Shai Agassi

World Without Oil

Better Place Builds a Future for Electric Vehicles

Innovations Case Narrative:
Better Place

So, how exactly would you run an entire country without oil?

Early in 2005, at the World Economic Forum for Young Global Leaders in Davos, Switzerland, someone asked me, "How would you make the world a better place by 2020?" No one would have thought to call me an environmental crusader back then, and I was primarily focused on my job as an executive at SAP. However, as I thought about my answer to the question, it became increasingly clear that ending our addiction to oil, and therefore running an entire country without it, would be the most significant progress we could make. That is why, eventually, I founded Better Place.

One needn't be an environmentalist to see the immense costs of oil dependence. First, it is economically and physically unsustainable. Oil is a finite resource whose price will only rise in the long run, compared to sustainable resources that are not finite and normally become cheaper over time. Furthermore, it has a highly volatile price that, given the volumes and prices in question, can have massive impacts on the global economy (see Text Box 1). Even countries that produce oil seem to understand this: The United Arab Emirates invests all of its oil profits in sectors that will be sustainable in the long run, including tourism, financial services, media, education, and even alternative energy. Beyond the economic concerns, we find that our addiction to oil also has lead to the greatest transfer of wealth in

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The Macroeconomic Impact of Oil

Switching from an oil-based transportation sector (and, by extension, an oil-based economy) to an EV world would constitute the largest economic dislocation in the history of capitalism. That makes it vital to note the potential macroeconomic impact this switch might have.

In fact, a recent study at the University of California at Berkeley, published this June, analyzed our company model quite specifically.[1] The first step in determining our macroeconomic impact was to figure out roughly what sort of market share EVs would have, at both a baseline level of gas prices and a high-price scenario. Even at the baseline, they projected that EVs will have 44% of market share by 2025, and 80% if the high-price scenario develops. They further projected that the total cost of owning an EV would decline from roughly equal to an ICE at the current baseline-price scenario to less than half of that by 2030; the difference was even more stark with the high-price model.

One of the most important macroeconomic impacts this shift presents is in the balance of trade. Of the current U.S. trade deficit, 40% to 50% stems from oil imports; by 2030, in our model, those imports will fall 18% to 38% depending on the oil price scenario. This would have the same impact as eliminating all imports from Saudi Arabia and Venezuela: each year we would redirect between $90 billion and $260 billion back into the domestic economy.

Also essential to the shift is the impact on employment. Being at the forefront of the EV switch could be a way for currently struggling U.S. automakers to re-tool and regain their competitiveness. In addition, jobs will be gained in the sectors of battery production and charging infrastructure, while they are lost from service stations and parts suppliers. However, the study projected that this will lead to a net creation of 10,000 jobs in the U.S. alone.

The study even explores how much the U.S. would save on healthcare costs from a cleaner atmosphere and concluded that we would save $22 billion to $40 billion every year, roughly 1% to 2% of 2008 health care costs.

1. Celeste Chavis, Kazutaka Kanairo, Angel Lopez Samartino, Nakul Sathaye, Ikhlaq Sidhu, Phil Kaminsky, and Burghardt Tenderich, "Strategies for Electric Vehicle Deployment in the San Francisco Bay Area." Center for Entrepreneurship & Technology (CET) Technical Brief No. 2009.7.v.1.1, September 18, 2009. http://cet.berkeley.edu/dl/EV%20Deployment%20Final.pdf.

history—mostly to countries that don't share our democratic principles. Ending our addiction to oil would also end this immense geopolitical cost.

The final and most important issue is the impact that an oil-reliant economy has on the environment. CO_2 emissions have already caused catastrophic changes in climate that are well documented, and, tragically, those changes will continue even after we rein in the current rate of carbon emissions. Arguments about geopolitical and economic interests will be utterly irrelevant unless we significantly curb the steady flow of carbon into the atmosphere, and soon. Fifty years from now, in an oil-dependent economy, we will have one political issue: finding a way to make the planet habitable. Meanwhile, oil presents plenty of other environmental issues such as local air pollution (which causes immeasurable negative health effects, including death) and oil spills in the open ocean or other forms of contamination that destroy environments and are extremely costly to clean up.

The transportation sector accounts for nearly half of oil use worldwide, making it the natural place to start considering how to end our oil addiction. My project for Davos was to figure out a framework for ending our addiction to oil in our transportation system; I hoped not to rely on a government mandate or on technology that would require a scientific breakthrough to be feasible.

