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Research Report – UCD-ITS-RR-12-41

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January 2012

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Learning about electric vehicle range: findings from the UC Davis MINI E consumer study

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Word Count: 5,149
Number of Figures/Tables: 9 X 250 = 2,250
Combined Word Count: 7,399

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ABSTRACT

Popular media and even researchers commonly assume that battery electric vehicle (BEV) ownership will provide consumers less performance and mobility. A common claim is that consumers will have constant worry about the range of their BEV, often termed “range anxiety”. BMW converted 450 MINI Coopers to all-electric drive (named the *MINI E*) and leased them to fleets and 235 private households in the Los Angeles and New York/New Jersey regions from Spring 2009 to Spring 2010. Through the course of the one-year lease, UC Davis researchers conducted multiple online surveys, in-person interviews, and administered weeklong driving diaries. This paper explores the reactions of MINI E drivers to the range of the MINI E through the framework of a Lifestyle Learning Process. Over time, MINI E drivers learned how the 104-mile range of the MINI E fit into their lifestyles. Drivers adapted and explored with their MINI E through activities like altering driving behavior (such as speed and trip routes), optimizing charging opportunities, trip planning, and educating themselves on distances to destinations with the help of online mapping tools. In the course of the UC Davis MINI E Consumer Study, we found evidence suggesting that range was not a major concern among these early adopters. Even with no public charging available to their vehicle, 100 percent of survey respondents stated that BEVs are suitable for daily use. The results of this study will be of interest to policymakers and practitioners interested in expanding the BEV market.

INTRODUCTION

Battery electric vehicles (BEVs) introduce a wider set of differences into the consumer experience than do hybrids or other alternative fuel vehicles. These differences include new social meanings, unique vehicle drive feel, new sounds, a shorter range (50-150 miles), longer refueling times, completely new refueling locations (home, work, parking lots, etc.), new units of energy (kWh), new payment systems (home electricity bill), new maintenance regimes, different ways of measuring emissions (at power plants) and other differences arising from using electricity rather than gasoline or diesel.

One challenge to understanding how consumers might assess these new technologies is that their evaluation will unfold over a long period of personal experience. Even with conventional vehicles, buyers often suspend judgment on a new purchase – a "honeymoon period" - during which they learn to use and enjoy the particular features of a new vehicle. BEVs have a broad variety of new attributes for buyers to experience, thus this honeymoon period is expanded and can include a greater sense of discovery and adventure.

Analytic approaches often compare internal combustion engine (ICE) vehicles and BEVs in a non-historical, quantitative format and attempt to assign monetary values to a set of vehicle attributes, not all of which have an explicit monetary value. In some cases, these analyses use survey data from respondents who have no experience with BEVs *(1,2)*. However, with new technologies like BEVs, the functionality, pleasures, problems, meanings, and values of vehicle purchases unfold over time, a process we call lifestyle exploration.

Popular media and even researchers commonly assume that battery electric vehicle (BEV) ownership will provide consumers less performance and mobility, resulting in lack of consumer demand in the market *(3,4)*. MINI E drivers were willing to put up with challenges and situations that from the outside seem impractical. However, these drivers were engaged in a period of lifestyle exploration during which they found value in attributes of BEVs beyond the obvious. The well-known limitations of range and long recharge times may be outweighed by a whole new set of activities and values discovered through their lifestyle exploration. The goal of this paper is to outline the consumer response to limited range of an electric vehicle through a framework of a lifestyle learning process.

The UC Davis MINI E Consumer Study *(5)*

The BMW MINI E trial offers the largest and most recent investigation of driver response to BEVs. The MINI E is a useful platform for this investigation in that its nostalgic design is well liked, but is distinct from other BEV designs, which are more futuristic or untested in the public. While the battery took the back seat and storage area of the MINI E away, this design allowed BMW and UC Davis researchers to explore the market response to a sporty electric vehicle with a powerful battery and motor with an already-popular vehicle design.

BMW offered MINI E leases to consumers based on an online screening recruitment survey administered by MINI USA. Households were chosen only if they lived in the Los Angeles area or the New York / New Jersey area, where BMW would be able to provide support for the vehicles. A critical component to this process was determining the consumer had an appropriate place to install a home charger. In addition, the $850 (+tax) monthly lease price acted as a filter that led to mostly affluent households receiving MINI Es.

Once the selection process was complete, 235 private U.S. households leased MINI Es. Fifty-four of those households volunteered to be part of a more intensive study by the UC Davis

team. Throughout this article we will refer to the group of 235 households as the *full sample*, the subset of 54 households as the *UCD sample,* and the remaining 181 households as the *BMW sample*.

DATA COLLECTION TOOLS AND METHODS

In this study we used surveys, interviews, and driving diaries to learn about the MINI E drivers. Figure 1 shows the timeline of the study along with the various data collection tools and their sample sizes. BMW, Chemnitz Technical University (Germany) and UC Davis researchers worked together on the content of the surveys to ensure coverage of the many technical and behavioral issues of interest.

