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Emerging Electric Vehicle Business Models

On August 1, 2012, The National Petroleum Council (NPC) in approving its report, *Advancing Technology for America's Transportation Future*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

Emerging Electric Vehicle Business Models (White Paper for the NPC Study)

Introduction:

Historically, the transition to electric cars has been slowed by numerous obstacles, including range limitations, battery affordability, battery obsolescence and durability risks, and strains on the electric grid. The complexity and novelty of the electrification value chain - which merges the utility value chain with the automotive, battery and charging infrastructure value chains - suggest a number of challenges as to how cost-effective business models will be defined and how electrification of the transport industry will be successfully delivered. Creative models are being devised to overcome key challenges related to technology cost, scale and grid management, with different distribution of roles, responsibilities and relationships across the industries. These activities will expand traditional value chains— creating opportunities for incumbents and new market entrants

The development of electric vehicles and charging infrastructure is inextricably linked. Ensuring consumers are able to appropriately maintain their batteries, easily charge their vehicles at home and/or in public locations and at their convenience, and be accurately billed will be critical to the consumer experience and the successful uptake of plug-in electric vehicles (PEVs, which includes both pure battery electric vehicles and plug-in hybrid vehicles). Brand new infrastructure will be required for charging PEVs. Charging equipment will need to be located at homes, on streets and in private/commercial locations (e.g., offices, shopping centers and parking bays) to provide charging capabilities for consumers with differing requirements. These requirements include different levels (or speeds) of charging, such as fast charging at supermarkets or on motorways. Support services such as infrastructure maintenance, back-office systems and customer support will also be necessary to underpin the functioning of the market. They are essential to maintaining the infrastructure, preventing strain on the electricity supply chain due to vehicle charging, and managing the high volumes of data that will come online, ensuring accurate billing and a positive consumer experience.

When establishing the optimal charging infrastructure model and the roles and responsibilities across the value chain, several questions could be raised, including:

- Who is the owner of the charge spot and pays for the up-front investment?
- Who installs, operates and maintains the charge spot?
- Who provides the charging and billing of the electricity from the charge spot?
- How will a customer with a plug-in electric vehicle pay for the electricity consumed?

Models may vary depending on the market and regulatory context, and more than one model may exist within any given market, allowing options for the consumer. This paper covers two distinctly different charging infrastructure business models, both of which offer a comprehensive end-to-end offering for the customer.

The first example, NRG's eVgo^{SM} model, offers customers a subscription model where NRG acts as an end-to-end solution for installation, permitting, maintenance, and repair of the charging equipment as well as unlimited public charging for a fixed monthly fee. (Customers are responsible for home

electricity use.) Customers can request charging equipment for their home location as well as access to public charge points. In addition, NRG collaborates with property owners/managers to wire and pre-wire parking spaces in multi-unit dwellings or workplaces for potential customers. NRG's subscription model removes the upfront cost for the customer, in addition to offering a single point of contact.

The second example, Better Place's comprehensive network operator model also offers an end-to-end solution for the customer and includes battery switch stations along with charging infrastructure. Better Place's model coordinates all aspects of the electric car ecosystem and provides range extension for the driver. The unique component of the Better Place model is the switchable battery. Better Place controls all the batteries in the system while the customer owns the electric car. This model addresses the traditional customer-oriented obstacles to electric cars by lowering their high up-front costs, shifting battery obsolescence and durability risks away from consumers, and providing driving autonomy through rapid battery switching, charging spots and in-car support. Better Place also plans to manage and integrate the electric vehicle with the grid.

Many business models for providing charging stations have been launched and/or proposed, but it is too early in the PEV market to determine which model provides the most value to consumers while earning an appropriate financial return to the provider. Regardless of the model, the variety of companies and organizations that fulfill these roles implies the need for strong collaboration between them, a strong focus on the consumer, and a landscape that will likely vary by geography.

The eVgo[SM] Network: A Subscription-based Solution for Plug-in Vehicle Charging

In late 2010, New Jersey-based NRG Energy, Inc. launched the "eVgo[SM] Network," a first-of-its-kind privately funded Level 2 and DC fast charging network for Plug-in Electric Vehicles (PEVs). The program offers packaged subscription-based charging solutions that address three key consumer barriers: (1) up-front costs associated with the purchase of charging equipment, (2) uncertainty over up-front costs of the charging equipment and incremental monthly electricity costs, and (3) concerns over limited vehicle range.[1] The eVgo[SM] Network is targeted foremost at owners and prospective owners of battery electric vehicle (BEV) and secondarily at plug-in hybrid electric vehicle (PHEV) customers. NRG anticipates that BEV customers will desire both "home and away" charging infrastructure to accommodate daily travel needs. On the other hand, PHEV customers can rely on the vehicle's conventional motor for desired range away from home.