Electric Vehicle (EV) technology is here already, and completely implementing EVs would lead to a massive reduction in oil dependence. The only barrier between EVs and widespread adoption is a coherent plan that would allow them equal or better performance, usability, and affordability when compared to traditional internal combustion engine (ICE) cars.

The Better Place business model starts with a fundamental rethinking of the role the battery plays in an electric vehicle and in the business model of personal transportation. From there, all major problems with electric vehicles are solved.

The Better Place solution evolved from the understanding that people have a social contract with their vehicles and that a mass transition will occur only if the switch to EVs is a seamless one for the driver. Therefore, the EV must be similar to an ICE vehicle in terms of size, driving experience, driving range, and price (see Text Box 2). The Better Place business model starts with a fundamental rethinking of the role the battery plays in an EV and in the business model of personal transportation. From there, all major problems with EVs are solved. Car manufacturers have historically regarded the EV's battery as a fixed piece of the car. But what if they saw the battery as a separate component? Then the consumer would not necessarily have to own it. At Better Place, we view the battery as a consumable and as part of the infrastructure. We remove that cost from the consumer. We sell miles—or mobility—much as people purchase minutes for their mobile phones.

This facilitates the most important innovation of our model: switchable batteries that extend the vehicle's range, and can be switched at Battery Switch Stations (BSS) which will be installed along major highways. A driver can stop at one of these carwash-like installations and have a battery swapped out for a fully-

What kind of cars will they be?

To make a real difference, we need a solution that is scalable to the world. However, we cannot expect anyone to purchase an electric vehicle unless it can compare to an ICE car in terms of price, convenience, and performance. These basic demands essentially constitute a social contract as to what a car is and what it should provide. If we fail to meet that social contract then the EV is not really a car at all. We cannot be selling a glorified golf cart. Therefore, I have always demanded that EVs must be more convenient and more affordable than what consumers currently get today with gas cars. So what exactly is that social contract for a car? I think there are five distinct elements:

"It's my car." It needs to look like a real car, and be something you can actually be proud to call "my car." We are seeing that this is actually quite easy to achieve as Fisker, Tesla, and Renault-Nissan have all come up with EVs that look just like ICE cars.

Equal or better performance. EVs have all their torque available instantly, so the acceleration is linear and smoother than with an ICE. In fact, for normal driving, the acceleration is usually noticeably faster at lower speeds or in quick bursts, like a 0-to-60 push.

Sufficient space for cargo and passengers. If a normal sedan does not have five seats or room for a respectable amount of luggage, then it loses a lot of the freedom of transportation that cars are supposed to bring.

Affordability. Price is 85% of a consumer's decision at a dealership. Producing cars at scale and with our unique model should quickly solve the upfront price problem. As for operational costs, ICEs are twice as expensive to run per mile, and the EV cost is likely to decrease over the years while the ICE cost only grows. Finally, the servicing is even cheaper.

Convenience. The average customer has to stop about 50 times a year for five minutes to fill up with gas. The EV has to be quicker, and it can be. Charging reduces the frequency of stops, and switches have been performed in as little as 60 seconds. If we are not more convenient than an ICE in terms of the number or length of stops, we do not have a business.

charged one in less time than it takes to buy a tank of gas. This will give drivers essentially unlimited range, just like any ICE car now enjoys with the current infrastructure.

In addition to these switch stations, ubiquitous charge spots will exist in each major location where a typical consumer parks (at home, work, shopping malls, and downtown areas); these will allow people to continually charge their batteries in a way that renders moot the everyday range issues. Of course, a typical car is parked for 22.5 or more hours out of a 24-hour day, so the charge spots themselves will almost always be sufficient. Batteries have a range of roughly 100 miles, so people will only need to use a BSS when they are driving over 100 miles in just one leg, well beyond most normal commutes. The infrastructure costs of this plan are also smaller than one might imagine because the charge spots do not have all the "smart" technology (which is mainly stored in the car). The switch stations rely on a simple robot that moves in onedimension; they do not need the comprehensive equipment and staffing of today's ordinary gas station. Finally, the switch stations will use renewable clean electricity (such as solar or wind), allowing each car to have a carbon footprint of zero.

Before January 2005, I knew very little about the issues presented by an oil economy. I started several software companies, the last of which we sold to SAP, and was in line to become CEO there one day. Even after the Davos conference, where I first proposed getting the world off oil, I never seriously thought it would become my livelihood and indeed my life.