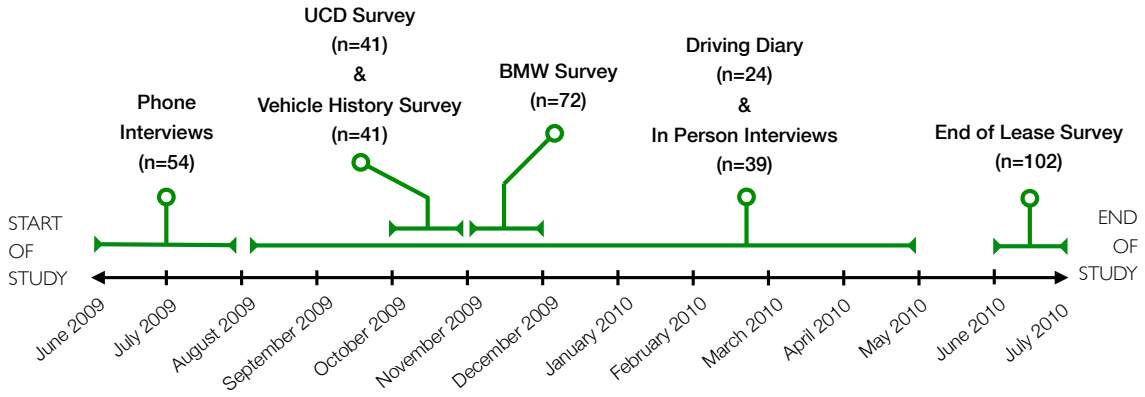

FIGURE 1 – MINI E study timeline and sample sizes of the various data collection tools

Online Surveys

The first online survey was developed by UC Davis researchers and sent to the 54 households in the UCD sample during October 2009. The questions focused on why households leased a MINI E, range, attitudes toward BEVs, environmental attitudes, purchasing behavior, and driving behavior.

The second online survey was sent to the non-UCD sample of 181 US households leasing the MINI E and was primarily developed by BMW and conducted in November 2009. We refer to this survey as the BMW survey. Respondents answered questions regarding driving range, opinions about BEVs, charging and batteries, the MINI E as a whole, acoustics, regenerative braking, dashboard displays, safety, mobility, purchase intentions, and human and BEV environmental impacts.

At the conclusion of the first year of MINI E leases, we sent the last online survey out to the full sample of 235 MINI E drivers to ask some new questions as well as see if their opinions had changed over the course of the year. We refer to as the end-of-lease survey. This survey was conducted in July 2010 and comprised the following subjects related to the MINI E: general experience and use, attitudes toward BEVs, technical aspects, charging and range, and pricing.

Driving Diaries and Maps

Prior to interviewing the households in the UCD sample, we sent them driving diaries to fill out for a week. We asked the households to indicate their destinations, how far they traveled to each destination, the SOC at the end of each trip, whether they had a passenger or cargo in the vehicle, and whether they charged the vehicle once it returned home. For the 24 households that completed driving diaries, we used the diaries in the in-person interviews to better understand

each household's driving and recharging habits. The diaries also indicated if a trip was modified or canceled due to any limiting factor of the MINI E and what that limitation was.

Some MINI E drivers supplemented their driving diaries with Google maps. The Google maps tool is a new research device that we used to try to explore the activity space of a household in a clear, visual manner. We asked drivers to enter their regular destinations into a personalized Google map and color-code those destinations according to the frequency of travel. We used these in the interviews to aid discussions of activity space and critical destinations. If a household did not complete the Google map, we substituted a paper map of their region during the interviews to help visualize and understand their current and desired activity space.

Interviews

During the first two months of the project, June and July 2009, we interviewed all 54 households in the UC Davis sample over the phone. This was timed such that the households had either not yet received the MINI E or had only had it for a short time so we could get an idea of their early perceptions of BEVs. This interview focused on drivers interest and motivations, how they plan to use the MINI E, and knowledge and perceptions of electric vehicles compared to combustion engine vehicles.

Between August 2009 and May 2010, we conducted in-person, interviews with 39 of the 54 households in the UCD sample. Most of the in-person interviews took places in the drivers' homes. During each interview, we discussed the household's vehicle purchase patterns, current household fleet, the MINI E community, the driving diary and Google map, experience with the MINI E, charging behavior, environmental attitudes, and used priority tables to explore the household's desired BEV design and charging availability.

Analysis Framework: A Lifestyle Learning Process

The analysis in this report is framed around understanding this learning process by splitting it into three phases: Discovery, Translation, and Application. The inspiration for this particular framework is Nobel Laureate Tim Hunt, who uses the three steps to describe the social process of science.

Figure 2 shows the three phases of the learning process and an example for each of the two routes that drivers may follow through these phases.

