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Article (Accepted Version)

Why Did Better Place Fail?: Range Anxiety, Interpretive Flexibility, and Electric Vehicle Promotion in Denmark and Israel

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Abstract: With almost $1 billion in funding, Better Place was poised to become one of the most innovative companies in the electric mobility market. The system Better Place proposed had two novel prongs; first, to reduce the cost of batteries, and second, to reduce range anxiety, public infrastructure concerns, and long charging times. Yet, despite this seemingly strong combination, Better Place failed to make any progress in Denmark and Israel, the first two markets it operated in, and subsequently declared bankruptcy, selling off its collective assets for less than $500,000. Drawing from science and technology studies and the notion of "interpretive flexibility," this paper posits several reasons to explain the failure of Better Place, including that Denmark is not as "green" as it seems nor is the Israeli market as attractive as believed, and that Better Place's solution to charging time and range anxiety resolved a psychological, not a functional, barrier of the general public to adopt electric vehicles. Before investigating these two reasons, the paper presents a short history of Better Place and explores the contours of its operations in Denmark and Israel. It then discusses why Better Place "failed" across both countries before concluding with implications for energy planning, policy, and analysis.

Keywords: electric mobility; battery swapping; electric vehicles; business models

Acknowledgements: The authors are appreciative to the Research Councils United Kingdom (RCUK) Energy Program Grant EP/K011790/1 “Center on Innovation and Energy Demand” and the Danish Council for Independent Research (DFF) Sapere Aude Grant 4182-00033B “Societal Implications of a Vehicle-to-Grid Transition in Northern Europe,” which have supported elements of the work reported here. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of RCUK Energy Program or the DFF. The authors would also like to thank Gerardo Zarazua for his help finding data for the manuscript.

1. Introduction

Electric vehicles have the potential to provide society with many substantial benefits, including reduction of carbon emissions, improvement of public health, increasing national security, and savings on fuel and maintenance cost (Neubauer et al., 2012; Tran et al., 2012). Despite these benefits, electric vehicles have yet to be adopted on a large scale (IEA, 2013a) (IEA, 2015). Specifically in Denmark and Israel, electric vehicle adoption did not historically move beyond a very niche level. While Denmark has had a recent increase in EV sales, total alternative fueled vehicle registration in 2014 was stagnant at about only 3,000, only representing 0.1% of all vehicles in use in Denmark (ANFAC, 2015). Likewise, Israel currently has 1,088 electric vehicles, comprising 0.04% of total private registered vehicles (Central Bureau of Statistics, 2016). Several extant barriers to electric vehicles in the late 2000s encountered include higher capital cost, range anxiety, lack of public infrastructure, and long charging time (Lieven et al., 2011; Parsons et al., 2014; van Bree et al., 2010).

Seeking to erode these barriers, with almost $1 billion in funding Better Place proposed a novel system to differentiate the purchase of an electric vehicle with recharging the battery (Chafkin, 2014). The system Better Place proposed, launched in 2007, had two novel prongs; first, to reduce the cost of the battery, Better Place would own the battery in the electric vehicle, and consumers would instead pay for an annual “mileage plan” (much like a cell phone data plan), and second, to reduce range anxiety, public infrastructure concerns, and long charging time, Better Place constructed a network of chargers and battery swapping terminals for their consumers to recharge or switch their batteries. These two prongs would reduce initial capital costs, create a network of public chargers, and with battery-swapping, reduce charging time to as little as 2 minutes (Naor et al., 2015). As one magazine article put it, “Better Place was born to be revolutionary, the epitome of the kind of world-changing ambition that routinely gets celebrated”(Chafkin, 2014).

Thus, in principal, it would appear that Better Place was a well-conceived idea well-poised for success that entirely removed one of the barriers to electric vehicles, long recharging time, and reduce many of the other barriers. Moreover, Better Place, at least as they perceived it, was in one of the world's "greenest" markets in Denmark, and piloted in another country, Israel, desperately seeking energy security. While neither the "greenness" of Denmark nor Israel's prioritization of energy security would make or break the Better Place business model, Better Place viewed each of these countries as optimal environments that would help encourage electric vehicle adoption. Finally, Better Place had substantial amounts of funding and important partnerships with major automobile manufacturers, electric utilities and government departments. Nonetheless, despite this seemingly strong combination, Better Place failed to make any progress in Denmark and Israel, and subsequently declared bankruptcy, eventually selling their $850 million-in assets for only $450,000 in 2013 (Kloosterman, 2013).