While doing research in the lead-up to that conference, I had to decide what path to take towards my goal. The first step was to determine which sector to focus on. I looked across the board, from home energy usage to power generation. But transportation caught my eye: not only does it represent nearly half of world oil usage, but it is also widely regarded as the most difficult to address, given the entrenched need for infrastructure among other issues.

Various "solutions" to this problem have been getting play in the media over the last few years, leading to a lot of discussion about which solution will work in the end. I researched all the potential solutions myself, and the answer I came to was electric transport.

A few years ago, Ethanol was the most talked about "solution" to the oil problem. Indeed, ethanol is renewable, and has the potential to replace oil. But it cannot solve the trickier issues related to oil—and it is not entirely feasible. If every square mile of land on earth was covered in Amazonian rainforest that could grow sugarcane like that used to make ethanol in Brazil, the world would have enough ethanol-generating material. But the world does not have that amount of arable land, so ethanol is not feasible as a worldwide solution. Moreover, in ICEs, ethanol delivers fewer miles per gallon (mpg) than gasoline, and it does emit CO_2. Ethanol is not nearly as energy efficient as electricity: it takes energy to create it, and ICEs are naturally inefficient. Furthermore, ethanol is corrosive and cannot be transported through pipes, making it impractical. Finally—and most crucially—it distorts prices on corn, sugarcane, and related food goods, making it harder to feed the world.

Similarly, the "Hydrogen Economy" was championed by the previous administration, but it also faces problems. First, hydrogen has been the energy of the next decade for the last four decades, and it is still decades away from being in any way a reality. Second, hydrogen fuel requires more energy to produce than it produces when burned; that's a negative energy equation. Finally, fuel cell cars are prohibitively expensive. The infrastructure issues are also massive, and would require a complete overhaul. Dr. Stephen Chu, the United States Secretary of Energy and a Nobel Prize winner in physics, recently rescinded all government funding for hydrogen.

Plug-in Hybrid Electric Vehicles (PHEVs) are now in fashion, epitomized by the recent Chevy Volt. Although PHEVs are indeed much more environmentally friendly than an ICE or a standard hybrid, the addition of the "range extender" in the form of an internal combustion engine and gas tank causes enough problems to doom it entirely. First, it does not remove us from the oil economy. Second, price is a deal-breaker: with a range extender, the car would cost twice as much as a similarly practical and capable car. Finally, it is debilitatingly heavy, making it harder to achieve efficient energy use and performance equal to ICEs.

We have even heard some noise lately about natural gas (NG) as a potential source of power for cars. But, like ethanol, it still emits carbon; and like oil, it is a finite resource. It would require the same sort of overhaul of infrastructure that hydrogen would, but would not ultimately solve any of the problems related to oil. Therefore, at best, it is a "bridge" solution, but not one worth investing in if we have better technology already in place.

Electric cars, on the other hand, offer a full solution and the technology is already available. EVs use resources far and away more efficiently than any other system. The principal piece of infrastructure already exists: the electric grid. EVs emit absolutely no carbon, and they can be produced affordably at scale with no need for any technological advances. EVs are also cheaper to operate than ICEs, and even come with lower maintenance costs because the engines have fewer moving parts.

So why are people not already buying EVs? The two main reasons start with the battery: high upfront cost and a limited range.

At the moment, EVs cost significantly more up front than comparable ICEs, mostly due to the battery cost. Although this cost will drop over time as battery density improves (by roughly 50 percent every five years) and with scale, it will remain the single most expensive component in the car for the foreseeable future.

No matter how much battery density improves, however, it will always limit the range. Once the battery hits the end of its range, it must be recharged for hours if we regard the battery as a fixed unit. This "range anxiety," the driver's fear of reaching the end of the charge and not being able to go anywhere for hours, is especially prevalent in markets like the United States that have many long-haul routes and consumers accustomed to great mobility. Range anxiety is less of an issue in emerging markets like China and India, where people will be more than satisfied to have any range at all.

EV infrastructure is also far behind what is needed to encourage widespread adoption. Imagine a parallel: that the cell phone revolution is peaking but we have no cell towers to transmit calls. The car is not a complete product in itself; the actual product is personal mobility. Therefore, the complete product relies on the infrastructure being in place before people start buying the cars themselves. If we wait until 100,000 people buy EVs before we build an EV infrastructure, everyone will wait until they can be the 100,001st buyer, and we will never get there.