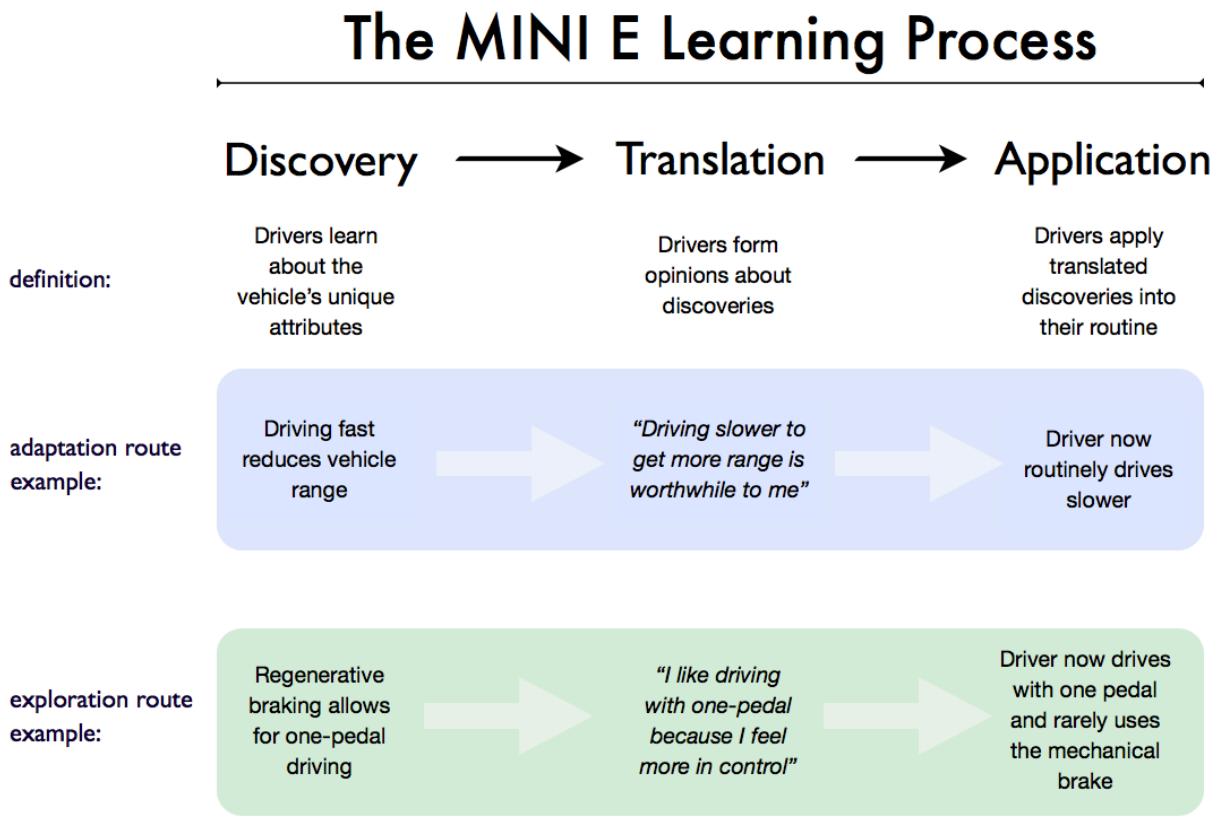

FIGURE 2 - The MINI E Learning Process

In **discovery**, drivers learn about the unique attributes of an electric drive vehicle, such as its drive feel, regenerative braking system, range, using electricity as a fuel, and how vehicle speed and accessories affect range. Drivers also discover what their co-workers, friends, or families think of their new-technology vehicle.

In **translation**, drivers evaluate their discoveries both individually and through dialogue with family, friends, and other BEV drivers. For example, drivers may evaluate whether they prefer charging at home to refueling at gasoline stations. In translation, drivers decide if they and their households like the lifestyle package BEVs offer.

In **application**, drivers incorporate translated discoveries into their lifestyles, deepening the value and commitment. For example, drivers who discover that they like how quiet the vehicle is at low speeds or the vehicle's rapid acceleration seek out driving contexts in which they can enjoy these features.

There are two *routes* that a driver can follow through the MINI E Learning Process. In one route, **expansion**, drivers explored new lifestyle opportunities resulting from these dimensions. One example of expansion is a newfound interest in energy use. Several MINI E buyers became interested in solar electricity through their experience with the MINI E and bought photovoltaic panels for their home. In the other route, **adaptation**, drivers found ways to compensate for the limitations of the MINI E. For instance, drivers swapped vehicles with other drivers in the household when they needed additional seats, cargo space or driving range.

RESULTS: DRIVER RESPONSE TO MINI E RANGE

The driving range of a BEV is lower than that of an ICE vehicle due to there being less energy stored on board a BEV than on board an ICE vehicle. Conventionally fueled vehicles can go over 300 miles on a single tank and can be refueled quickly at gas stations. The test range of the MINI E is 180 km (111 miles) and on the FTP72 test cycle 240 km (149 miles) before it is fully discharged and must be plugged-in for approximately four hours to recharge. Highly efficient vehicles like the MINI E are very sensitive to weather conditions, driving speed and style, accessory loads, and route detail (such as topography). Therefore, BEVs like the MINI E show a wide distribution of experienced ranges across drivers, seasons, and trips. Given the limited energy of batteries, this wide distribution of "ranges" makes learning about range an important process for drivers, especially if their lifestyles, driving style, or local climate challenge the energy storage of a particular design.

Our households did drive their MINI Es less than the average new vehicle in the US, which is 13,200 miles *(6)*. Based on self-reported estimates in the end-of-lease survey, the MINI Es averaged 8,639 miles over the course of the year, with a wide distribution of mileages across the households. According to our surveys and interviews, a significant portion of the lost mileage can be attributed to the vehicle being a two-seater with reduced storage. In addition, there was no public or workplace charging for most drivers, so the MINI E trial is not yet a test of the average mileage for a sample of BEVs. We found that households *adapted* their driving around the capabilities of the vehicle and even *explored* ways to maximize the use of the MINI E. Households mentioned not being able to do specific trips due to range limits, but did not express an overall feeling of losing mobility.

Learning about MINI E range

This discussion focuses on drivers' reactions to the limited range of the MINI E and BEVs in general. The MINI E also has limited cargo and passenger space. Some survey questions targeted range whereas others address general limitations of the MINI E, which may include range, cargo space, and passenger space.

Ninety-five percent of the 102 respondents to the end-of-lease survey reported driving the MINI E 80 or fewer miles per day on average. Figure 3 shows the percent of days versus daily vehicle miles traveled (VMT), where each point represents a driver's daily mileage. These daily VMT values were based on information from 24 weeklong driving diaries, with a total of 168 days shown in the chart. The chart shows that most drivers were not pushing the range of the vehicle on a daily basis. However, on occasion drivers did drive more than the single-charge range of the vehicle in a day, with the maximum daily distance being 184 miles. This happened when drivers went through the exploration route of the learning process; drivers discovered that they could charge more between trips in anticipation of a high mileage day. They applied this behavior only when necessary, learning over time how often and when to charge, ensuring they had enough range for their day's activities.

