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The Better Place Paradigm: Creating Unlimited Electric Vehicle Range and New Demand for Renewable Energy

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Abstract

This paper discusses the Better Place vision, model, and achievements since the company's inception in 2007. It addresses how Better Place provides a sustainable personal transportation alternative through the mass adoption of electric vehicles and how this solution can help end the world's oil addiction. Within this context, the paper details Better Place's answer to the two barriers that have historically precluded mass electric vehicle adoption: limited range and the cost of the vehicle. Better Place presents a model where the electric vehicle owners/ operators have subscription plans for leasing batteries instead owning them, and thus can utilize battery switch stations to greatly extend the vehicle's range. It also discusses how Better Place will accelerate the adoption of renewable energy through demand-side management and "smart charging" of the batteries. These vehicles, under the control of an aggregator, have the potential to be a useful tool in grid-stabilization and have the potential to provide ancillary services to utilities.

Keywords: battery management, infrastructure, load management, range, smart grid

1 Introduction

Imagine living free from oil. Picture zero-emission electric vehicles running on a clean energy.

Electric vehicles have received significant attention over the last several years and have been positioned above other alternative means to become the most promising alternative personal transportation method. This vision is possible today, if governments, automakers, energy companies and Better Place work hand-in-hand to make it a reality.

2 Better Place

Founded in October 2007, Better Place directly addresses the two key barriers of mass electric vehicle (EV) adoption: range and cost. Better Place is an electric vehicle infrastructure and service provider that creates the electric charge grid necessary to give electric vehicles unlimited range and redefines the EV economic model, catalyzing the transition to world-wide sustainable transportation.

The Better Place vision of the EV ecosystem is as follows: automakers make the electric vehicles that plug into the Better Place charge spots and battery switch stations. Energy companies provide the network's power through growing clean energy

projects. Finally, Better Place provides the batteries, charging spots, and supporting infrastructure to make owning an electric vehicle affordable, convenient and enjoyable.

Better Place, the leading electric vehicle infrastructure and service provider has identified a recent fundamental shift in the economics of car ownership—EVs can be dramatically less expensive to own and operate than their fuel-based counterparts [1]. There are two primary drivers for this shift in vehicle economics. First, price plus performance improvements for EVs, mainly the battery component, have made them a more viable alternative to vehicles with traditional combustion engines. This cost reduction of driving electric vehicles is the result of recent advancements in battery technology that offer a safe electricity storage solution with longer cycle life at a lower cost. Second, battery ownership is held by Better Place rather than the vehicle owner operator and these batteries are swappable.

This opportunity to transform the century old oil-based transportation model is global, Better Place is rolling out its solution all over the world. In just over a year, Better Place has announced cooperative agreements with Denmark, Israel, Australia, California, Hawaii and the Province of Ontario to transform their transportation infrastructure from oil-based to renewable energy and significantly reduce their transportation sector emissions.

Better Place has created a disruptive business model to capitalize on this fundamental shift in the cost of vehicle ownership and operation. The model includes the deployment of a ubiquitous electric vehicle-charging infrastructure with full system integration. It includes an operating framework that connects stakeholders in all relevant sectors—technological, financial, and governmental. Finally, the model treats batteries as a component of the electric vehicle infrastructure to be monetized over a long period of time, and not just simply part of the vehicle purchased by the consumer. Batteries are the key component that makes an electric vehicle more expensive than its countpart, and it is through moving battery ownership from the vehicle owner to the electric vehicle service provider that Better Place reduces the initial cost of the vehicle to a lower price point than its equivalent gasoline-powered car.

In essence, this opportunity represents a similar business model to that used by mobile phone operators. Just as a wireless operator deploys a network of cell towers to provide a given service area with mobile phone coverage and then charges its customers a subscription fee, Better Place will deploy a network of charge spots and battery switch stations to provide the consumer with the ability to keep his or her car charged and available for use at all times.

3 EV Owner/ Operator Value Proposition

To achieve Better Place's goal of ending the world's oil addiction, electric vehicles must become the dominant paradigm for fuelling global light transport vehicles. Therefore, total cost of ownership for an electric vehicle (vehicle cost plus operating cost) must be lower than that of an equivalent gasoline-powered vehicle. It is through providing the same performance at a cheaper price that EVs will cross the chasm from early adopters to the mass market. Specific pricing will vary depending on the particular market or region and based on the particular individual customer selected subscription plan.