Exhibit 1 - eVgo[SM] "Freedom Station" with one Level 2 charger (left) and one DC fast charger (right) at a Houston H-E-B supermarket.

Due to high battery costs, BEVs are considerably more expensive than conventional vehicles. On top of this, customers face additional up-front costs for home-based 240-volt Level 2 chargers to meet daily driving needs. As noted in the FTF study report, the average cost to a residential PEV customer is about $2,600 but can range from $1,600 to roughly $5,000 installed. While competition and scale are expected to reduce costs over time, the combination of incremental costs and range concerns limit the appeal of PEVs to niche markets.

The eVgo[SM] Network aims to solve this by eliminating the customer's up-front charging equipment costs and by providing access to a ready infrastructure of 6.6 kW Level 2 and 50 kW DC fast charging stations (DCFS) for a fixed monthly fee. The DCFC chargers are capable of delivering an additional 30

[1] Online interview with eVgo CEO Arun Banskota. http://thebusinessmakers.com/episodes/shows/2011/march-2011/episode-302/arun-banskota.html (accessed August 31, 2011).

miles of range to a PEV in less than ten minutes.[2] By placing stations at popular retail destinations (see Exhibit 1), NRG aims to deliver an intra-city charging solution that is no more than 5 miles from the customer at any given time, though this may be relaxed to 10 miles as the market grows.[3]

VALUE PROPOSITION AND REVENUE MODEL

The eVgo[SM] Network initially offers three membership tiers, as illustrated in Exhibit 2. The most basic "Home" plan includes installation of a 6.6kW 240V Level 2 home charging dock capable of delivering 18-25 miles of range per hour. A ten-dollar up-charge applies if the customer's primary charging location is away from home (e.g. at the workplace). The "Mobile" plan adds unlimited charging at all eVgo[SM] Network stations. For a small premium the "Complete" plan adds unlimited off-peak home charging. All plans come with a three-year service agreement covering maintenance and repair of the dock and equipment. Optional add-on packages are available in which the customer can request installation of a supplemental charging source at a secondary location such as the workplace for a $29

Exhibit 2 - Monthly pricing for eVgo Network subscribers

premium to the selected rate plan.

Because automakers are not currently outfitting PHEVs with DCFC connectors, NRG offers a less expensive option for PHEV owners focused on residential Level 2 charger installation and access to the eVgo[SM] Level 2 charging network.

Upon signing up, subscribers receive a key fob, receiver, and quick-start installation guide from eVgo[SM]. Members use the key fob to gain access to the network when away from home. To access an eVgo[SM] charge port, the subscriber waves the key fob in front of the charger's display. The charger verifies the

[2] Press Release. "eVgo[SM] Unveils Houston's First Freedom Station Charging Site." September 8, 2011. https://www.evgonetwork.com/News_and_Events/News_Archive/eVgo_Unveils_Houstons_First_Freedom_Station_Charging_Site/ (accessed October 2, 2011).
[3] ibid.

user's subscription status and activates the desired charge port. Each Freedom Station is equipped with an emergency intercom tower and alert system that can be activated remotely to provide an added measure of personal security for eVgo[SM] customers.

Most PEV early adopters are higher income, technology-savvy early adopters living in suburban single-family homes with multiple household vehicles. Reaching a broader market entails reaching consumers residing in rentals and/or multi-dwelling unit (MDU) properties such as condominiums and apartment buildings with public garages, parking lots or on-street parking. NRG's own internal studies found that 60% of Los Angeles residents, for example, live in MDUs. In San Francisco County, the number is 67%.[4] In these and in renter-occupied housing situations, the vehicle purchaser lacks direct ownership of the property and/or parking structure and therefore cannot authorize charger installation where the vehicle is typically parked overnight.

Exhibit 3 - eVgo[SM] DC fast charge tower (left) and emergency tower (right)

NRG subsequently launched the "Ready for EV" (REV) certification program to serve these customers. It is available to both commercial and residential properties as well as to new and existing facilities. For new construction, partners can by agreement allow NRG to pre-wire parking spaces to receive Level 2 eVgo[SM] charging docks at no or reduced up-front cost. In return, the partner agrees to allow NRG to post signage designating the space as a "Future EV Parking Space." For existing building stock, NRG retrofits in-place parking spaces to accept the charging dock. The designation does not block the space from use by other vehicles; it remains open until a tenant signs up for the eVgo[SM] Network. Upon request, NRG installs the charging dock in the designated pre-wired parking space, at which time the space is assigned to the subscriber.

The charging dock houses a revenue grade meter that communicates the subscriber's electricity usage to NRG. The company then rebates the property owner for all electricity charges. REV certification works similarly at workplace locations.