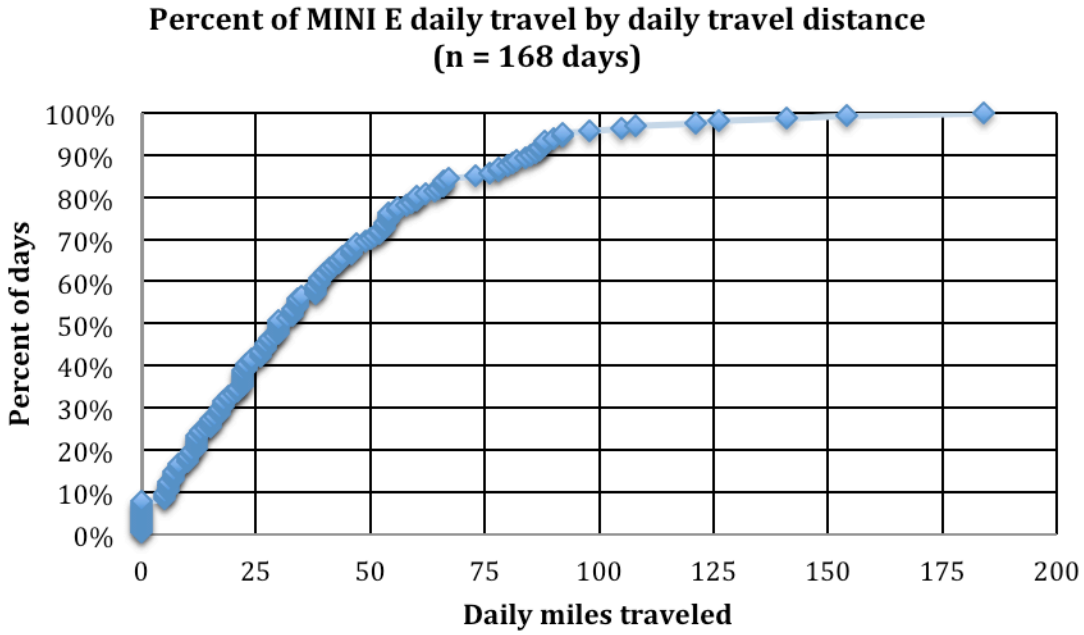

FIGURE 3 – The chart shows the percentage of days MINI Es were driven the specified distances. The data were taken from 24 MINI E seven-day driving diaries in our study.

Many households learned that they were driving the MINI E more than expected; the following is one example of a trend that we heard in many of the in-person interviews.

> *"The MINI E has been reliable and fun to drive. It has definitely exceeded my expectations in terms of general utility. I expected to be able to use it for 70 percent of my driving but I have actually used it for 97 percent of my driving." – Survey household 15*

Figure 4 shows that 100 percent of the BMW survey respondents agree that electric vehicles are suitable for daily use, based on their experiences with the MINI E. Although this question asked about general suitability of BEVs, range would be one of the considerations for daily use.

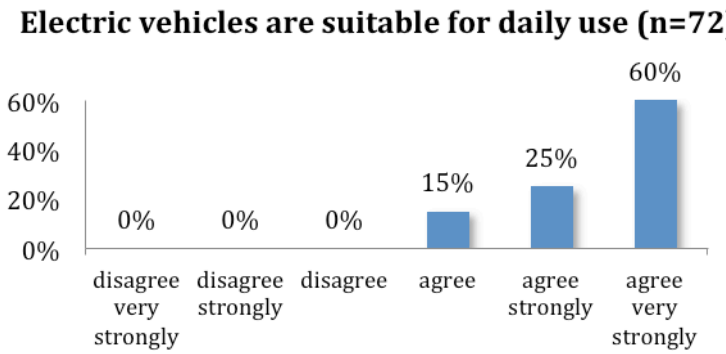

FIGURE 4 - EVs are suitable for daily use (BMW Survey)

Despite their stated satisfaction with the range of the MINI E, we discovered from the end-of-lease survey that 81 percent of drivers wanted to access places in their MINI E that the range did not allow. It seems that drivers desired destinations were primarily infrequent destinations rather than routine driving. Out of all the desired destinations reported by drivers, 77 percent of them would be visited once a month or less.

The following discussion of desired destinations focuses on the responses from the 81 percent of people who responded that they did want to travel outside of the range of the MINI E. Drivers' desired destinations varied by trip type (e.g. work, shopping, family, etc.), trip frequency (e.g. monthly, annually), and distance. Figure 5 shows a breakdown of these desired destination types, the most common of which are recreation/entertainment and family/friends.

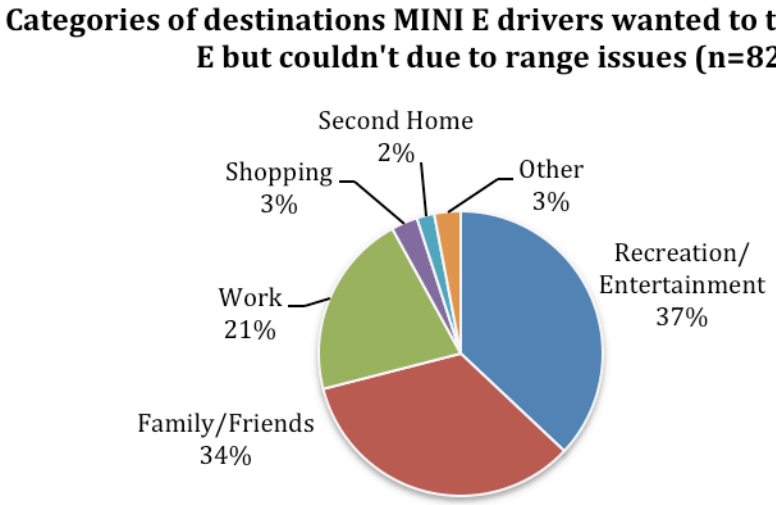

FIGURE 5 – Categories of locations MINI E drivers wanted to drive their MINI E, but couldn't because of range (End-of-lease survey)

