ChargEd

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Prototype: http://nx779g.axshare.com

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The Problem

As fossil fuels wane and our society demands more efficient and effective means of transportation, electric cars will fill that void. There are two main problems with current designs of electric cars:

1. The technology is not available, currently, in order to make them as reliable as those that run on fossil fuels. Current models have:
    a. Lengthy charging times
    b. A tendency to use Lithium-ion batteries, which are easily damaged, reducing the amount of charge stored
2. We as a society have not yet adopted electric cars into the mainstream which has made us ignorant. They are seen as a luxury and not a necessity. It takes time and effort to adjust to a new method of driving.

These main problems have potential buyers questioning the usefulness of electric cars. Our team is trying to solve both of these problems by creating a sleek, new interface that manages energy usage more efficiently and is easy to use. The goal is to make the car more reliable and provide a seamless transition from driving the cars of the past to those of the future.

It is important that we solve this problem because of its enormous scope in terms of the environment and money. Every semi-developed area in the world has automobiles or machines running on fossil fuels. That means billions of people operating machines that are harmful to their environment and the organisms that live there. Burning fossil fuels releases carbon and other harmful elements into the air that overtime can lead to significant environmental impact. Electric cars on the other hand, have almost no environmental impact when being operated. With regards to money, it costs millions of dollars to try and clean up the environment once it has been destroyed. We can prevent this problem in the future by using reliable, efficient electrical cars.

The automobile is a multibillion dollar, worldwide industry that is dominated by models that run on gas. Companies like Tesla and Toyota are attempting to break into this market with cars like the Model S and Prius. Just a small market share of this industry is enough to catapult an electrical car company into the mainstream. Utilizing and interface like the one my team has created will help ensure the customer gets the best product available and will let the manufacturer stay in business, making money and helping the environment.

Creating an interface that could be operated quickly and easily should be the focus of any design process. In our case we had to keep in mind that our users would be driving while interacting with our product which presented a series of challenges with the design. We had limited design space because realistically, drivers only interact with the steering wheel, pedals, and dashboard while driving. Our design could not be too big so that it would not fit within the car but could not be too small so users could not interact with it. We also had to decide what the best ratio of steering wheel to dashboard would be for effectively operating our product. There was heavy consideration for using the whole windshield but that idea was scrapped when we decided it would be too distracting to the driver. The most important design issue was how to obtain maximum capability while not making it too complicated. When operating a vehicle, taking your attention away from the road for even an instant can be dangerous so we had to create a way to use our interface effectively while not putting the operator at risk.

Throughout the course of our research our team did not find any one product that was specifically designed to manage power in a wide variety of vehicles. What we did find was a collection of tools that could be combined to address the need for reliable power, such as:

1. GPS
    a. Google Maps
    b. TomTom
2. Voice input/output
    a. Apple's Siri
    b. Samsung's Cortana
    c. "Ok Google" voice command to initiate search in Google on smart phones
3. Variable lighting
4. Touch screens
    a. Existing onboard touch screens for cars
    b. Smart phones
5. Scroll bar on wheel
    a. Audi MMI Control Knob
6. Electric cars
    a. Tesla Model S
    b. Toyota Prius

Our team was able to take certain elements of products already on the market and link them together with a single, cohesive interface design.

Over the last 15 years there has been an increase in research for managing power in vehicles. One such study from IEEE Control Systems Society states that simulations for energy management concepts are working. The most promising avenue to pursue in this area is regenerative braking that will provide charging to the battery every time the brakes are applied. That being said, the vast majority of research done for electric cars is centered on manufacturing more reliable and efficient cars and gauging consumer interest in the product. Engineers and companies need to make sure their products work before they can focus on managing the power usage. As stated before, steps are being taken to experiment with making more efficient Lithium-ion batteries in order for cars to be charged faster and keep the charge longer. Topline does a yearly report on the state of electric cars because they are the "frontier of unharnessed possibility". Between 2010 and November of 2012 there was an exponential increase in market demand for electric cars. With products becoming more and more efficient, coupled with increase in market demand, it will only be a matter of time before gas powered cars are a thing of the past. The question now is; how will the power be managed in these cars? Our team believes it has the answer.

Based on an early survey and our own design considerations, this is the list of features the users would require:

- Large dashboard screen
- GPS
- Visual display of power consumption
- Power saving modes
- Route planning around power levels
- Mobile app of car status

Users

Our product is specifically designed for electric powered cars. This means that the design is specialized for consumers who currently own an electric car or are likely to purchase one in the future. The demographic range has a wide variety of traits that must be considered. According to the Electric Vehicle Information Exchange (EVIX) the median income for owners of electric vehicles is $108, 624.00, about double the national median household. Further statistics show that 77 percent of electric car owners hold a four-year degree, 79 percent are male, and the average age is 46 years old. It is clear that the typical consumer we are designing for are aware of the energy crisis the planet is going through and are knowledgeable enough to consider electric cars. Also, we would likely target middle-aged consumers who have a steady enough income to purchase an electric vehicle.

While the target consumer of electric cars is clear they may not be the only audience that is targeted to purchase ChargEd. Another outlet we are looking into is the car manufactures. Since ChargEd is an interface that can be installed into a car it is easier to have cars manufactured with the interface pre installed before a customer purchases it. Obviously, to be effective at this we must focus on companies that are leading the way in electric car innovation like General Motors, Toyota, Nissan, Tesla, etc. Licensing our product to a bigger car manufacturer could be a quick way for it to gain in popularity.

The persona we created to fit the ideal candidate for our product is Drew 'Danger' Driver. Drew is a 31 year old male who can be described as funny, quirky, socially insecure, a good public speaker, and has commitment issues. His hobbies include: going to happy hour with coworkers, attending board game nights, and brewing with his old man. He also loves sports and is a season ticket holder for the Seattle Seahawks. He is currently the VP of sporting goods at Amazon where he makes 150,000 dollars annually. Much of his job consists of him driving around to sporting goods warehouses to get status updates, meet with clients, and check on inventory. Like many electric car owners he hates paying for gas but is hesitant to switch to electric cars because he lacks confidence in the power ability.

Tasks

The primary focus of our interface is to manage the energy and power of an electric powered vehicle. As technology grows cars have been able to achieve so many more complicated tasks resulting in more tools to be controlled on the interior dashboard. Something that wanted to emphasize with ChargEd was simplicity. After all, it is an energy-managing interface and many other car features do not need to be incorporated into it. With that being said there were a few tasks we definitely wanted ChargEd to be able to accomplish for the user.

One of our big focuses was on navigation and the inclusion of a location map. As we mentioned, a growing concern with electric cars is the lack of confidence in the ability to get to a charge station. After all, no one wants to be stranded in a deserted area with no power in his or her car. The navigation system in ChargEd allows for users to get to any required destination, or multiple destinations, in the most efficient and power saving manner. Also, the home screen of ChargEd is a map that shows the driver their exact location.

Along with navigation, we wanted ChargEd to record and display usage statistics and make energy recommendations based off these. ChargEd allows for the user to ask about the car status which promptly displays the temperature, battery left, power used, time to next charge, power available, destination to next charge, and the pressure in each tire. These statistics assure the driver understands key components of his battery level. ChargEd can also internally study the daily stats and ask the driver to make adjustments accordingly. For example, if on a Tuesday the driver averages five hours of battery and there is only three hours available ChargEd will let the driver know.

Another key feature is the energy modes. Right now we have three different energy modes: maximum performance, balanced, and energy saver. The user can adjust these modes at any moment. However, if at a certain point the battery level is too low ChargEd will give a warning to the user to switch to power saving mode. This coincides with the fact that one of ChargEd main objective is to get the user home to charge. This means ChargEd is constantly tracking the location of the car and comparing it to the house location to ensure the driver has the ability to make it home.

All these tasks can be seen put to use in our scenario design and storyboard. Our scenario is Drew and his wife traveling to Comic-Con in San Diego. They want to stop by in Oregon along the way. Our storyboard includes Drew entering the destinations and picking the best route to use the least amount of energy. Along the way he runs into unexpected traffic and switches to energy saver mode to match the new circumstance.

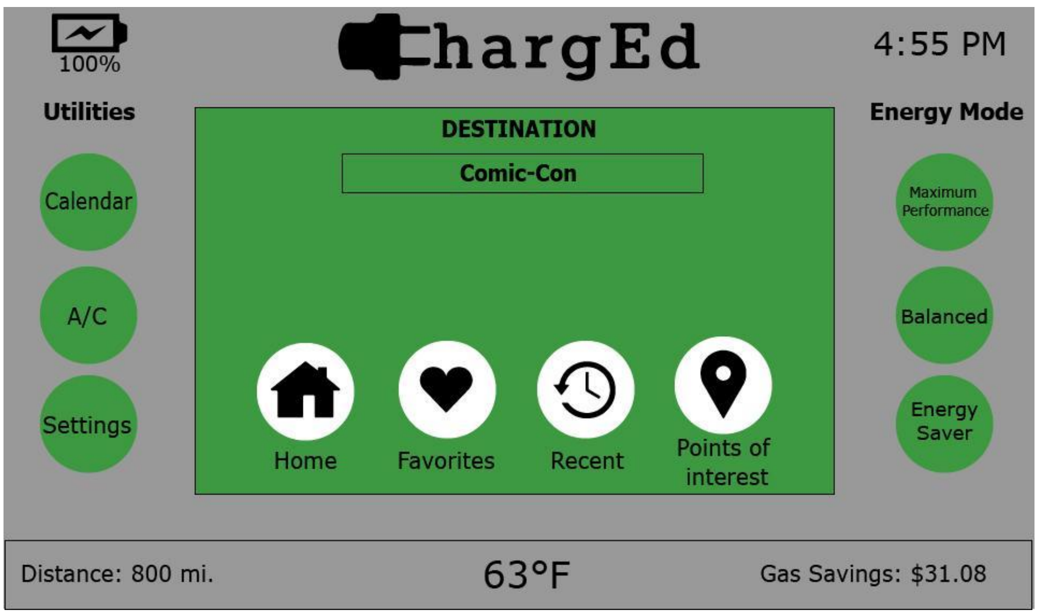
Design Criteria

When designing the final prototype of our product and system, we had four priorities in mind. These priorities were determined from our research into similar products and the electric car user profiles, and from testing of our initial prototype. The priorities are:

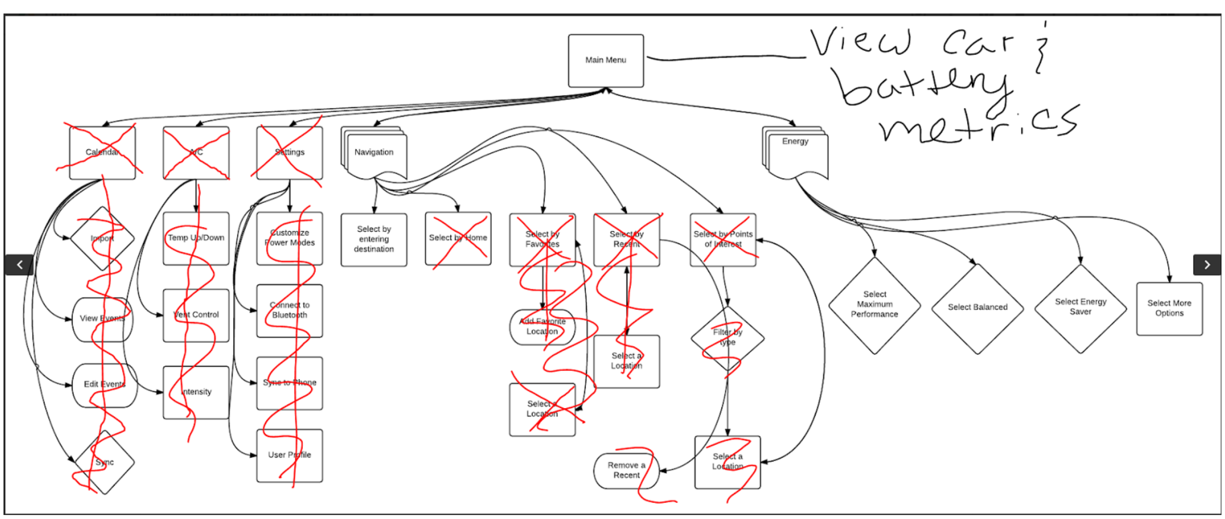
1. **The user has to be able to use our product safely while driving.** This means large target areas for buttons and slide out menus as well as large text on screen and zero clutter. Additionally, the product responds to voice commands and has an integrated digital personal assistant to assist the user with hands free actions.
2. **The system prioritizes the user getting home to charge over stopping at a charging station.** We created smart recommendations that notify the user when they need to change to a more energy efficient power mode and when they need to navigate home to charge. Additionally, the system looks at energy usage metrics and will make recommendations on length of charging time.
3. **Information on battery health should be transparent to ease user worries.** We included a panel that the user can access from any screen. The panel has data on the car's health and performance so users can make informed decisions about their driving itinerary.
4. **Energy management is heavily dependent on where the user is driving**. Thus a live updating map and the ability to route a trip are front and center on the interface.

