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Clean Transportation Program
FINAL PROJECT REPORT

Fuel Cell Electric Vehicle Carshare Program

**Prepared for: California Energy Commission
Prepared by: StratosFuel, Inc**

**Gavin Newsom, Governor
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ACKNOWLEDGEMENTS

StratosFuel, Inc. was founded in 2014 with the vision to make hydrogen an everyday fuel. They have carried this vision by implementing three strategies to make hydrogen available to everyone: Renewable Hydrogen Production, Retail Hydrogen Stations, and Shared FCEV Mobility. Through these three strategies, Stratos was able to develop a hydrogen ecosystem that encompasses all levels of hydrogen mobility.

That being said, Stratos's vision would not have been possible if it were not for the support of the California Energy Commission. The CEC has the foresight and understanding that hydrogen will play a major role in the decarbonization of the transportation system. As such, the CEC has invested funds into StratosFuel, as well as other companies to develop hydrogen infrastructure. Furthermore, StratosShare also recognize Toyota Motor of North America, Launch Mobility, University California Riverside, City of Riverside, and Luxivair Airport for providing the hardware, software, vehicles, and parking locations for the StratosShare vehicles.

Finally, the comprehensive efforts of the StratosFuel team to bring the StratosShare program to life must be highlighted. Each team member played a key role in the deployment, and operation of StratosShare. They ensured each of the vehicles were ready to rent and customers were adequately taken care of.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational. The Clean Transportation Program has an annual budget of about \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued GFO-16-605 to fund projects that will demonstrate innovative electric vehicle mobility services in four specified areas in California. In response to GFO-16-605, StratosFuel, Inc. submitted an application for an all hydrogen electric mobility service in the Inland Empire (San Bernardino and Riverside Counties). The application was listed in the CEC Notice of Proposed Awards (NOPA) on September 10, 2017 and the agreement was executed December 18, 2017.

ABSTRACT

The California Energy Commission awarded a \$684,421 grant to StratosFuel, Inc. under GFO-16-605 to deploy a fleet of hydrogen electric vehicles that can be rented by the hour or day through a smartphone app. The vehicles were to be deployed in disadvantage communities within Riverside and San Bernardino Counties. These areas were chosen for initial vehicle deployment because they had high levels of pollution, and Cal Enviro ratings of over 90. Moreover, these communities did not have zero-emission or on-demand transportation services available.

Overall, the project deployed 15 vehicles at six locations throughout the Cities of San Bernardino and Riverside. The parking locations were carefully selected based on accessibility, visibility, and density. The parking locations were at downtown districts, universities, hotels, municipal airports, and transit hubs. Each parking location was retrofitted with signage, and visible through the StratosShare app.

Based on this, StratosFuel was able to successfully implement an on-demand hydrogen carshare program. The system functions by users downloading the StratosShare app to reserve, unlock, and start a vehicle from their phone. To implement such a service, each vehicle was equipped with special hardware that allowed communications with StratosFuel servers to authenticate user reservations. To advertise the program to members of the community, StratosFuel distributed marketing material throughout the Cities.

Keywords: carshare, fuel cell electric vehicle, shared mobility

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EXECUTIVE SUMMARY

Introduction

Carshare is a mode of car rental where customers rent cars for short periods of time, often by the hour. Carsharing typically works by providing a network of cars to pre-screened members for short-term use, with rental time generally measured in hours rather than days like traditional car rental. The service is ideal for mid-to-long range trips (five to 20 miles, or more). A single hourly price generally includes the costs of fuel and insurance, and often parking and tolls. Rentals are exclusively self-service, relying on apps and transponders that allow remote access to vehicles.

Overall, there are two forms of carsharing, station-based, and one-way. Station based carsharing is when vehicles are picked up and returned to set parking spots. While one-way carsharing is when users can pick up and leave cars anywhere within a service area. This flexibility enables carsharing to provide many benefits to the community it serves. For example, carsharing is seen as a form of transportation that can reduce congestion, pollution, and provide a more inclusive mobility service. It can also serve as a reliable first and last miles solution for commuters.

To capitalize on the many benefits of carsharing, the California Energy Commission awarded funds to deploy zero-emission carshare programs within disadvantage communities. Understanding that, Riverside and San Bernardino were locations that fit the criteria under this grant solicitation. Through the solicitation GFO-16-605 StratosFuel proposed a zero-emission carshare program, which they called StratosShare. StratosShare is a subsidiary of StratosFuel that is designed to operate shared mobility services in an effort to generate hydrogen demand. Through this, StratosShare staked out multiple parking locations within Riverside and San Bernardino Counties to deploy shared vehicles. These vehicles were hydrogen powered and rented by the hour or day through the StratosShare app.

The program was launched in late 2019 and attracted over 2,000 active members. These members would rent on a regular basis and use the vehicles for short-term use. At the program's height, 80% of the vehicles were being utilized daily. At the onset of COVID-19, StratosShare saw a reduction in travel, which forced the program to focus on servicing essential workers.

References in this document about StratosShare refer to the shared mobility program, or carshare. Overall, prior to this project, there were no zero-emission carshare programs within the State of California. This project was the first of its kind within these areas, and the first to utilize hydrogen fuel cell electric vehicles as the prime vehicle type.

CHAPTER 1:

Vehicle Procurement

Procuring a fleet of hydrogen fuel cell electric vehicles (FCEVs) required various steps and the following summarizes the most critical items.

Purchase & Delivery of Vehicles

For this project, StratosFuel chose Toyota Motor of North America (TMNA) as the vehicle partner. Based on this, Toyota was selected to supply up to 15 Mirai hydrogen FCEVs. In order to procure these vehicles, StratosFuel had to review pricing from Toyota dealerships that sold the Mirai. The fleet group at TMNA assisted Stratos in sending out Requests for Information (RFI) on vehicle pricing. Stratos received quotes from almost every dealership that sold the Mirai. After narrowing down the RFI responses, Longo Toyota, located in El Monte, California offered the most economical price and was willing to meet the project's procurement schedule.

Once the vehicle vendor was selected, Stratos was registered into the dealerships fleet portal, where they imputed their company information and insurance documentation. From this point Stratos initiated a purchase order of \$645,000 for 15 Toyota Mirai vehicles at a price of \$43,000 each.

On June 26, 2018, Stratos took delivery of 15 Toyota Mirai at Longo Toyota in El Monte, California. Stratos assembled a team of drivers to transport the vehicles from the dealership to a parking lot in Riverside, California. See Figure 1 for a photograph of the fleet delivery.

Figure 1: Fleet Delivery



Source: Markedbylove Photography

Registration and Insurance of Vehicle

During the time when Stratos was taking delivery of the vehicles they registered all 15 of them with the California Department of Motor Vehicles (DMV) under StratosFuel, Inc. Immediately after the vehicles were registered, Stratos ordered digital license plates from Reviver Auto, located in Granite Bay to be installed on all of the vehicles. The digital license plates helped to manage the fleet by enabling vehicle registration online. See Figure 2. Furthermore, the digital license plates provided an extra level of telemetry to help with the data collection portion of the project.

Figure 2: Digital License Plates



Source: StratosFuel, Inc.

After the registration was complete, Stratos placed all the vehicles under the company's commercial insurance policy. Based on this, the commercial insurance policy only covered the vehicles for company use and not for rentals. Stratos did not intend to place the vehicles under a rental insurance policy until all the vehicle hardware and software was installed. Though during this time, Stratos's insurance agent was speaking with multiple rental insurance agencies about the project to source the most cost-effective rate. In ~~November, November~~ 2018, all vehicles were placed under a rental insurance policy that provided comprehensive and liability protection for the company and its renters.

CHAPTER 2:

Integration of Software and Hardware

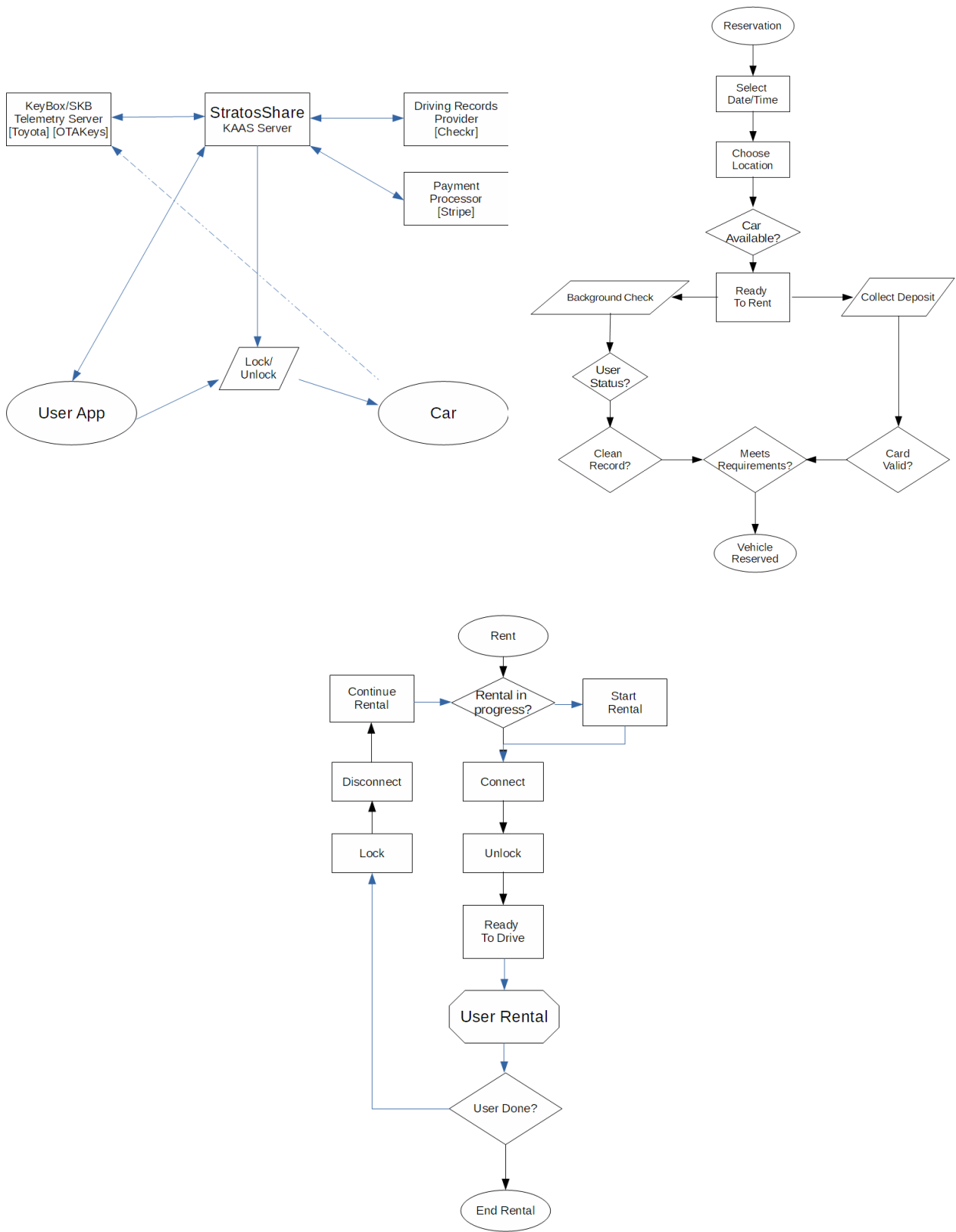
StratosFuel developed and integrated reservation software and telemetry hardware which they installed in the FCEVs to communicate with the StratosFuel servers for the vehicle data, location, mileage, fuel, battery voltage, and reservations.