Also, EVs will likely have a substantial impact on the electric grid. If electricity flowed automatically to any EV at the second the owner requested it, that would create a load on the system throughout the day and often right at peak hours, like the minute the driver gets home from work. That would mean that electric companies would have to expand capacity to match every single new electric car, watt for watt.

Finally, many of our climate goals could be defeated by the tailpipe-to-smokestack effect. That is, if the extra energy produced to drive EVs is itself derived from fossil fuels and thus causes carbon emissions, we are not significantly cutting a car's carbon footprint. Emissions would merely move from the tailpipe of the car to the smokestack of the power plant that runs on coal, oil, or another fossil fuel.

For two years after the 2005 Davos conference, I spent whatever free time I had learning about the energy sector and researched solutions to the issues described above.

I started with the science, with what I actually had. Starting from that perspective led me to the conclusion that solutions other than electrons are neither short- nor long-term solutions. Any time we turn energy into a molecule (such as oil) and then turn that molecule back into energy, we lose energy along the way to heat and other by-products that are useless to our end goal of propulsion. Electricity was scientifically ideal.

After evaluating technologies for fast-charging batteries and dismissing it as a possibility, I first had to find a way to eliminate the issue of range anxiety. For me, the "Eureka!" moment came when I concluded that the fastest way to gain a full charge would be to simply swap out the battery, much like swapping computer batteries during a long flight. Here, the car industry had made a conceptual error: regarding the battery as a fixed unit within the car, which could not be removed easily or quickly. In addition to the impacts on range and price I mentioned above, I saw another consequence of having a battery that was non-removable and consumer owned: What happens when a battery becomes obsolete and better ones have appeared on the market? Allowing easy transfer solved this smaller problem, as well as the two broader ones of range and up-front price.

The concern with obsolescence became even more important once I considered the rate of battery development. As I said above, the energy density of batteries typically improves by 50 percent every 5 years, or around 8 to 10 percent per year. This means that consumers would always have obsolete technology with fixed batteries in a product (a car) that they ordinarily own for much longer periods of time than other consumer products with similar innovation curves.

Now it might be tempting to regard this improved density as a step toward expanding the range for all EVs, when in reality it could be much more usefully allocated toward a smaller, lighter, and cheaper battery. Most of us make few trips longer than 100 miles one way; the typical driver does it five times a year. Therefore, a longer range is not nearly as desirable as a lower-cost option. Drivers would have no reason to pay a premium for a 300-mile-range battery if they could

The Oil Whiplash Effect

At its peak, in the first quarter of 2008, global oil demand stood at 87 million barrels per day (Mbbl/day).[1] Current predictions for global oil demand for 2009 vary from 82.6 Mbbl/day to 84.9 Mbbl/day, according to the International Energy Agency.[2]

The decreased demand is largely a result of the current economic crisis, with people driving and flying less often than they did before. Over the course of 2008, drivers of motor vehicles decreased their miles driven by up to 3.6% compared with their driving habits in 2007, and in the first four months of 2009 that figure dropped by an additional 1.1% compared with data from the same months in 2008.[3] Similarly, the number of flights taking off or landing in the U.S. in 2008 was 4.8% lower than in 2007, and the figures for the first quarter of 2009 were down more than 8.5%, compared with that quarter of 2008.[4]

Yet this decline in demand is predicted to be temporary, given the predicted growth in global fleet size and the expected economic recovery. The UN predicts that by 2010 some 939 million vehicles will be moving along roads around the world, compared with only 751 million vehicles in 2002. It breaks down that growth as a 15% increase in the fleets of nations in the Organization for Economic Co-operation and Development (OECD), and a whopping increase of more than 73% in the fleets of the non-OECD nations, such as China, India, and Brazil. It predicts that the global fleet will reach 1.26 billion vehicles by 2020 and 1.66 billion by 2030.[5] Considering that each 25 million vehicles require 700 million barrels of oil a year, or approximately 2 Mbbl/day, we can expect oil demand to grow dramatically, by 26 Mbbl/day, just to account for these new vehicles.

The trend toward increased demand in the very near future is troubling: Increased demand will drive up the price of oil, just as we are moving out of the current recession. Not only do prices affect the behavior of the end consumer; more importantly, the price of oil is linked with national and global economic growth and GDP. On the national level, meaningful oil price increases have preceded nine of the last ten recessions in the United States, including the current one. The one exception was the 1960 recession; see Figure 1.