Our Design

The original design for our product was complex and feature heavy. Our intent was to give the user control over all systems in the car that used battery power and give the user the ability to plan complex driving itineraries. Users found this system too cluttered and did not take well to the design. We went back to our system map and narrowed down our features list to help us design for a less complex system.



Original dashboard home screen which participants found too cluttered.



Revising our system map after our first round of user testing.

Our final product is a touch screen interface and custom wheel that would come pre-installed in a fictional electric car called the Phoenix ChargEd. We decided to put it in a fictional car to better envision an entire system that was built to be harmonious with our product.

The core functionality of our design is to help users make informed decisions on managing their car's battery power. This is achieved through popup alert smart recommendations prompting the user on actions they should take to maintain sufficient charge, a details panel of car and battery metrics, and a menu of energy modes users could choose from.

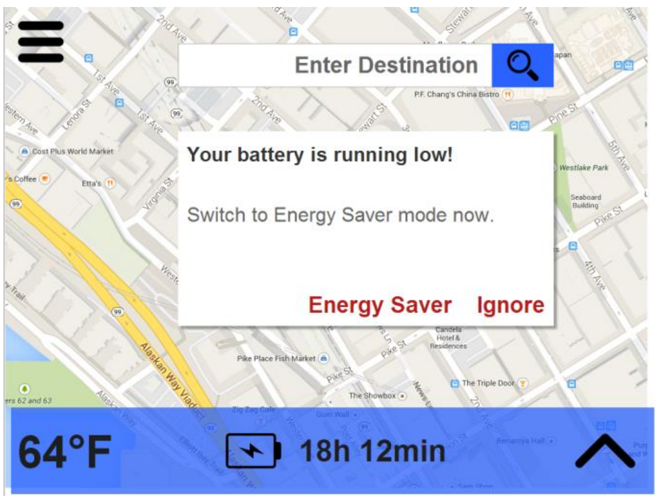


Figure 2: An example of a popup alert smart recommendation.

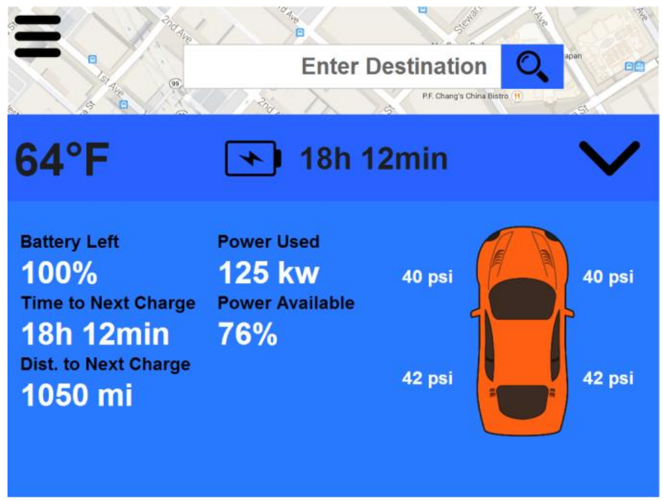


Figure 2: Bottom pull out panel with car and battery metrics.

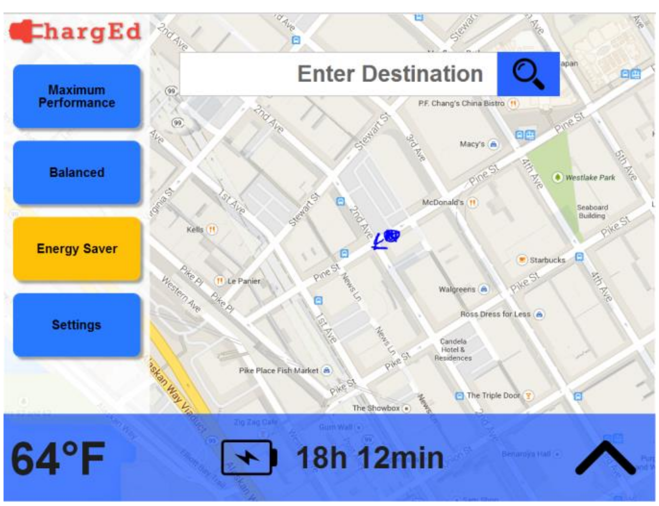


Figure 1: Side pull out menu of car energy modes

Additionally, our system has two auxiliary functions: a digital personal assistant that can respond to voice commands and a GPS map and routing feature. Since it is difficult to integrate a digital personal assistant into a prototype, we created a promo video of our product that includes what that experience might sound like: http://bit.ly/1yYHrgw . The GPS map and routing feature is an important auxiliary function to our product because many of the decisions users would make about energy modes and when and where to charge are based off where they are going, traffic to and from their destination, and other travel related factors. Additionally, during our first round of user testing, some participants mentioned that they expected an in car dashboard to always have a map with their location front and center.

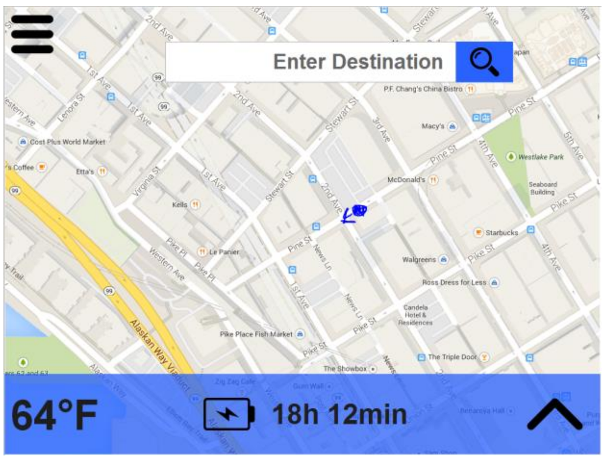


Figure 4: Home screen with map and option for directions taking up most of the screen.

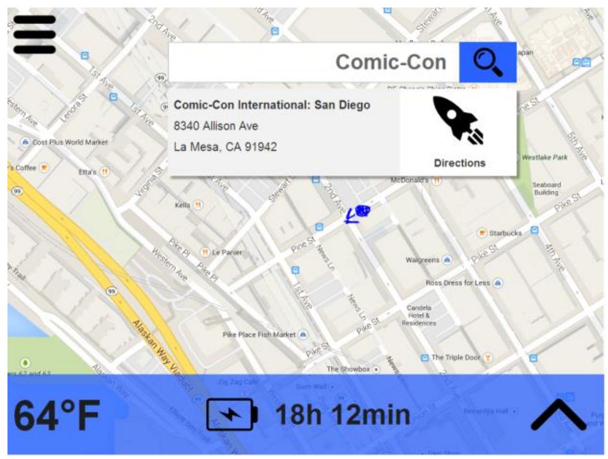


Figure 5: Intermediate step in getting directions.

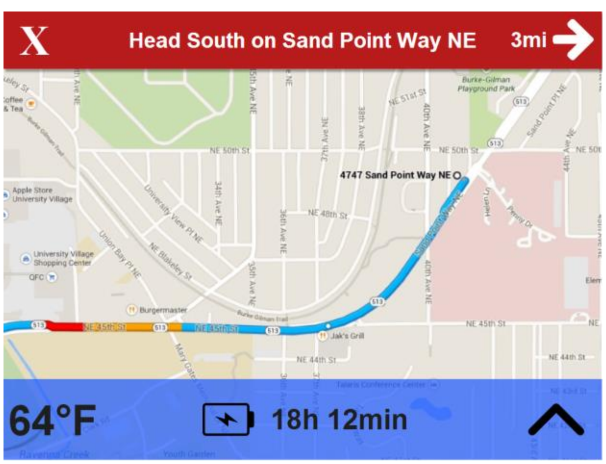


Figure 6: Active navigation to user's destination.

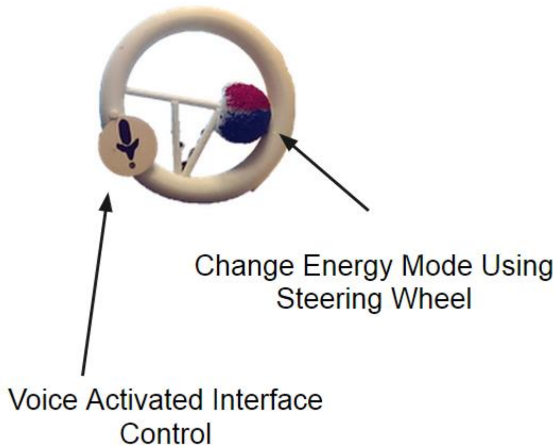


Figure 7: In addition to the dashboard, we created a wheel prototype with a button to activate voice commands and a dial for switching between energy modes.

The organization of our new system is centered around the home screen and battery levels. Most features can be accessed from the home screen whereas smart recommendations appear based off battery metrics. To see a working version of our dashboard system, follow this link: http://nx779g.axshare.com/ .