This paper posits several reasons to explain the failure of Better Place, drawing from insights in science and technology studies that hold that new niche technologies possess "interpretive flexibility" and can be constrained by heterogeneous technical and social factors. These include that Denmark is not as "green" as it seems, Israel's concern of energy security did not prioritize decreasing oil consumption, and, more generally, that Better Place's solution to charging time and range anxiety resolved a psychological, not a functional, barrier of the general public to adopt electric vehicles. Before investigating these two reasons, the paper presents a short history of Better Place and explores the contours of its operations in Denmark and Israel. It then discusses why Better Place "failed" across both countries before concluding with implications for energy planning, policy, and analysis.

In embarking on this path, the contribution of the article is manifold. First, no studies have yet looked comparatively at Better Place performance across Denmark and Israel, the two markets where it was most embedded. The energy studies literature on the topic so far is out of date. Published studies

only focus on its likely trajectory as a success (Andersen et al., 2009; Budde Christensen et al., 2012; Kley et al., 2011), something invalidated by history. We explore why.

Second, examining the trials and tribulations of Better Place brings to the forefront discussions about the profitability and business models surrounding EVs, a topic of high relevance for those looking at secondary markets for batteries or attempting to eliminate key barriers such as range anxiety (Tyfield et al., 2015). A similar model to Better Place is being considered in France with the national electricity supplier EDF and the automobile manufacturer Toyota, whom are focusing on piloting the expansion of recharging networks in France and the United Kingdom (Enbysk, 2014). In these types of models, Better Place acts as something unique: an aggregator or integrator as well as the provider of infrastructure. To use an analogy from telephony, they are the AT&T rather than the Apple. Some have even framed Better Place's business model as a new archetype known as "Electric Recharge Grid Operators" or ERGOs which can become a transformative agent for merging electric mobility with renewable electricity infrastructure (Andersen et al. 2009). We test the efficacy of such claims.

Lastly, our comparative case study approach in this instance investigates not a project success, but a failure—something understudied in the literature due to both the difficulty in collecting data and the pejorative nature of dealing with unsuccessful projects that often result in bitterness and anger (Brix, 2015). Failure is also more common than success, with many possible permutations leading to failed innovation or adopt but only a contingent synergy of complex factors leading to success. Braun even suggests that "in analyzing technological development, failed innovations are just as important as, and possibly even more so than, successful ones" (Braun, 1992).

2. Research Methods and Concepts

Our primary method of data collection for this study was a review of the peer-reviewed literature on both electric mobility generally and more specifically the contours and operations of Better

Place. We searched key academic databases such as Scopus, ScienceDirect, and EBSCO-Host for articles published in the last ten years (2006-2015). During these searches, we looked for articles relating to (a) the social acceptance of electric vehicles, (b) business models for electric mobility, and (c) case studies of Better Place, of which there were only a handful) We compiled a few dozen studies though we reference only the most relevant ones here.

To help filter this voluminous amount of data, we relied on the concept of "interpretive flexibility" from science and technology studies. This literature argues the evolutionary pathway of a novel technology, such as an electric vehicle or a more refined business approach such as better Place, is not only a function of its technical qualities and characteristics, but equally so of its perception within society. In this context, interpretative flexibility is of great importance as it holds that technology emerges in society as a "seamless web" (Hughes, 1986) or a "sociotechnical imbroglio" (Latour, 1999). This concept of interpretive flexibility emphasizes the mutually constitutive nature of technology, which suggests that differing interpretations of the same technological device are possible. That is, different social groups see particular technologies in different ways. These technologies, then, become "heterogeneous" because their meaning, rather than being fixed, is interpreted and negotiated by those social groups connected to it (Sovacool, 2011). Pinch and Bijker distinguish that technological artifacts possess interpretive flexibility at two levels: first, in how different social groups conceive of technology; second, that there is no one possible way that technologies are designed (Pinch and Bijker, 1984). Artifacts are always the product of inter-group negotiation, and as we will see throughout the article, such negotiation does not always bode well for the future market acceptance of a technology.

3. History of Better Place

Better Place was founded by entrepreneur Shai Agassi in 2007 with the aim to imagine a society that was no longer reliant on fossil fuels. Better Place imagined that the two barriers to the adoption of

electric vehicles, and thus the barriers to removing oil from society, were the higher prices of electric vehicles and the problems associated with recharging the battery. While electric vehicles had higher capital costs, lower fuel and maintenance cost made them cost competitive with gasoline vehicles over time. Looking to capitalize on longer term economic benefits, Better Place formulated a way to reduce initial capital costs by monetizing the battery, and recharging thereof, as a service to which customers would subscribe. While Better Place would retain the ownership of the battery, its main value was providing energy for consumer's batteries, either through its charging network or its battery swapping stations (Wolfson et al., 2011).