These data demonstrate not only the link between the two but also the causal relationship between them: the increase in oil price *precedes* the drop in GDP, and thus supports the claim that these increases are one cause of the drop in GDP, and not the other way around.

The figure also shows an asymmetry in the impact of changes in oil prices. Increases in oil prices have a larger impact on GDP than do declines in oil prices.[6] Thus, the economy is hurt much more by price increases than it is helped by price decreases. This asymmetry means that the economy is subject to the disadvantages associated with increasing oil prices without getting nearly as many benefits from any potential declines.

The harmful link between oil prices and GDP puts our economy at risk and makes us more vulnerable to global economic trends. Because oil is a commodity that can be traded across the world, its price is affected by the economic and supply/demand trends of different countries. This means that with the anticipated fleet growth in India and China, demand for oil in the next decade is anticipated to rise substantially, and thus affect the national price of oil as well.

Indeed, many experts are predicting another price shock once the current recession eases. A report this spring issued by McKinsey and Co., "Why Energy Demand will Rebound," indicates the potential for yet another price spike between 2010 and 2013.[7] Eliminating our dependence on oil will break this cycle and insulate the economy from this volatile market.

One key way to minimize the impact from increases in oil prices is to eliminate its use in the passenger vehicle sector by switching to electric vehicles. Given that over 60% of the oil demand in the U.S. is used for transportation and that the U.S. car fleet is growing dramatically, focusing efforts on that sector will provide the greatest leverage to break the link between oil price increases and recessions.

Electric vehicles are the only technology available today that could be mass produced in a short time frame to promote the effort of decoupling our economy from oil. Reducing our dependence on oil will help secure our economy, while also improving our air quality, reducing our carbon footprint, and increasing our national security.

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5. United Nations Yearbook; and International Monetary Fund staff calculations, as quoted in Martin Sommer, *World Economic Outlook*, Chapter IV: Will the oil market continue to be tight?, International Monetary Fund, April 1, 2005
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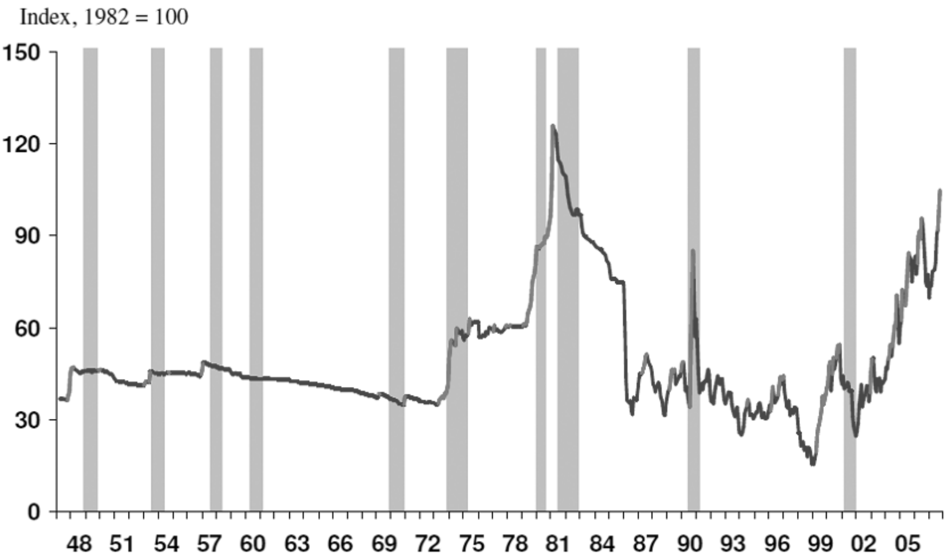

Figure 1. Real Oil Price (darker line, sustained price increases lighter line) and Recessions (shaded in gray).

Source: Stephen Brown, of the Federal Reserve Bank of Dallas, at 2008 Conference of the U.S. Energy Information Administration, "Globalization, Oil Prices and U.S. Economic Activity."

switch it and have the same effective range.

Once I had completed my scientific research and innovation, I had to create a business model to implement these findings in a way that could actually have an impact on a worldwide scale. Since all the technology already existed, it was obvious what we needed: not a technological innovation but a business innovation that would set up a meaningful market shift.