In August 2018 StratosFuel met with Toyota Connect (TC), located in Plano, Texas. TC is the group in charge of vehicle connectivity and hardware for TMNA. During this meeting, StratosFuel and TC discussed the requirements for connecting OBDII devices to the Toyota Mirai. OBDII devices utilize a vehicles onboard OBDII port to communicate vehicle data. Based on the initial discussion, it was found that the OBDII devices would not be able to provide key metrics for the project, such as mileage and fuel. TC recommended that StratosShare utilize a Toyota made device called a smart key box. The smart key box would have the ability to communicate all key data points, as well as unlock, and start the vehicle through an app. Understanding this, StratosFuel ordered 15 smart key box units from Toyota in September 2018.

Though after initial testing of the smart key box units, it was found that they were not communicating accurately location data. This was due in part because it was sending vehicle location pings every 30 minutes via a GPS signal. For the purpose of the project, this was not acceptable and needed real time data. Through this, Stratos got in contact with OTA keys, who manufactures a hardware system that communicates vehicle location and telemetry via an LTE connection. After a trial, Stratos ordered 15 additional hardware units from OTA because they provided accurate telemetry. In addition to resolving the connectivity issues, OTA keys also provided a secondary access point into the vehicles. The OTA keys allow for users and staff to gain access into the vehicles through a Radio Frequency Identification (RFID) key card. Through this, Stratos was able to provide key cards to staff as opposed to using the app or physical keys.

Figure 3 depicts the flow chart of the hardware and software communications.

Figure 3: Flow Chart of Hardware and Software Communications



Hardware Installation

For the project, specialty hardware was used for the vehicles to communicate with software. Based on this, the hardware needed to be installed in such a way that it prevented theft and maximized communication. This process required for the dashboards of each vehicle to be removed so that the hardware could be installed. To install the hardware, Stratos contracted with Longo Toyota. See Figure 4.

Figure 4: Photograph Showing the Installed Reservation Hardware





Source: Stratosfuel, Inc.

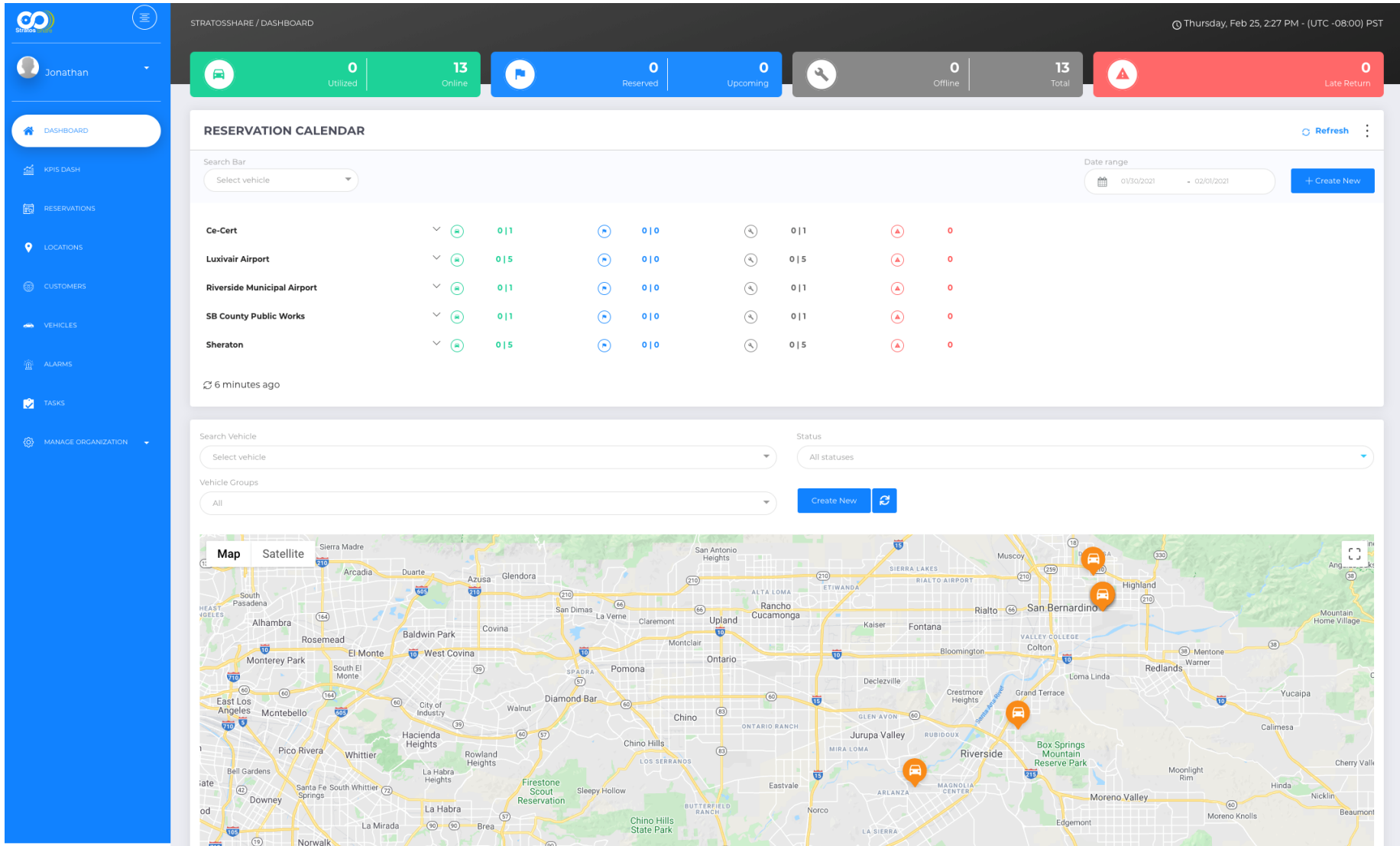
Once all the hardware was installed, Stratos began to validate the communication between the vehicles and servers. This was done through company iPad's, where Stratos confirmed the vehicles could remote unlock, lock, and start. After basic vehicle functionality was verified through a smart device, such as a phone, the cars were individually set up on the backend system.

Hardware and Software Configuration

Up until this point, the vehicles had the ability to communicate with a device on-demand. The communication included transmitting vehicle data, and initiating basic functions, such as locking and powering on. Though, for the vehicles to present the same functionality under a reservation, they had to be tied to a backend software system, with a frontend application. For this process, Stratos began to work with the TC team to develop a front and backend software program that would allow the vehicles to be rented by the hour or day.

To begin, TC developed the first version of the backend system, which is called the Dashboard. The Dashboard was designed to display all the key metrics of a carsharing program, such as vehicle locations, active reservations, and revenues. Below is an example of the most current Dashboard that is used to manage the entire vehicle fleet.

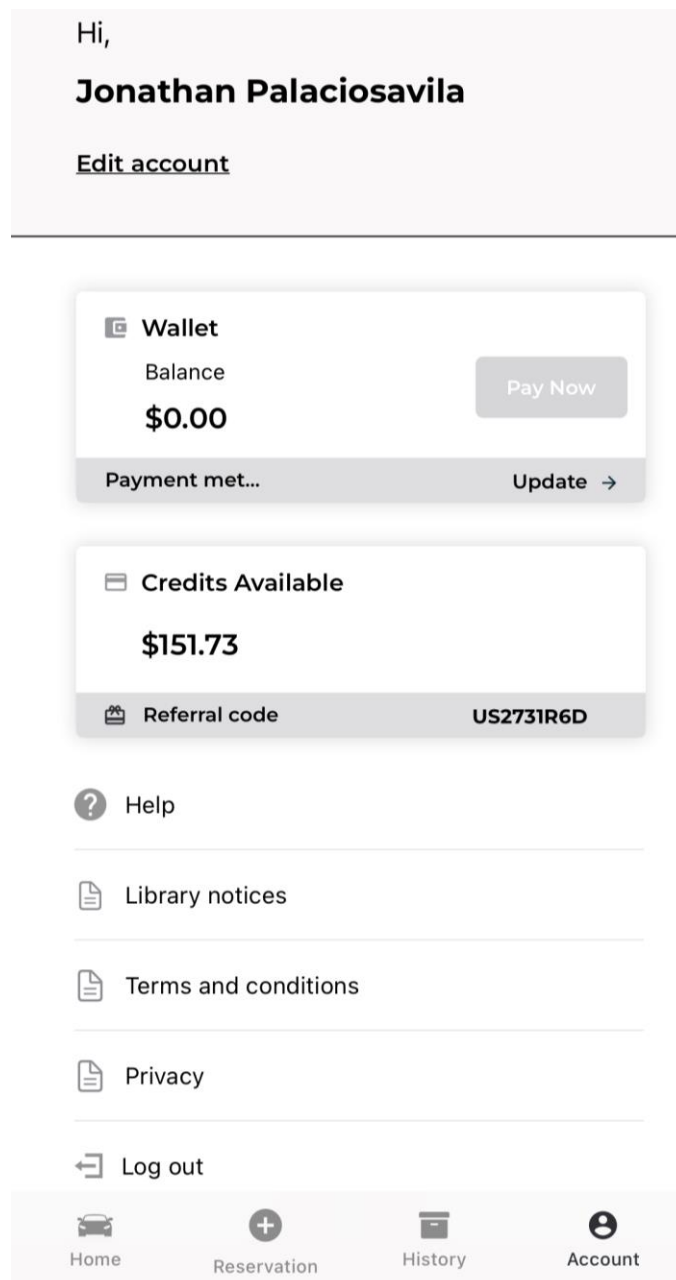
Figure 5: Screenshot of the Dashboard Fleet Management System



Source: StratosShare

The Dashboard system took two versions to correctly evaluate the user interface and display all the necessary metrics. The one shown above, displays active vehicles, current reservations, revenue, and vehicle locations. The current Dashboard also allows Stratos employees to leave comments on vehicles. This functionality is helpful when flagging a car as dirty or needing maintenance. Furthermore, the Dashboard ties into the Motor Vehicle Reporting (MVR) database, as well as with the StratosShare Point of Sale (POS) provider. This integration enables for a smoother management process of approved renters and payments. For example, when a user signs up for the app, the Dashboard will store their information, such as email, phone, address, user identification, and credit card. From here, the user has a profile, enabling them to rent vehicles within the StratosShare system. See below of user profile example:

Figure 6: User Profile Example on the Mobile App



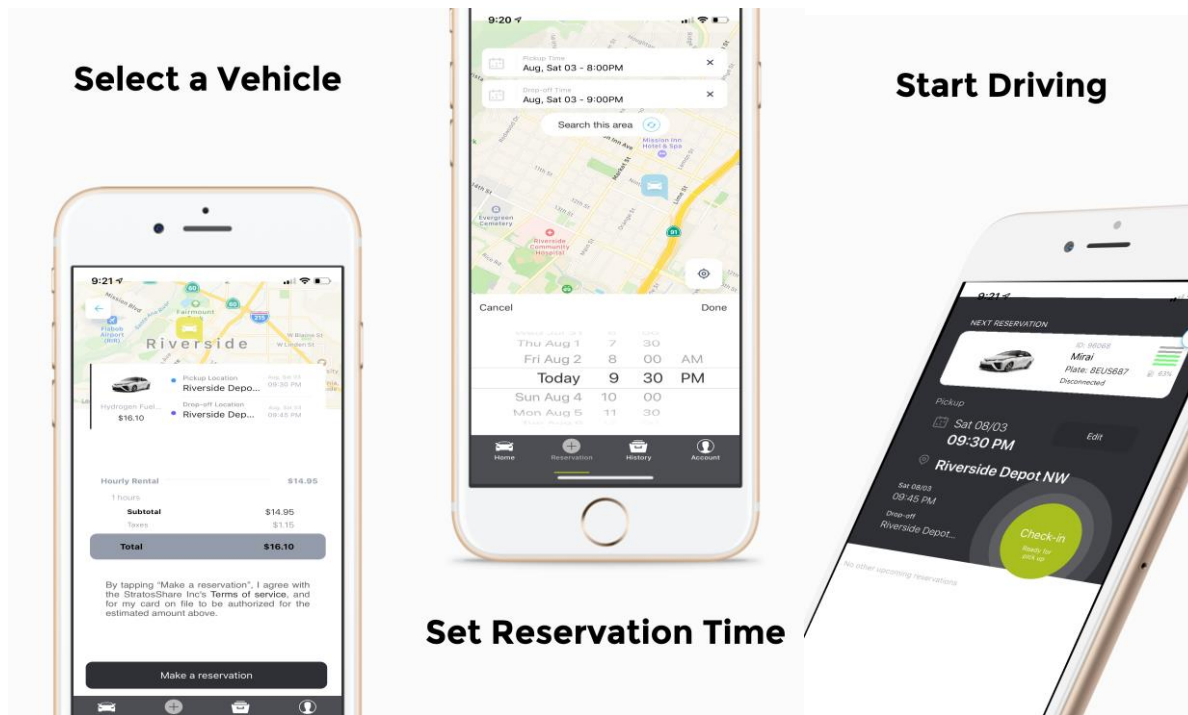
Working with the Dashboard is the front-end software program known as the StratosShare app. The StratosShare app is what users download and see when they rent vehicles. Without the Dashboard, the app would not be able to allow users to create an account, reserve, or pay for a rental. TC developed the first version of the app in November 2018. Version 1.0 of the app was not available to the public, but rather by an invite only basis to test its functionality. During this time, Stratos had all its employees and partners to download the test version of the StratosShare app. By them downloading the app, they were able to help test the app in real-time by signing up and reserving vehicles. Over the course of the testing phase, Stratos was able to modify its functionality and interaction with customers and the Dashboard. Some of the lessons learned are outlined below:

- **Ease of use-** The initial design of the app had a cumbersome ease of use. For example, most customers were confused on how to select reservation times and even rental location. These comments were vital in the second version of the app, which were reflected in the redesign.
- **Customer Data-** The initial version of the app was not fully integrated with the MVR system. This was something that was needed in order to approve customers on the system within 5-minutes of signing up. Over the course of the second version, the programmers worked with CheckR¹, the MVR system, to obtain an API so that StratosShare could integrate the MVR into the mobile application.
- **Damage Reporting-** The first version of the app lacked certain features that were requirements under the rental insurance policy, such as damage reporting. This comment regarding the app's functionality was brought up by many users as a way to show they left the vehicles in the same condition they received it. This comment was implemented by requiring photos to be taken of the vehicle before and after rentals.

Overall, testing version 1.0 of the StratosShare app had an impact on the app's final design. As StratosShare began to program Version 2.0 of the app, TC notified the Stratos team that some of the features that were going to be added were not possible under the existing software license. Understanding that, Stratos began to work with Launch Mobility, who is a shared mobility software provider that Toyota invested in. Launch Mobility took over the development of Version 2 of the app and incorporated all of the comments into the functionality of the new version. In July 2019 the second version of the app was completed and uploaded onto the iOS and Android app stores under the name "StratosShare". The second version of the app was available for all members of the public to download and use. See Figure 7 below for Version 2 of the app on the app stores and its functionality.

¹ CheckR provides either online access or an application programming interface that returns automatically generated background checks. This system runs all of the Motor Vehicle Reports for StratosShare drivers and confirms drivers' age, driving history, and background.

Figure 7: StratosShare App Functionality

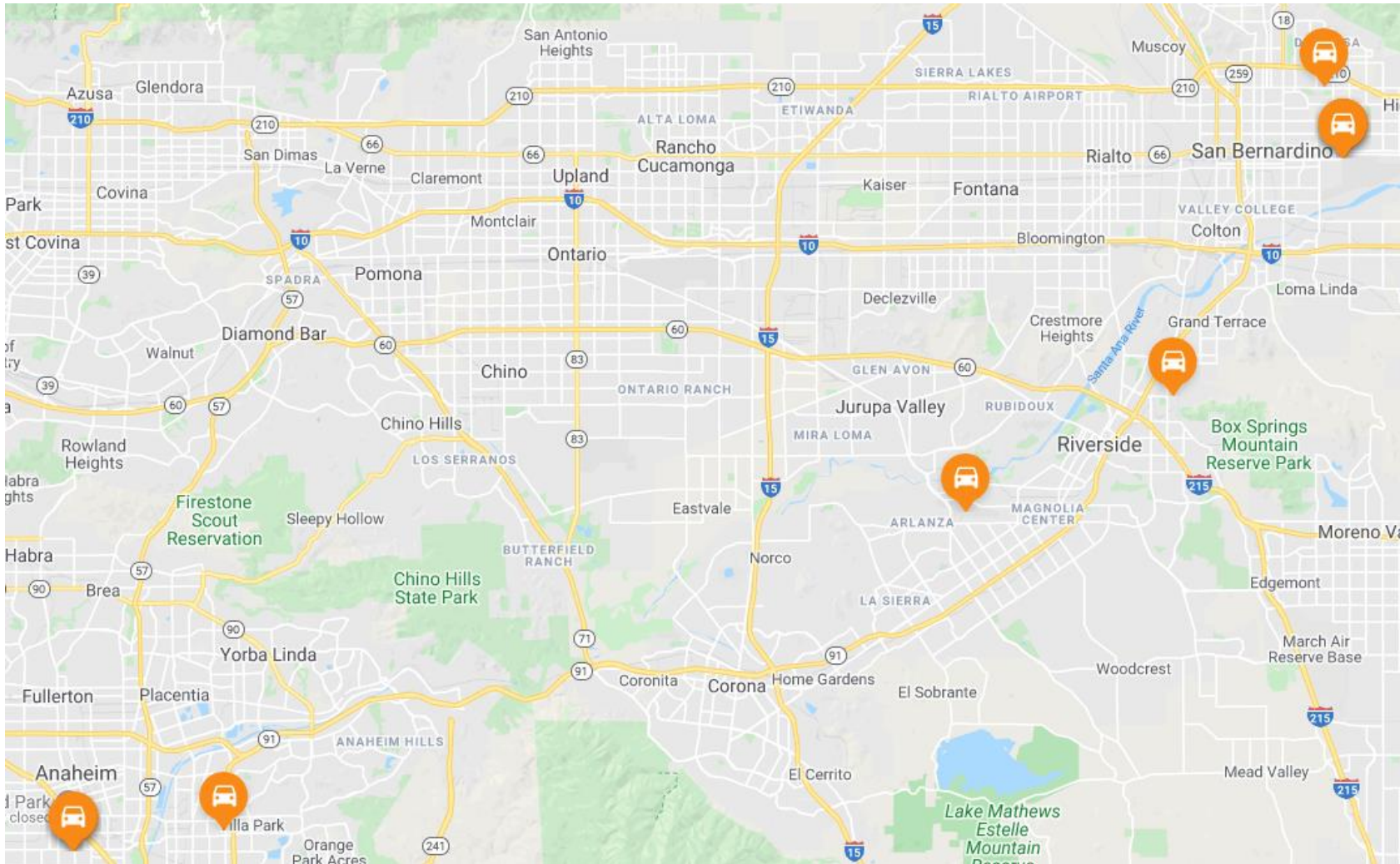


Source: StratosFuel, Inc.

Vehicle Deployment and Location Registration

During the development of the Dashboard and StratosShare app, Stratos negotiated parking contracts with both private and public entities. These entities would be the initial deployment locations for the vehicles. The concept is that renters can pick-up and drop-off StratosShare vehicles at any of the listed locations. These locations are shown on the app and have designated parking spots for StratosShare vehicles. Please see Figure 8 below for a StratosShare parking location:

Figure 8: StratosShare Parking Locations



StratosShare FCEV renters can identify the parking locations by selecting the pin on the app. Once selected, it will show the number of available vehicles at that specific parking location. From here, renters are able to select which location they will be picking up and dropping of their vehicles.

Figure 9: StratosShare Signage and Parking



Source: Markedbylove Photography

To begin, Stratos deployed 15 cars at six locations throughout the Cities of San Bernardino and Riverside. Each location has between 2-4 designated parking spaces that were marked with StratosShare signage. All the parking locations are unique and serve a specific transportation need for the community. For example, the airport parking locations were to

serve last mile transportation needs for travelers, while the University location was to serve students living on campus. One of the locations that had a unique purpose was the County of San Bernardino. The County of San Bernardino incentivizes their employees to vanpool to work. Based on this, some County employees needed transportation while they were at work. Having the StratosShare vehicles available at the County offices enabled county employees to have reliable transportation. How it worked at the County was they would subsidize the vehicle rental fee for their employees. Employees would use a key card to access the vehicles, from here StratosShare would submit a monthly invoice to the County for reimbursement.

StratosShare reviewed the uses of vehicles and concluded that last mile transportation and subsidized rentals were the most effective rental locations for the community and yielded the highest number of rentals. Using this information, StratosShare began to target parking locations, such as transit hubs, and hotels. These locations have high foot traffic and appeal to people needing on-demand transportation. As the StratosShare program continues to grow, more vehicles will be deployed at these types of locations.

To understand the number of vehicles at each location, please see Table 1 below. It showcases all of the parking locations and their designated vehicles. Locations with more parking stalls are due to higher throughput numbers. **Note: The vehicles are not static but instead dynamic, their locations can change based on rental patterns.**

Table 1: Initial Parking Locations

Parking Location	Address	License Plate#
CE-CERT ²	1. 1084 Columbia Ave., Riverside, CA 92507	2. 8EUS674 3. 8EUS684 4. 8EUS622
StratosFuel HQ	1. 2601 N. Del Rosa Ave., San Bernardino, CA 92404	2. 8EUU674 3. 8EUS671
San Bernardino Airport	1. 295 N. Leland Norton Way, San Bernardino, CA 92408	2. 8EUS620 3. 8EUS687 4. 8EUS619 5. 8EUS637
Riverside Airport	1. 6951 Flight Rd., Riverside, CA 92504	2. 8EUS640 3. 8EUS625
San Bernardino County Offices	1. 825 E. 3rd St., San Bernardino, CA 92415	2. 8EUS622 3. 8EUS689
Downtown Riverside	1. 3370 9th St., Riverside, CA 92501	2. 8EUS624 3. 8CJA614

² Center for Environmental Research & Technology, University of California, Riverside

The deployment locations were secured through parking agreements with each entity. For most of the sites StratosShare was able to get management to approve the parking agreements, while others such as the City and County locations have to go through public approval. On average it takes between 2-4 months from when the contracting process is started and approved. An example of this is the approval process that the Riverside Municipal Airport had to go through. The agreement had to be vetted and approved by City management before it was heard before Riverside City Council. Upon being heard by the City Council, they approved up to 10 parking spaces at the Riverside Municipal Airport.

Furthermore, StratosShare found that securing parking locations in select parts of the Inland Empire were not economical. Most private entities charge exorbitant fees for their parking. In order to provide a low cost zero-emission rental services to community members, parking must be subsidized by the site host, which is why StratosShare put together an incentive package for certain entities. The goal behind compensating for parking is to share the risk with the site host. StratosShare did so by providing a 10%-15% revenue share from each rental. Agreements like this were put into place at the San Bernardino Airport, and hotel locations. Through this arrangement StratosShare incentivized site hosts to advertise the StratosShare program to their patrons.

COVID-19 Closures

When COVID-19 closures went into effect in March 2020, StratosShare put multiple cleaning measures in place to ensure the safety of customers. The cleaning procedures are outlined below:

- **Gaps Between Rentals:** To ensure the vehicles were clean StratosShare would put 2-hour rental gaps between rentals. For example, when a customer would return a vehicle, StratosShare would take it offline and schedule it for cleaning. This allowed the cleaning team to disinfect the vehicle before it was rented again.
- **Cleaning Time Stamps:** In addition to cleaning, the team would leave stickers on the steering wheels that stated the time and date the vehicles were cleaning.
- **Hand Sanitizers and Masks:** Every vehicle was stocked with hand sanitizer and packaged masks. In addition to the PPE items located in the vehicles, StratosShare also included a sanitizing check list to follow before each rental. The checklist included steps, such as sanitizing hands before driving, wiping down the steering wheel after use, and wearing a mask while in the car.