Better Place originally focused on Israel, where they planned a large network of charging and swapping stations to cover the entire nation by 2012. This plan included 2.5 charging spots for every car on the road in Israel, starting with 500,000 charges, in total costing between $50 and $100 million (Andersen et al., 2009). At the same time, Better Place did not restrict its operations only to Israel and soon expanded to Denmark, with plans to expand to Australia, China, and the United States. Better Place partnered with Renault, and their joint battery swap-capable car was the Renault Fluence Z.E.[1] In Denmark, the vehicle cost $37,000, plus about $1,500 for their personal home charger (Loveday, 2011). At the same time, the Fluence Z.E. sold for $35,000 In Israel (Chafkin, 2014). On top of these costs, drivers were offered a "subscription" plan that allowed them to utilize Better Place's charging infrastructure, based on the amount of miles driven per year, with prices ranging from $3,300 to $6,700 per year, or $275 to $560 per month (Loveday, 2011).

To give readers a bit more detail, in Table 1, we compare Better Place's capital and monthly costs to the costs of the bestselling ICEVs in Denmark (NationMaster, 2014) and Israel (Auto1, 2015) (OECD, 2013) from 2013 (the Volkswagen Golf (Statistics Denmark, 2015) and the Kia Picanto (Gasnier,

[1] Thus, the cars were actually sold by Renault and at their dealerships, but they were jointly designed and advertised with Better Place.

2014), respectively) based on average driving behavior in each country (Technical University of Denmark, 2015),(Central Bureau of Statistics, 2015) and 2013 average gasoline prices (OECD, 2014). While Better Place was a substantially cheaper capital in Denmark, and roughly the same capital cost in Israel, the monthly cost was markedly higher for the Better Place subscription plans. While surveys have found that people are willing to pay thousands of dollars more for an electric vehicle (Larson et al., 2014), (Hidrue et al., 2011), perhaps Better Place was premature due to its costly monthly plan (though presumably still more than 1,400 consumers would still be interested in the two countries).

[INSERT TABLE 1 about here]

Soon after beginning their operations in these two countries, Better Place began to quickly expand its plans internationally. Next came Australia, where the electric utility AGL and the finance house Macquarie Bank explored applying the model there with support from the state government of Victoria (Andersen et al., 2009). Then in the US, the mayors of several Bay Area cities in California (including San Francisco) signed on, and Hawaii became the first state in the US to sign up for statewide coverage in early 2009 (Andersen et al., 2009).

Better Place planned on building the system for electric vehicles before selling the electric vehicles. Based on the assumptions that the lack of a charging system was a main barrier to the adoption of electric vehicles, constructing this large system would have been a costly, but certainly logical foundation to base their business on. Moreover, by amortizing the high capital cost of the electric vehicle to more manageable yearly payments, Better Place appeared to set itself up as a solution to electric vehicle implementation's biggest problems. Nevertheless, in 2013, Better Place announced bankruptcy after selling less than 1,000 vehicles in Israel and fewer than 400 vehicles in Denmark.

4. Why didn't the Danish support Better Place: Are Danes truly "Green"?

While Better Place's main operation occurred in Israel, Better Place conducted a survey and found that Danish people were the next most likely users to consider purchasing an electric vehicle (Naor et al., 2015) and began operations there in 2011. Indeed, given Denmark's reputation as a leader on climate change, one would assume that Danes would be very willing to adopt electric vehicles. However, this did not happen in the case of Better Place, as only a few hundred vehicles were sold in total.

To be sure, there were some legitimate technical and business concerns. The significantly colder climate in Denmark meant that lithium ion batteries did not perform as well as in the arid climate of Israel, something exacerbated by the additional strain that the salting of roads (in the winter) had on the degradation of battery performance (Younesi, 2013). While battery degradation is not an insurmountable barrier, as EV adoption in Norway would show, these concerns may have added to the *perceived* barriers to EV adoption in Denmark. These technical problems were coupled with structural flaws in the business model – as one formal employee stated (quoted in (Chafkin, 2014)):

> Everything we needed to go right went wrong. Every cost on our spreadsheet wound up being double, every time factor took twice as long. There was nothing normal about Better Place.

For instance, Better Place's battery-swapping stations, one of them shown in Figure 1, were projected to cost about $500,000 each; they ended up costing more than $2 million. In addition, there were problems with hiring, problems with marketing, and limited oversight by the company's board of directors.