MARKETING & CHANNEL PARTNERS

NRG partnered with equipment maker Aerovironment to deploy an "EV ecosystem" of branded charging stations in select metro areas. The service targets PEV and fleet customers through direct-to-consumer sales and through channel partners that include automakers, dealerships, and residential and commercial property owners and management firms.

For OEMs, NRG can bundle the charging solution with the car either on the window sticker or as an option during the financing or leasing process. The solution enables auto dealers to close plug-in vehicle transactions same day, on-site, by guaranteeing residential charger installation within 48 hours at no up-front cost. This affords customers certainty in monthly charging cost, access to a ready charging network, and assurance of single-point charging support to PEV customers. NRG has partnered with Gulf States Toyota dealerships and Nissan North America. Nissan offers eVgo[SM] as its

[4] Coulomb Technologies. "Brief to California Public Utilities Commission." February 8, 2009.

preferred charging option for area LEAF buyers.[5] Similarly, NRG partnered with a major national apartment builder to begin equipping new projects with "Ready for EV" parking spaces.

NRG spun off eVgo[SM] as a separate entity with the goal of lending it the flexibility to operate as a well-funded start-up. Currently, the network is available in the Houston and Dallas/Ft. Worth markets, with plans to add 3-5 new markets within the next year. The company aims to prove out the business model in Texas, where the deregulated utility environment provides a high degree of flexibility for timely adjustments of the model to changing market conditions. NRG's goal is a portable business model that works in a variety of markets and/or regulatory settings, a topic that is discussed later in this white paper.

BARRIERS ADDRESSED

Up-front Cost

Today's "buy and drive" customer experience typically involves an up-front payment followed by monthly car payments and fueling and other expenses "as needed." PEVs already carry a substantial premium over conventional offerings; infrastructure adds yet another cost. The installed cost of a Level 2 home charger averages around $2,600 but can vary widely, ranging from $1,600 to as much as roughly $5,000. OEMs and auto dealers are concerned that this cost uncertainty will discourage some potential PEV buyers. NRG's model removes this barrier by offering a packaged fixed-fee fueling solution as an aftermarket option, or option during the financing or leasing process, enabling customers to forego any added up-front costs. In this way, the purchase experience mirrors the more familiar conventional vehicle purchase process.

Residential EVSE Installation Process & Installed Cost

As stated in the FTF study report, successful introduction requires consumers to be able to 'economically and conveniently' prepare their residence for vehicle charging. Current processes for charging equipment installation are immature, non-standardized, and fragmented. These processes involve multiple entities, and are subject to wide variation in cost and timing. Most consumers are ill equipped to navigate these processes. NRG acts as single-point solution for installation, permitting, maintenance, and repair of the charging equipment for a fixed monthly fee. Currently, the company guarantees installation within 48 hours of notification.

Commercial/Public/MDU Installed Cost & Business Model

Through NRG's Ready for EV (REV) Program, owner/managers of premium properties can pre-wire parking spaces at no up-front cost and with no sacrifice of existing parking spaces until requested by a tenant. Partners gain a differentiable amenity to attract tenants and realize higher rents. NRG's REV Program targets dense urban environments where high land values and centrally located parking offer the most favorable economics to potential partners. For new construction, the company estimates a cost of around $15K to pre-wire ten parking spaces, a relatively minor expense when folded into the property's financing. Retrofits, however, involve higher costs to the property owner/manager but can

[5] St. John, Jeff. Nation's First Privately Financed Vehicle Charging Network, Gigaom.com, November 18, 2010, available at http://gigaom.com/cleantech/nrg-nations-first-privately-financed-vehicle-charging-network/. Accessed October 3, 2011.

run as little as $20K for ten "make ready" spaces, to as much as $200K in suburban environments with diffuse parking infrastructure. NRG is considering accommodating such retrofits at a reduced cost in return for a commitment from partners to outfit all future new construction with branded EV-ready spaces.

Commercial/Public/MDU Charging Availability and Universal Access

Universal access to charging infrastructure is a key enabler for widespread PEV acceptance. Its absence could exacerbate range anxiety concerns by removing charging sites from an already very limited pool of accessible charging infrastructure. Such a development would raise costs and undermine the already challenging economics for PEV infrastructure deployment. NRG does envision access to the eVgo^{SM} Network, though it would be contingent upon a commitment to one of the network's charging plans for some as yet undetermined contract period. Due to the company's need to recoup the high fixed cost of DCFC infrastructure, access in such instances might be limited to the network of Level 2 chargers only. Alternatively, non-members who find themselves stranded could turn to third party providers such as AAA for roadside assistance.