Figure 6 shows the distances between driver's home locations and their desired destinations reported in the survey. The one-way distances were calculated using shortest-time paths along the road network between each driver's home location and desired destinations. About half of the desired destinations are actually within the range of the MINI E. However, the distances are one-way and do not include other possible stops that might be taken in a driver's tour, which explains why drivers were not able to use their MINI E for those trips. Work place charging or charging at their desired destination may have enabled these trips to take place.

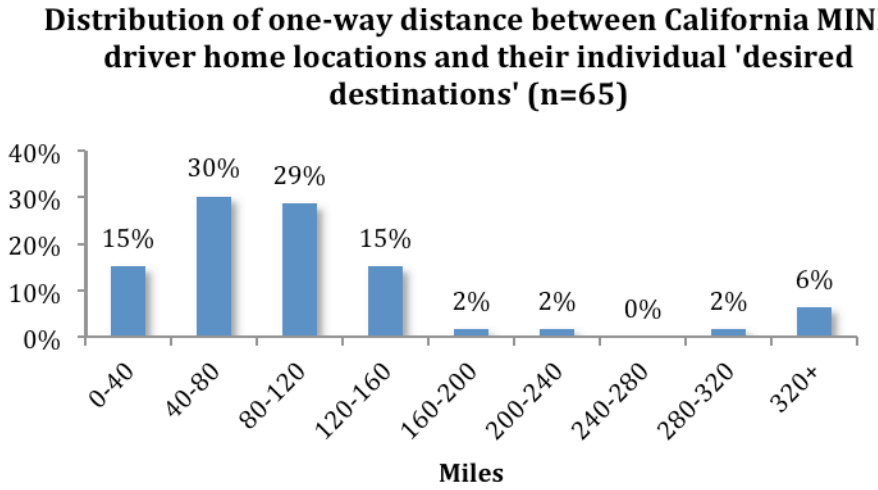

FIGURE 6 - Distribution of distances between MINI E drivers' home locations and desired destinations (End-of-lease survey)

In Southern California, since most home locations were concentrated around Los Angeles, neighboring regional cities like San Diego, Santa Barbara, and Palm Springs were among the most common places drivers would like to drive to in the MINI E. Another common area was downtown Los Angeles, Los Angeles International Airport, and nearby cities. Although most drivers lived around Los Angeles, a few lived on the outside edge of the city, like Victorville and were unable to drive the MINI E to and from the core of Los Angeles without either additional range or charging. Another explanation for the high number of desired destinations in the city center was people chaining multiple trips together throughout the day. The sum of multiple short trips' distances exceeded the range of the vehicle and they were therefore unable to make it to destinations that are relatively close to their home.

The home locations and desired destinations of the California end-of-lease survey respondents are shown in Figure 7. Drivers' desired destinations are aggregated at the city level; the size of each bubble on the map represents how many drivers listed a given city in the survey that wanted to access in their MINI E, but couldn't or preferred not to because of range issues.