With all of the sanitizing procedures that were implemented certain sites had to be closed until further notice. The parking locations that were closed were at the request of the site hosts following California Orders. Parking locations at University California Riverside (UCR), San Bernardino County and Downtown Riverside were closed temporarily, with the Riverside Airport location being closed due to lack of renters. From the locations that were temporarily closed due to COVID, they all reopened in January 2021 with the exception of UCR, and the County of San Bernardino, which will reopen in fall of 2021 as the campuses reopen.

In relation to parking locations being closed due to COVID, agreements with prospective sites were placed on hold. During February 2020, StratosShare was negotiating parking agreements with the Metrolink and two other hotels. Unfortunately, due to stay-at-home orders and a reduction in travel, the agreements were placed on hold. As of March 2021, StratosShare has reengaged discussions with these entities.

CHAPTER 3:

Outreach and Marketing

Before Stratos launched its carshare program StratosShare in August of 2019, they began to outreach and market to the surrounding communities about the program. Marketing is an important aspect when introducing a new service into a community, it is a way to educate and instill knowledge about the program. That being said, as soon as the Notice of Proposed Award (NOPA) for the project was announced, Stratos outlined a marketing strategy that involved social media, public outreach, and working with entities to advertise to their community spheres.

Social Media & Online Marketing

To create an online presence Stratos created a brand that people could identify as being a zero-emission shared mobility service. While preparing for the solicitation the Stratos team came up with the name StratosShare, which symbolized hydrogen and sharing. Capitalizing on this concept enabled Stratos to contract B-Design to design a logo that signified the name of the program. In August 2018, B-Design created the StratosShare logo shown in Figure 10 below. By having the logo, Stratos was able to create social media pages that community members could recognize and become familiar with.

Figure 10: StratosShare Logo-

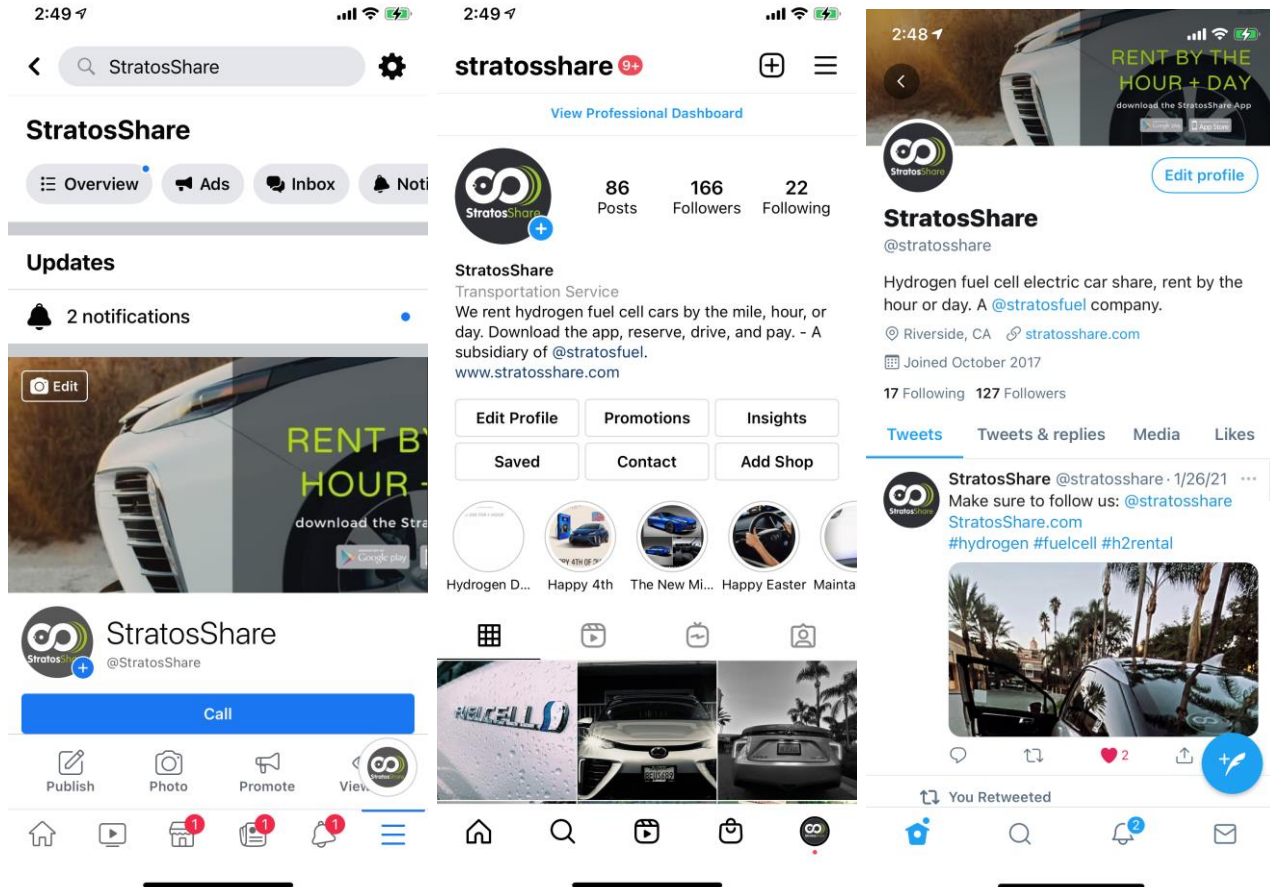


Source: B-Design

Stratos created three main social media accounts to interact with community members. These social media accounts include Facebook, Instagram, and Twitter (See Figure 11). Collectively, these accounts have nearly 500 active followers and thousands of views. As a way to faster responses to community members and customers, StratosShare allows for direct messaging through Facebook and Instagram. Additionally, the same people are kept updated on new sites and program information through the social media accounts. As a way to target specific demographics, Stratos runs ads through Facebook and Instagram. By running ads through

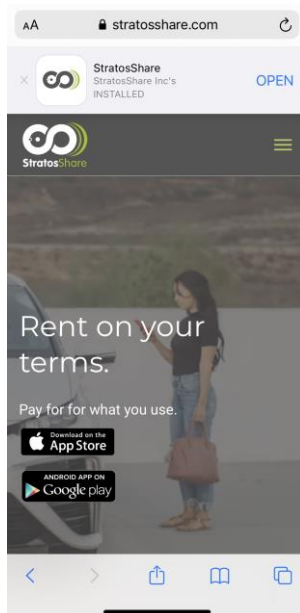
social media platforms, StratosShare targets customers within a 5-10-mile radius of a StratosShare parking location. Nearly 10,000 people seeing the program ads every month.

Figure 11: Social Media Accounts



Furthering the reach of social media marketing, Stratos engaged with community members through an online presence. For example, Stratos developed an interactive website that the renter can use to learn about the StratosShare program, hydrogen vehicles, and the States initiatives for implementing zero-emission transportation technology (See Figure 12).

Figure 12: Renter Accessing the Carshare Service



Through the website, Stratos would advertise StratosShare on Google ads. This worked by aggregating peoples searches for keywords, such as car rentals. If someone searched for a car rental location and they were near a StratosShare parking hub, the website would show up first. This type of advertising was effective because it marketed the program to people who were not on social media, which yielded between 3,000-5,000 web hits per month. Out of these web hits, nearly 10-15% would download the app and use it.

Stratos used social media and online advertising to communicate with the community. Social media enabled customers to directly engage with the concierge team. For example, some people would message the social media pages with questions about how the program works. As a result, StratosShare’s concierge team was able to respond within minutes of their messages. Furthermore, creating program awareness through an online presence was helpful, especially during the COVID-19 stay-at-home orders. There were a lot of outreach plans that involved community engagement, which were put on hold due to COVID. Through social media StratosShare were able to deliver a greater message to the local communities by educating them on hydrogen fuel cell technology and shared mobility. Moving the program forward, StratosShare will continue to be marketed online through social media platforms.

Outreach Efforts to the Public and Disadvantaged Communities

To showcase hydrogen FCEVs to the public, Stratos engaged in many public outreach events. Most of the outreach events Stratos participated in were within San Bernardino and Riverside Counties. The reason why Stratos chose these locations for outreach was their potential to engage with the community members that would be using the StratosShare carshare program.

Stratos sponsored events, set up booths, and printed materials at a number of events within the Inland Empire. The Stratos team have handed out hundreds of information material to members of the community and given dozens of ride-and-drive events. Furthermore, Stratos participated on panels that went into detail about the positive effects carsharing has on the

environment. Based on this, the outreach activities helped educate the public about zero-emission transportation alternatives, such as carshare services like StratosShare. It was this hands-on education to the public that allowed the benefits of StratosShare to spread to the community.

Since 2018, Stratos participated in over eight public outreach events. Below is a list of events for this project:

- **Sister Cities Golf Tournament, September 2018**
- **Innovation 8, September 2018**
- **Hydrogen day at JPL, October 8th, 2018**
- **City of LA District 4 StratosShare Demo, November 2018**
- **Festival of lights, Riverside California, December 2018³**
- **ACT Expo, April 2019⁴**
- **Unami Oil Group Visit demonstration, May 2019**
- **Driving Mobility 6, June 2019⁵**
- **Riverside Green Summit, October 11, 2019⁶**
- **Alt Car Expo, October 13th, 2019**

For reference, Figure 13 showcases various outreach events Stratos has attended, sponsored and participated in.

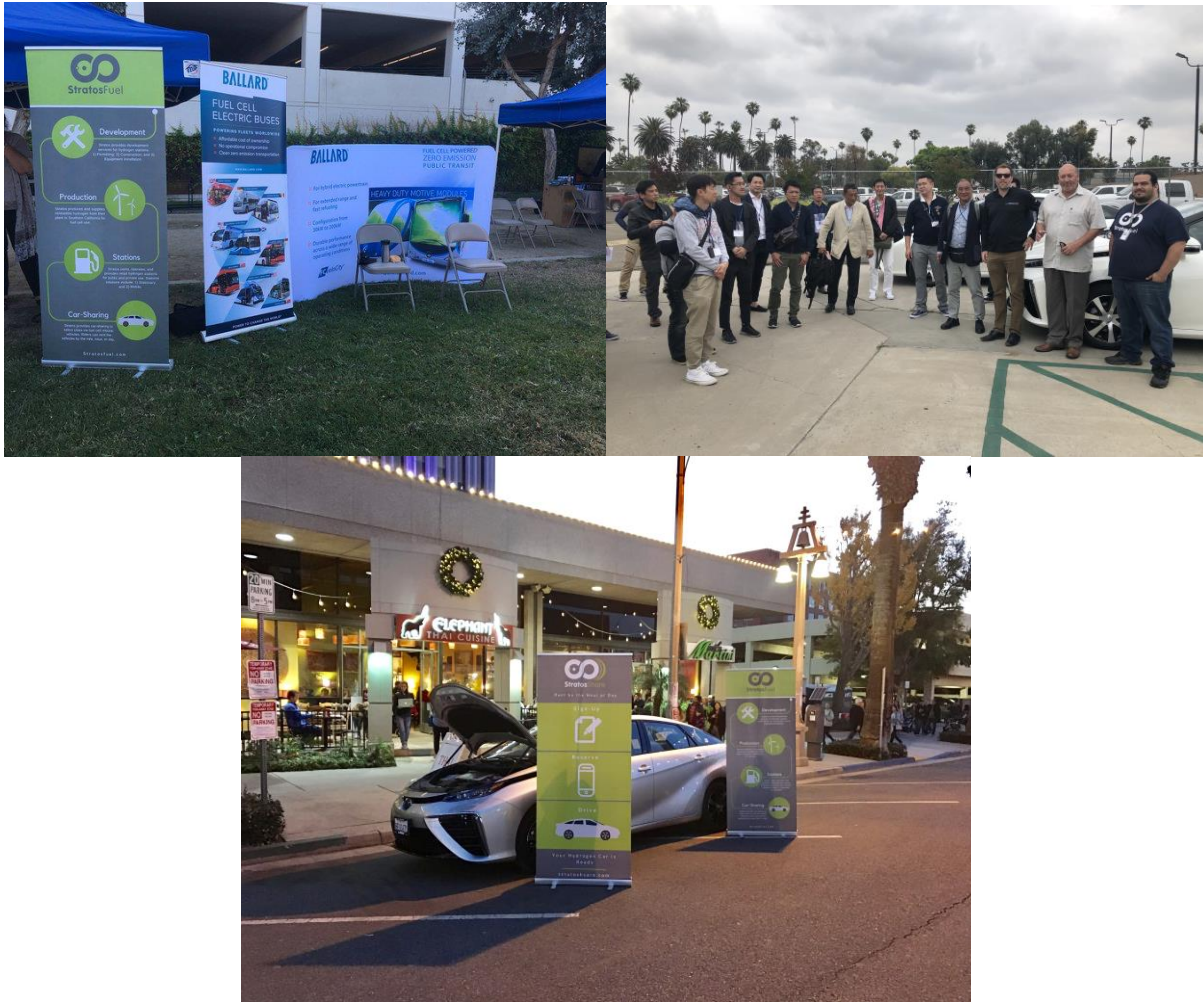
3 <https://www.riversideca.gov/fo/>

4 <https://www.actexpo.com/announcement/2019-act-expo-event-recap>

5 <https://innovation.uci.edu/event/sustain-socal-driving-mobility-6/>

6 <https://sustainability.ucr.edu/event-list/2019/10/05/riverside-green-summit>

Figure 13: Images of Public Outreach Events Sponsored or Attended by StratosShare