Charging – System Diagnostics and Repair

Should a BEV fail to charge, tracing the fault to the responsible party for resolution could prove problematic due to the involvement of multiple entities with no direct accountability. The fault, for example, could rest with the vehicle, the off-board charging equipment, or upstream on the utility-side of the meter. The eVgo^{SM} subscription model removes this uncertainty through a packaged end-to-end charging solution that offers a single point of contact to the customer for diagnostics and repair of all interfaces external to the vehicle.

Grid Integration - Managed Charging

NRG asserts that its pricing structure encourages customers to be responsible stewards of the grid. The monthly fee, for example, covers off-peak power draw at the subscriber's residence (peak is considered 3pm – 8pm during summer months). NRG also expects gradual market up-take will provide ample time for utilities to adjust to demand. Consequently, the company does not expect the network to adversely impact peak electricity load. Of note, NRG recently announced the "eV2g^{SM}" initiative with the University of Delaware to develop electric vehicle-to-grid technology that would allow individual network subscribers and PEV fleet operators (e.g. rental car agencies such as Hertz and Enterprise) to conveniently sell electricity back to the utility during peak demand periods.[6]

BEHAVIORAL CHANGES

Success of the subscription-based charging model is contingent upon some shift in end-customers, as well as channel partners, attitudes and behaviors. This requires an effort to cater to customer expectations in novel ways.

[6] Press Release. "NRG Energy, University of Delaware Announce eV2gsm initiative to Develop Electric Vehicle-to-Grid Technology." *BusinessWire*, September 26, 2011. http://www.businesswire.com/news/home/20110926005420/en/NRG-Energy-University-Delaware-Announce-eV2g-sm (accessed October 2, 2011).

Current purchase behaviors strongly favor continuation of the ownership model in which consumers expect to purchase or lease vehicles that can meet 100% of occasional trip needs. A study by the University of Delaware indicates that 32% of drivers would consider a PEV if doing so entailed securing a different vehicle (e.g. through renting or car sharing) on six or fewer occasions annually. The percentage increases with willingness to incur more such trips annually.[7]

Another key factor is the strong cultural bias toward car ownership in the U.S. Though recent evidence suggests a shift away from car ownership by younger buyers, it still remains a symbolic 'right of passage' to independence and adulthood, and an outward indicator of socio-economic status. Consumer education and awareness, however, combined with real world experience around "home and away" charging may result in reduced demand for vehicles equipped with long-range capability. This could free up vehicle designers to reduce pack size, the main driver of vehicle cost.

The subscription model also obliges utilities and automotive OEMs to concede to third party electric vehicle solution providers (EVSPs) the role of serving as value added intermediaries in the industry value chain. It is unclear whether and how these players will accommodate this development. It is similarly important that consumers make the shift to thinking about the service in terms of how it provides convenient additional mileage rather than in terms of kilowatt-hours.

Resistance by property owner/managers also presents a challenge to the NRG model. Despite the REV program's promise of minimal cost and burden, uncertainties over potential demand charges are giving pause to potential partners. These charges are the fees associated with a property's share of electrical power drawn during peak hours (equal to about $6/kW or roughly $200 monthly). This may ultimately compel eVgo[SM] or its partners to charge for on-peak DCFC usage.

OTHER CONSIDERATIONS

NRG's end-to-end subscription model faces institutional challenges from existing codes, statutes, laws, and practices that could hinder expansion of the service into additional markets. Foremost are provisions for subsidized public charging infrastructure that distort markets. DC fast charge infrastructure represents the single largest contribution to cost. High uncertainty around charger placement, DC electrical standards, and utilization rates burdens firms with increased risk of stranded capital. Well-intended efforts by governments to jump start PEV adoption could ultimately impair competition from private sector firms whose business models depend on cost certainty and on monetizing the high fixed costs of charging infrastructure.

Most dense metro areas are comprised of multi-dwelling units. In many cases, builders are required to provision a minimum number of parking spaces per unit. This is beginning to change. San Francisco's Planning Commission, for example, has moved in recent years to ban minimum parking provisions and "unbundle" parking from any particular residential unit.[8] Consequently, a builder can sell those parking spaces separately from the residence. This provides added incentive for builders to provision parking

[7] Nathaniel S. Pearre, Willett Kempton, Randall L. Guensler, and Vetri V. Elango. "Electric vehicles: How much range is required for a day's driving?" *Transportation Research Part C: Emerging Technologies* 19, no. 6 (2011): 1171-1184. http://www.sciencedirect.com/science/article/pii/S0968090X1100012X (accessed October 30, 2011).

[8] A Brief History of Parking Requirements in San Francisco. https://livablecity.org/campaigns/parkinghistory.html (accessed March 12, 2012).

spaces pre-ready for EV charging equipment. Adoption of similar ordinances by other metro areas could encourage more builders to pursue this option.