[INSERT FIGURE 1 ABOUT HERE]

Such difficulties became full-fledged crises when they seriously jeopardized the management of the company. Although Shai Agassi labelled himself a "serial entrepreneur," he had no direct experience

with automotive manufacturing or electric mobility. Agassi also hired his little brother Tal Agassi to manage the battery swapping stations components of BP, despite the fact that he had experience only in accounting. In this way, BP promoters succumbed to a process of "selective remembrance" where they ignored or forgot historical data suggesting that BP was neither novel nor the first to propose battery swapping. For instance, the Electric Vehicle Company in the United States operated a Battery Exchange Station on Broadway in New York City for a fleet of electric taxis in 1900 which ran until 1912, and the battery swapping itself occurred in three to four minutes via a hydraulic stabilizer (Kirsch, 2000). Furthermore, BP repeatedly misrepresented actual vehicle ownership and operating costs to users. Agassi reputedly said in meetings and speeches his car would be cheaper than conventional ones or even free; yet in Denmark, due to higher transportation costs and income taxes for dealerships, a BP car cost close to $40,000 (excluding the cost of the battery). A fascination with the BP vision also meant that BP managers didn't pay close enough attention to their contracts with suppliers which created more than $100 million in liabilities that started to accrue as delays and technical difficulties occurred. BP lost $80 million alone with troubles over a billing system software with the firm Amdocs (Chafkin, 2014).

But these concerns are certainly and strongly complimented by social ones. There is a clear incongruity with the perception that Danes are "green" and the lack of adoption of electric vehicles. One explanation is that Danes are not as "actively" green as one might assume. To some, Denmark is renowned the world over for being a "green" country (Jamison and Baark, 1999), famous for its emphasis on healthy, active, non-motorized transport (Pucher and Buehler, 2008). Indeed, Copenhagen was awarded the European Green Capital Award for 2014 for planning to have 50% of commuters cycling to their offices in 2015 and to become carbon neutral in 2025 (Business Insights, 2014).

Yet while Denmark has achieved substantial success in certain aspects of climate change mitigation, such as decreasing economic carbon intensity, implementing wind energy and combined heat and power (CHP), while maintaining taxes on fossil fuels and carbon dioxide (Sovacool, 2013), these actions have required little to no active behavioral changes from the Danish public. Indeed, a recent study on Danish environmental attitudes found that very few people knew their price of electricity, and often overestimated their own knowledge of environmental issues (Sovacool and Blyth, 2015). The main accomplishments of Danish climate change mitigation, e.g., energy efficiency and wind energy, required little to no behavioral change from the average Danish consumer. On the other hand, switching their gasoline vehicle would require several different behavior changes, even with Better Place's plans for an extensive charger and battery swap network.

In spite of Denmark's reputation, Danish consumers seem no more likely to be willing to change behavior to be more environmental. Indeed, Danish consumers may be "passively" green, in that the main achievements of Denmark are largely invisible to the average Danish consumer. Given the broad policy support of wind turbines, and the already high cost of electricity, the transition from coal in the 1990s to the current mix of CHP and wind did not require substantial behavior changes or increases in energy expenditures from the average Danish consumer. Compare this to electric vehicles; though fuel prices are highly taxed, the switch to electric vehicles would require substantial behavior change (e.g., more planning due to limited driving range, charging overnight or at work), something the average Danish consumer declined to do, despite their "passive" greenness.

Compounding this issue is that Danish people view themselves as renewable energy leaders, especially in Europe. Indeed, many Danes may feel as if their other "green" actions, such as paying a premium for cleaner electricity, are compensating for their environmental impacts from their vehicles (Flamm and Agrawal, 2012). Moreover, surveys have found that Danes are more resistant to changing their entrenched attitudes and behavior (Sovacool and Blyth, 2015), and also have found waning

environmental attitudes in Denmark (Sovacool and Tambo, 2016). Thus not only is Denmark is not inherently more attuned to being green and adopting electric vehicles, it may be less willing to change their behavior than neighboring European countries. Kilbourne et al. (2002) conducted a multinational survey of energy and environmental attitudes, and concluded that Danish respondents were less accepting of change, and more set in their values, than every other country studied except for the United States. Payne (2013) also suggests that Danish people are also known for being stoic and less emotional than other European societies, evoking their own type of "defensive pessimism" and "negative politeness culture."

In Denmark, therefore, there is no easy solution to the implementation of electric vehicles, and perhaps existing incentives remain insufficient. In contrast to the stagnation of electric vehicles adoption, Demark has established a successful recipe for mitigating the climate emissions from its electricity grid. For example, Denmark accomplished a large scale replacement of coal and oil with CHP and wind as result of several factors including; consistent, long-term government support of renewables by way of taxes, R&D and subsidies; polycentric planning that included all stakeholders; and utilizing learning-by-doing, bottom up focus of implementation (Lund, 2010),(Parajuli, 2012). In contrast, the extent of Danish support of electric vehicles includes taxes on gasoline, electric vehicle registration tax exemption (which expired at the end of 2015), and investment in public charging infrastructure (IEA, 2013b), as Table 2 documents. In comparison to Denmark's broad policy support of wind, electric vehicles are correspondingly under-incentivized, as well as requiring more substantial behavioral change. If Denmark aims to eliminate the climate change emissions from its transportation system, the idea was that it should at least replicate the same steps they took to encourage wind energy, in order to encourage the adoption of electric vehicles.