Source: Markedbylove Photography

In addition to the public outreach efforts within the communities of Riverside and San Bernardino, StratosShare also engaged in outreach efforts within the disadvantage communities surrounding the StratosShare parking locations. These outreach efforts involved the StratosShare team displaying the Toyota Mirai and StratosShare app to the public. Often times the StratosShare team would set up a booth within a populated area and showcase the StratosShare program. The booths contained material about the California Energy Commission and related programs, fuel cells, and StratosShare. Examples of the booths that were set up can be seen below:

Figure 14: Images of StratosShare Public Outreach booth

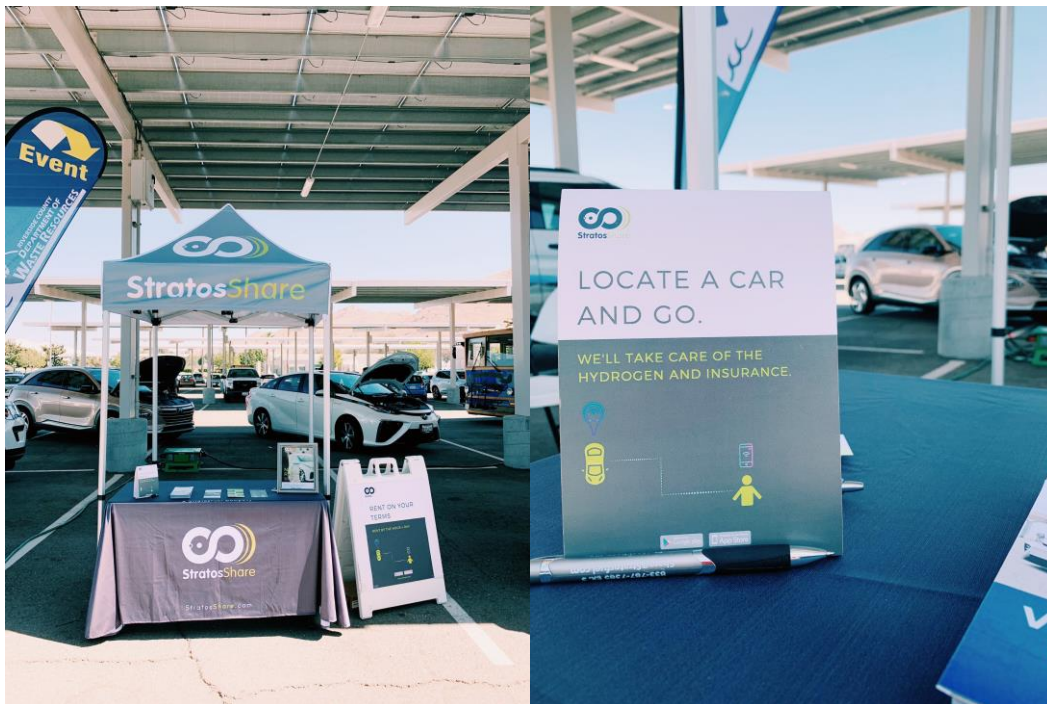


Image Source: Markedbylove Photography

Furthering the reach of outreach within disadvantage communities, StratosShare wanted to increase the affordability of its rental service, while educating the community about hydrogen. One way that the StratosShare team conducted this was through Hydrogen Day. Hydrogen Day lands on October 8th, which is the anatomical number of the periodic symbol of hydrogen (1.0078). Using this day, StratosShare would market hourly rentals at \$1.008 per hour. The goal of this outreach strategy was not only to educate disadvantage community members about hydrogen but also provide an even more affordable ride. This outreach strategy proved to be effective because it would always attract new customers and increase vehicle utilization. An example of the outreach efforts can be seen below:

Figure 15: StratosShare Hydrogen Day Outreach Campaign



Image Source: StratosFuel, Inc.

COVID-19 Awareness

During the COVID-19 pandemic, the Stratos team strived to make renters feel safe and comfortable in their vehicles. As part of this effort extensive marketing was made to showcase the StratosShare cleaning measures. To begin, cleaning procedures were marketed and explained on social media. Some of the images included StratosShare personnel cleaning the vehicles. An example of this is shown below:

Figure 16: StratosShare Additional Measures



Image Source: StratosShare Instagram and Twitter Pages

Additional COVID marketing measures were taken to remind people to clean their vehicles before each ride. To this extent, StratosShare placed floor signs at every parking location with the following material:

Figure 17: StratosShare Awareness Marketing



Image Source: StratosShare COVID-19 Awareness Marketing Material

The use of COVID-19 marketing material proved to be effective because of the feedback StratosShare received. For example, renters were thankful for the effort put into making the StratosShare vehicles safe and clean for use.

Collaborative Outreach

Many of the vehicles deployed under the StratosShare program were in partnership with entities, such as cities, universities, and businesses. These entities had groups of people within their reach that could benefit from a carshare program. That being said, Stratos collaborated with these entities to distribute marketing material about the StratosShare program. For example, at each location Stratos put up signage, and left flyers at front desks. Additionally, emails were sent out to the entities contact lists about the StratosShare program, as well as occasional social media posts.

This form of outreach was helpful because it created a core audience for the StratosShare program. Most of the people within these entities rely on the StratosShare vehicles for their day-to-day transportation needs. Below is a summary of each entity that relied on the vehicles:

- **Luxivair Airport-** Luxivair SBD offers low-cost refueling and first-class services and amenities for corporate and general aviation customers. Their primary customer are UPS pilots that transport cargo in and out of the Inland Empire. The pilots would rely on the StratosShare vehicles to get them to and from the San Bernardino and Ontario Airports. They would also use the vehicles to get around the City while their planes were being loaded with cargo. These customers would learn about StratosShare through the signage displayed throughout the airport Terminal.
- **Sheraton Hotel-** The Sheraton hotel within the Inland Empire displays StratosShare signage throughout their hotel. Additionally, when guest inquire about transportation within the area, the hotel explains that they have on-demand vehicles onsite for their use.
- **University California Riverside-** UCR is a partner for the StratosShare program and has provided parking locations throughout the campus. When StratosShare launched in August 2019, UCR included an expert about the program in their newsletter, as well as sent out various mass emails to students.

Furthering the marketing strategies listed above, Stratos distributed other marketing material to members of the entities. Stratos did so by passing out stickers, t-shirts, hats, and gift cards by setting up booths at these locations. For an example of distributed marking material, please see Figure 18 below.

Figure 18: StratosShare Marking Material



Source: Markedbylove Photography

CHAPTER 4:

Innovative Mobility Requirements

Over the last year StratosFuel has successfully implemented and demonstrated the following Innovative Mobility Requirements under Task 5 in the scope of work:

- Secure acceptance of payment for rental through app
- System validating the rental and use of the vehicles
- 24/7 concierge number to assist renters
- Fueling infrastructure secured
- Accessibility requirements met for rental vehicles

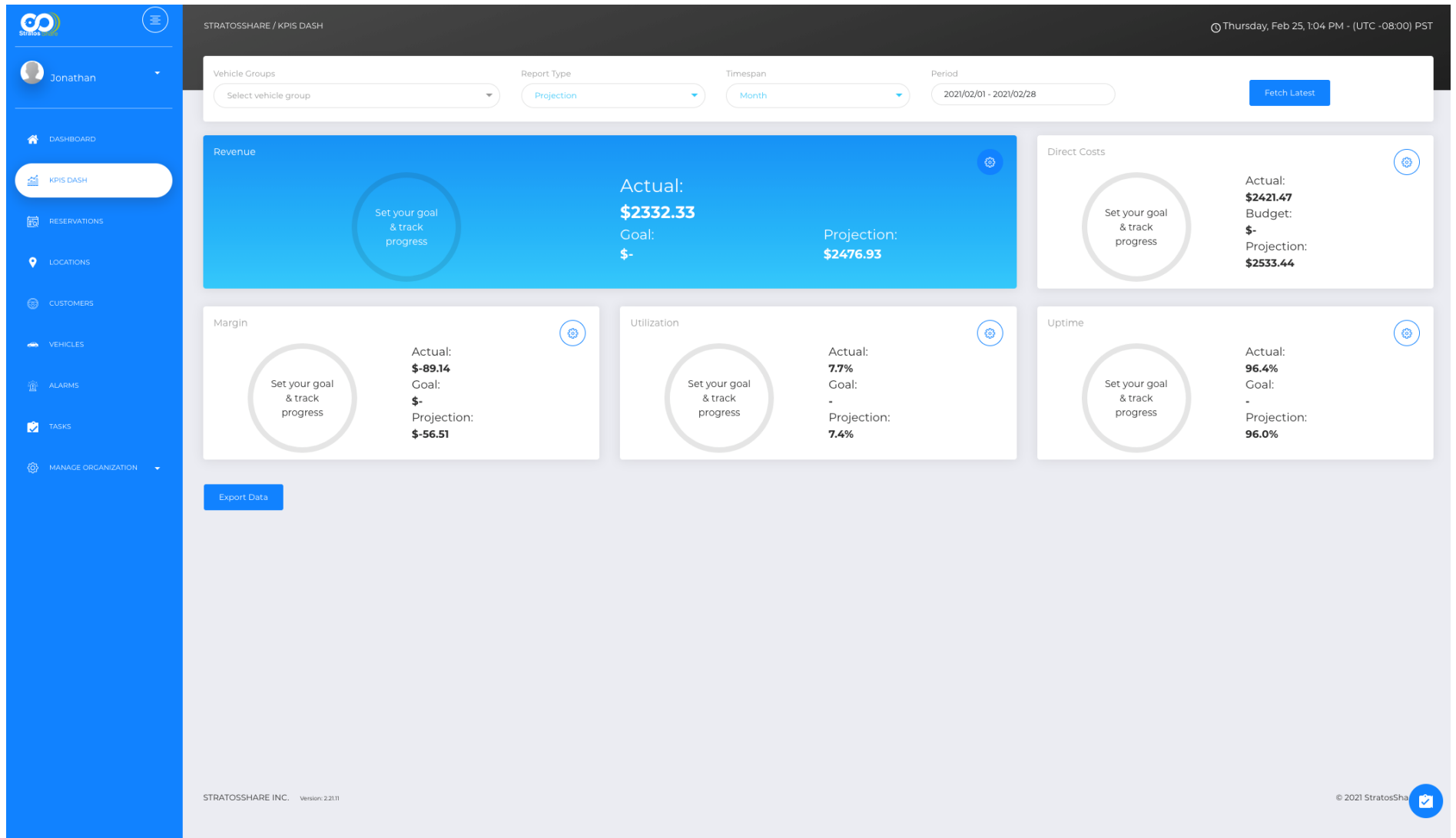
Based on these six key requirements under Task 5 in the scope of work, Stratos has deployed 15 hydrogen FCEVs to be rented by the hour or day. How the system works is the vehicles are available for rent using the StratosShare app and can be picked-up and dropped-off at "LandingZones". The LandingZones are parking locations that are accessible 24/7. Renters set up an account on the StratosShare app and select their rental times. Once confirmed, the renter's phone and app become their key fob and are able to drive the vehicles. StratosShare's vehicle rental system encompasses all of the innovative mobility requirements under Task 5.