The treatment of EVSPs by over 3,000 electric districts in the U.S could also play a determining role in reducing costs and growing the market for charging infrastructure. For a third party model such as NRG's eVgo[SM] Network to compete in regulated markets, states must assure that such entities are exempted from treatment as a regulated utility. States must also assure EVSPs can secure eligibility for existing time-differentiated residential and commercial rates from utilities while avoiding 'roaming' schemes that could complicate back office billing. Lastly, public utilities must be prohibited from incorporating charging equipment and installation costs into the rates paid by their customers. Such conditions are necessary for the timely adjustment of business models to actual market conditions and for promoting a fair and level playing field. In regulated markets, utilities could gain advantage by spreading the cost of charging equipment across its rate-base.

California recently moved to ensure these provisions through an interim ruling issued by California's Public Utility Commission (CPUC) and with the signing of Assembly Bill 631 into law in early October 2011.[9,10] AB 631 codified an earlier CPUC decision to exempt regulation of entities that deliver electricity used as a transportation fuel for vehicles. Other states may follow suit.

OUTLOOK

It is still too early to tell whether customers will embrace PEVs, let alone a subscription-based charging model. The first PEVs are only just now coming to market, and charging equipment providers are limiting initial deployments to select metro areas. Current subscription levels are small and roughly coincident with the number of Nissan LEAF BEVs sold in the Houston and Dallas markets (~100). Surveys conducted by NRG, however, indicate promising capture rates in excess of 90%. Of these, 70% select one of the premium subscription plans. NRG aims to sign up 1,000 subscribers within its first year of operation.[11] The company's financial models indicate that eVgo needs approximately 10,000 members to achieve profitability in any given metro area, though the number could run as high as 20,000 by some estimates.

In closing, privately funded charging networks could enable faster PEV growth rates in targeted segments by lowering costs, removing uncertainty, and by offering a more familiar purchase experience to potential customers. Critically, nearly half of the American driving population resides in locations that are not amenable to charging infrastructure.[12] By serving this demographic, the subscription-based network model could provide an avenue for reaching a much broader market of

[9] California Legislature. Assembly Bill No. 631, 2011-2012 Regular Session. Signed into law October 6, 2011.
[10] California Public Utilities Commission. "Phase 2 Decision Establishing Policies to Overcome Barriers to Electric Vehicle Deployment and Complying with Public Utilities Code Section 740.2." Rulemaking 09-08-009. July 14, 2011. http://docs.cpuc.ca.gov/published/Final_decision/139969.htm (accessed October 3, 2011).
[11] St. John, Jeff. "Nation's First Privately Financed Vehicle Charging Network." *Gigaom.com*, November 18, 2010. http://gigaom.com/cleantech/nrg-nations-first-privately-financed-vehicle-charging-network/ (accessed October 3, 2011).
[12] Axsen, Jonn and Ken Kurani. The Early U.S. Market for PHEVs: Anticipating Consumer Awareness, Recharge Potential, Design Priorities and Energy Impacts, Institute of Transportation Studies, University of California Davis, August 2008. pubs.its.ucdavis.edu/download_pdf.php?id=1191 (accessed October 23, 2011).

potential customers that could serve to broaden the appeal of plug-in vehicles and accelerate PEV adoption.

Better Place: The electric car network that makes driving more convenient, affordable and sustainable through a revolutionary switchable battery model

1. Introduction to Better Place

Better Place seeks to make driving electric cars more affordable, convenient and sustainable than internal combustion engine ("ICE") cars through an electric car charging network and a switchable battery model.

Historically, the transition to electric cars has been slowed by numerous obstacles, including range limitations, battery affordability, battery obsolescence and durability risks, and strains on the electric grid. Diverse companies, including utilities and grid operators as well as manufacturers of cars, electric car batteries, and charge stations, have attempted to address these obstacles individually. However, Better Place believes mass adoption of electric cars requires a comprehensive solution to these obstacles – an electric car network operator that can seamlessly and simultaneously coordinate all aspects of the electric car ecosystem and provide range extension for electric car drivers. Better Place's comprehensive business model addresses this opportunity by serving as the electric car network operator.

The key component that allows Better Place to serve as the network operator is the switchable battery. This allows Better Place to offer a genuine alternative to ICE cars. In the Better Place model, Better Place controls all the batteries in the system while the customer owns the electric car. Better Place plans to provide subscription-based plans through which the customer gains access to a battery in his or her car, a broadly distributed pool of readily available batteries and a broad electric car infrastructure including battery switch stations ("BSSs"), charging spots and in-car support. This model addresses the traditional customer-oriented obstacles to electric cars by lowering their high up-front costs, shifting battery obsolescence and durability risks away from consumers, and providing driving autonomy through rapid battery switching, charging spots and in-car support.