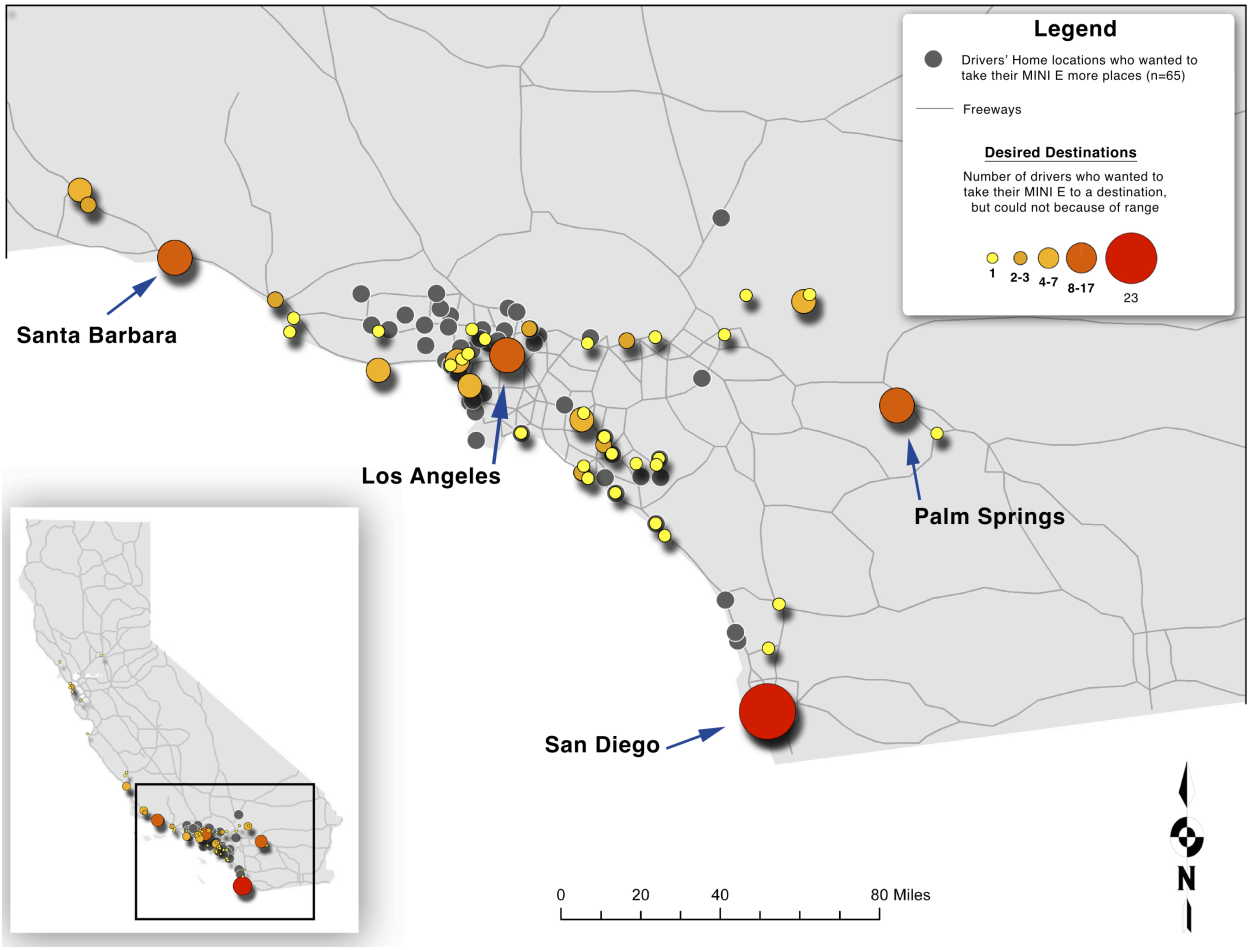

FIGURE 7 - Map showing home locations and desired destinations for California MINI E drivers who wanted to travel beyond the range of the vehicle.

A line density of the road network routes used to calculate the distance between home and desired destinations from the data in Figure 5 and 6. The calculated route density is illustrated spatially in Figure 8, where the dark red colors show the sections of road network that had the highest number of generated shortest-time routes between home locations and desired destinations. The sections of freeway around Santa Barbara, San Diego and downtown Los Angeles have the highest density, which coincides with popular desired destinations and areas near the home locations.

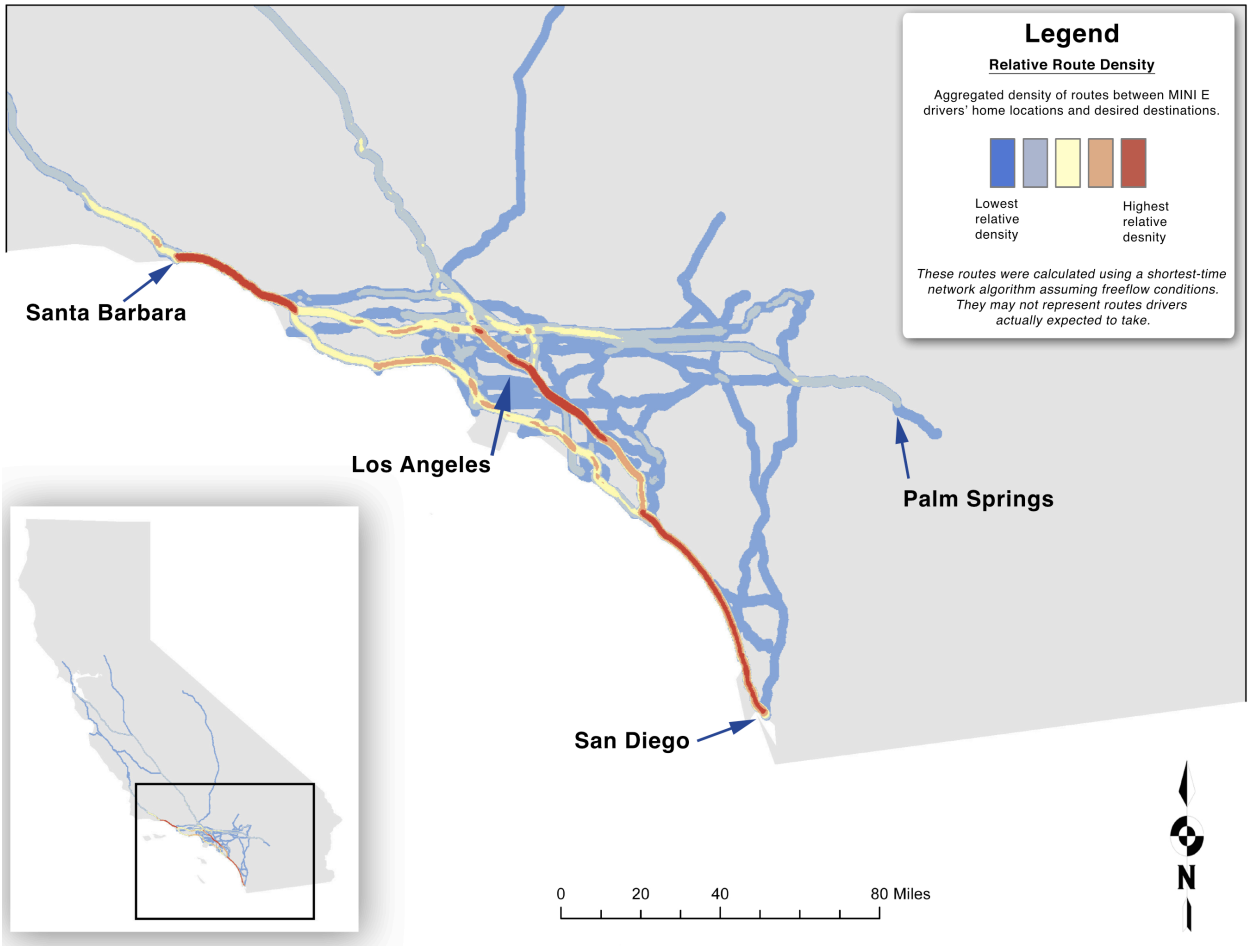

FIGURE 8 - Map showing a line density of the routes between California MINI E drivers and their desired destinations

Given that 89 percent of the destinations that drivers wanted to take their MINI E are within 160 miles of their homes, it appears that strategic placement of charging stations could allow drivers to make it to most of their desired destinations with a 90-100 mile range electric vehicle.