4 EVs with Unlimited Range

The subscription-based model where the EV owner/ operator does not own the battery has three distinct advantages with regards to the range of the vehicle.

1) Better Place will continuously update its supply of batteries so that the user will always have access to the latest technology and the best batteries on the market instead of being stuck with the battery technology that was available when the car was purchased.

2) Continuously updating the Better Place's supply will also guarantee that EV drivers will not be in possession of old batteries whose performance has deteriorated since they were originally manufactured. Drivers will always be provided with batteries that have maximum functionality and performance.

3) If the consumer does not own a specific battery but simply a subscription to one, batteries can be swapped at any point to instantly replenish the vehicles range to 100 miles. The original battery can be charged by Better Place until it is full and can be swapped back into another subscriber's vehicle.

The infrastructure to be installed will take the following form:

Ubiquitous charge spots will keep batteries topped off with power so that as long as the driver plugs in, he or she can always have 100 miles of driving capacity. They will be located where EV drivers work, live, shop and dine in parking lots so that they have the ability to recharge their battery as the software instructs the charge spot to do so.

For trips longer than 100 miles, battery switch stations will be available roadside. Stations will be completely automated, and will provide the swap-replenishment functionality as previously described. The driver's subscription takes care of everything. The driver pulls in, and the depleted battery will be quickly replaced with a fully charged one without anyone having to leave the vehicle. The process will take less time than it does to fill a tank of liquid fuel.

Better Place will install, scale, and operate this regional and global infrastructure. With these two methods of increasing the car's immediate, driveable range, Better Place will provide consumers with a viable, compelling alternative to fuel-based vehicles that completes on performance, price and driveability.

5 Renewable Energy as a Transportation Fuel

Better Place will also work with governments and electric utility companies to deploy renewable energy generating facilities with the electrical output greater or equivalent to the amount consumed by the collective fleet of vehicles that Better Place services. When such renewable energy facilities are in place, and a significant number of cars convert to electric drive, a country develops not only an oil-independent but also renewable power supply for both the transportation and stationary sectors. Countries will benefit in a myriad of ways including an improvement in their trade balance (through lower oil imports) and a reduction in the environmental impact of their transportation sector, which contributes roughly 20% globally of the manmade greenhouse gas (GHG) emissions today [2].

6 Aggregated EV Batteries as Distributed Energy Storage and More

Better Place will typically charge the EVs during off-peak hours while at home, so the batteries can actually become tools in grid stabilization, load management, and promotion for the mass - adoption of renewable energy.