As the electric car network operator, Better Place can also provide grid management services to the power grid operator by a) managing the electricity demanded by its electric car network, b) shifting demand to off-peak hours and c) leveraging the storage capacity of its batteries to potentially offer grid operators other value-added services such as frequency regulation, load balancing, and distributed

storage. Additionally, aggregate battery storage capacity may offer a solution for effectively integrating intermittent renewable energy resources into the grid.

Better Place has established a partnership with Renault for the supply of switchable-battery electric cars.

2. Better Place Solution

2.1. Barriers / Issues Affecting Development of the Electric Car Market

Historically, several barriers have limited the mass adoption of electric cars. The primary barriers are listed in Table x.

Key Historical Barriers and Issues	
Customer affordability / risk	• In the early years of electric car production – where production runs are not yet at mass volume – the average electric car price is expected to include approximately US$12,000 for a 24kWh battery. While battery prices are declining rapidly, there is no equivalent capital cost in an ICE car. As a result, the upfront battery cost is ordinarily a significant obstacle to electric car adoption as price sensitivity in the car market is high and drivers are frequently unwilling or unable to fully consider ongoing running costs in making purchasing decisions. Given an average new car purchase price of $28,400[13] in the US, an additional $12,000 of battery cost significantly increases the final electric car purchase price, and has consequently slowed electric car adoption considerably • Electric car customers have traditionally perceived significant risks in electric car battery ownership, such as the potential for obsolescence, diminished performance due to memory effects or outright product failure • The risk of battery obsolescence presents a significant barrier for most consumers given the high upfront cost and long ownership life of cars
Driving experience	• Car customers require significant confidence in electric car functionality before demonstrating a willingness to switch from traditional ICE cars. Consumers want assurance that an electric car will provide similar convenience, reliability, comfort, speed and performance to ICE cars

[13] Federal Trade Commission: http://www.ftc.gov/bcp/edu/pubs/consumer/autos/aut11.shtm

Range limitations	• A core requirement of an electric car ecosystem is the broad availability of battery charging infrastructure to assure drivers that their electric cars will contain sufficient charge to meet their transportation needs • Charging stations must not only be ubiquitous, but must also be safe, allow for wide interoperability, and provide for simple billing and payment. Additionally, electric car drivers will require charging spots to be safely and effectively installed in their homes • While charge spots are ideal for charging electric cars when drivers are at home, at work or shopping (most cars are parked the vast majority of the time), they are not capable of fully charging a car battery in the time it takes to fill a tank with gasoline, which is approximately five minutes. Further, available fast charging technology takes at least 30-45 minutes to fully recharge a lithium-ion battery and involves potential degradation of the battery if not performed in ideal charging conditions • Consumers are concerned that range limitations will limit their ability to take long-distance trips, affect their day-to-day driving patterns and habits, and compare unfavorably to the convenience of today's ICE cars. Many consumers, particularly those who drive long distances, will not accept range limitations
Customer support	• Given the perceived uncertainty associated with electric cars, consumers require enhanced assurances of security and convenience, together with expanded support, in order to induce them to transition to electric cars from ICE cars. The quality of tailored in-car customer support and telematics plays a pivotal role in determining the overall comfort level and driving experience of electric car consumers, and in turn, their willingness to transition from ICE cars
Effect on electric grid	• Electric utilities and grid operators are also seeking solutions to the significant challenges that mass adoption of electric cars pose, as they seek to manage their loads and utilize increasing supplies of renewable energy. Without management of electric car-related electricity demand, the strain on the grid may lead to brownouts and electricity failures, particularly if many users plug in electric cars at similar times (e.g. in the evening after arriving home from work) • Additionally, many markets with significant renewable energy generation suffer from low utilization of renewable resources due to a mismatch between the unpredictability of wind and solar generation and the strict supply reliability constraints that utilities face. This leads to under-exploitation of existing renewable resources, and substitution of higher emitting thermal generation plants such as coal and natural gas

2.2. The Better Place Solution

Diverse companies, including utilities and grid operators, as well as manufacturers of cars, electric car batteries and charge stations, have attempted to address these obstacles individually. Better Place believes that mass adoption of electric cars requires an electric car network operator that can seamlessly and simultaneously coordinate all aspects of the electric car ecosystem.