Drivers learned that the MINI E was capable of satisfying the bulk of their driving needs. Most households preferred to drive the MINI E and wanted to use it for more trips. In interviews, we asked households what their ideal range for a BEV would be and the most common response was 120 miles.

Adaptations to the MINI E's Range

The limited range of electric vehicles leads to a set of learned adaptations and new behaviors on the part of BEV drivers. Turrentine and Kurani discuss adaptations from simulation games in the 1990s *(7)*. These adaptations included:

1. Using a gas vehicle for long trips
2. Trip chaining
3. Eliminating trips

MINI E drivers developed additional adaptations that were not foreseen in the simulation work:

1. Learning the distance between personal activity locations (work, shopping, post office, friends) and sometimes finding alternate locations within range
2. Planning trips using GPS or online mapping tools
3. Turning off the air-conditioning or the heater to increase range
4. Driving slower
5. Employing hypermiling techniques
6. Switching to another vehicle when the MINI E had a low battery
7. Using the 120 volt convenience charger at work or other destinations

The MINI E was limited not just by range, but also by seating capacity and cargo space. In fact, many MINI E drivers found that the two seats and limited cargo space were more restrictive than the limited range, which made it difficult to carry unplanned extra passengers and cargo. While several households were able to fit impressive quantities of cargo into the vehicle, the limited interior space was mentioned frequently in interviews. For example, one couple described having to return some items after arriving at their MINI E and discovering that they could not carry home what they had purchased. To compensate for the limitations of the MINI E - whether it be by range, seats or cargo space - the primary adaptation was for households to use a second car; 94% of respondents in the BMW survey (n=72) agreed to using a second vehicle to overcome limitations of the MINI E (including cargo and passenger space).

Other measures that households took to adapt to the limited range of the MINI E were to employ multi-modal driving, for example using various modes of transportation for different legs of a trip. The other modes may include carpooling, using the train, or even renting a car. One significant method that drivers employed to learn and adapt to the limited range of the MINI E was the use of GPS devices or online mapping tools to plan their routes ahead of time, and ensure that the MINI E would be able to complete the trip. Household 4 noted that this might be a challenge for BEV drivers:

> "*Most people wouldn't have the patience to drive this car because of all the brain power it takes to plan the trips.*" *– Household 4*

Other households did not find planning to be an inconvenience and employed a trip planning process using online mapping or GPS, similar to the one described below:

> *"First, [I used] Google maps to … plan my route. Second, … I know it's going to be… 81 miles round trip or something like that. I would either not use the car before hand [to do] errands or school runs or whatever, or I would do that and then plug in before I [left].*
> *(Interviewer clarification: Make sure you started with 100 percent?)*
> *Right. Secondly, trying to do my homework…is there a facility or someplace where I could plug in?" – Household 42*

MINI E drivers were willing to adapt to the limitations of the MINI E that they discovered. Most drivers were not seriously inconvenienced by having to make changes to their lifestyles to accommodate the use of the MINI E. In fact, these pioneers moved past adaptation and explored new uses of the MINI E.

Exploration of MINI E Range

MINI E drivers described many outings with the MINI E that were more like exploration than routine activity. Several households talked about driving more with the MINI E than with their other cars. For example, one household commented on the expansion of their driving using the MINI E compared to the vehicle it replaced:

> *"I'm driving more with the MINI E than with the normal car, and that has been an absolute shocker for me. .....Expectation was that it would be my commute car, but we wouldn't use it, and what's happened is the reverse is absolutely true.....there's one trip we haven't made in the car....when we're home the MINI E is always the car that we take." – Household 50*

Most MINI E drivers preferred to use the MINI E as their primary vehicle even when roomier conventional vehicles with a longer range were available in their driveways. Across our sample, drivers learned that the MINI E's range satisfied most of their driving needs. Drivers will shift the responsibilities among the vehicles in their fleet to maximize their utilization of the MINI E. For instance, a household might use a secondary vehicle instead of the MINI E for long vacation trips beyond the range or when they need more cargo space. However, when possible some drivers replace trips done in other household vehicles for the MINI E. The motivation for this switch can be for the driving performance (fast and fun), operating costs (cheaper than gas), environmental (cleaner than gas), social reasons, or any combination thereof. In addition to switching trips among their household fleet, drivers would even create new trips and activities, going places they did not go in other vehicles.

Drivers often used trips that they would normally take in another car as opportunities to use and show off the MINI E. For example, one business-oriented respondent wanted to engage visiting investors in talking about integrating BEVs into housing developments they were planning. He described parking the MINI E near the front door of a restaurant so the investors would notice the MINI E when they entered the restaurant. The MINI E driver was particularly pleased to find another MINI E also parked near the door on the same day. This driver explored using the MINI E to start a discussion about broader environmental efforts, which was a role that his conventional car could not perform.