The following are examples that StratosShare have complied with the Innovative Mobility Requirements under Task 5:

Secure Acceptance of Payment for Rental Through App

The convenience of using the StratosShare app to rent a car is being able to pay securely through the app. The StratosShare app process payments using Stripe as the point of sale system. This is done by integrating the Stripe payment API into the StratosShare app so that each user has a secure account to process payments through. StratosShare tracks daily transaction and generate summaries. For an example of how payments are processed and tracked, please see Figure 19 below:

Figure 19: Payment Processing System

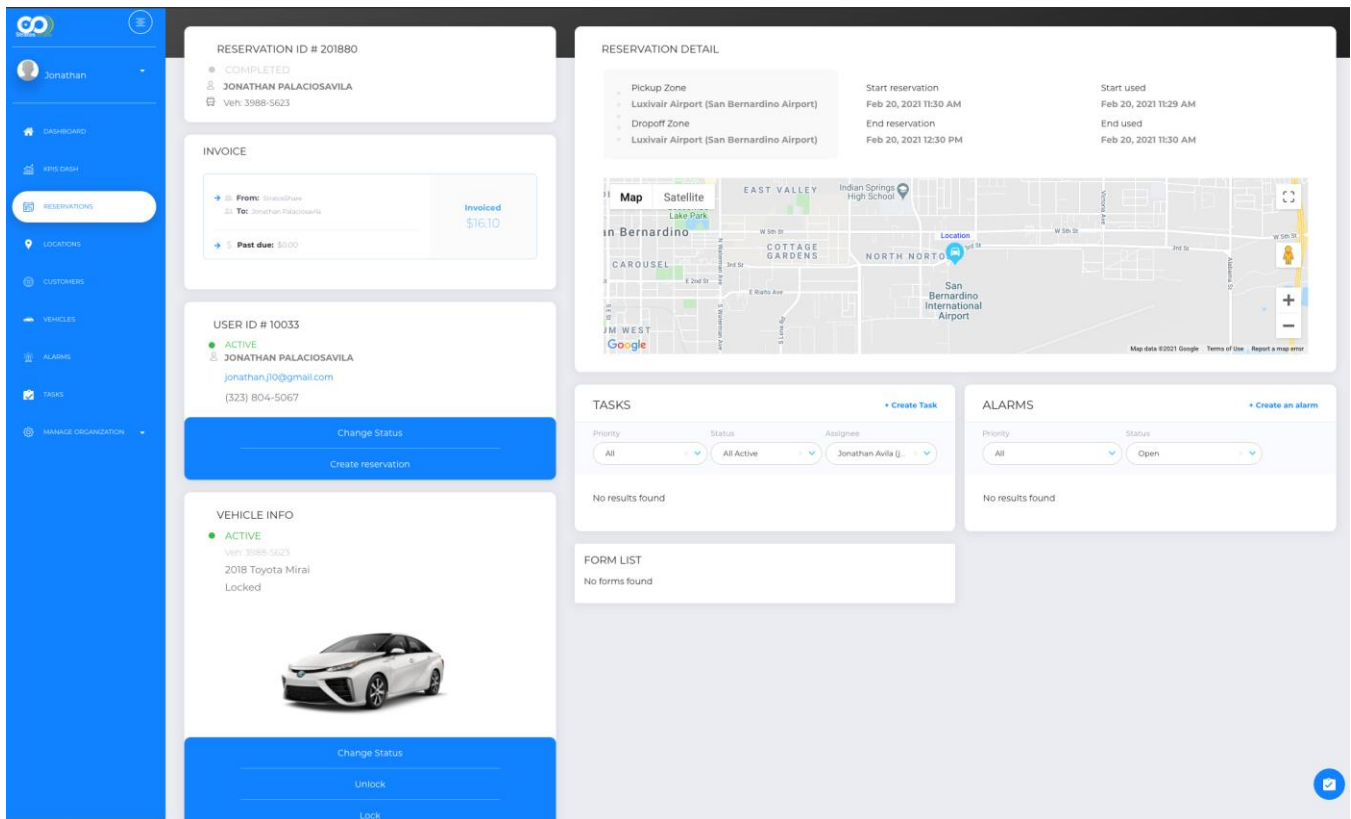


Source: StratosShare Dashboard System

Rental Validation and Use of Vehicles

In order to validate the vehicles and their use, StratosShare developed an entire backend system that stores all of the vehicles and customers information. Every trip a driver takes is stored in the backend system. StratosShare categorized customers' trips by the amount of time used, milage, and pickup and drop off location of vehicle. This backend system also enables us to keep track of the vehicles fuel levels, cleanliness, and any damage that may occur. To show how it works, StratosShare booked a car under the name "Concierge" and flagged it as needing fuel and a wash. See Figure 20 below for an overview of the vehicle management system:

Figure 20: Rental Reservation System

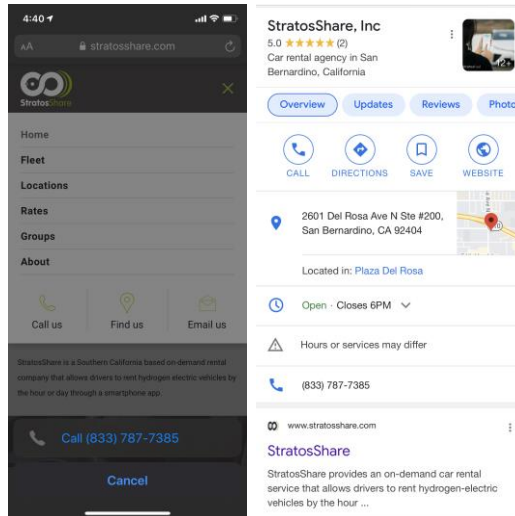


Source: StratosShare Dashboard

Concierge Service

In order to provide the utmost customer service for vehicle renters StratosShare has a 24/7 concierge call center that assists renters with any issue relating to their rental. No matter what time of day, customers can call **833-787-7385 Ext. 3** to request for troubleshooting the app, equipment, or roadside assistance. The number is available on both the StratosShare and StratosFuel websites, as well as the StratosShare app.

Figure 21: StratosShare Website Contact Information



Source: Google

Fueling Infrastructure

The StratosShare fleet exclusively consists of hydrogen FCEVs. To keep the vehicles fueled, StratosShare has designated publicly funded hydrogen fueling stations within the Inland Empire to act as fueling post for the fleet. The main station utilized is the Riverside Hydrogen station because of its central location to where the StratosShare fleet is located. StratosShare has an arrangement with the station owner to fuel during off-peak times, either in early mornings or late evenings. This helps conserve fuel for FCEV commuters and allows StratosShare to maximize refuel times. The StratosShare fleet also utilizes other stations within the Inland Empire as well, such as the South Coast Air Quality Management District Station in Diamond Bar, CA. StratosShare used this station when the Riverside Station is offline for maintenance or out of fuel. Figure 22 shows some of the StratosShare fleet refueling at stations.