[INSERT TABLE 2 ABOUT HERE]

Of course, incentivizing electric vehicles is quite different than encouraging the development wind energy, as electric vehicles will require the average Danish consumer to change their behavior. Indeed, some authors have postulated that the mitigation of climate change may only occur when changes to the average consumer is incremental and not encroaching on their lifestyle (Naor et al., 2015). Switching to an electric vehicle requires that Danish consumers usually invest in a higher capital cost as well as change their behavior, as well as their identity. To the extent possible, governments should seek to enact policies that minimize the economic, behavioral, and social differences between gasoline vehicles and electric vehicles if they wish to reduce the carbon emissions associated with personal vehicle use.

In sum, Denmark was not inherently more prone to adopt electric vehicles than any other country that Better Place could have operated in, in spite of their green reputation. Sustainable development of transportation systems requires both personal willingness to change behavior as well as consistent government support. Absent both of these factors, market-based solutions like Better Place, despite their novelty, will face an uphill challenge, in Denmark and beyond.

5. Why didn't the Israelis support Better Place? Don't they value energy security?

In addition to Denmark, Better Place originally operated in Israel. Israel seemed to be an appropriate location to adopt electric vehicles, given its lack of domestic oil resources and its ongoing and persistent geopolitical strife with neighboring oil-rich countries. Not surprisingly, Israel has been recently concerned with its energy security and pushing for energy self-sufficiency in light of regional hostility and mistrust (Bahgat, 2014). In addition to the energy security benefits of electric vehicles, Israel is also especially prone to the impacts of climate change as a result of its hot, dry climate and growing concern of water supply (Bahgat, 2014), (Newman, 2009). Thus, reduction of oil consumption—which leads to significant amounts of water pollution through normal operations, accidents, and

resulting emissions from tailpipes—would appear to have several clear benefit to Israeli society that would directly incentivize the development of a self-sufficient, renewable transportation system. Thus while Better Place viewed Denmark as an optimal market to operate due to their "greenness", Israel was perceived as amenable environment due to their commitment to energy security.

Adding this to Israel's concern for energy security, Israel also has a rich history of environmental awareness, with an active and large environmental community, with over a hundred active and legally register environmental non-governmental organizations (Tal et al., 2013). However, Israel's environmental community is markedly different than the rest of the Western world, as Israeli environmental concern does not originate from subjective materialistic values (e.g., level of education and income), but rather as a response to more of environmental hazard that poses an existential threat (Drori and Yuchtman-Yaar, 2002). Oil consumption and climate change appears to constitute a real threat to Israel's national security, energy security, and environmental quality. In spite of the security threat and historical environmental awareness, Israel's climate change and environmental trend in recent years has been largely negative, and per capita greenhouse gas emissions, already higher than most European standards, are expected to double over the next 15 years (Tal et al., 2013). Thus, despite an active environmental community and citizen awareness of general environmental issues, as well as Israel's prioritization of energy security, very little direct action has been taken to mitigate greenhouse gas emissions.

Essentially, Israel's securitization of energy stands as separate and arguably more important than environmental concerns. Israel has long prioritized the security of its fuel supply, regardless of if it was fossil fuel based or renewable. Because Israel's energy system is almost entirely disconnected from its neighboring countries, it is considered an "energy island" (Bahgat, 2008), (Fischhendler, 2015). After the Yom Kippur War and the oil crises in 1970s and 1980s, Israel imported coal its primary fuel source

for electricity (Teschner and Paavola, 2013), and began importing oil from various non-Arab regions, including Russia, the Caspian Sea and Africa (Bahgat, 2014), (Fischhendler and Nathan, 2014).

This growing dependence has had three somewhat negative implications for Better Place. First, because an isolated electricity grid is more difficult to maintain reliably, as documented by rolling blackouts in the early 2000's (costing the Israeli economy hundreds of millions of dollars) (Fischhendler, 2015), there has been more of a focus to develop and diversify reliable fuel supplies for electricity, not transport. This essentially minimizes the importance of oil dependence for Israeli, at least vis-à-vis electricity. For example, the one connection Israel's energy system had with a neighboring country was a natural gas pipeline with Egypt, where Israel agreed to purchase 60 billion cubic feet (bcf) per year of natural gas from Egypt. However, the pipeline has been attacked a dozen times by terrorists and since been suspended by Egyptian authorities (Bahgat, 2014), and is unlikely to continue, making Israel's electricity grid more vulnerable (Siddig and Grethe, 2014), (Bahgat, 2014). As such, energy policy in Israel has focused largely on the electricity grid rather than transport, even though the policies set in place to develop a more robust electric grid would also have developed an electric grid readily capable of cheaply charging EVs (Teschner and Paavola, 2013). In 2010, the Israeli government passed a climate change bill (the National GHG Emissions Reduction Act), focusing on reducing electricity consumption by promoting energy efficiency, development of solar energy and the development of natural gas, but was critiqued by the environmental community for failing to take a system-wide approach (such as implementation of a carbon tax) (Michaels and Tal, 2015).