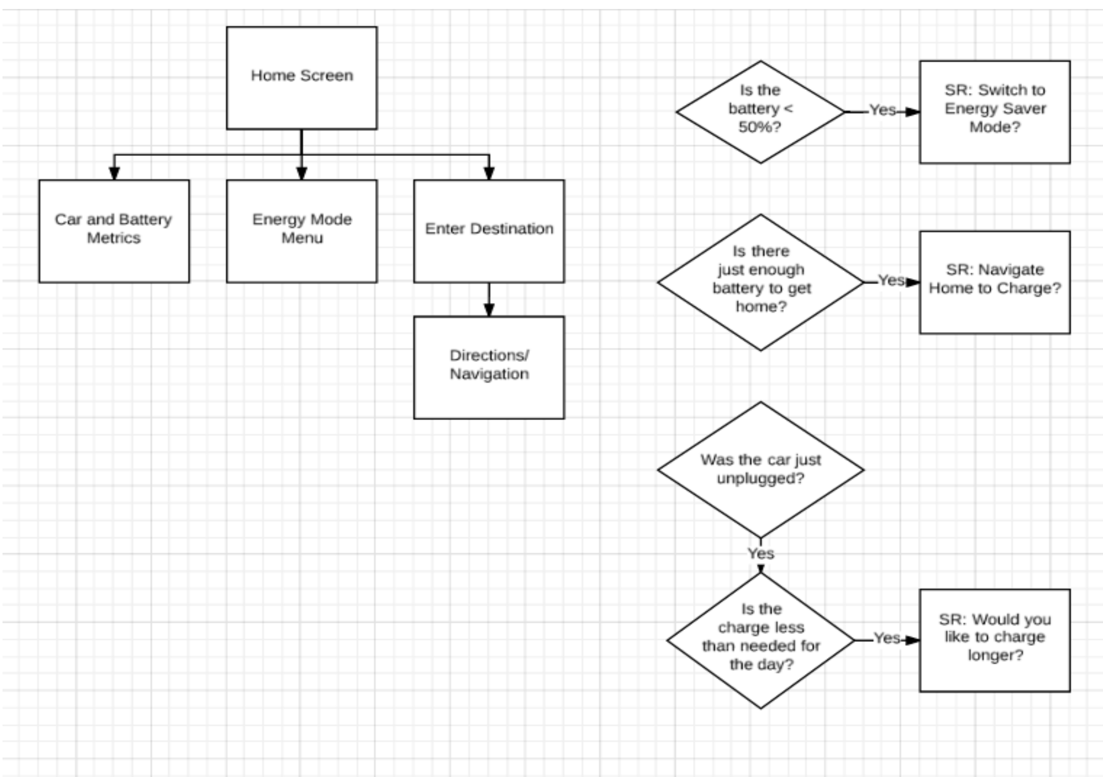


Figure 8: Updated system map after first round of user testing.

Testing

We decided our test designs by conducting several usability tests on our Flipbook and Physical prototype.

For our first usability study, we tested our flipbook. Since it was a flipbook we didn't have an actual prototype however we had an interactive design that was loaded up on a computer screen. The team did not do the usability testing together for our Flipbook, instead we all did two usability studies per person, which resulted in eight usability tests.

In order to keep the usability testing as consistent as possible throughout the testings, the team created a checklist and a script that they would use and follow so that the tests are very similar to one another.

The Checklist and Script are below, the questionnaires and survey can be found in the Appendix.

Moderator checklist

- ❏ Laptop
    - ❏ Open to the Energy Management System interface
- ❏ Notebook & Paper
- ❏ 2 power outlets accessible from the table where the test will be conducted.
- ❏ Table for conducting the test. Should be big enough for all test personnel present and the participant to gather around and perform their individual duties.
- ❏ Seating for all personal and the participant. Seating should be generally comfortable. A desk chair is preferred to a "lounge" chair as some participants may require ample back support.
- ❏ "Office-quality" lighting in the room. Should be bright enough for all present to comfortably use a computer, read paper and write on paper.
- ❏ Drinking water. Should be sufficient enough for each person present to be satisfied during the session. Bottled-water is preferred over a nearby drinking fountain so as to minimize interruptions to the session.
- ❏ 2 consent forms (one for participant and one to read along for answering questions).
- ❏ Pen.
- ❏ (Optional) Mechanical pencil with extra lead.

Before participant arrives

- ❏ Obtain drinking water. Should be sufficient enough for each person present to be satisfied during the session. Bottled-water is preferred over a nearby drinking fountain so as to minimize interruptions to the session.
- ❏ Secure a moderately quiet space.
    - ❏ 2 power outlets accessible from the table where the test will be conducted.

        - ❑ Table. Should be big enough for all test personnel present and the participant to gather around and perform their individual duties.
        - ❑ Seating. Should be generally comfortable. A desk chair is preferred to a “lounge” chair as some participants may require ample back support.
        - ❑ “Office-quality” lighting in the room. Should be bright enough for all present to comfortably use a computer, read paper and write on paper.
    - ❑ Load the user interface (Energy Management System) for participant on participant’s computer…
        - ❑ Plug in the computer. This is to prevent data loss in the case of a battery malfunction.

Participant arrives

- ❑ Offer participant a bottle of water.
- ❑ Read the script.

Participant is leaving

- ❑ Thank them again for their time.
- ❑ Give them your contact information in case of questions
- ❑ Give directions on exiting the building

After participant leaves

- ❑ Discuss what was observed and note as much of this as possible.
- ❑ Discuss general impressions. Note this.
    - ❑ Upload to Google Docs.
- ❑ Analyze the results and data
- ❑ Categorize and organize the content

Facilitation script

Welcome

Hello. My name is ______________, thanks for coming today and participating in this study.

Can I offer you a bottle of water?

Throughout the session, I will be reading from this script to ensure my instructions are consistent for all the participants of our study.

Today we are testing how users interact with our *Energy Management System designed for Electric Cars*. We will begin by asking you to complete a questionnaire using the computer to gather some general information.

Next, we will ask you to perform some tasks on the Energy Management System, it's currently not built yet but the user interface is very similar to what you will se, it will be displayed on a website using the computer. During this part of the session, we are going to ask you to "think aloud" - to explain your thought process and actions as you move through the Tasks. This will help us understand how you are moving through the Tasks. After each Task, we will also ask you a few questions. Additionally, ______________ will be taking notes on your actions and behaviors, and about any conversations we have.

Following the Tasks portion, we will ask you to complete a second and final questionnaire. Finally, there will some time for you to ask me questions and give us general feedback about the session.

Feel free to ask me questions at any time during the study. I may not be able to answer all of them right away but I will try to answer any questions you have after. Of course, you are completely free to exit leave the session at any time.

To continue with the study session today, we need formal consent for a few items.

Give participant Consent Form.

Please read this document and, if you agree, please sign at the bottom. Feel free to ask me questions.

If the participant is NOT willing to sign, tell them you cannot continue the study, thank them for their time and stop the session.

If the participants signs, say continue reading...

Thank you. Do you have any questions before we move on?

For our Flipbook Usability Testing, we all seperated and did two participants each, as mentioned above. For our Prototype Usability Testing, we followed the same script and protocol but we all conducted the usability testing together.

We held our testing in Johnson Hall, room 075. It was a lecture style room and we held our usability testing in the back row. We had each participant go in one by one and did the usability testing by following the script. The only difference was that we had an actual physical prototype where they had a steering wheel and one of our team members held up a tablet like a dashboard so that it replicated the scenario of driving.

For our Flipbook usability testing, we definitely found out a lot about our design. In the picture below, it shows our report card on our Flipbook design. All tasks took a longer time than we expected and the ease of use and likeability were very low. The number of errors were high as well with the average emoji being bored or confused.

Based on this result, we validated that although our design decisions worked, they definitely needed a lot of improvements and change.

	Average Seconds for Completion	Average Ease of Use	Average Likeability	Average Errors	Average Emoji 
Task 1	41.125	6.75: Somewhat Easy	6: Somewhat Liked	1.625	
Task 2	40.625	5.25: Neither Easy nor Difficult	4.75: Neutral	2.25	
Task 3	55.125	6.25: Somewhat Easy	6.375: Somewhat Liked	1.75	

As mentioned in our Design section, we took the results as a great indication for change in our design. After changing and refining our design we tested our Prototype again, with different participants. As you can see in the table below, we do a comparison of our results from the Flipbook (White Background) and the results from the Prototype (Blue Background). There was a huge improvement in the prototype testing, with all of the tasks decreasing in time completion, number of errors decreasing, and the likeability and ease of use increasing. Based on this results we were able to validate that our design changes to our prototype lead to faster task completion, it's more likeable, easier to use, and less error prone.

	Average Time for Completion (s)		Average Likeability		Average Ease of Use		Average Errors	
	6a	6b	6a	6b	6a	6b	6a	6b
Task 1	41.125 ± 13.26	18.49 ± 7.33	6 ± 1.85 Somew hat	9.33 ± 1.12 Very	6.75 ± 1.28 Somew	9.12 ± 0.93 Very	1.63 ± 2.07	0

			Liked	Likable	hat Easy	Easy		
Task 2	40.625 ± 9.15	17.89 ± 16.56	4.75 ± 2.19 Neutral	8.23 ± 1.92 Very Likeable	5.25 ± 1.75 Neither Easy nor Difficult	9.78 ± 0.71 Very Easy	2.25 ± 1.83	1.22 ± 1.56
Task 3	55.125 ± 67.77	14.75 ± 14.22	6.38 ± 2.56 Somew hat Liked	9.23 ± 1.39 Very Likeable	6.25 ± 2.43 Somew hat Easy	9.23 ± 1.30 Very Easy	1.75 ± 2.76	0.33 ± 0.71

The team decided to test 3 major parts of the design, and they are all represented as tasks in our testing. The first task was to have them navigate to a specific destination, Comic-Con. We wanted to know if people have an easy time figuring out and inputting directions using our design. We felt that this was important because our designs main function is to calculate wherever the user wants to go and make automated alerts and tips such as when to charge or if they should change their battery mode. The second part of the design that we wanted to test was the our statistics interface that shows all the information about the electric car, we felt that it was vital for users to be able to access this feature easily since it shows all the information about their car while they are driving. The last part of the design that we tested was the changing your mode feature, we felt that giving the ability for users to change the way the car is managing the battery is an important feature, so we wanted to make sure users can easily use the feature.

From our first usability testing the main things that the users liked was that it was easy to figure out how to navigate to a certain location, however many users didn't like all the extra features we had such as the A/C control, calendar, settings, and many more. They felt that we should focus our design on energy management and leave the rest of the stuff out of the design. Which was heavily reflected when we were designing our prototype.

From our second usability testing, users really liked the design. They said it was very simple and easy to use. They didn't have a hard time figuring out how to do all the tasks and everything was very smooth. One thing they didn't like was that you had to slide up to see the statistic of the car, people didn't want to swipe while they are driving since it takes more effort than it should.

From our Flipbook testing to our prototype we made a lot of changes to our design, we took a different angle at tackling the energy management system and really focused on "getitng the users home" what we mean is focusing on energy management alone. This meant taking out all the features we had in our flipbook that was not relevant to energy management. We also kept it very minimalistic and straight to the point. Very few buttons and they all had larger target area.

Another big change we incorporated was utilizing the steering wheel. We added a voice control button by the steering wheel that they could press and give voice commands to our interface, our interface would also have a speech built in that would reply when the user used voice control. This made it so that users didn't have to actually touch things in the interface to use it. We also added a quick dial to our steering wheel that allowed users to change their battery mode.

The changes worked, as mentioned above in our testing portion. All the times decreased in all of the tasks, the likeability and ease of use also went up.

We tested our flipbook separately because of the time given, we felt that it was best to do two separately. We created a script and checklist to try and offset the inconsistencies that might happen between the team. For our prototype testing, we all did it as a group to make sure that the tests are all consistent, it was also easier since all of the team was there to help and take notes. All the tasks we chose also was a reflection on the main functions that we felt was the most important in our design. We chose to gather all the quantitative and qualitative data so that we can use those results to improve our designs and also get a good understanding of our current design.

Appendix A: Reflections

Erin's Reflection:

During my time in HCDE/INDE 455 I learned the value of doing research and defining key documents before I even think about the design of a product. In my other HCDE classes, I am used to jumping right in to the ideating and sketching phases. Additionally, I find myself regretting my prototypes design at some point in the process because it does not feel fleshed out enough nor as though I have a clear audience I am designing for. Taking the time to do background reading, interview potential users, create a persona, and draw out a site analysis helped my group approach our design problem with a good sense of needs and factual evidence for our design decisions.

The part I most enjoyed was seeing the evolution of our design and thus the difference between the two user testing sessions. Our first design was cluttered and tried to accomplish too many tasks. This was brought to light during our first round of user testing and generated good discussion on scoping the project down. I was reluctant at first to make the design simpler because it felt like I was taking autonomy away from the users. This lead to the creation of smart recommendations that make suggestions based off the car and battery metrics. The user does not have to put too much thought into their car's energy levels but still has the choice of what mode to run on and when to charge.