Figure 22: Hydrogen Infrastructure Utilization



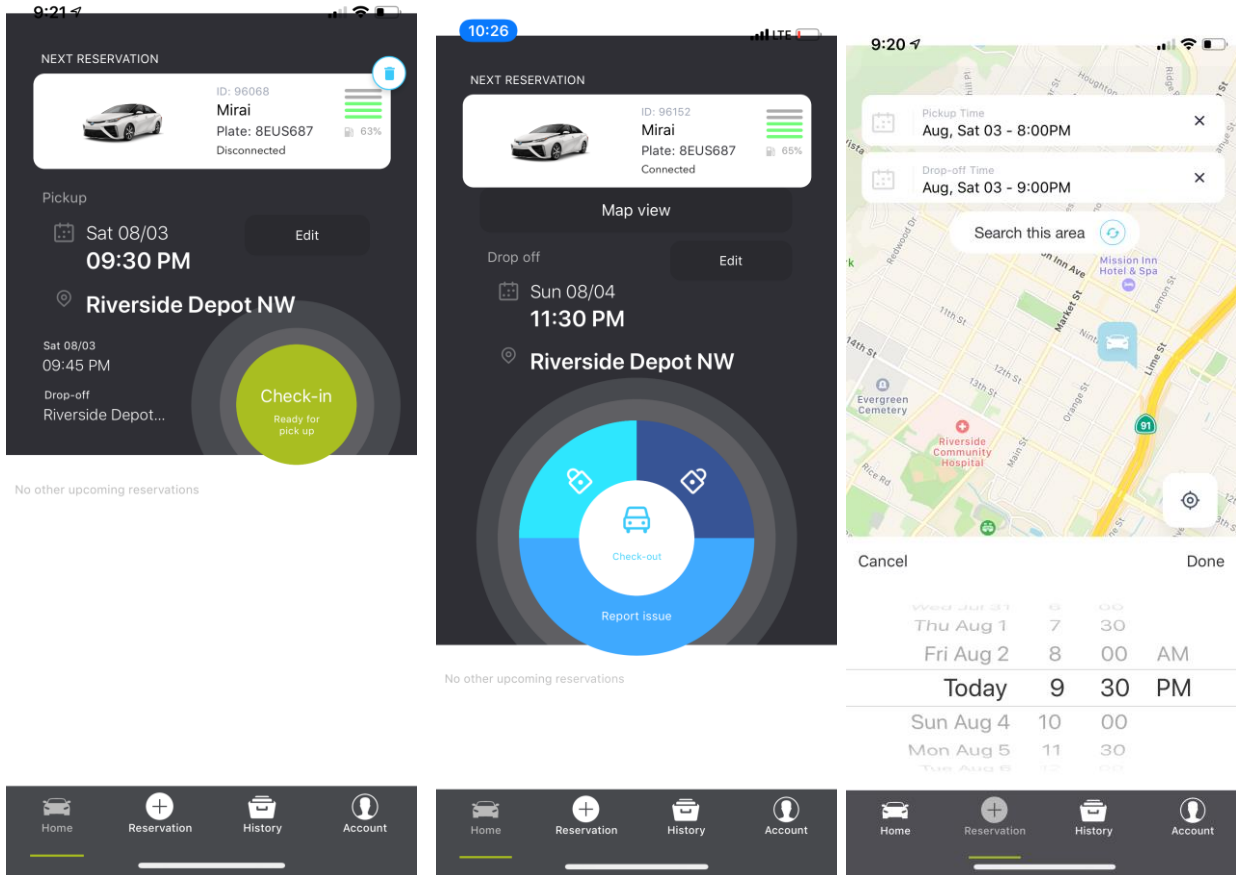
Image Source: Markedbylove Photography

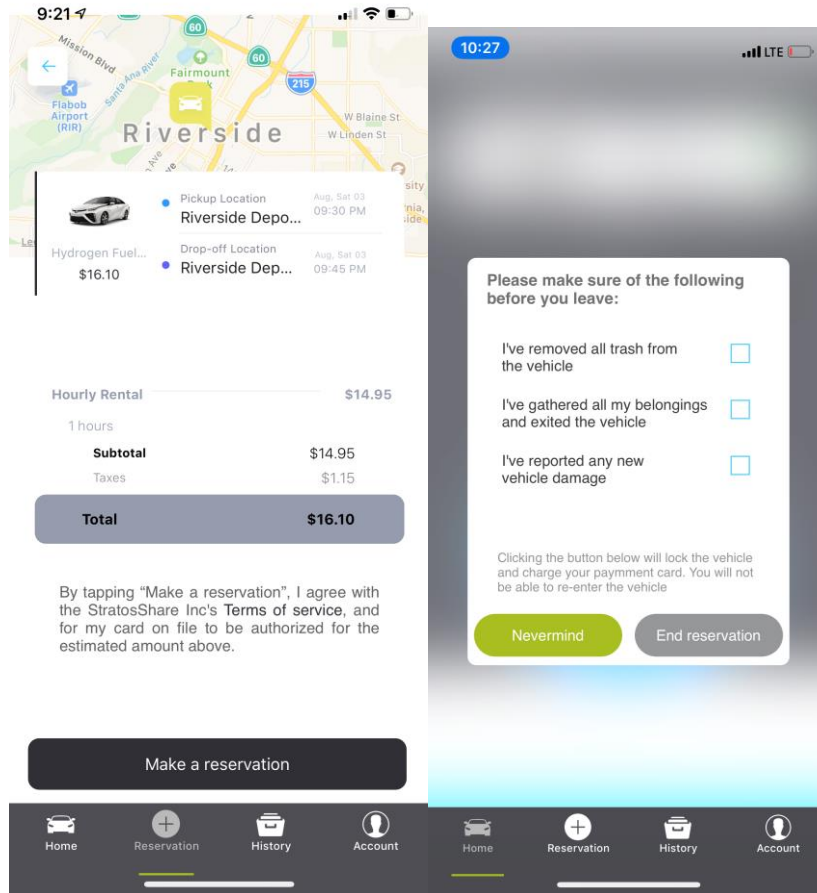
Rental Vehicles and Accessibility

The StratosShare app is unique in the sense that it allows people to rent a hydrogen FCEV through their smartphone. Customers are able to reserve a car by the hour or day and pick up vehicles at designated parking stalls. The vehicles are accessible through the app, which allows your phone to essentially become a key fob. This convenience is revolutionary to mobility and allows people who otherwise do not have a car, be able to drive a zero-emission vehicle at the push of a button. Therefore, the accessibility requirements of the shared mobility service are met through integrated hardware and software.

StratosShare has developed a software platform that connects to vehicle hardware and allows the cars to be controlled through a smartphone device. This major milestone has been met through the installation of a smart key box connected to the OBD II port inside each vehicle, as well as the development of the mobile app and backend server. Below is Figure 23, which showcases the ability to rent a vehicle by the hour or day using the StratosShare App:

Figure 23: StratosShare App Accessibility and Functionality





Source: StratosShare App

Figure 23 demonstrates how the StratosShare app complies with the accessibility requirements stipulated in ARV-17-010. The app allows customers to rent vehicles by the hour or day on an on-demand basis.

CHAPTER 5:

Data Collection

StratosFuel collected data for 15 vehicles over 2.5 years. The data collected included vehicle mileage, greenhouse gas emissions reduction, and customer demographics. Other data pertained to paths of travel and use of vehicles. Overall, the data collected supports the growth of this shared mobility project.

Vehicle Utilization

Stratos focused on collecting vehicle use data. The goal of this task was to understand the use for each rental vehicle, which included mileage, fuel consumption, GHG emissions, and maintenance cycles. Through this, the following are summaries of key utilization data collected:

- **Average Fuel Consumed per Trip**- Over the course of the data collection period 4,000 kilograms of hydrogen were consumed. This is the total number of kilograms consumed amongst 15 vehicles. That being said, the average trip taken was roughly 65 miles and 5 hours in length. Understanding this, the EPA estimated miles per gallon equivalent for the 2018 Toyota Mirai is 67 MPGe. Though, through fuel receipts and fill records, the average MPGe was closer to 50-55 MPGe. The variation between the EPA estimated MPG was due in part from having multiple drivers, driving under various modes. For example, the Toyota Mirai has “eco,” “normal,” and “power” modes to use and toggle from. StratosShare suspects that most drivers had the vehicles under the normal mode setting, and drove under mostly in street conditions, as opposed to highway. This variation in driving habits yielded a much less expected range than originally planned. Through this, ***the average kilogram of hydrogen consumed per trip was close to 1.1 kg***. As a note, this number is directly tied to individual trips and does not account for trips taken outside of the app, such as car washed, maintenance, and refueling.
- **Gallons of Gasoline Displaced**- According to the EPA, a single passenger vehicle travels an average of 11,500 miles per year and consumes roughly 521 gallons of gasoline. Using this as a basis for the project, the 15 FCEV’s traveled a combined 183,000 miles over the course of two years. This leaves each vehicle with over 12,000 miles in zero-emission trips. From the EPA estimated gallon consumption of vehicles based on the average miles traveled per year, ***each vehicle within the shared fleet displaced 553 gallons of gasoline, with a total displacement of 8,295 gallons over the course of two years***. This number does not account for the fact the vehicles are shared. Because the vehicles are shared, one car has the ability to replace up to 9 vehicles on the road. When taking this into account, all 15 vehicles could potentially displace up to 74,600 gallons of gasoline.
- **Expected Air Emissions Reduction**- A typical passenger vehicle emits about 4.7 metric tons of carbon dioxide per year. This number can vary based on a vehicle’s fuel, fuel economy, and the number of miles driven per year. The average gasoline vehicle on the road today has a fuel economy of about 21.6 miles per gallon and drives around 11,400 miles per year. Every gallon of gasoline burned creates about 8,887 grams of CO₂, and there are one million grams per metric ton. Based on this metric, ***each vehicle within the fleet reduced approximately 5.1 metric tons of CO₂, with a total reduction of 76.5 metric tons***.

The following equation is what StratosShare used to calculate the estimated CO2 reduction per vehicle:

$$\text{Annual CO2 emissions} = \text{CO2 per gallon MPG} \times \text{miles} = 8,887 / 21.6 \times 12,000 = 5.1 \text{ metric tons}$$

According to a shared mobility study conducted by UC Berkley⁷ they found that one vehicle being shared replaces nine vehicles. Based on this assumption, StratosShare estimate that ***one FCEV being shared reduced CO2 emissions by 45.9 MT. Therefore, the potential CO2 reduction of all 15 vehicles being shared was close to 688 MT.***

- **Duty and Maintenance Cycle of FCEVs**- Toyota provides a recommended schedule of maintenance that occurs in 5,000-10,000-mile increments. To begin the first maintenance cycle began at 5,000 miles, or 6 months. Because the utilization of the vehicles varied in terms of distance traveled, StratosShare would schedule the vehicles for maintenance every 6 months regardless of mileage. Each maintenance visit consists of checking on the fuel cell stack, tire rotation, hydrogen tank, breaks, and other fluids. Each vehicle was maintained 4 times over the course of 2-years. During routine maintenance checks there were vehicles that needed headlight and battery replacements. This was due to some faulty parts and were noted by technicians. Each of the replacements were covered under the vehicles warranty and service contract. Below is a list of vehicles that needed parts replaced:

Table 2: Maintenance Summary

VIN#	Replacement Part	Date
JTD BVRBD9 JA003988	Battery Replacement, and Headlight	3/20
JTD BVRBD9 JA004123	Battery Replacement	3/20
JTD BVRBD0 JA004317	Battery Replacement, and Headlight	12/20
JTD BVRBD6 JA004239	Battery Replacement	1/20

Despite having the vehicles scheduled for maintenance, there were cars that needed unscheduled maintenance. For example, over the course of the vehicles being deployed some cars suffered road and rodent damage. This damaged caused the vehicles to be brought in for unscheduled maintenance. Below are images of the vehicles that sustained rodent damage:

⁷ <https://www.berkeleyside.com/2017/04/19/bay-areas-first-one-way-car-share-debuts-berkeley-oakland>

Figure 24: Rodent damage to the wire harness on four Mirai Vehicles



Source: StratosFuel, Inc

The rodent damage was due to the vehicles being parked at a parking structure and having soy coated wiring. The rodent damage issue was found in four vehicles and noted by people trying to rent the cars. Below is a list of the vehicles that sustained rodent damage:

Table 3: Damage Summary

VIN#	Replacement Part	Date
JTD BVRBDX JA004258	Rodent Damage	2/19
JTD BVRBD4 JA004286	Rodent Damage	2/19
JTD BVRBD6 JA004080	Rodent Damage	2/19
JTD BVRBD2 JA004268	Rodent Damage	2/19

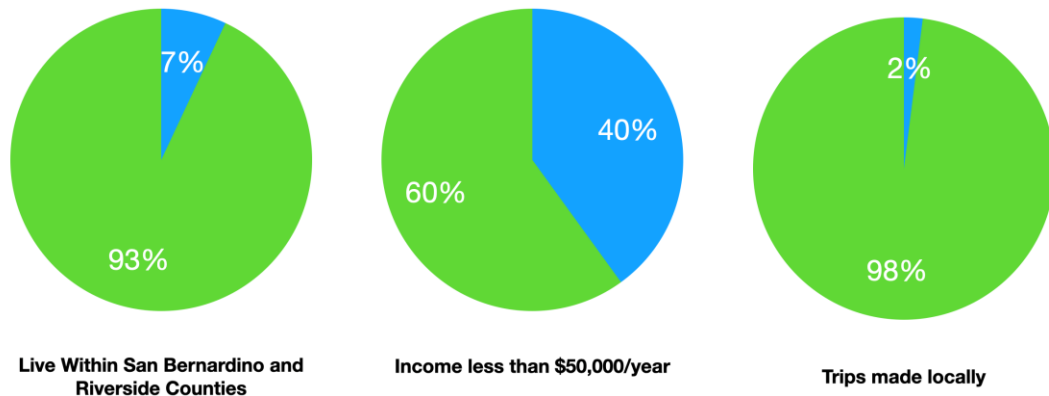
Other unscheduled maintenance that occurred was the replacement of the radiator in one of the vehicles. The radiator suffered rock damage from the road, which required for it to be replaced. This occurred in February 2020, which took less than a day to repair.

Over the course of two years, the duty cycle of the fuel cell was less than minimal. Each vehicle traveled an average of 12,000 miles and showed little to no signs of interior or exterior wear and tear. The Toyota Mirai can travel well over 100,000 miles and has a lifespan of greater than

10-years. Based on this, StratosShare can maximize the usable life out of the cars by keeping them in the fleet for 5-8 years.