In stark contrast, there has been little discussion or policy regarding the energy security of oil and the electrification of transportation in Israel. As shown in Table 2 above, the extent of policies encouraging EV adoption in Israel is largely an exemption from taxes. Likewise, because Israel largely imports it oil from distant countries (Bahgat, 2008), the fuel supply and consumption of oil continues to be disconnected from Israel's prioritization of energy security. A disruption of one Israel's oil suppliers

would entail switching importers and potentially increasing gasoline prices, while a disruption in natural gas supply could potentially cause economically devastating blackouts (Michaels and Tal, 2015)(Teschner and Paavola, 2013).

Second, such dependence has convinced Israel to focus on natural gas as a preferred fuel source for power and vehicles, cannibalizing the market potential for electric mobility. Around the same time as its pipeline was getting attacked, Israel discovered one of the largest offshore natural gas deposits in the world, aptly named Leviathan, estimated at a size of 16,000 trillion cubic feet (tcf), vastly outweighing Israel's annual use of 0.24 tcf/year (Bahgat, 2014). Israel's electricity grid remains (according to some) "on the verge of a crisis" (Teschner and Paavola, 2013), and the development of domestic offshore natural gas would have substantial economic implications, increasing the welfare of Israelis by $300-$400 million (Siddig and Grethe, 2014). Thus, energy policy discussions have frequently centered on the importance of developing and diversifying to natural gas, not electric mobility (Fischhendler and Nathan, 2014). Similarly, the development of solar electricity facilities in the Negev Desert has likewise been discussed in the context of energy security and independence (Fischhendler, 2015).

Third, and further hurting markets for EVs, Israel has enacted some of the most beneficial policies and incentives for the development of fossil fuels, and somewhat marginalized environmental concerns such as climate change (Bahgat, 2014). Israelis think of climate change as a quality of life issue and therefore put other elements of national security first (Michaels and Tal, 2015), rather viewing climate change as a real, present, environmental hazard that Driori & Yuchtman-Yaar (2002) postulated led to greater environmental awareness among Israelis. And worse yet, even when environmental issues are visible to the Israeli, studies have shown that Israeli citizens tend to blame largely government and industry, almost none blame citizens. For example, a survey conducted in Israel's three largest cities found that around 80% to 90% of the blame regarding air pollution should be the central or local

government, with less than 2% of the blame associated with private citizens (Drori and Yuchtman-Yaar 2002). Absent significant and substantial government support for electric vehicles, it is unlikely that citizens will adopt electric vehicles out of their own impetus for purely environmental reasons. Confusingly, Israelis and their institutions are well aware of many of the ecological problems in their country, often acknowledge their severity, but fail to take any action to prevent environmental degradation, showing signs of "environmental schizophrenia" (Newman, 2009).

The average Israeli may not "connect the dots" to the energy security implications and environmental impacts of their transportation and oil consumption. Thus, similar to how Danes are "passively" green, we propose that Israelis are "passively" energy secure. Like Denmark's prioritization of green energy, Israel's prioritization of energy security has largely been done without the active participation of Israeli citizens – rather it has been done at a national scale. While natural gas and solar development do not require action of average Israelis, the adoption of electric vehicles requires personal investment and behavioral change. Without the support of policy or the securitization of transportation (Michaels and Tal, 2015), Better Place also faced an uphill battle with the Israeli public. Finally, a large portion of the Israeli vehicle fleet, especially newly purchased vehicles, are purchased by employers and offered as employment benefits (Frenkel, Bendit, and Kaplan 2014). Indeed, a significant subsection of the Israeli population does not pay for their car or its fuel (Bahgat, 2014), further removing the consumer from being "actively" energy secure. Thus, the average Israeli citizen, assuming that they were not provided a company car already, may not have viewed Better Place in the context of energy security nor have been willing to pay for its environmental benefits.