Our group process was to divide and conquer each milestone, taking on tasks that suited our skill sets. While this was an efficient way of approaching the project, if I were to do it over again, I would have us split up tasks by which ones we would learn the most doing and by ones that weren't in our skill set. Overall, I feel that I did not challenge myself to learn many new skills during this class. By taking on tasks in areas I wasn't skilled, maybe I would be walking away feeling more accomplished. (Not to say I don't feel accomplished, I'm really proud of the product my team and I made).

My biggest suggestion for course improvement is to make it a studio class. The classroom setting for Friday class was not conductive for group work. Additionally, during the proto and promotyping phases, it would have been useful to have access to a space with tools and materials to create a sleek looking prototype. During my time at the UW, I've seen studio classes and spaces be taken away from undergraduate students, which I believe has led to the trend of students creating more apps and interfaces that can be mocked up and stored digitally, instead of physical prototypes. I would have been more inclined to create a detailed physical prototype of our product if we had a studio space to work in.

Jonas's Reflection:

Taking HCDE 455 was definitely a worthwhile experience for me. Taking the class I wasn't sure what to expect, and I was definitely blown away about all the things I have learned in this class. I think the most important thing I learned about this class was the process of user interface design. Being in a department like Human Centered Design & Engineering, I thought that all of the things we learned and did was very valuable to my skillset and knowledge. From writing the Prospectus, problem characterization, to Personas, storyboards, and so on. They were all things that I didn't really know how to do at first but learned throughout this class. I learned how to properly write a prospectus and problem characterization, this will probably be very useful in the future in my career. Personas are something I have done before but I always learn something new from making one, and it also really helped the team see the audience that we were designing for.

The thing I enjoyed the most was the whole process of designing our user interface, from flipbooks, to mockups, and to the actual physical prototype. It's interesting to see how much we got done in just 10 weeks from researching about our topic, to actually testing out our prototype design. It's also really amazing to see the improvements and changes we made from each design, flipbook to mock up to our physical prototype. The most difficult part of the whole project was time. We had a lot on our plates with a very limited schedule. Especially since it's group work, it was hard sometimes to find schedules outside of class to meet up since we are all students with busy schedules. The first usability testing was also challenging for us because there were two major things do for our project with a small time frame. It was very challenging to get the appropriate participants and find time that works for everyone to do the testing in under 4 days.

As a group there were definitely some ups and downs along the way. Fortunately it was mostly ups, it was really nice to have a group that was able to split the work evenly without having to worry about one another not doing their task. This really helped us throughout the class because we just split the work evenly and was able to finish assignments without having to meet up multiple times. A down is that since it's a group project, it was difficult sometimes to find a time to actually meet up since we all had different schedules, there were also the inevitable miscommunications that happen sometimes when working in groups. We mostly used groupme to communicate as well as google drive to share files with one another. It worked out pretty well for us. We also used the friday quiz section to handle all the in-person planning out, we would usually write an outline of what needs to be done for that week and then we would split the task and keep tabs on one another through groupme throughout the week.

I definitely will use all the techniques we used in this project. I thought our communication was pretty reliable throughout the quarter. Splitting up the task worked really well for us because we were all trusting of one another to get the job done and our busy schedules didn't allow us to meet up in person often. Something that I would do differently next time is the way we did our first usability test, although we created a very specific script I feel like the usability testing still should have been done as a group.

As mentioned earlier the main thing that worked about our group's process is being able to rely on one another without meeting up often. We only met up once a week outside of class and during that meeting we would plan out the rest of the week and split up task evenly between the group members, our personalities meshed really well with one another which helped make every group project go smoothly. We were all very considerate and responsible with the task we got assigned to. What didn't work is that since we only met up once a week, sometimes it was a lot of communication being done online, which I felt was a little hectic at times.

I really liked the course as a whole the one thing that I would change is the time frame for each usability testing, I felt like it wasn't enough time for groups to get an appropriate target group for their audience and usability test them all in one week.

Nick's Reflection:

I chose to take this class because it came highly recommended by a friend of mine, Brian Christensen. He promised me that if I took this class there would never be a dull lecture and the projects would be anything but boring. I agreed but did not have high expectations until the first day of class when it became apparent that he was telling the truth. Throughout the duration of the quarter I have been exposed to different techniques for designing interfaces that were not only effective, but easy to use. I honestly can't remember a course where I have learned more about a subject I came into the class being virtually clueless about. All these lessons culminated and were reinforced in the Final Project. Perhaps the most important lesson that I learned was to be conscious of how to best present the information and controls of the interface. I took for granted the great interfaces I use every day and simply adapted to those that were subpar. Little did I know that with some careful planning and rigorous testing, there were ways around a poor interface. Speaking of testing, that was the second most important lesson I learned, especially with our project. Our team was very confident in our concept design and was incredibly eager to test it on willing subjects. The different responses and perspectives of our product were not only interesting but helpful as well. While it's true that you can't please every user, testing over a broad range of people will help your product and future design processes.

I have not taken many design courses and the fact that this product (or concept) could be used in the real world was an excellent incentive to consider every detail in production. I also enjoyed the online resources I was exposed to through Erin and Jonas. Creating a functional prototype that could be operated via tablet required software that I was unfamiliar with and genuinely enjoyed learning about. Believe it or not, I enjoyed testing our design with other people. Like I mentioned earlier, it was really cool seeing the different responses people had to our product and how some people seemed to have a knack for operating it and others had to try several times. What I liked most about this project was creating our product largely from scratch. Watching it go from being an idea put in words on a PowerPoint slide to concept drawings to a final product we could touch and use was amazing. I enjoyed being a part of that.

I was incredibly thankful for the class time every Friday because with four group members it was fairly hard to find time outside of class to meet up and get work done. We all have heavy course loads, we all work, and we all had to find windows within the week to finish any work we weren't able to get to on those Friday's. As much as I enjoyed the user testing, that was challenging as well. Finding people willing to try our interface was more complicated than I thought it would be and deciphering their feedback was difficult. We didn't know if what one particular person wanted would benefit the product as a whole or just that one person which led to a lot of debate and design alterations. And even though most people were pretty nice, accepting criticism is still not something I do well. I think the hardest part of this process was designing the product for the users before we tested it. Trying to put yourself into the mindset of another person whom you don't know was simultaneously fun and confusing because we didn't know if what we were proposing would work or blow up in our faces. These were all large hurdles we as a team had to deal with and overcome but the process of solving them made us a better team and made our interface that much more robust.

I believe this project could not have been done by just one person and working in a group was ideal. The shear amount of planning and implementation involved with this report would have consumed just one person. Because we were in a group we were able to divide and conquer most of the work. On a more personal note, I liked working in a group because my group members were helpful, energetic, and fun to get to know. I knew Hary a little bit from other classes we had been in together but had never really gotten to know him on a personal level. I met Erin and Jonas for the first time in this class and surprisingly, over the duration of this project, I know consider them my friends, not just partners.

I have two words for when I am going to use these techniques again: Senior. Design. Based on what I have heard about the Senior Design class that starts for myself next quarter, it is a rigorous class that focuses on optimizing a real world work place. There is more at stake with this class than just a grade; businesses might potentially adopt a design which puts added pressure on us students to put in the maximum amount of effort and creativity. The technique that stands out the most in my mind for helping along this design process is the Thinking Hats example. I fully intend on using my Thinking Hats early and often throughout the project.
One part of our project that we as a group could have done differently would be to film the users before the tests when we were explaining our interface, during the testing, and afterwards while they were giving us feedback (assuming they were comfortable with that). Being able to go back and know exactly what happened and when with any given subject would have been incredibly helpful because it was difficult to remember who did what after so many test subjects. Referencing our own instructions could have helped us in the second round of testing as well. We could have altered our original instructions to make a comprehensive set of detailed instructions to help the user and ourselves.

If I had this project to do all over again there honestly wouldn't be that much I would do differently. Part of that has to do with the way the class is structured. I really liked the fact that there were clearly defined checkpoints during the quarter that we had to meet to make sure we were keeping on top of the work load of this class. Our group hit the ground running on this project and put in a lot of detailed work early on which would be one thing I would keep the same. This provided a solid base in which we were able to work off of in the more complicated aspects of the project.

I think we as a group had a very good dynamic and work ethic which served us well. What we did every week was to meet during the Friday lecture time and do as much as possible that afternoon. If one group member couldn't make a meeting or we ran out of time we would divide up the work based on our skills and preferences and complete it individually. By working well with our group as well as individually we would almost guarantee being finished by the due date while taking our time and doing the work correctly. Something we could have improved upon would have been meeting up in person the night before the assignment was due. All we did was compile the separate portions of the documents onto a Google Drive and have Jonas submit it. I think it would have been beneficial to have been able to talk over what we did for the assignment and where we planned to go from there every week.

I honestly think this was one of the most well designed (go figure) courses I have taken during my time at UW. I have two potential improvements. First, it would have been nice to do some in class exercises where we physically build an interface with basic construction materials. I realize that time constraints would make this difficult but having hands on experience with real time feedback would have been something I found useful. Second, having guest speakers come in from industry. I don't know exactly who Professor Furness' business contacts are but getting other real world insight would provide an increased scope to the class. All things considered though, this was a great class that I will be recommending to my friends.

Hary's Reflection:

Going into the class I had really little experience with interface design. The class was different than other college courses because Professor Furness really emphasized creativity from the beginning. It was certainly refreshing to take an engineering class that is less about crunching numbers and doing calculations and more about broadening one's perspective on design.

There were many things that I learned about interface design throughout the quarter. First, a good interface will be intuitive, efficient, effective, and likable. While these may be obvious when thinking about interfaces these four characteristics really are crucial to a good design. I also learned about the long and intricate process to create a new product. When working on our product we couldn't just jump in and start creating a design. We had to start by analyzing the problem and studying the background of the problem. Then we created a persona who would be the ideal customer for our product. After this was completed we could finally move on the product design and prototyping. I also learned about the importance of field testing and really adjusting the product based on user feedback. I think the hardest part of the class was the timeline to complete each step in the product development process. I feel like we were sometime rushed to get the work done by the due date, which may have resulted in ideas that were not completely grown. If we had more time for some of the tasks it would have given us more of an opportunity to be more creative, however, I understand the timetable is designed based on the quarter schedule.

Working in a group was actually really helpful because it allowed for a variety of ideas and perspectives when developing the product. The member of my group all got along really well so it was enjoyable when we worked together on the project. Being a part of a group also allowed for us delegate and balance out the workload. We developed a system where we used the Friday lab time effectively and did a lot of our work during that time period. Any additional work we needed to get done we would do over the weekend so we could have it done by the Monday due date. I would say what did not work in how our group worked was we did not meet in person as often as I think we should have. When we worked on the weekends it was individual work and we communicated online. I think I would have been better if we actually met up because it would have made for easier and more effective communication.

I can see myself using some of the techniques we learned in this class again, especially in a product development situation. It is crucial to address the issue before the product design begins which is something we learned in this class. Also, making the persona was something that I had never done before but found very useful. It allowed for the group to create an individual that would be the ideal customer for our product and allowed us to focus on that.

One way that I would improve the course is to alter the deadlines so groups are required to turn in progress reports every few days instead of once a week. Since assignments were typically due a week apart from each other our group would wait until a few days before the assignment due date to begin working on the tasks. However, I feel if we were required to show progress more often we could have better managed our time. This could also help in the fact that many tasks felt very rushed which limited creativity. Furthermore, it was hard to gage how well our product was because none of the assignments were graded. I liked how the assignments were not graded because it allowed for more risks to be taken but at the same time qualitative feedback would be nice as well.

