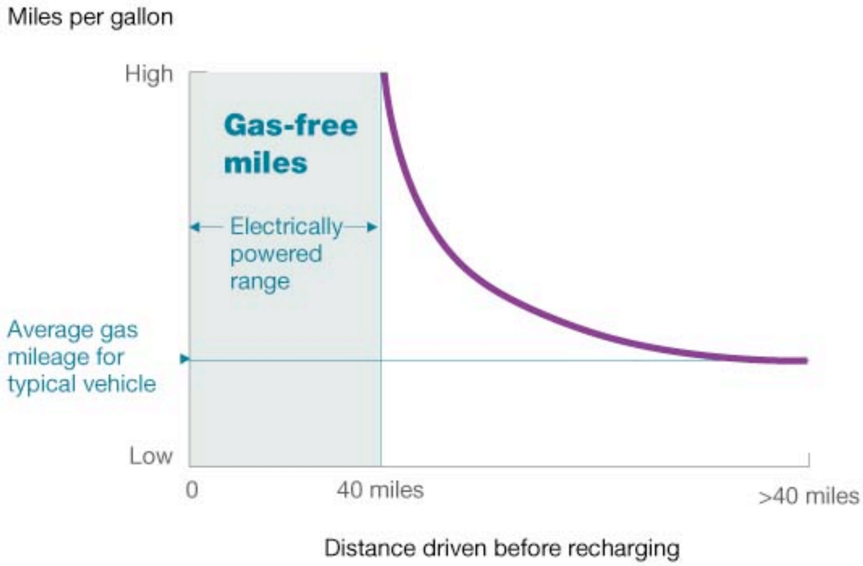
Electric miles do not necessarily mean relying on all-electric cars, which would require building an extensive and expensive infrastructure. They can be achieved by so-called plug-in electric vehicles (PEVs). (Since many plug-in cars are modified hybrid automobiles, they are sometimes called PHEVs.) PEVs have both a gasoline-fueled engine and an electric motor. They first rely on the electricity stored onboard in a battery. When the battery is depleted, the vehicle continues to run on petroleum. The battery then can be charged when the vehicle is not in service.

The amount of gasoline a PEV consumes is dependent on the number of miles it is driven between the times when it is recharged. Let us explain this by simplifying the picture a bit. If the electric-only range is, say, 40 miles, and the number of miles driven between charges is less than 40, the vehicle uses no gas at all, so it's not possible to calculate the miles per gallon. If the number of miles driven is greater than the electric range, the gas mileage starts out very high and then declines with the additional miles until the mileage approaches what an ordinary gasoline-powered vehicle would provide. Consequently, the fuel performance of the vehicle is defined by a curve (exhibit). The 40-mile mark was chosen because it is a good range to shoot for. More than 80 percent of the cars on US roads are driven less than that distance daily.

EXHIBIT

The case for electric miles

The average daily distance most Americans drive roughly fits the range of today's electric batteries. With plug-in electric cars, the first forty miles are gas free. Drive beyond that, and you eventually approach the performance of the standard gasoline engine.



Several hundred prototypes of PEVs are currently on the road. So what would it take to build enough of them to make a significant dent in oil consumption? Revamping the fleet of automobiles already on the road through production of new automobiles would take far too long for comfort. If ten automobile manufacturers each introduced a new PEV now and increased its production as fast as Toyota did with its highly successful Prius, the vehicles would still account for less than 5 percent of the 250 million vehicles on US roads a decade from now.

We believe the United States should consider accelerating this movement by creating an industry of after-market retrofitters. What problems—technical and economic—would need to be solved in order to do that? With the help of a team of second-year graduate students in our Bass seminar at the Stanford Business School, we examined this question in the context of a proposed pilot program, whose aim would be to retrofit one million vehicles in three years. We felt that such a project would represent what in game theory is referred to as the "minimum winning game": a significant step toward a long-term strategic objective (see sidebar, "Inside Andy's real-world seminar").

Inside Andy's real-world seminar

Much of this material is based on the work we did with a team of second-year business school students in a special Bass seminar at the Stanford Business School. In our seminar, we discuss strategy in terms of the "consequential" actions that enable an entity to control its destiny.[1] This requires a certain degree of "paranoia"[2] on the part of that entity about its dependency on forces that affect its destiny. If that dependency evolves to exceed the entity's capacity to influence those forces, strategic subordination is the likely unfavorable result. Especially dangerous are situations with nonlinear dynamics; that is, when each round of interaction with the forces simultaneously increases more than proportionally the entity's dependency and reduces its capacity to influence those forces, making it increasingly difficult to turn the situation around.[3]

We applied this thinking to the energy situation facing the United States.[4] Based on our own and our students' analysis, we worked up the accompanying analysis, which highlights the "strategic inflection point" [5] that the country now faces, offers a plan for addressing it, and defines a "minimum winning game." [6]

This article incorporates the contributions of the students in the 2008 Bass seminar at the Graduate School of Business, Stanford University. Special thanks go to Debra Schifrin, our research associate.

Notes

[1]Robert A. Burgelman, *Strategy is Destiny: How Strategy-Making Shapes a Company's Future*, New York, NY: Free Press, 2002.

[2]Andrew S. Grove, *Only the Paranoid Survive: How to Exploit the Crisis Points that Challenge Every Company*, New York, NY: Doubleday, 1996.

[3]Robert A. Burgelman and Andrew S. Grove, "Let chaos reign, then rein in chaos–repeatedly: Managing strategic dynamics for corporate longevity," *Strategic Management Journal*, 2007, Volume 28, pp. 965–79.

[4]Andrew S. Grove, Robert A. Burgelman, and Debra Schifrin, "US dependence on oil in 2008 and beyond: Facts, figures and context," Stanford Business School Research Paper Series, Number 1997, September 2008.