In sum, Israel is indeed very concerned about energy security, however it is mostly associated with developing their own supplies of fossil fuels, and little was done to actually encourage more sustainable transport. While Israelis were thought to be more cognizant of environmental issues, these are not defined in terms of national security (Newman, 2009), and often take the backseat to more

traditionally focused energy security issues such as import dependence or security of supply. At the same time, the environmental community in Israel has not made great strides in proactive climate change mitigation policies, but rather focus on responding to environmental hazards – essentially dealing with the symptoms, not the roots, of environmental problems (Tal et al., 2013). While it was expected that Israel would define climate change and oil consumption in terms of national security, this argument never truly gained traction, and led to a lack of government support of renewable energy systems (Michaels and Tal 2015), as well as indifference from the Israeli public. As a result of Israel decoupling oil consumption from matters of national security, the argument for the adoption of EVs was solely environmental, and still required substantial behavioral change from the average Israeli. Absent consistent and substantial policy support, Better Place, despite its potential, geopolitical, energy security and environmental benefits to Israel, competed in a market that was not inherently more supportive of electric vehicles than any other country.

6. Why Didn't Better Place Overcome Range Anxiety?

The fact that Denmark and Israel may have not been special environments for electric vehicles to flourish may not explain the failure of Better Place in these two countries by itself. Moreover, Better Place also failed to make a substantial mark in other parts of the world, despite their seemingly solid business model. From a purely electric vehicle perspective (ignoring variances in environmental perspectives from country to country), this paper contends that the main barriers that Better Place attempted to resolve, long charging time and range anxiety, may not be the most salient barriers to electric vehicle adoption.

From a purely technical perspective, the range of most electric vehicles is already more than sufficient for the vast majority of trips taken by personal vehicles (and it has been for many years). For example, in California, Zhang et al (2015) found that the average vehicle traveled only 7.8 miles per trip,

and 31.8 miles per day. Moreover, with installing only 290 charging stations in the entire state, the authors found that 98% of vehicles could feasibly be converted to electric vehicles. If people were willing to alter their driving behavior for no more than 10 days a year, then well over 95% of people's driving needs could be met by an electric vehicle with a range of only 100 miles (Pearre et al., 2011). Likewise, even after substantial wear on the battery, such as 20% loss of battery capacity, 85% of daily travel needs can still be met, implying "that range anxiety may be an over-stated concern" (Saxena et al., 2015).

In spite of this, however, it has long been established the average consumer *views* range anxiety and charging time as a major barrier to the adoption of electric vehicles. However, of the several factors that form range anxiety, such as battery size, charging infrastructure, and charging time, most surveys have shown that reducing charging time is the least of these barriers. For example, Hidrue et al. (2011) found that people are willing to pay 44% more to extend the range of an electric vehicle from 150 miles to 200 miles than to decrease the charging time from 1 hour to 10 minutes. Perhaps the average consumer is willing to stop for longer if this implies that they would have to stop less often. The difference in additional willingness-to-pay (WTP) for reducing charging time from 1 hour to ten minutes is roughly similar to the additional WTP for increasing the performance of the electric vehicle from 5% slower than a gasoline vehicle to 5% faster (Hidrue et al., 2011).

Likewise, a study in South Korea found that consumers were willing to pay $2,500 as a lump sum to increase the accessibility of chargers from just ordinary locations to specialized locations, such as at gas stations (Hong et al., 2012). On an annual basis, Hong et al. (2012) noted that South Korean consumers were only willing to pay $1,250 per year for the ability to swap batteries, and $751 a year to be guaranteed access to chargers in all locations. Adding these numbers together, about $2,000 per year, is still significantly less than any of Better Place's annual subscription plans, which were 50% to 300% more expensive than this WTP (Loveday, 2011). Therefore, while the average consumer is willing

to pay more to make charging more convenient and accessible, it is not clear that the creation of a quick and large network of chargers and battery swapping stations would erode a major barrier to the adoption of electric vehicles, nor would it be cost effective.

In light of the above, the question remains why range anxiety persists as a barrier to adoption of electric vehicles. Some studies have found that driving range was no longer considered a problem after drivers experienced electric vehicles (Ryghaug and Toftaker, 2014),(Rauh et al., 2014). Range anxiety could be borne largely out of their ignorance of daily driving practices compared to an electric vehicle's technical capabilities. At the same time, other studies found that after experiencing electric vehicles, range anxiety continued to be a critical factor for drivers, in some cases increasing (Jensen et al., 2013), (Krause et al., 2013). Thus, confusingly, range anxiety has been found to both decrease and increase after an individual experiences driving of an electric vehicle.

Perhaps range anxiety, and the correlated need for public charging infrastructure, is not dependent on the technical aspects of the electric vehicle or the charging system, but rather entirely dependent on individual characteristics (Rauh et al., 2014). Essentially, those who have characteristics more attuned to driving an electric vehicle will view range anxiety is a limited barrier, whereas those who reject electric vehicles will view range anxiety as a major barrier, even after driving an electric vehicle. We concur with Kirsch (2000: 24-25), who astutely noted more than a decade ago that:

> Blaming the battery does not provide a full explanation … the shorthand determinism explicit in the blame-the-battery explanation continues to cloud present debates about the future role of alternatives to internal combustion.