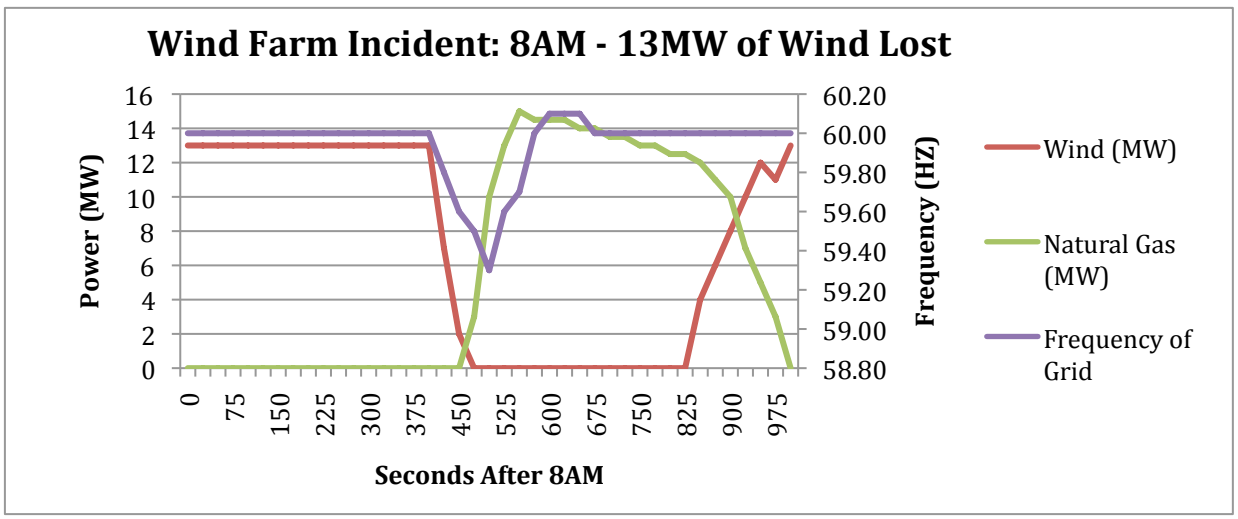

Figure 1: Wind Event - Immediate Loss of 13 MW Wind [4]

In California, wind tends to blow at night [3], when the demand for power is low. To ensure a stable grid, wind energy is occasionally simply "dumped. Through the use of "smart charging," and the Better Place aggregation system, Better Place will be able to utilize this intermittent renewable energy by coupling the generation with EV demand. While one EV battery does not make a much of a difference on a utility grid scale, a network that aggregates and orchestrates charging of hundreds of thousands of EVs can significantly increase the utilization of wind-energy. Furthermore, by increasing the amount of energy generated by wind farms, the overall generation costs are reduced making wind a more attractive investment.

Likewise, when wind generation stops suddenly, the typical solution is to turn up inefficient, quick-response diesel or gas-fired generators to maintain the power supply and grid frequency. An aggregated fleet of EVs pausing their charging process and reducing their consumption of electricity when intermittent power generation stops enables the load to follow the generation curve and prevent these fossil fuel fired units from temporarily coming on line.

An example of this instance is shown in Figure 1, which is a stylized utility graph tracking grid frequency and wind generation. It details an event where a small utility loses a significant amount of power almost instantly when the wind stops blowing. As noted on the figure, at 400 seconds the wind turbines start slowing, and in the next minute their generation falls by a total of 13 MW and the frequency falls to approximately 59.4 Hz.

To address this issue a fossil fuel unit is immediately switched on to cover for the loss of power and to rectify the even more pressing issue of grid frequency, which experiences a corresponding drop. Not only did this take a over a minute to stabilize the grid, but 1.2 MWh of fossil fuel power has to be used to compensate before the wind began to blow again, approximately 10 minutes later.

With the Better Place model, the stabilization could have been done with a faster response time and without engaging the fossil fuel unit. Instead, the aggregated fleet of EVs that were charging at the time would be dialed down to have the demand follow the wind generation until it recovered.

In the above example, where the maximum generation of the fossil unit was around 18 MW for the stabilization effort, roughly between 3,000 and 6,000 vehicles would have temporarily stopped charging to create the same stabilization effect.

Further, in the future, there is the potential for the vehicles to upload a small amount of energy each from thousands of cars. Not only would this address the above situation but also enable moving renewable energy harvested at night (typically from wind) or from solar power generated at noon to when the electric grid needs the energy and to even potentially avoid brownouts and blackouts.

7 EV Batteries and Standards

Due to the open, standards-based approach that Better Place has adopted in the development of its batteries, there will be many manufacturers contributing to the pool of available batteries. This will help maintain a steady supply and stable prices as more and more nations join Better Place in its efforts to remake transportation as a sustainable service.

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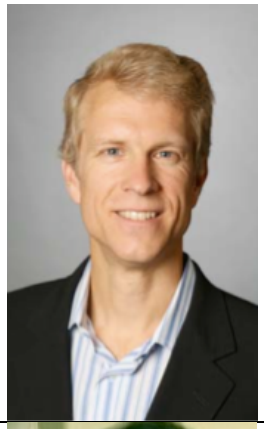
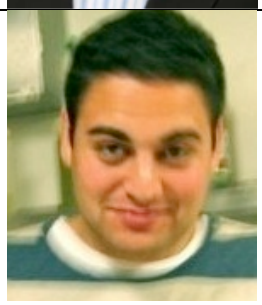
Authors



Sven Thesen responsible for driving the Better Place's sustainability vision and strategic relations. As a result of his contributions to the IPCC for national greenhouse gas inventories, he shared the 2007 Nobel Peace Prize. Thesen received a Bachelor of Science degree in Chemical Engineering from North Carolina State University.



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