In the future I would like to hopefully work as an Industrial Engineer focusing on process improvement. While interface design may not be a huge part of this there are still some things that can be taken from the course. The big thing is project management. Project management is very important in many professions because it creates a systematic approach to a problem. I feel like that is what we did with our interface design. We had many tasks and steps that had to be accomplished and it was our job to manage the work and stay on schedule.

Overall the course showed me a different side of product development. There is so much that goes into creating a successful product that I had not previously considered. The best part of the class was that it was open allowing for creativity to take over. We had very little restrictions on our design, which made it fun and interesting to be a part of. The individual assignments were also designed to allow us to think outside of the box. Specifically the natural elegant interface and the arcade assignment were interesting. What I really appreciated about the assignments was they stretched the way I usually thought of things and observed from a different perspective.

Appendix B: Prospectus

Title of the project: Energy management system for electric car

Team Identity

Team Name: ChargEd

Motto: We go farther, faster, cleaner.

Product Functionality

Our team's new energy management system has one key function and several smaller sub functions. First and foremost, we are designing this product to control and distribute electrical power to automobiles in the most efficient way possible in an effort to conserve energy. The goal is to get the maximum amount of energy with the least amount of charge. This will be accomplished through the subfunctions mentioned earlier. Our device will give the user approximate route energy requirements. Users can then pick the desired route based on how much time they have and how much energy they are willing to use. Another useful feature will be built-in locations for charging stations which will be another criteria that the user can plan their trip around. These fueling stations will be periodically updated to ensure the most accurate results.

Problem Solving

According to the Washington Post, while American's are spending less and less on foreign oil, we still imported and consumed almost 19 million barrels a day in 2012.[1] We aim to make electrical power for cars a viable option and therefore reducing and hopefully eliminating American dependence on foreign oil. Not only would this help our economy but because electricity is a much cleaner fuel source than gas, it would help our environment as well. Another problem this new system addresses is concern from electrical car users about whether or not they will be able to make it to their destination. With clear, reliable power readouts and consistently updated charging locations, our users can be sure that they won't be left stranded on the road without power.

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[1] Plumer, B. (2013, January 9). U.S. oil imports are falling to their lowest level since 1987. *The Washington Post*. Retrieved October 5, 2014.

Features (preliminary)

What features does it need to have?

- -Large dashboard screen
  - -GPS
  - -Visual power display
- -Power saving adjustable cruise control
- - Different Modes
  - Power Saver
  - Maximum Power

How much can it cost?

Goal is $399.99

It is difficult to estimate the cost of an energy management system for an electric vehicle because similar systems are pre-installed and their cost is included with the total cost of the car. Since our visions is to have the system as a center-console dashboard, we researched the prices for touchscreen dashboards that could be installed post-purchase. Prices ranged from $100-500. Since electric car are currently considered a luxury vehicle, we aimed our price point on the higher end of this range.

User Population

The Electric Vehicle energy exchange, a subset of Oceanus Automotive, an analytics firm in Austin, TX, did a national consumer survey of electric vehicle (EV) owners. They characterized current EV owners as not your typical americans since 'early enthusiasts of new products often differ demographically from the general population'[2]. EV owners are generally middle-aged, white men holding a four-year degree or higher. They are homeowners and have $100,000+ salaries. Since the market is growing, the survey also looked at those strongly interested in purchasing an EV within the next five years. This group is younger than current owners and the percentage of women interested is much higher, but still predominantly male. Across the board, EV owners and interested parties live in single family homes, which are ideal for charging stations, they consider themselves advocates of energy independence and environmental conservation, and value the convenience and cost savings that come with an EV. Finally, it

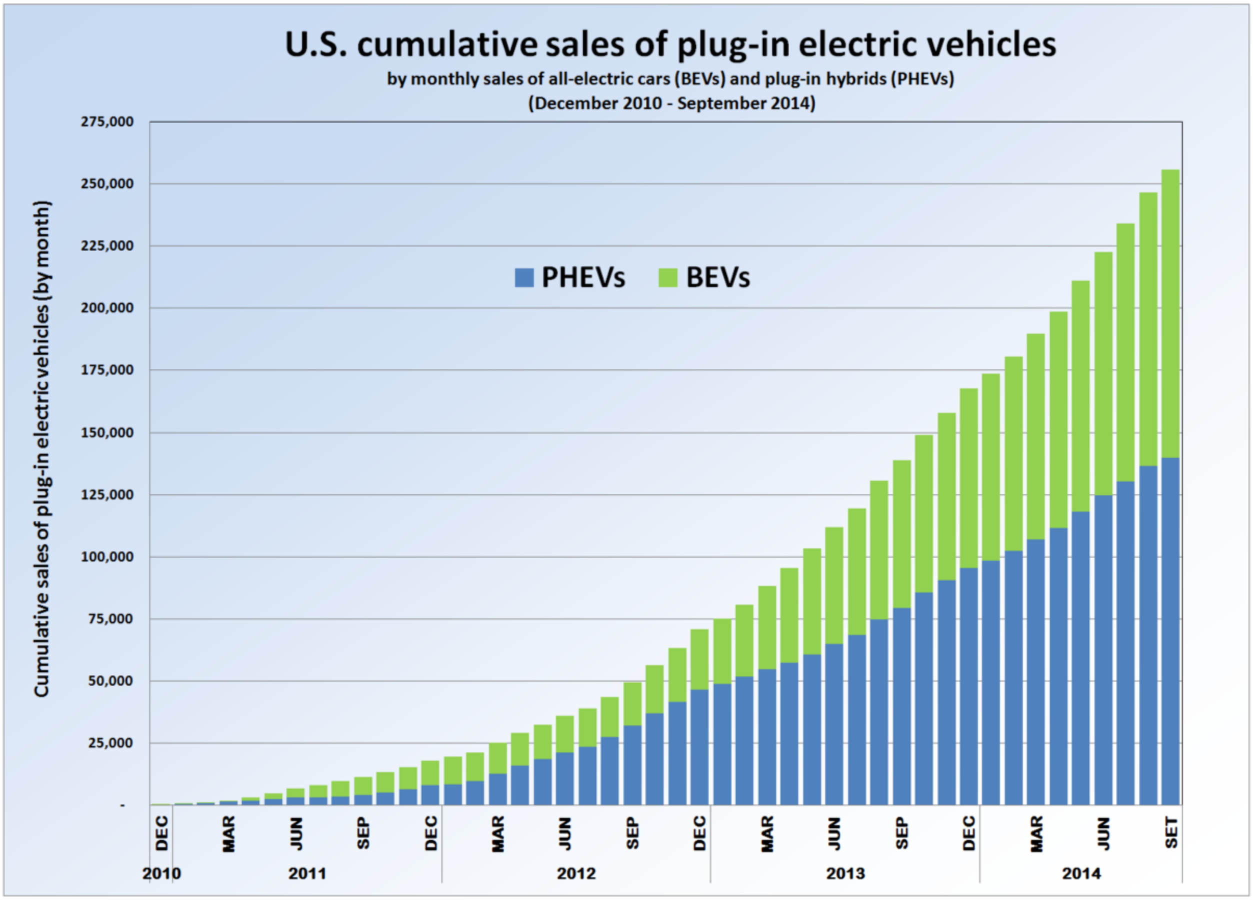
[2] EVIX. *ELECTRIC VEHICLE SURVEY PANEL*. Rep. Austin: Electric Vehicle Information Exchange, 2012. Print.

should be noted that “when it came to actually purchasing an EV... respondents were more focused on brand reputation and sticker price”[1].

Using this data, the user group for our EV energy management system has the following characteristics and values:

Characteristics	**Values**
Upper-middle class	Concerned about the current state of the environment
Live in a single-family home	Against dependence on oil
Well-educated	Look for ways to save money
30-50 years old	Value convenience
US Residents	Early adopters of new technology

America has the largest fleet of electric cars in the world, with over 250,000 on the road today. During the 2011 State of the Union, President Obama envisioned there being over 1 million electric cars on the road by 2015. While based off the rate of growth it would be unfeasible for the demand to quadruple in a year, the market is growing fast (See chart ‘U.S. cumulative sales of plug-in electric vehicles’). Additionally, there are currently 12 EV models on the market right now with more set to be released in the next few years. Thus, there is a growing market for an energy management system for EV owners.



3

We plan for the energy management system to be used in the car while the user is driving, during pre-drive trip planning, and possible have a remote extension on a phone or internet enabled device. EV owners will use it to help monitor their car's energy consumption and save power where possible to get most distance out of a charge.

<u>Resources</u>

What do I have to work with?

We have a great team working on the energy management system for electric cars. The team consists of 4 students from the University of Washington. Our team has a great deal of variety in skillsets and experience. From our team, we have two students studying Human Centered Design & Engineering (HCDE), Jonas and Erin and two students studying Industrial Engineering, Hary and Nick. Jonas and Erin provides skills in User Experience and Interface Design, Physical Prototyping, and Project Management. Hary and Nick excels in maximizing the team's efficiency, and analyzing data and providing statistics.

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[3] Jose Pontes (2013-07-19). "USA June 2013". EV Sales. Retrieved 2013-07-20.

People in team

Name	Role	Skills
Erin McLean (425-268-5503)	Project Coordinator	UX/Interface Design, Physical Prototyping
Hary Tumber (360-927-9271)	Course Schedule Keeper	Efficiency management, Statistics, Analyzing
Jonas Nocom (206-733-0217)	Archivist	UX/Interface Design, Project Management, Programming
Nick Picatti (509-985-6012)	Team Communications	Writing & Articulating, Efficiency management, numbers

Skills
-Nick: IE. Writing and articulating a point. Finding efficiencies. Numbers.
-Erin: UX/Interface Design and Physical Prototyping
-Jonas: UX/Interface Design, Project Management, Programming
-Hary: IE, Efficiency management, statistics, analyzing

Constraints

The main constraint for the team in this project is the amount of time we have to release the product. We are given only 10 weeks to finish the project which makes it very difficult for the team. This time constraint limits all of our phases in different ways, specifically our usability testing. With the 10 weeks deadline that the team was given, we could only fit two trials for our product, one for the Flipbook, and one for the Prototype. Another constraint that the team has is our lack of experience with electric cars, because of this we will have to do more research and will take up time in our project schedule. Although we have these constraints the team will strive to finish each phase earlier than the due date so that the team will have more time to reflect on the phases before they are turned in.

Project Organization/Schedule

What are the tasks you have to accomplish?

Throughout the duration of the project we have many tasks that must be accomplished in order for us to be successful. The tasks and necessary due dates have been assigned to us at the beginning of the project and we will be given further detailed instruction on what needs to be done as the project continues. These tasks include the prospectus, background review, creating persona, storyboard, task analysis, developing flipbook, making a prototype, giving our final presentation, and finally submitting our report. Along with these tasks we will have individual objectives as the project continues.

Who is responsible for what? (e.g. roles/assignments within the team)

Project Coordinator: Erin McLean
The Project Coordinator is an integral member of the project team responsible for delivering and developing the project and controlling the complexities that may come up. They are responsible for directing, organizing, and controlling project activities.

Course Schedule Keeper: Hary Tumber
The course schedule keeper tracks all assignments and task due dates and updates the rest of the team members. They are also responsible for communicating with Professor Furness if there needs to be clarification on tasks.

Archivist: Jonas Nocom
The archivist has the duty of keeping track of project material and turning in all assignments. This is a very crucial role in organization of all the work the team completes during the duration of the project.