If, for instance, energy density and other salient technical properties govern technological preferences alone, we would all drive uranium fueled, fission-powered cars. Thus, the solution to range anxiety may not be construction of an expansive and expensive charging and battery swapping network, but rather investigating the individual characteristics that determine general willingness to buy an electric vehicle.

Indeed, because changing behavior, expectations and attitudes regarding electric vehicles may be untenable (Flamm and Agrawal, 2012), the best solution to range anxiety may be drastically increasing performance of batteries and chargers such their designs minimize alterations to lifestyle and behavior in comparison to the traditional vehicle (Sovacool and Hirsh, 2009). Nonetheless, until that point, range anxiety may continue to be a post-hoc excuse for consumers to reject electric vehicles in order to avoid changing their behavior or desires. However, the structure of Better Place as a company was designed specifically to reduce range anxiety and make recharging an electric vehicle more like a traditional gasoline vehicle, yet still failed. Examining the failure of Better Place, as well as the existing literature, this paper proposes that range anxiety may only be the surface of a much deeper, more complex problem regarding identity and electric vehicles.

7. The Future of Battery Swapping: Will there be another Better Place?

Though Better Place failed due to a mix of overstretch, overinvestment in battery swapping technology, general mismanagement, and a misunderstanding of its first two core markets, there are several reasons that battery swapping may still be in the future of electric vehicles. Tesla has recently investigated battery swapping technology (but putting off large-scale development until interest develops)(Korosec, 2015), and battery swapping remains the only way to recharge an EV to a similar rates to traditional gasoline vehicles. One major driver that may lead to the future development of battery swapping stations is the drastic historical and projected future decreases to battery costs (DOE, 2014). Since Better Place was in operation, battery prices per kWh capacity have dropped by about half, and are projected to drop by another half in the coming years. This would have greatly reduced the cost of having extra batteries stored in the swapping station network. At the same time, the development of vehicle-to-grid (V2G) technology could have also presented another use for the batteries in the swapping stations (Battistelli and Conejo, 2014). Both of these would have reduced the operational cost

of the charging and battery swapping network, and this financial stability may have allowed Better Place more time to get Israelis and Danes to adopt EVs.

On the other hand, there are several reasons that battery swapping may already be obsolete. Because batteries are becoming cheaper, combined with future technology developments increasing capacity (DOE, 2014), the future electric vehicle will likely have a range of 200 to 300 miles , greatly reducing the times where charging outside of the home or work is even necessary (Zhang et al., 2015). Second, the average charger will continue to increase in capacity, becoming more efficient and has become less costly, thereby reducing recharging time, and decreasing the marginal benefits of battery swapping (Yilmaz and Krein, 2013) (Burger and Reichert, 2011) (Korosec, 2015). Finally, large-scale implementation of battery swapping would likely require standardization across car manufacturers, but car companies would have limited incentive to all agree to a single standard (Budde Christensen et al., 2012). Thus, the future of battery swapping is at a critical juncture, where it could become obsolete or relegated to a niche role in the EV infrastructure system.

8. Conclusion and Policy Implications

In sum, Better Place presented a novel idea to reduce range anxiety and the high capital cost of electric vehicles, and operated in one of the most widely-perceived "green" societies in the world (Denmark) alongside one where energy security is perceived to be of paramount concern (Israel). Nonetheless, Better Place operated from only 2007 to 2013, failing to sell more than 400 vehicles in Denmark and 900 vehicles in Israel. This paper finds that this failure can be explained by a confluence of social, technical, political, and environmental factors that precipitated the demise of BP. These factors cut across environmental attitudes and resistance to change among users, mismanagement and strategic blunders involving corporate strategy, and higher than expected capital costs for vehicles. In addition, the fact that Danish society is only "passively" greener than other societies, and because

electric vehicles require active changes to behavior or lifestyle, electric vehicle implementation in Denmark was still an uphill challenge. In Israel, general government and citizen environmental awareness did not translate to interest in electric vehicle adoption because this was not viewed as either an essential energy or national security issue. These all created a "seamless web" of sociotechnical constraints on BP's ability to successfully meet its mission and promote its rather innovative business model, leaving their vehicles and charging stations open to "interpretive flexibility" where many potential adopters simply rejected the technology.

Moreover, this paper supposes that range anxiety may not be a functional barrier to electric vehicle adoption, and may instead be an excuse given by consumers to refrain from changing their behavior, identity and desires regarding ownership of a vehicle. We must, as Kirsch has noted, reject the determinism inherent in the "blame the battery" explanation for failure. Future developers of electric vehicles and its systems should be cognizant of the potentially deeper connotations of range anxiety pertaining to consumer's personalities and the required governmental, societal, and personal support required for successful implementation of electric vehicles.

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