At first, as I considered what organization would deploy the infrastructure and manage the network, I envisioned a governmental agency. The government traditionally controls matters of infrastructure and electricity, so an extension into EV networks seemed logical. But offering a competitive market solution would be much more effective in enticing customers and also had the potential to be profoundly profitable. It would also facilitate competition within the industry that might not be ideal from an individual firm's perspective, but would certainly help Better Place to eventually realize its goals.

Having decided that a private venture would be the best vehicle for conversion, I then had to figure out how to create a network that would not be prohibitively expensive to install yet would be comprehensive and thus fully functional for consumers. The first step would be blanketing the target region with charge stations. People tend to park in four key locations: their place of residence, their place of work, shopping districts and malls, and downtown areas. If we provided charge spots at all these locations, most consumers would always have a place to plug in and therefore to maximize the benefit of using our network. To make this work, that network would need to have approximately 2.5 charge spots per EV, so charge spots will need to be ubiquitous at full deployment. Switch stations would be located roughly 30 miles apart, mostly on highways between urban areas, to assist with commutes and long trips when needed.

But how could we roll out millions of charge spots if they were prohibitively expensive? Thus, we designed charge spots that are not stuffed full of computer equipment and instead put the computational and network power into the cars themselves and into a network management hub. A consumer would flash a card at the charge spot, which would communicate with the on-board computer system, telling the charge spot to start charging based on the consumer's usage plan. This would let us build cheaper charge spots than in other models that build network software and credit-card-reading mechanisms into every spot. Also, as I said earlier, the simplicity of the BSS robot, with only one arm that moves in just one dimension, should keep costs down.

Where does the margin exist in our model, given the infrastructure costs? Quite simply, it comes from the fact that electricity is far cheaper than gasoline. Even the most expensive electricity (such as solar, which is steadily becoming cheaper) costs approximately 2 cents for a mile of EV usage in the U.S. Factoring in the cost of the battery, it costs roughly as much to operate an electric car as to operate an ICE vehicle on gasoline at $1.50 a gallon, with a barrel of oil costing about $25.

So where does the margin exist in our model, given the infrastructure costs? Quite simply, it comes from the fact that electricity is far cheaper than gasoline. Even the most expensive electricity (such as solar, which is steadily becoming cheaper) costs approximately two cents for a mile of EV usage in the U.S. Factoring in the cost of the battery, it costs roughly as much to operate an electric car as to operate an ICE vehicle on gasoline at $1.50 a gallon, with a barrel of oil costing about $25. That does not include maintenance costs or depreciation, two elements of operating costs that should also be favorable for EVs. Over the long term, oil prices will likely never again fall below $50 a barrel, and $1.50 a gallon is unheard of in the U.S., let alone Europe, where the difference is even starker. Oil remains over $50 a barrel today, and that is in the midst of recessionary conditions. Once the economy recovers, oil demand (and therefore price) will recover with it (see Text Box 3). Consider some numbers. It costs roughly 16 cents a mile to operate an ICE car and 8 cents a mile to operate an EV. When battery prices fall and clean energy is cheaper when produced at scale, the operating cost of an EV should be four cents a mile by 2015 and two cents a mile in 2020.

The next problem has to do with acquiring electricity. The problem of strain on the electrical grid is an important one, but can be avoided easily. Network management software can schedule car charging intelligently; for example, around the low-demand periods of the day such as late at night when most people are asleep. That will let drivers take advantage of cheaper electricity that will be more readily available, and therefore not significantly increase the total capacity needs of the electric grid. For example, you might plug in your car at 5 p.m. when you get home, but it would not start charging until 10 p.m. or later, whenever the software determined that the network load was low and the cost cheaper. If you suddenly needed to run out on an errand, your car would likely still have enough energy to do what you need, but even if it didn't, you could find a switch station. If this sort of network management existed, electric grids would only have to expand their capacity by roughly 6 percent, which is relatively easy to do compared to the expansion necessary for non-managed charging.

Of course, it is essential to our goals that all this expansion of energy come from clean sources, such as solar and wind. We cannot guarantee that every electron in your car is clean, but we will guarantee that for every electron you use, someone will be generating a new one that is clean. Given that it would take about 10 years to switch a country from fossil fuels to clean sources, we are talking about expanding the grid with clean energy, by just one half of a percent per year.