Team Communication: Nick Picatti
Team communication is one of the most important qualities of any team project. The team communicator has the role of keeping everyone connected and on the same page.

Timeline for performing tasks

Phase	**Due Date**
Prospectus	October 6
Background Review	October 13
Persona	October 20
Storyboard	October 27
Task Analysis	November 3
Flipbook	November 10

Flipbook - Field Trial	November 17
Prototype	November 24
Prototype - Field Trial	December 1
Presentation	December 4
Report	December 8

Appendix C: Problem Characterization

Energy management systems for electric cars are a rather new technology. To help characterize our project, we researched power management, electric batteries, and the technologies in electric cars. This led to some insights on when more energy is expended by electric vehicles (EV's) and what experiences potential users would like. Additionally, we surveyed 15 UW students who were considering buying EV's in the next 5 years. From the results, we further refined our approach to the design process and developed insights on our limitations.

Background Reading

Users

Users are a very important aspect of our product. Their interaction and feedback are very critical in identifying the functions, features, and other needs that will make our product successful. One of our main focus was usability, in terms of our product one of the main issues are the knowledge of the user in terms of energy management. They will have to have the knowledge and skills of being able to intelligently integrate and calibrate the battery, monitoring the flow of energy to get the maximum efficiency in terms of cost, weight, and volume, knowing the proper response in emergencies such as when the car battery is in peak demand times (Thyagarajan, et al., 2014). Another problem that comes up is that many studies the users in the past are

> Well-educated, upper-middle class, white men in their early 50's with ideal living situations for EV charging. The vast majority graduated with a four-year or postgraduate degree, and they said they make well over six figures in household income each year. They represented the last of the Baby Boomers and the beginning of Generation X. Over half were living in the West and almost a quarter in the South (Klockner, 2013)

This means that many interfaces similar to our product are based on these users and this is a problem. We want to provide an interface that caters to all users since different types of users may interact with a system differently. (Goodwin, 1987). While we agree that having an interface that suits the majority of the user is valuable, we believe that an interface that suits all users will be more successful in the future.

Technology Considerations and Issues

The electric car battery management interface controls a complicated system and will require collaboration with other technologies. First, many electric cars run on lithium-ion batteries. The problem with this particular battery is they are very sensitive to overcharge or deep charge, which can damage the battery resulting in shorter lifetime or even hazardous situations (Brandl 2012). So our interface must to be compatible with lithium-ion batteries so it can run with maximum efficiency. The link between our interface and the battery will be made by sensors connected to both (Kallfelz 2006). The sensors will be crucial in determining the accuracy and synchronization between the battery and the battery monitoring interface. Similar to the sensors, the interface may require high quality lights (LED) that are used as signals and warning signs that the interface provides. It is important that the lights are clearly visible so the driver is aware of the information the interface is providing.

There are also components that are used to satisfy some of the intricate features the interface which sets it apart from its competition. Obvious tools like GPS and Waze will assist drivers in understanding their charging station options while driving. These technologies will need to be incorporated into our scheme. If a voice UI system is installed to our design that is another technology that must be considered. Wi-Fi is becoming more common in cars and it would be an added bonus if our interface had the ability to be connected; opening up more opportunities for its use. Finally, communication is key to creating a successful interface because it enhances the user experience as well as improves the ease of use. That is why a mobile app that links the battery status to a phone, tablet, or computer can greatly benefit the user. It also allows them to be aware of the battery status even if they are not around their car.

Task Issues

As previously mentioned for this project, the purpose (or task) of this interface and system is to actively engage the user is saving electricity in their electric car. On top of just managing power more efficiently in the car itself, our interface is supposed to allow drivers the freedom of choosing their driving routes based on the amount of time and energy the car will use. A few subfunctions of this system are to identify where third party charging locations are located as well as provide an estimation of how much money they saved and how much they reduced their carbon footprint. Reliability is inherent in this product because studies have shown that "electric car buyers use the car more often for their everyday mobility." (Klockner 2013) This means the system will be responsible for adapting to a person's lifestyle and being able to provide clean, well managed power to their means of transportation.

Environmental and Other Issues

While electric cars are toted as the green alternative to gas powered cars by the general public, environmental anxiety is not the reason users purchase their electric vehicle. EV owners are more concerned with energy independence and the associated cost savings and have adopted other technologies such as solar panels to further their energy independence.

In the context of energy expenditures due to the environment the car is driving in, we have to design for winter conditions and rougher terrain. Cold winters mean batteries do not hold as much charge and EV owners have to charge their cars more frequently. Having features such as a winter power saving mode can save owners the time and cost of charges, as well as help take a load off the power grid during a high demand time. Additionally, rougher terrain roads will drain the battery more frequently and effective detection and management of power will also help the user.

Survey

ChargEd created an online catalyst survey and invited UW students in our social networks to participate. We chose to do a survey instead of in-person interviews to accommodate our busy schedules and reach out to more participants. 15 UW students participated in the survey (the survey can be found in Appendix A).

Our first question was for screen purposes. We originally chose to look at data only from students who would purchase an electric car in the next 5 years and thus phrased our first question to screen out participants not interested in electric cars. Our next three questions are multiple choice to gauge participants comfort with electric car reliability, using touch screen dashboards while driving, and taking long trips in an EV. We plan to use the results from these questions to gauge the current level of comfort with electric vehicles and their interfaces. In addition, our original idea for our project was to manifest itself as a dashboard in the car. If the comfort level for that question is low, it would encourage us to pursue other options.

Questions 5 through 7 use the Likert scale method to gauge the importance of features we defined as necessary for our energy management system. If participants rank a feature low (least necessary), that would prompt us to re-evaluate if we need it. In addition, we asked participants for additional features they would like to see in an electric car. We were mainly looking for inspiration and additional features we missed.

In our problem characterization, we had trouble finding similar products to our energy management system. Thus, we asked participants how much they would pay for our product. The figure we get from the results will inform our design decisions and constraints.

Lastly in the survey, we asked demographic questions including gender, ethnicity, yearly income, and type of area they lived in. Since most current EV owners are white men, earning six figures, and living in single family homes in the suburbs, we wants to see how that differed from potential EV owners. A population of participants that makes less than six figures and lives in the city has different constraints for their electric car than the current pool of owners.

We had 5 questions in the survey that asked the users to gauge their comfortability level on a certain feature or idea. The following will show the questions that we asked that fit this criteria and the options they had to answer the question.

- Question 1: Would you purchase an electric car in the next five years?
    - Yes or No
- Question 2: How much do you agree with the following statement: Electric Cars are reliable
    - Scale of 1-5 from Not Comfortable at all to Comfortable
- Question 3: How comfortable would you feel using a touch screen dashboard in your car?
    - Scale of 1-5 from Not Comfortable at all to Comfortable
- Question 4: How comfortable would you be taking a long distance (200+mi) trip in an electric car?
    - Scale of 1-5 from Not Comfortable at all to Comfortable
- Question 8: How much more would you pay for an electric car if it had an energy management system monitoring car power levels?
    - $100 - $299
    - $300 - $499
    - $500 - $699
    - $700 - $1,000

Our first question was that we asked if they were comfortable with the idea of purchasing an electric car in the next five years. Out of the 15 users that filled out the survey, 11 users said yes and 4 said no.

In our survey we also had a list of five interfaces we felt could be useful in considering the design for our interface. These features were:

- Large dashboard screen
- GPS
- Visual display of power consumption
- Power saving modes

- Route planning around power levels
- Mobile app of car status

We wanted to start the survey by trying to gauge the users interest in buying an electric car in the future. Majority of the users(11 out of 14) said yes. This shows us that the users who took the survey had thought about electric cars and owning one before taking this survey. Question 2 to 4 were questions that helped us gauge the opinions on ideas and comfortability with electric cars within the the users. We found that 11 out of 14 agree that electric cars are reliable and that 10 of them would feel comfortable with using a touch screen dashboard in their cars. The 4th question showed interesting data in terms of the comfortability level of the users and going on long distance trips with an electric car. Only 6 out of 14 felt comfortable with this and gave us an understanding that many users may be concerned about the battery issue and the scarcity of electric charging stations in comparison to gas stations. Our last question was to address the pricing of our product, although there are similar products out there there aren't any that are just like ours. We want to provide a good balance between affordability and quality and this question showed us that majority of the users (9 out of 14) felt that $300 - $499 is a price they would be willing to add for an energy management system monitoring car power levels.

Usefulness Rank:
1.Visual Display of Power and Consumption 5.00
2.Power Saving Mode: 4.40
3.GPS: 4.13
4.Route Planning around Power Levels: 4.13
5.Large Dashboard Screen:3.33
6.Mobile App of Car Status: 3.13

Desirability Rank:
1.Visual Display of Power and Consumption 4.73
2.GPS: 4.47
3.Power Saving Mode: 4.27
4.Route Planning around Power Levels: 4.07
5.Large Dashboard Screen:3.53
6.Mobile App of Car Status: 3.40

Our results clearly show the users find a visual display of power and consumption both useful and desired. Including this feature in our interface will result in more satisfied customers. Power saving mode, GPS, and route planning around power levels all had average scores above

4.00 in both categories making them strong features that should be considered. Large dashboard screen and mobile app ranked fifth and sixth in both categories, respectively. While they are useful features their scores indicate we should think about how to improve them to enhance user appreciation, or if we should have them at all.

Our survey also asked if there were additional features that the user would like to see that were not included on our list. There were a few that stood out as something that we could include in our interface. One person said that a tool that showed the amount of gas was saved by the electric car. This could also be used to show the amount of money saved. Another surveyee suggested visual displays of driving tips to lower power consumption. Another good suggestion was a voice UI so the driver can easily communicate with the interface without taking their eyes off the road.

Of the fifteen people surveyed, six lived in an urban area while the other nine identified as suburban dwellers. This is important because the majority don't live in cities with frequent access to charging stations so it is more important to make sure the power calculations are correct and people know exactly how many miles they can drive before their car dies.

The vast majority of our subjects turned out to be male. There were eleven males and four females. In terms of forecasting for our product, this means that we will design it to accommodate larger hand and finger size for the buttons on the touch screen. If the buttons are too close together, they could become mashed when a larger male attempts to use the system.

We had basically a half and half distribution of Caucasian and Asian for ethnicity. In an area like Seattle this is not surprising and just served to confirm our plans to design for all ethnic groups.

Lastly, our spread of incomes was fairly sizable but most were below $40,000 a year. This is a clear indicator that if we are trying to make this available to the majority of consumers we must strive to keep costs as low as possible.

Design Considerations

As with any new product that is being released into the market, we are sure to face a myriad of problems before we command a market share. First and foremost is lack of a reputation. Why should people trust our product? Overcoming this hurdle cannot be accomplished any other way than being persistent and making sure our name is advertised. Another potential problem with our product is the way in which the system and interface are synced to the automobile. Everything always works in theory but it is another issue entirely to get the product to overcome real work bugs like the fact that “tracking of operational history to evaluate the actual battery condition is difficult due to the accumulation of measuring inaccuracies.” (Koot 2005) There are plenty of other challenges we will face but these are the main two that we can foresee.

One of the most pressing questions we need an answer to is: “will people like this product enough to be willing to pay extra for it?” We can design the best interface imaginable but if people are not willing to buy it then it has been a waste. Speaking of the interface, another question that needs to be answered is: “what will this interface look like?” There are literally millions of questions that need to be asked and answered but as long as we are able to design an effective interface then the rest will work itself out as we dive deeper into the unknown.

The survey highlighted the fact that while there are certainly wealthy people that would pay for a more efficient power management system, people with smaller incomes are willing to as well. That is all the motivation we need to reach our goal of producing this product at the manufacturer level while adding less than $400 to the ticket price of the electric car.