- **Travel Patterns and Customer Demographics**- Over the course of 2 years, StratosShare gathered over 2,000 users and provided over 3,500 trips. The demographic profile of the average customers is shown below:

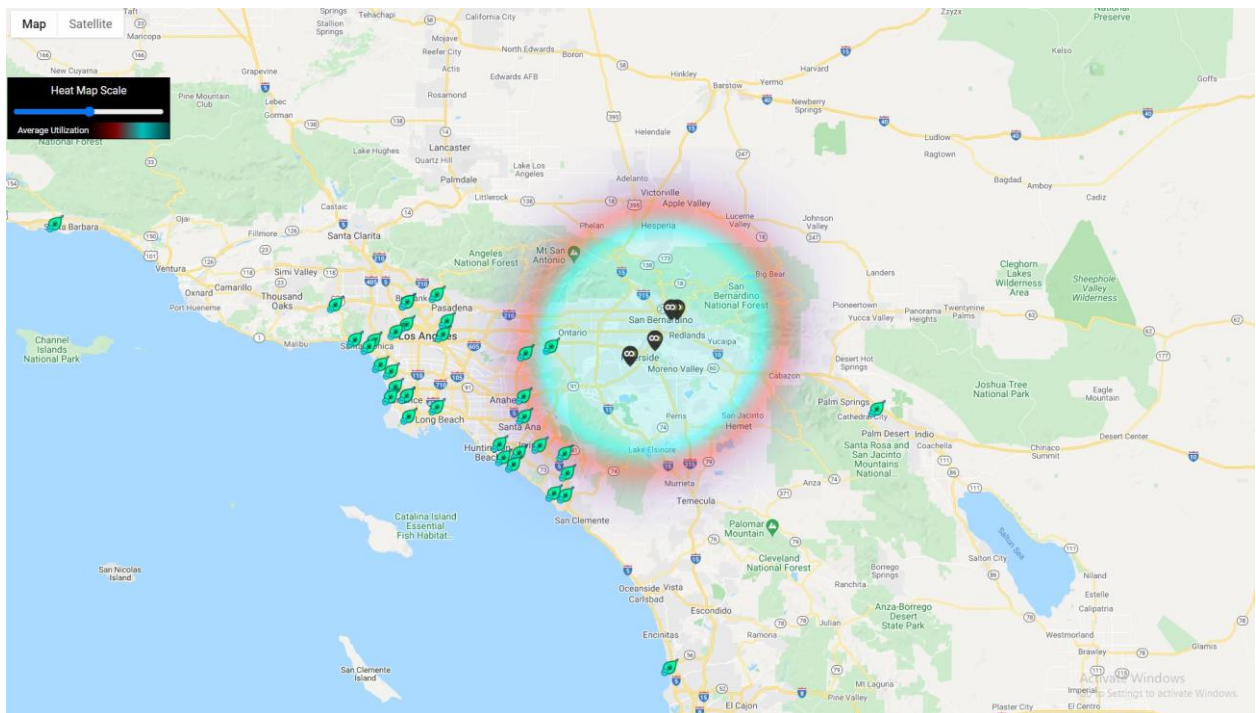
Figure 25: StratosShare Travel Patterns and Customer Demographics



Source: StratosShare

Dissecting the above data shows that 93% of trips taken were from people living within Riverside and San Bernardino Counties. Additionally, 60% of drivers had a household income of less than \$50,000/year. Breaking down the average user demographic reveals that most trips were taken for business or leisure purposes. People use the vehicles out of necessity as opposed to pleasure, which is why 98% of trips were local, with only 2% of trips traveling further than 100 miles from a StratosShare parking location. Below is a heatmap that shows how far the average vehicle traveled from StratosShare parking locations:

Figure 26: Heatmap of vehicles traveling within a 40 mile radius of StratosShare drop off locations



As shown in the image above, the vehicles traveled on average 30-40 miles outside of the parking locations. This shows that most trips taken were local, which is evidence shared mobility is useful to communities within the Inland Empire.

Job Creation and Economic Benefit

Studies of 9,500 people who participated in carsharing programs in the US and Canada documented numerous impacts (UC Berkeley's TSRC): 25% of members sold a vehicle due to carsharing, and another 25% postponed purchasing a vehicle, leading to the conclusion that one carsharing vehicle replaces nine to 13 vehicles among carsharing members because their vehicles were sold or they postponed purchasing vehicles. This reduction in vehicles results in notable reductions in VMT (27% to 43%) and in greenhouse gas (GHG) emissions (a 34% to 41% decline in GHG emissions or an average reduction of 0.58 to 0.84 metric tons/household). The car-sharing program had a strong environmental impact on the air, which improved the overall health of communities within San Bernardino and Riverside Counties. When communities are healthier, residence are more likely to go out more, which means economic growth. On top of that carsharing users also walk, bike, and carpool more often, which leads to decreased monthly household transportation costs (more expendable income). Overall, car sharing provides a means to not sacrifice transportation, but to use a more convenient form that saves money for community members that use the service. After reviewing the car-sharing project in Riverside, and San Bernardino StratosShare found that it yielded a number of economic benefits for the communities:

1. **User Benefits from Increased Mobility:** Close to 50% of members within the StratosShare program did not have a car. The program provided a means for people to

transport. This in turn added economic value because one it was utilizing a transportation provided by a local company, and secondly it was promoting commerce. For example, most trips were made out of necessity, meaning they were to run errands, get to work, or conduct business.

2. **Access to Employment:** The vehicles were used frequently by UPS cargo pilots, and commuters. People that would fly into the San Bernardino Airport for work would use the vehicles as a last mile solution to arrive at their destination. Furthermore, the County of San Bernardino used five of the vehicles for one year to conduct their operations. For example, the County of San Bernardino had a shortage of zero-emission vehicles for their employees to use. Through the carshare program, StratosShare made it possible for County employees to drive zero-emission vehicles for their work purposes. This in turn saved over 24 MT of CO2 emissions and generated revenue for StratosFuel.
3. **Job Creation:** Over the course of the project, StratosShare created two-full time positions and one part time job. The jobs created were to manage the customers and maintain the vehicles in service. Each job paid above minimum wage and ranged between \$15-\$23/hour. As the StratosShare program begins to expand the team anticipates creating four to six more jobs within the next 12-18 months.
4. **Tax Revenue:** Over the course of the program, StratosShare generated over \$10,000 in local sales tax revenue for San Bernardino and Riverside Counties. These tax revenues do not account for the other monies spent by customers arriving at their destinations, such as super centers, hotels, and restaurants. As the program expands into other regions of Southern California, the team estimate that StratosShare could potentially generate upwards of \$50,000/year in local tax revenue for cities.
5. **Use of Local Resources:** Having a FCEV car-sharing vehicle means that they only take hydrogen fuel. All of the vehicles in the fleet utilized local hydrogen and state funded hydrogen stations. StratosShare purchased over \$100,000 in hydrogen from local hydrogen stations that spanned from Riverside, Diamond bar, and Anaheim.
6. **Community Benefits:** By reducing per capita vehicle travel carsharing supports transportation demand management (TDM) objectives. It can help reduce congestion, road and parking facility costs, accidents, pollution, resource consumption and other environmental impacts. By reducing vehicle traffic and parking requirements, carsharing allows more flexible, infill development and helps create more livable communities. These benefits can be particularly significant in higher density urban neighborhoods where carsharing is most feasible and the external costs of automobile use are greatest. Specific examples of avoided costs are described below:

- Urban freeway congestion costs are estimated to average 6-9¢ under moderate congestion (50 mph), and 37¢ when congestion is heavy (traffic flows at less than 40 mph).⁸
- One study found that local governments spend about \$275 per vehicle on local roads and traffic services that are funded by general taxes.
- Motor vehicles are major contributors to urban air, noise and water pollution. Adding zero-emission FCEVs to a local car-sharing fleet will improve the overall local community. Carsharing need and should be offered in every city because of the benefits they provide.

Well-to-Wheel and Carbon Intensity of Fuel

The transportation sector is a leading source of pollutants that threaten lung health and lead to asthma attacks, hospitalizations, emergency room visits and even early death. While all communities that suffer from unhealthy air experience health effects, communities located near major roadways are at increased risk of illness. Often, low-income communities and communities of color bear a disproportionate burden due to near-roadway pollution. Recent research concluded that exposure to traffic pollution causes asthma attacks in children, and may cause a wide range of other effects including contributing to the onset of childhood asthma, impaired lung function, cardiovascular impacts and premature death⁹. Based on a 2016 study by Time Magazine they found that Riverside, Ontario, and San Bernardino were among the top 10 cities with the unhealthiest air quality. They all had over 105 days per year that had unbearable air. These cities are dubbed the smog belt.

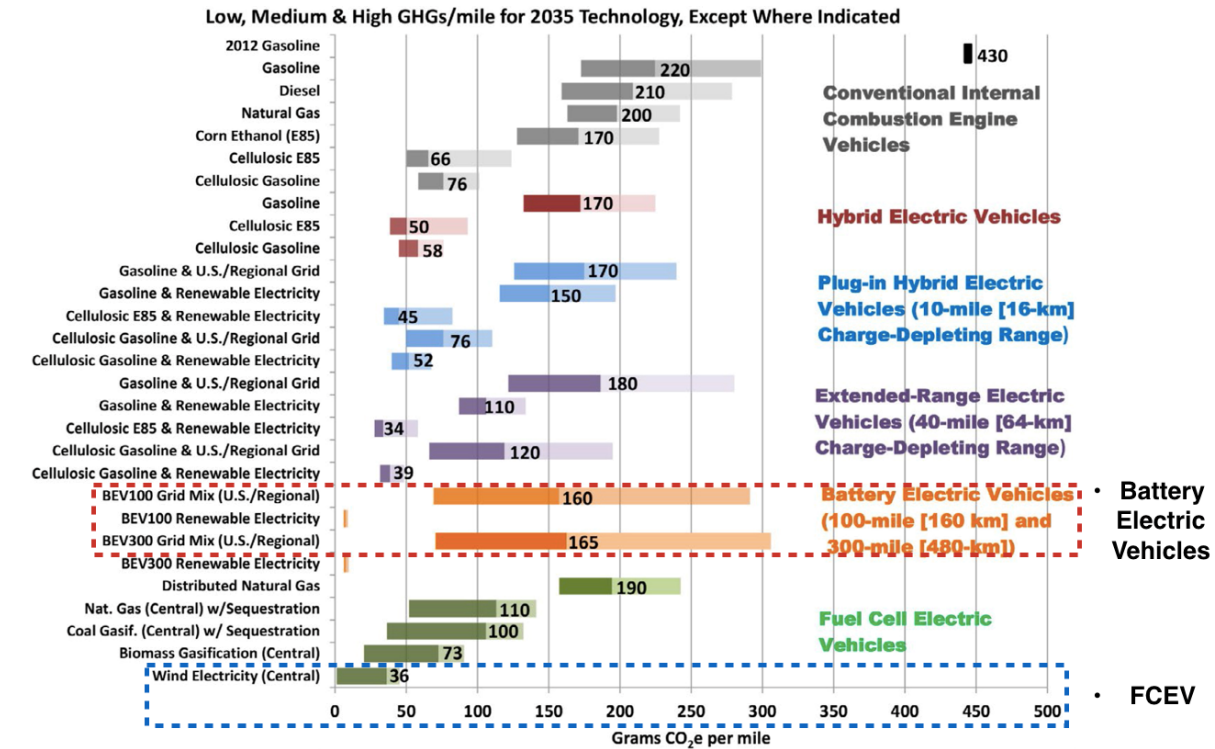
That being said, the deployment locations for the FCEV car fleet are ideal because they will help reduce air pollutants within these cities. FCEVs will have more of an impact on the air quality in the local communities because of the level of emission reductions they have. FCEVs emit less greenhouse gas emissions on a well-to-wheel basis because of the fuel pathways. See Image below for an example:

8 Herbert Levinson, "Freeway Congestion Pricing," Transportation Research Record 1450, 1995, pp. 8-12.

9 Health Effects Institute: Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. Jan. 2010.

<https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health>

Figure 27: Health Effects Institute: Traffic Related Air Pollution



Source: Health Effects Institute

Each of the car sharing vehicles will replace nine to thirteen gasoline powered cars on the road. This translates to over 42.3 tons of CO₂ that will be reduced each year from one FCEV. Additionally, the FCEVs did not emit other NO_x and SO_x emissions and used hydrogen with an average CI value of 44 gCO₂e/MJ. the StratosShare program significantly reduced any GHG emissions and improved the air quality in the communities it served.

GLOSSARY

ALTERNATING CURRENT (AC) – Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

BATTERY ELECTRIC VEHICLE (BEV) – Also known as an “All-electric” vehicle (AEV), BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

CALIFORNIA ENERGY COMMISSION (CEC) – The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

1. Forecasting future statewide energy needs
2. Licensing power plants sufficient to meet those needs
3. Promoting energy conservation and efficiency measures
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels
5. Planning for and directing state response to energy emergencies.

FUEL CELL ELECTRIC VEHICLE (FCEV) – A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.