Given that both solar and wind are intermittent, the EV actually solves yet another problem. Electric grids have remarkably little storage capacity. Reserves are kept for unexpected demand spikes and usually cannot be recovered when they go unused. However, if millions of EVs with large batteries were on the network, they would provide an excellent resource for energy storage. For example, wind is often at its most productive at night, but demand at night is often low. Combining EV batteries with the network-management software, all the excess electricity generated by wind power by night (or solar power by day) can be stored in EV batteries during non-peak usage times late at night and used as a buffer on the network. This solves a previously tricky problem in making renewable sources effective. More importantly, this is one more step in negating the tailpipe-to-smokestack effect.

Solar and wind energy are often criticized as being prohibitively expensive, and indeed they are more expensive than certain other non-renewable energy sources. However, in this context they should really be compared to the cost of gasoline, the comparable propulsion method for cars. To supply an entire nation's car fleet with enough solar and wind energy for the next 50 years would require the same amount of money it costs to import and refine crude oil for just one year. Viewed in this context, solar and wind are in fact remarkably cheap. In the U.S. we spend $300 billion a year on oil imports. To give an example from Israel, we asked the government if they would be willing to build a two gigawatt power plant in the desert. They were put off by its size, so I framed the question differently: What if we found oil in that exact same region? They said they had tried and knew there was none. I said I knew there was, and that I could prove it. Just let me drill *up*, build a power plant, and supply enough power for Israel's entire car fleet. Better yet, *this* oil will not run out.

By late 2006, I had figured out the technological kinks in the business, but I saw my plan as no more than an innovative idea that someone else, be it a government or an entrepreneur, would eventually take up and make their own. In December of that year, Haim Saban kindly invited me to present my idea at his annual forum of American and Israeli leaders. After I gave my presentation, former President Bill Clinton had a provocative critique: the idea was good, but what about the Average Joe consumer who buys a well-used car, drives it into the ground, and buys another? That sort of person, a large segment of the market, is not likely to go for a car at the "new" price, and therefore is not likely to switch at all.

> Only in the very last days of 2006 did I start thinking of making a career out of my plan. Shimon Peres, the President of Israel, called me at home just as I had gone to bed after the Saban forum. He said, "You have a good idea, Mr. Agassi, now what are you going to do about it? If you believe in it but do not do it yourself, why would anyone else jump on it?"

After the Saban forum, we further developed our model on the parallel to cellphones. The auto market as a whole actually has some striking parallels to the mobile phone market, where the network and the handset are independently useless but together necessary and ubiquitous. The product that operates on the network is (relatively) expensive in either case, and both systems charge for usage. Mobile phone networks are owned and operated by private companies, and they have a starkly different business model than auto companies currently do despite those similarities. First, they charge based on usage of their network. Second, they sign customers to long-term contracts, in exchange for which they will subsidize their handsets.

This cell phone-based model of business allows for some extremely interesting innovations in the EV business model. Of course, it allows service providers to own batteries and thus allows for the all-important battery switching; at the same time, it lowers the price of the car by something like $10,000 to $15,000. It also allows the customer to pay on a usage basis, much as we all do now for gasoline, but with a network that is ideally cheaper, more ubiquitous, and easier to use. Drivers would have no reason to buy used, inefficient ICE cars when they could get brand new ones that are cheaper to buy and cheaper to operate. This model also allows for value-added services, such as network-management software and emerging management planning for drivers that can point each consumer in the direction of the nearest available BSS or charge spot, as needed. It could even send the customer an instant message saying that the car is fully charged or that the charging was unexpectedly interrupted.

It is telling that someone so closely involved with oil would not only allow for a switch but would boldly support it financially, and that will become a theme. About a year later *BusinessWeek* quoted Ofer as saying, "If I did not do it, someone would. What is the point of fighting something that is inevitable?"

But only in the very last days of 2006 did I start thinking of making a career out of my plan. Shimon Peres, the President of Israel, called me at home just as I had just gone to bed after the Saban forum. He said, "You have a good idea, Mr. Agassi, now what are you going to do about it? If you believe in it but do not do it yourself, why would anyone else jump on it?"

He was all too persuasive, and convinced me to leave my job at SAP to go off into the uncharted territory of my new idea. He also set me up with Ehud Olmert, then Israel's Prime Minister, who said the Israeli government would support my project if I lined up enough funding and a major automaker to back my plan.

Realizing that funding would be difficult to come by without at least a tentative agreement from an original equipment manufacturer (OEM), Peres helped set up meetings with them a month later at the Davos 2007 conference. Only two of the five we invited showed up. But that was enough.