[5]5 The SIP concept and the framework matching "what it takes to win" with "what we have," and "what we say" with "what we do," are further elaborated in Robert A. Burgelman and Andrew S. Grove, "Strategic dissonance," *California Management Review*, 1996, Volume 38, Number 2, pp.8–28.

[6]The first MWG is limited enough to be won with the available resources within the short-to-medium term, and sufficiently large that winning it provides a foundation for the next, more difficult result on the way to achieving the long-term strategic. See Robert A. Burgelman and Robert E. Siegel, "Defining the minimum winning game in high-technology ventures," *California Management Review*, 2007, Volume 49, Number 3, pp. 6–26.

We estimate the price tag of such a pilot project to be around $10 billion, owing to the present high cost of batteries, which are around $10,000 each. One might expect such costs to drop as volume increases, but because this program is accelerated by design, we have to assume that batteries will remain expensive. Assuming an average gas price of $3 per gallon, the payback period to the owner of a retrofitted vehicle is at least ten years, not a strong economic incentive. But the benefits of this program—testing and validating a key approach to energy resilience—accrue to the well-being of the United States at large. As the general population is the predominant beneficiary, economic assistance flowing from everyone to vehicle owners, in the form of tax incentives, is justified.

There are different approaches to retrofitting vehicles. We favor GM's Volt design, in which the car is directly driven by an electric motor. The vehicle's existing gasoline engine is replaced by a smaller one, whose sole purpose is to generate electricity and recharge the battery. To simplify the retrofitting task, we would limit the scope of the program to six to ten Chevrolet, Ford, and Dodge models, selected on the basis of two criteria: low fuel efficiency and large numbers of vehicles on the road. Most of these vehicles would be SUVs, pick-ups, and vans.

Further, we propose targeting fleets of automobiles owned by corporations or government entities. That way, many retrofits could be performed at just a few locations. Fleet owners may also be motivated by a desire to support corporate or governmental green initiatives. However, some number of retrofits should also be performed on vehicles owned by individual consumers, exposing this process to that more demanding market segment.

Given the current difficult economic conditions, auto dealers and garage operators may well be attracted by this potential new source of revenue and be eager to participate, helping the program in its early stages.

The engineering and organizational issues involved in retrofitting on a large scale are far from trivial. The biggest problem, however, is the availability of batteries. The most suitable battery technology, which offers both a sufficient range and enough power to provide the acceleration required by today's drivers, is the lithium-ion battery system. Current battery-manufacturing capacity is limited, and nearly all of it is dedicated to supplying batteries for the nearly 200 million laptop computers and other handheld electronic devices built each year. Making the batteries required for one million vehicles would mean doubling current manufacturing output.

There is another issue we need to consider. While there are many sources of the batteries' raw materials—such as lithium and cobalt—battery manufacturing is almost exclusively based in China, Japan, and Korea. The reason can be found in history. When consumer-electronics manufacturing moved from the United States to Japan in the 1970s, battery manufacturing followed. Later, when laptop computers emerged, they and their portable power sources were also made in Asia. To avoid battery manufacturing becoming the next source of dependency, we have to build domestic technical and manufacturing capability. This will require large and patient investments. We can build on the technical expertise of some US universities, as well as national laboratories such as Argonne. In fact, one of the national laboratories could be placed in charge of the program. An appropriate target: by the end of the three years, making domestic sources for about half of the batteries required for this pilot program.

Another important goal is to improve the cost and quality of battery technology. Advances in material technology, experimenting with different chemicals, and the use of nanotechnology may all play a role in this. If the government makes a significant commitment to a program of electric miles, as we propose here, the venture-capital industry would likely respond to this signal. Large US high-tech companies currently on the sidelines may join as well. The overarching aim for all participants should be to develop an equivalent to Moore's Law[1] in battery technology.

The study of corporate transformations yields a valuable lesson. Whenever a business finds itself in the midst of a major upheaval, a critical situation—called a "strategic inflection point"—occurs. Leaders at such times must clearly articulate a strategy that, through transformation, aligns the capabilities of the corporation to the demands of the new environment. Only when such a match is achieved can the corporation seize the unique opportunity inflection points offer.

We are approaching the inevitable decline of oil availability—the mother of all inflection points—which gives the United States the opportunity to move into a more desirable strategic position. Today, we compete with countries whose richer natural resources give them a strategic advantage. If we shift transportation towards electric miles, we gain an opportunity to employ our own resources: newly energized governmental leadership, a tradition of high-volume manufacturing, and a culture of technological innovation. These capabilities and skills have served the United States well in the past, and the drive toward electric miles may help revitalize them. That result is every bit as important as the electric miles themselves. Q

About the Authors

Andy Grove, former CEO of Intel, teaches a seminar on strategy at Stanford Business School with Professor **Robert Burgelman**. They enlisted the students in their fall 2008 Bass Seminar to help develop this plan.

Behind the Story

On December 12, 2008, the *Wall Street Journal* reported that former Intel CEO and current senior advisor Andy Grove has been pushing the world's leading chipmaker to get back into a business it long ago abandoned—making batteries. This article, commissioned months ago by McKinsey for an upcoming publication called *What Matters*, lays out his case for why. Whether Intel gets into the game or not, Grove thinks the United States should launch a major effort to convert existing gas-fueled vehicles into plug-in electric ones. It's just one of nearly 100 provocative essays that will be featured in *What Matters*, which will be available as both a print magazine and on this Web site in late January. Follow the conversation—and then join in.

Notes

[1] Moore's Law was a trend developed by Intel cofounder Gordon Moore to describe the trajectory of computing hardware.

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