Components of the Better Place Solution that Address Barriers and Issues	
Customer affordability / risk	• In the Better Place model, battery ownership is separated from car ownership, relieving drivers of the high upfront cost of the battery. In the Better Place model, batteries will be a consumable, with the cost of the batteries amortized over distance and time, and the customer pays through periodic subscription fees • Separate battery ownership will remove any perceived customer risk associated with investing a substantial sum in a potentially soon-to-be-obsolete battery, thus making the obsolescence risk and shelf life of an electric car comparable to that of an ICE car
Driving experience	• Electric cars can offer a superior driving experience (better acceleration, smoother

	ride and no noise).
Range limitations	• An extensive charging infrastructure that includes subscribers' homes and places of work, as well as public charge spots in cities, large parking lots and other high visibility locations will enable drivers to alleviate a significant portion of range limitations. • Battery switch stations and removable batteries will provide instant range extension for those trips that are beyond the range of the vehicle, and for which the customer cannot wait for a charge. An in-car software will further facilitate range and travel flexibility by managing battery charge levels and directing and navigating drivers to swich stations as needed. ic car as freely and conveniently as ICE cars
Customer support	• An in-car software platform provides drivers with information about the state of the battery, access to charging and battery switching infrastructure, navigation assistance and other services
Effect on electric grid	• Real-world data on driving patterns and charging habits will help to ensure that the widespread adoption of electric cars does not place an intolerable burden on electricity grids. Managee charging also has the potential to offer frequency regulation and load balancing servicesto grid operators and utilities.

2.3. Key Components of the Better Place Model

Consumer Facing Components

Separated battery ownership

Key enabling innovations in the Better Place model include the use of a switchable battery and the separation of the battery from the ownership of an electric car. Customers will purchase "electric kilometers" through subscription plans tailored to their driving patterns and needs.

Better Place's ownership of the battery will lower the upfront cost of the electric car from the consumer's perspective. Given an average new car purchase price of $28,40014 in the US, an additional $12,000 of battery cost significantly increases the final electric car purchase price, and may consequently slow electric car adoption considerably. In the Better Place model, this initial capital cost is incorporated into the subscriber fee that the user pays over time, better aligning the upfront cost of electric cars with ICE competitors.

Additionally, Better Place's ownership of the battery will transfer ownership risks away from customers and reduce these risks by allowing Better Place to effectively manage the portfolio of batteries. The Better Place solution relieves the driver of the perception of risk in investing a substantial sum in a potentially soon-to-be-inferior battery.

By owning the batteries, Better Place can match batteries with customer driving patterns and to market opportunities over the life of the battery, thereby enhancing battery performance and improving battery lifetime, thereby extracting the highest economic value over the life of the battery asset. Large-scale purchasing of batteries will also allow for more attractive supply and financing arrangements for batteries on a global basis.

[14] Federal Trade Commission: http://www.ftc.gov/bcp/edu/pubs/consumer/autos/aut11.shtm

Convenient charge spots

As the vast majority of driving trips are much shorter than the range of a fully-charged electric car battery, most customers will use charge spots as their primary source of energy. Charge spots will be deployed predominantly in subscribers' homes and places of work, but the charging network will also include public charge spots in cities, large parking lots, and other high visibility locations where people park. The network of charge spots is accessed by an RFID reader that authenticates the driver and vehicle and communicates charge rate (current flow) to back-end systems. Subscribers are billed for the amount of electricity used.

Ability to Minimize Grid Impact of Vehicle Charging

Centralized aggregation of electric car charging data and centralized charging control can be used to mitigate the impact of a high number of electric cars charging on the grid.

Better Place Charge Spot Network

Better Place Public Parking Lot Charge Spot

Better Place Public In-home Charge Spot

Battery switch stations

The fully-automated battery switch stations provide a a simple and secure method to remove the battery from a vehicle and replace it with a fully-charged battery, without any involvement from the driver.

As a driver approaches a switch station, the car's on-board computer relays information on the type of battery needed. Upon arrival, the driver shifts the car into neutral, turns off the ignition and the car proceeds along guide rails into a switch-lane conveyor. The automated switch platform below the car aligns under the battery, initiates the battery release process and lowers the battery from the car. It then replaces the depleted battery with a fully-charged battery. This process can be completed in

approximately one to four minutes (including cleaning of the battery and the mechanism etc), allowing the driver a fast and safe range-extension solution. The depleted battery is stored in a charging bin and automatically transferred into a controlled charging environment, where a fully-depleted battery can be charged in approximately 60 minutes.

Battery switch stations should enable drivers to rapidly refuel by replacing a depleted battery with a fully charged one in less time than it takes to fill a tank with gasoline, thereby overcoming one of the critical traditional limitations of electric cars. This is expected to specifically address consumer concerns relating to the limited driving range of a single battery and long battery recharge times. Battery switch stations provide drivers with unlimited driving range (within deployment regions) in a convenient and accessible manner.