My meeting with Carlos Ghosn, the CEO of Renault and Nissan, changed the course of Better Place. Finding him surprisingly supportive of my plan, I asked if he was interested in hybrids. He said, "Hybrids are like mermaids. When you want a fish you get a woman and when you want a woman you get a fish." He hit the nail on the head: if you want gas car performance from a hybrid, you get a watered-down version, and if you want a clean environment you are still giving off substantial emissions. Moreover, only one million of the 500 million cars sold in the last 10 years are hybrids: a market share of just 0.2 percent. Even worse, hybrids are only about 20 percent more efficient than comparable cars, and therefore have almost no meaningful carbon impact on the world scale.

Ghosn immediately responded to my ideas and business model, and seemed to really appreciate its implications. His company had been doing research on advanced batteries and was technologically well prepared for the challenge. He promised that down the road his company could make fully functional EVs, compatible with our solution, at scale (Text Box 2 describes the sort of car we are talking about).

With Renault-Nissan on board, my next task was to line up funding for what remained a fairly audacious venture. Michael Granoff, the President of Maniv Energy Capital, pointed me in the direction of Idan Ofer, the President of Israel Corp. Ofer's company is one of the largest owners of oil refineries in Israel, and therefore stands to be affected the most by the switch to EVs. After we had met for several hours, he stepped into the elevator with me, and said he would support my venture with $100 million. I was floored, and not sure I believed him, but Ofer was deadly serious. In fact, he would end up contributing a total of $130 million to the project. It is telling that someone so closely involved with oil would not only allow for a switch but would boldly support it financially, and that will become a theme. About a year later, *BusinessWeek* quoted Ofer as saying, "If I did not do it, someone would. What is the point of fighting something that is inevitable?"

From there, Granoff helped me get funding from his own Maniv Energy Capital, and we acquired substantial funding from VantagePoint Ventures and Morgan Stanley, totaling roughly $70 million. Now, with $200 million in capital, and a major OEM as a partner, we launched Better Place in October 2007. We lined up partners for the various pieces of the supply chain, most importantly battery production (with Automotive Energy Supply Corp. and A123 Systems), and began working on target markets.

Given the support we enjoyed from President Peres and Prime Minister Olmert, Israel was a natural place to start. In addition to the policy support, however, Israel is an ideal place for our solution for several reasons. It is a transportation island (if your car leaves Israel it has probably been stolen). The longest route one could possibly drive is 250 miles. Most importantly, the geopolitical costs of oil dependence are extremely clear to every consumer in the country. Israel even has a fairly aggressive gasoline tax. On top of that, Israel has a favorable tax scheme, which was recently revised; it ensures an approximate 80 percent difference between the tax rates of ICE cars and EVs, and will maintain a substantial difference of at least 30 percent in the long term. We announced Better Place Israel in January 2008.

Barely two months later we announced our next market: Denmark. Again, the region presented a uniquely perfect fit for our business. Denmark has a relatively small and contained landmass, wind is a principal source of energy, gasoline is extremely expensive, and the difference in tax rates between an ICE vehicle and an EV is staggering: 105 percent to 180 percent depending on the price of the vehicle. Denmark's reliance on wind is a perfect example of EVs solving the problem of intermittent energy sources. In fact, Danes pay Germany to take some of the electricity they generate at night (the peak time for wind) because they have no method of storage and demand is not strong late at night. With millions of EV batteries and intelligent network management, the cars will be charged at night, providing a much more efficient usage of the energy generated around those hours. We managed to secure €103 million in funding as a seed fund for the Danish company, and quickly set up an office on the ground.

Since then, we have announced Better Place operations in Australia (beginning in Canberra), the San Francisco Bay Area, and Hawaii. As Renault and Nissan approach mass-market volumes in 2012, our next step is to get the infrastructure into the ground as fast as we can to help speed up the transition. Government programs to encourage EV adoption are essential, either from the supply side, the demand side, or via regulation such as those making it easier to acquire permits for charge spots. With a little government help and with OEMs taking notice of Nissan-Renault's commitment, EV growth can only be limited by the rate at which we reach agreements with new regions and put the infrastructure into the ground. Countries around the world are rapidly starting to pass EV legislation, and are looking to show leadership in the field. China, especially, with its $9,000-per-vehicle EV credit, is showing the western world the sort of decisive action needed to transition quickly and effectively. Now it is up to the United States and others to show leadership by taking action on their own and encouraging OEMs to help and foster the trend.