We are still set on having a large touch screen that the driver will be able to interact with in the car but there will also be buttons on the steering wheel that control the system. This way, if they would like, drivers can plan and pick their route while keeping both hands on the wheel. We will still have the power display but instead of having different modes that will have to be manually updated while driving in order to save power, the plan is to present all this information upfront before a route is chosen. This allows the navigator to pick the best path before the drive is in process and minimizes time spent tinkering at the wheel. Lastly, the system will automatically alert the driver of the nearest charging station once power levels reach a certain low point.

Conservative estimates at this point are to have this entire system cost less than $400 and save the average user double that ($800) every year in money they would have spent on gas. If we can accomplish those two goals then this interface will have been a success.

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Appendix D: Literature Review

Erin

Electric Vehicle Energy Exchange Market/Consumer Report:
https://evix.com/files/EVIX%20Survey%20Panel%20-%20Topline%20Report%20November%202012.pdf

EV Makers Leverage Dashboard apps to stay ahead
http://www.plugincars.com/ev-makers-leverage-dashboard-apps-stay-ahead-129995.html

Jonas

Energy Management Strategies for Vehicular Electric Power Systems
http://131.155.54.17/mate/pdfs/5064.pdf

Vehicle electric power systems are under change!

http://ac.els-cdn.com/S0378775300006078/1-s2.0-S0378775300006078-main.pdf?_tid=d2843e8c-50c0-11e4-9de5-00000aab0f01&acdnat=1412975162_e1966e833e40578fbb090276e6adeac3

Battery Monitoring and Electrical Energy Management Precondition for future vehicle electric power systems

http://ac.els-cdn.com/S0378775302007139/1-s2.0-S0378775302007139-main.pdf?_tid=984203e4-50c0-11e4-8ca8-00000aab0f6c&acdnat=1412975064_20380e85c341a179b8ad91903df2d9b2

- **User issues**
    - Balancing the cost considerations in relation to features/technology of an electric car/energy management system.
    - User might need to learn how to use the “intelligent integration of the battery as the storage medium into the overall concept of the vehicle Energy Management. Careful monitoring and control of energy flows allows for minimum investment with respect to cost, weight and volume.” Which can be difficult/too much to learn.

    - Finding a good balance between comfortability with the user/driver and functions for the battery management system.
- **Survey of possible technologies involved with building the interface**
    -
- **Task issues**
    - "Tracking of operational history to evaluate the actual battery condition is difficult due to the accumulation of measuring inaccuracies."
    - Accurately track periodical complete recharge, providing a well-defined reset to full state-of-charge (SOC)
    - "increased energy demands during engine-off and idle periods need high battery capacity, and if this situation occurs many times, high cycling capability" The need for the management system to calculate this quickly and accurately.
        - Obtaining accurate calculations of battery energy use/management in real world setting/use
    - The technology to and from battery can be measured, but balancing the charges and calculating the battery is difficult.
      Current integration will give the more deviation the longer it is done. Therefore, regular standstill phases are needed which are long enough for an algorithm to estimate.
    - Currently there isn't one battery that does the job right in all of battery monitoring, they mention that in the future specialized battery designs will be needed that combines all of the different batteries to meet needs, as well as the battery state detection. They proposed a dual battery dual voltage system.
- **Environmental issues**
- **Other issues(?)**
    - **"**intelligent integration of the battery as the storage medium into the overall concept of the vehicle Energy Management. Careful monitoring and control of energy flows allows for minimum investment with respect to cost, weight and volume."
    - Controlling power net of battery in order to get the maximum energy.
    - Drive modes are hard to implement (electric, both, battery charge, braking by mechanical brakes or recuperation). Implementing this to be automated or manually by an intelligent drive control system is difficult but necessary for many users.

Hary

Electric car station model
file:///C:/Users/Hary/Downloads/mce0548.pdf

Energy management systems
http://www.date-conference.com/proceedings/PAPERS/2012/DATE12/PDFFILES/08.8_1.PDF
http://cds.linear.com/docs/en/article/EPD_March_2009-BATTERY_MANAGEMENT_ARCHITECTURES_FOR_HYBRID-ELECTRIC_VEHICLES.pdf

- **Survey of possible technologies involved with building the interface**

    - Li-ion chemistry is very sensitive to overcharge and deep discharge, which may damage the battery, shortening its lifetime, and even causing hazardous situations. This requires the adoption of a proper Battery Management System (BMS) to maintain each cell of the battery within its safe and reliable operating range.
    - Battery management is mandatory for Li-ion batteries to ensure energy availability, lifetime and safety of the energy storage system.
    - Battery current, voltage, and temperature over time are a major inputs of an electronic BMS.
    - State of Charge, State of Health, State of Function
    - Challenge is to be accurate and synchronous when measuring the battery current and the voltage.
    - Wireless communication
    - Voltage and temperature sensors for each one of the batteries
    - LED lights as signals
    -

Nick
Positive and negative effects of buying and using electric cars
http://www.sciencedirect.com/science/article/pii/S1361920913000278

Electric power management
http://www.sciencedirect.com/science/article/pii/S0196890411003724
How does it address:

User issues

- “New mobile/automotive platforms will mean big changes for how and when electric cars receive a charge. They will encourage the creation of demand response and so-called “ancillary services,” that help stabilize the grid while earning revenue for EV owners”
- Tech savvy users that need a gadget laden car.
- Demand response is the act of monitoring the energy grid (in this case, the car battery) and at peak demand times, shut off non-essentials such as air conditioning, to get the most distance out of a charge. “Electric car charging stations—or communication systems on board the vehicle—could be built to respond to these signals”. This would save money.
- “The EV Driver Group was made up of respondents who currently lease or own electric vehicles. The group was heavily populated by very well-educated, upper-middle class, white men in their early 50’s with ideal living situations for EV charging. The vast majority graduated with a four-year or postgraduate degree, and they said they make well over six figures in household income each year. They represented the last of the Baby Boomers and the beginning of Generation X. Over half were living in the West and almost a quarter in the South.”
- “The Interested Group had more of a gender split than the EV Driver Group, but it was still mostly men. Group members were mid-career, predominately white, upper-middle class, very well-educated, in their early 40’s, and had a stated household income that was just over six figures. They were geographically distributed similarly to the U.S. population. A third lived in the South and a little over a quarter each lived in either the West or the Midwest. Those in the Interested Group seem to be good candidates for driving electric vehicles. A high proportion said they live in housing types that are suitable for EV charging – single-family homes with garages – and they only drove about 25 miles per day.”
- EV owners primarily charge at night, after they get home from work
- Few respondents consistently use public charging stations

Survey of possible technologies involved with building the interface

- “Having a familiar on-board operating system that synchs with your phone will encourage drivers to take advantage of the applications… In some cases, a dongle that snaps into the cars’s diagnostic port, and integrates app info with data from the car’s computer, might be required.
- “Navigation tools, such as Google Maps and Waze, will efficiently route drivers to their destinations, extending the car’s range and maximizing electric miles driven. EV navigation apps will also showcase charging locations and availability, reducing range

anxiety. Energy management applications for scheduling and minimizing the cost of charging, while balancing charging with home energy requirements, should be integrated with the dashboard to ensure safe driving that replaces fumbling with the phone."

Task issues

Environmental issues

- "Energy independence, and not environmental anxiety, was the primary reason that these respondents became interested in electric vehicles. Beyond switching to electric drive, some have taken further personal action to reduce their energy dependence. Almost a third of this group indicated that they are adopters of home solar panel and / or wind electricity generation systems. "
- Cold weather/winter causes the car to need charge more frequently

Other issues(?)

- EV energy management is cost saving

Appendix E: Initial User Survey

APPENDIX A

https://catalyst.uw.edu/webq/survey/emmclean/249771

Question 1.
Would you purchase an electric car in the next five years?

Required.
- Yes
- No

Question 2.
How much do you agree with the following statement:
Electric Cars are Reliable.

Required.
- Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Agree

Question 3.
How comfortable would you feel using a touch screen dashboard in your car?

Required.
- Not Comfortable at All
- Somewhat Uncomfortable
- Neither Comfortable nor Uncomfortable
- Somewhat Comfortable
- Comfortable

Question 4.
How comfortable would you be taking a long distance (+200mi) trip in an electric car?

Required.

- Not Comfortable at All
- Somewhat Uncomfortable
- Neither Comfortable nor Uncomfortable
- Somewhat Comfortable
- Comfortable

Question 5.
Rank the following features on their usefulness in an electric car where 1 is least useful and 5 is most useful.

Required.

	1	2	3	4	5
Large Dashboard Screen					
GPS					
Visual Display of Power Consumption					
Power Saving Modes					
Route Planning around Power Levels					
Mobile App of Car Status					

Question 6.
Rank the following features on their desirability in an electric car where 1 is least desirable and 5 is most desirable.

Required.

	1	2	3	4	5
Large Dashboard Screen	○	○	○	○	○
GPS	○	○	○	○	○
Visual Display of Power Consumption	○	○	○	○	○
Power Saving Modes	○	○	○	○	○
Route Planning around Power Levels	○	○	○	○	○
Mobile App of Car Status	○	○	○	○	○

Question 7.
What additional features would you like to see in an electric car?

Required.

Question 8.
How much more would you pay for an electric car if it had an energy managemet system monitoring car power levels?

Required.
- ○ \$100 - \$299
- ○ \$300 - \$499
- ○ \$500 - \$699
- ○ \$700 - \$1000

Question 9.
What type of area do you live in?

Required.
- ○ Rural
- ○ Suburban
- ○ Urban

Question 10.
What gender do you identify as?

Required.
- Male
- Female
- Other
- Prefer Not to Identify

Question 11.
What ethnicity do you identify as?

Question 12.
What is your yearly household income?

Required.
- <$20,000
- $20,000 - $39,999
- $40,000 - $59,999
- $60,000 - $79,999
- $80,000 - $99,999
- >$100,000
- Prefer not to disclose

Question 13.
Additional Comments:

Appendix F: Persona

“I think I’m ready for an electric car. All my coworkers have Teslas”

Name: Drew ‘Danger’ Driver

Age: 31

Gender: Male

Background: Drew went to Woodinville elementary school for his early learning and transitioned to the Woodinville high school. While he loved football and sports in general, his slim physique, asthma, and poor hand-eye coordination prevented him from participating. In an effort to become closer to the sports program he signed up to be the mascot for his football team: the Woodinville Fighting Owls. He decided to go away to college and enrolled in UC Santa Cruz. Sadly, he was not chosen to represent the school’s mascot, the banana slug. After graduation, he stuck around to pursue his masters degree in business. When he was finished with the program, he got a job with Amazon that progressed into VP of Sporting Goods after five years and currently lives in Capitol Hill. Drew met his fiance, Nagheen, playing World of Warcraft online. They finally decided to meet in person after 3 years of playing with each other when Drew realized Nagheen lived in Fremont.

Family associations: He grew up in woodinville, his Mom was a PM for Microsoft before retiring and taking on consulting work. His Dad is a craft brew master. He has two sisters, the older is a professor in astrobiology, and his younger sister is a sous chef at a michelin star restaurant.

Personality: Funny, Quirky, Insecure socially, Good with public speaking, commitment issues

Hobbies: Going to happy hour with coworkers, attending board game nights, and brewing with his old man. He goes camping at least once a year. Once a month he goes to a larping event, he is currently roleplaying as a vendor salesman for an apothecary. He plays online video games very often, has been gaming since he was little. He also loves sports and is a season ticket holder for the Seattle Seahawks.