MINI E drivers spent much of the interviews discussing the territory in which they were operating the vehicle and the uses they were discovering. They were often proud of having driven the vehicle to distant locations or organizing a long and complicated day. For example, if they lived in Pasadena, they described driving to the beach for dinner, or if they lived near the coast, they described driving to the inland areas. Based on one driver's hand-drawn map during an interview, we created Figure 9, which compares the respondent's MINI E territory to his gasoline vehicle territory.

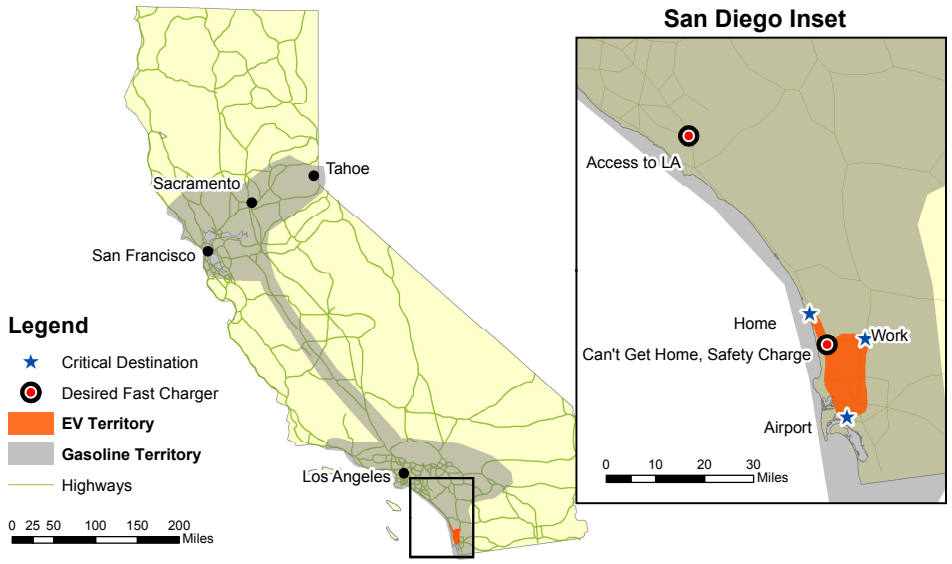

FIGURE 9 - MINI E territory versus gasoline vehicle territory. The map was constructed in an in-person interview on a paper map. The driver was asked to mark the area in which he had taken each vehicle over its lifetime.

Despite the difference in the sizes of the gasoline vehicle and MINI E territories, this MINI E driver discussed the MINI E's range as meeting most of his driving needs. The one exception was that he wanted to drive to Los Angeles in the MINI E (hence his selection of downtown Los Angeles as a desired spot for a fast charger). The driver did not refer to his MINI E territory as small or limiting. In fact, he described his use of the MINI E in terms of adventure. This framing of the use of the MINI E as a discovery of BEV territory was normal, not exceptional, in our sample.

CONCLUSION

It is important for policymakers and practitioners seeking to expand the BEV market to understand how consumers perceive and use electric vehicles as they enter the market place. How will consumers decide what range works for their lifestyle? Over the lease period MINI E drivers went through a learning process to understand how the MINI E's range fit into their lifestyle. When necessary, drivers adapted and explored driving techniques and charging behaviors to maximize their use of the MINI E. Drivers initially perceived the 104-mile range of the MINI E as a limitation, but after using the MINI E for one year, many drivers discovered that the available range suited their daily needs. Without a similar trial period, consumers may overestimate the range required to meet their driving needs and therefore decide that a BEV would not meet their driving needs.

It is therefore important for consumers to understand their daily driving patterns in order to accurately ascertain if a BEV would fit their lifestyles. MINI E drivers had the opportunity to learn about BEVs through direct and long-term experience. It might also be possible that this lifestyle learning process can be simulated through existing or future online or mobile applications to help users determine if a BEV's range would satisfy their driving needs by tracking their travel behavior and simulating charging when they park. In addition, potential BEV buyers can learn from the experiences of people in their social network. These learning tools do not allow consumers first-hand experience with the other BEV driving characteristics

that influence their ultimate opinions about the technology. However, It is not clear to us which method of learning about BEVs is superior. Future research may identify effective ways for consumers to learn about the overall value package that BEVs offer without requiring long-term, first-hand experience.

REFERENCES

1. Axsen, Jonn and Kenneth S. 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, Research Report UCD-ITS-RR-08-22. 2008.
2. Axsen, J., Mountain, D.C., Jaccard, M. *Combining stated and revealed choice research to simulate the neighbor effect: The case of hybrid-electric vehicles*. Resource and Energy Economics 31, 221-238. 2009.
3. Christensen, C. M., Shuman Talukdar, Richard Alton, Michael B. Horn. *Picking Green Tech's Winners and Losers*. Stanford Social Innovation Review, Stanford. 2011.
4. Hickman, L. *Will electric cars ever take over roads?* The Gaurdian. 2011.
5. Turrentine, Thomas S., Dahlia Garas, Andy Lentz, Justin Woodjack. *The UC Davis MINI E Consumer Study*. Research Report UCD-ITS-RR-11-05. Institute of Transportation Studies, University of California, Davis. 2011.
6. United States Department of Energy (USDOE) Transportation Energy Databook, 29th ed., Table 8.9. http://cta.ornl.gov/data/index.shtml, 2010.
7. Turrentine, T. and K.S Kurani. *The Household Market for Electric Vehicles: Testing the Hybrid Household Hypothesis— A Reflexively Designed Survey of New-car-buying, Multi-vehicle California Households*. Report prepared for the California Air Resources Board and The California Environmental Protection Agency. Institute of Transportation Studies, University of California: Davis California. Report UCD-ITS-RR-95-5. 1995.