Better Place Battery Switch Stations

BSS Battery Switch In-Progress

Better Place BSS in Ekron, Israel

Electric car customer care and experience

An in-car communication system provides the interface between the driver, the battery, the car and Better Place. Drivers are provided with information about the state of the battery, access to charging and battery switching infrastructure, navigation assistance and other services that ensure a seamless driving experience. The system also includes media and communication services (e.g., music, video, games, search) and safety assistance services (e.g., emergency call center). Drivers can access the in-vehicle system via WiFi or cellular communication channels.

Better Place Customer Care

Oscar In-car Interface

Better Place Israel Operations Center

Electric Grid / Market Components

Electric car charge and grid management

The centralized Operations Center technology will be the "brains" of the Better Place operation and represents a complete suite of operations applications needed to effectively enable electric car services. The Operations Center will intelligently manage energy demand and interactions with the electric utility grid, battery inventory and certain customer management activities. As the Operations Center will have control over the timing and amount of charging for each individual subscriber on its network, real-time communication with the local electricity distributor and the wholesale market or its generation suppliers will help ensure that charging takes place within grid constraints and at optimal cost.

The Operations Center is designed to manage the entire Better Place electric car network, including:

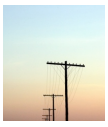
- The prioritization of consumer charging based on real-time customer data, including charge level, driving patterns, location and pricing package
- Optimizing the Better Place battery inventory by efficiently managing charging and maintaining optimal battery environment in BSSs
- Managing energy demand and other grid service applications for the electric utility grid

The Operations Center, together with the in-car software, will provide reassurance to drivers and can bring manageability and efficiencies to utilities, while providing cost-effectiveness to Better Place.

The Better Place "smart charging" solution includes aggregated energy demand management that can minimize charging requirements during peak electricity consumption hours and maximize the use of intermittent renewable electricity when available. Load management services, together with the ability to offer other grid services such as frequency regulation, will offer the potential for significant savings for electricity grid operators and revenue opportunities for Better Place.

Better Place manages a centrally controlled network of electric car batteries, which are connected to the grid via charge spots or via high-power quick chargers in each BSS. From the perspective of the electricity grid, a BSS has the potential to provide a large amount of grid-connected storage. Better Place believes its solution has the potential to provide utilities with energy demand management capabilities that can minimize charging requirements during peak electricity consumption hours by leveraging connectivity with the car and known user driving profiles. Better Place will have knowledge of each car's battery state and historical driving behavior. Better Place can take into account this data when managing the driver's current and anticipated charging demand, thereby ensuring that drivers receive sufficient charge for their needs while adjusting total network charging against the electricity supply constraints of the local grid.

The Israel Electric Company ("IEC") concluded in a November 2008 study that two million electric cars using Better Place's anticipated energy management capabilities could eliminate the need for additional generation capacity of 2.3 gigawatts (see table below) on a total current Israel electricity generation capacity base of 11.7 gigawatts. The IEC also stated that the Better Place energy management system (or a smart charging system like Better Place) is the only system they believe can be deployed without requiring new generation or transmission infrastructure, yielding significant benefits for all stakeholders.

	Ad Hoc Charging	Off Peak Incentive	Electric Car Network Operator
Generation 	Add 2,345 MW	Add 1,770 MW	No additional capacity required
Transmission 	Add 1 switching station, 10 substations and 18 transformers	Add 1 switching station, 7 substations and 13 transformers	No additional transmission required
Distribution 	Add 2,158 km of medium voltage cables	Add 1,581 km of cables	Add 287 km of cables
Total Cost	$4,586MM	$3,414MM	$471MM

Additionally, electric cars managed under a Better Place electricity demand aggregation system are expected to provide a potential solution to the storage challenges associated with intermittent renewable energy generation. Electric cars combined with a smart network are expected to be able to store renewable energy in the car batteries, control the time of day these batteries are charged, control the rate at which charging occurs and potentially deliver energy back to the grid from the

batteries. Addressing these challenges and maximizing these opportunities can significantly reduce greenhouse gas emissions from cars and significantly increase the earnings potential for Better Place.

Many markets with significant renewable energy generation suffer from low utilization of these resources due to a mismatch between the unpredictability of wind and solar resource generation and the strict supply reliability constraints that utilities face. This leads to under-exploitation of existing renewable resources, and consequent substitution with polluting thermal generation plants such as coal and natural gas. By providing an aggregated storage resource to utilities, Better Place hopes to dramatically improve the total emission profile by increasing the utilization of existing renewable energy resources. For example, 20% of Denmark's electric generation comes from wind-powered sources, with a significant amount of this power going unused because wind generation peaks at night. Better Place, however, can harness these resources given that the majority of electric car charging occurs overnight.