Professional life:
VP of Sporting Goods at Amazon. Has been there for 5 years. Makes $150,000 a year before bonuses.
Drives to meet with sporting good clients and check warehouse inventories

Personal goals:
Engaged for 7 years, no wedding bells ringing yet.
Become the head/president of the Electronics Department at Amazon
Wants to road trip to ComiCon 2015 and meet Patrick Stewart and Ian Mckellan
He’s thinking about getting a dog but got a potted plant in the mean time.

Frustrations:
Hates paying for gas and he doesn’t have the time to fill-up
Material envy of coworkers electric cars
His current car, a 1992 Subaru Outback, isn’t running well these days
Frustrated with the lack of action the rest of America is taking to conserve their energy usage

A day in their life:

- 7:00am - Wakes Up, gets ready for the day
- 7:45 - Picks up breakfast at the Starbucks near his house then drives to work in South Lake Union.
- 8:30 - Has client meetings with East Coast clients over Skype
- 9:15 - Coffee break then meeting
- 11:00 - Elevensies lunch
- 12:00 - Drive outside of Seattle to meetings with vendors, warehouses, etc
- 4:00 - Returns to his office for late afternoon meetings
- 6:00 - Happy Hour at Ivars with his team
- 7:30 - Picks up fiance
- 8:30 - Board Game night at RayGun lounge
- 11:00 - Netflix

Appendix G: Scenario Design

It was a Tuesday night, and Drew just got off work and was on the way to pick up Nagheen so that they can head to their annual board game night. However after driving about 5 miles his 1992 Subaru outback stopped working. This is not the first time it has happened to Drew, after trying about everything to get his car to start again, he finally gives up and takes the bus to pick up Nagheen. They ended up being too late for the board game night and this caused a very huge fight between Drew and Nagheen. Nagheen has been telling Drew to invest in a new car, specifically an electric car so that they don't have to pay for gas and that it's also environmentally friendly. After this event, Drew decided it was the last start and he ended up getting a Nissan Leaf .

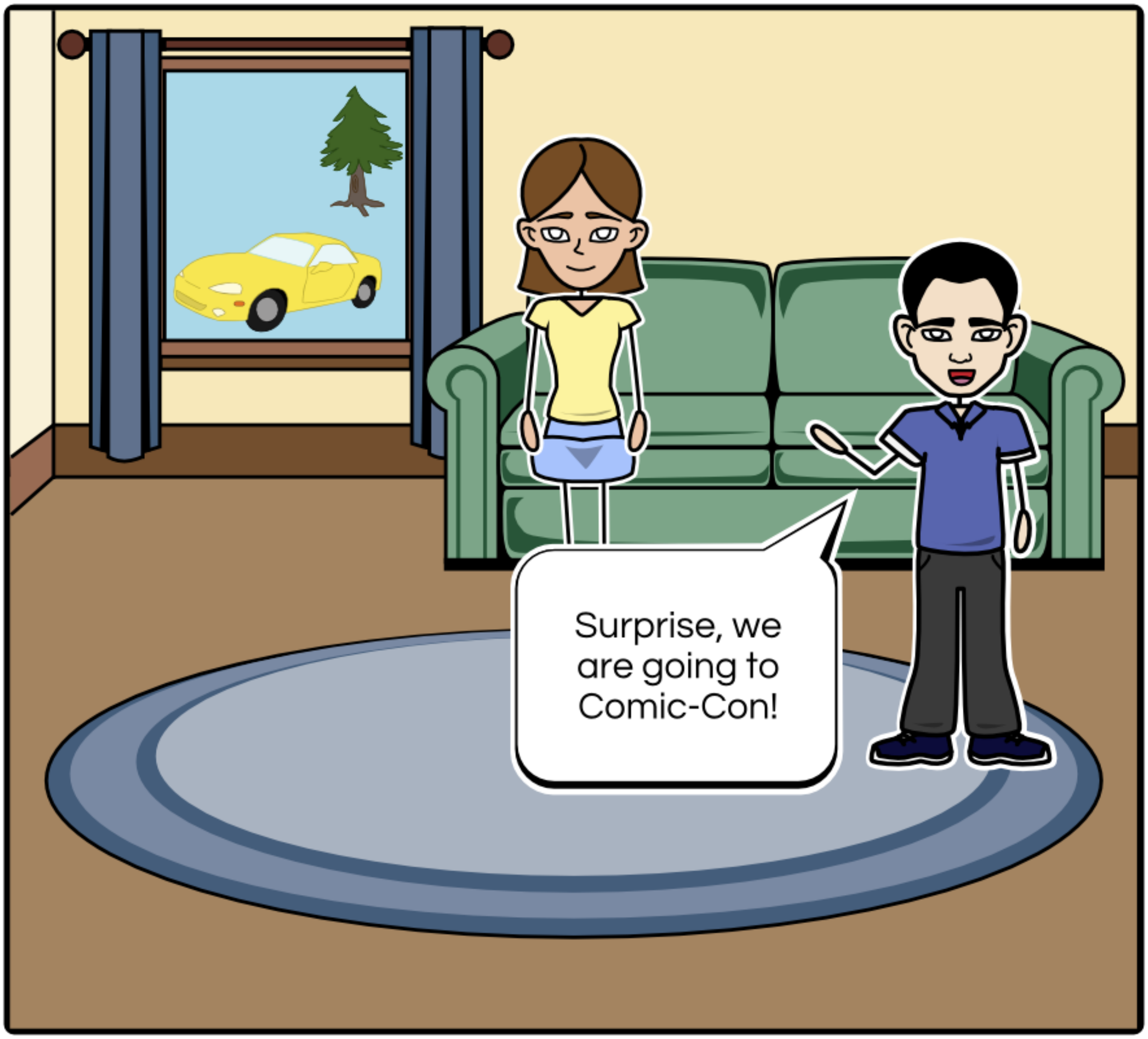
After using the Nissan Leaf for a few weeks, Drew realized that he was having trouble reading how much charge is left on the battery and has already been stranded a few times with his Nissan Leaf out of charge far away from a charging station. Additionally, Drew does not feel comfortable operating the cumbersome dashboard in the Leaf while driving. Some nights Drew gets home late from board game night and plugs his car in the charge. There is not a feature on his car's dashboard to tell him how long it will take to charge. When he leaves for work in the morning, sometimes the car is not fully charged and he has to pay to plug it in at a charging station downtown. A co worker recommends that Drew trade in his car for a Phoenix Charge, an electric vehicle with a new type of energy management system preinstalled.

With his new Phoenix Charge, his apprehension about electric cars fades away as he discovers how easily and efficient the energy managements system is. He is able to know where he needs to charge and can implement his schedule or destination and the system will plan his route around it. Additionally, in high stress driving situations, he can use the buttons on his wheel to change energy management settings for his car. The Phoenix Charge gives him such a confidence boost that he decides to surprise Nagheen with a road trip to Comic Con and a side stop to visit her parents in Klamath Falls, Oregon.

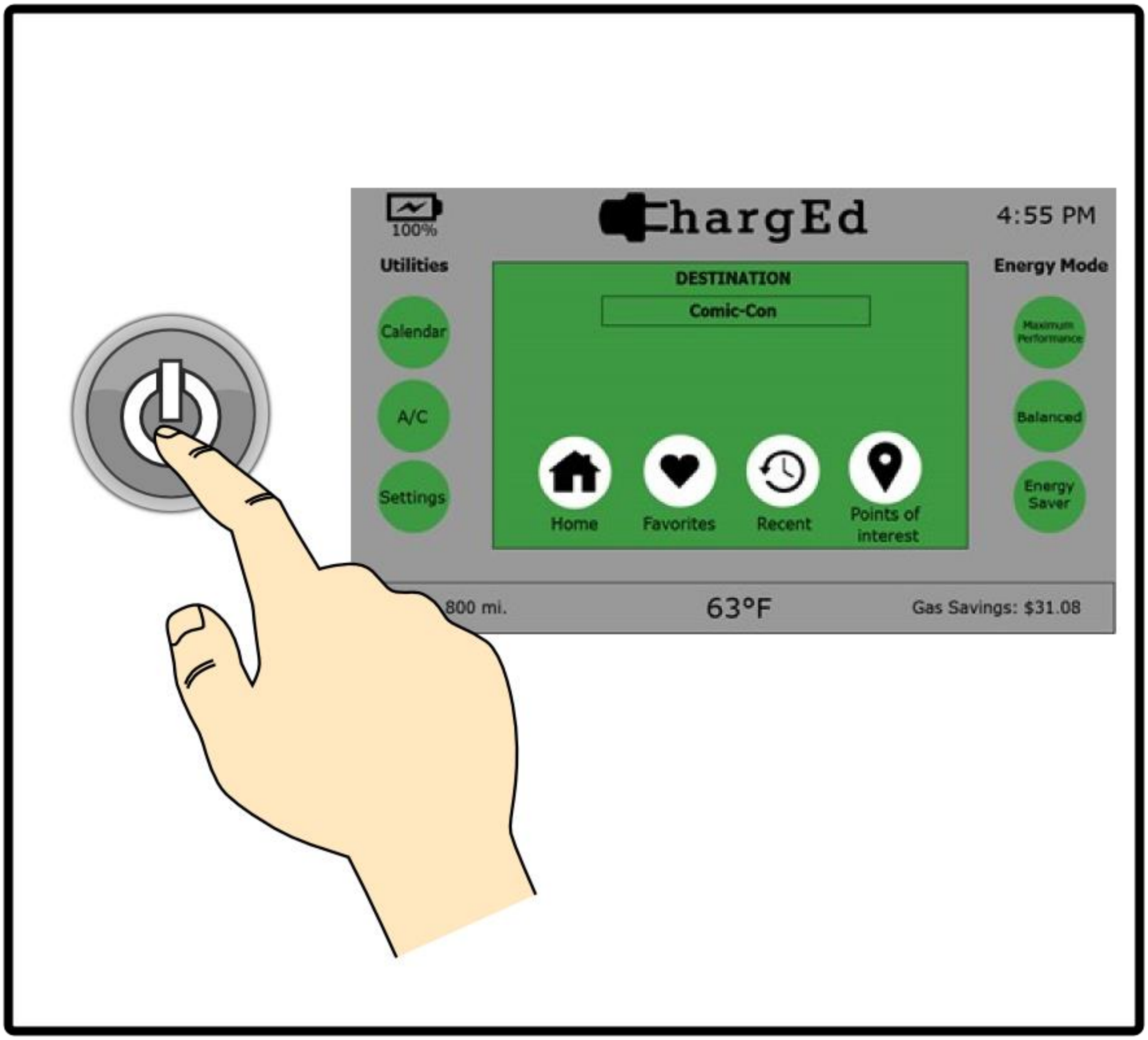
- (Drew at the dealership switching keys with the dealer) Drew is frustrated with the energy management options on his Nissan Leaf. He decides to trade it in for a Phoenix Charge.
- Drew tells Nagheen to pack her bags. "Surprise, we are going to Comic-Con"
- Drew turns on car and ChargED activates. GPS, Power mode (fast or slow), Calendar sync, Battery life, estimated time (and distance) on battery.

- Drew pre-programs their schedule for getting to San Diego, including two side stops: 1 to Klamath Falls, Oregon and another to Weed, California. (Show management system UI here).
- Road trip begins as their neighbor (with bright pink Yukon) leaves
- Them passing their neighbor at a gas station, shows their charging stations and how long the car will go
- Hit traffic in Klamath Falls, switch to power saving mode (adjusting calculations)
- At the charging station
- Arriving (welcome to Comic-Con) Patrick Stewart says, “Nice car!”
- After having a good time at the Comic-Con they were able to go home smoothly without any car troubles, “I knew our Phoenix would get us back”

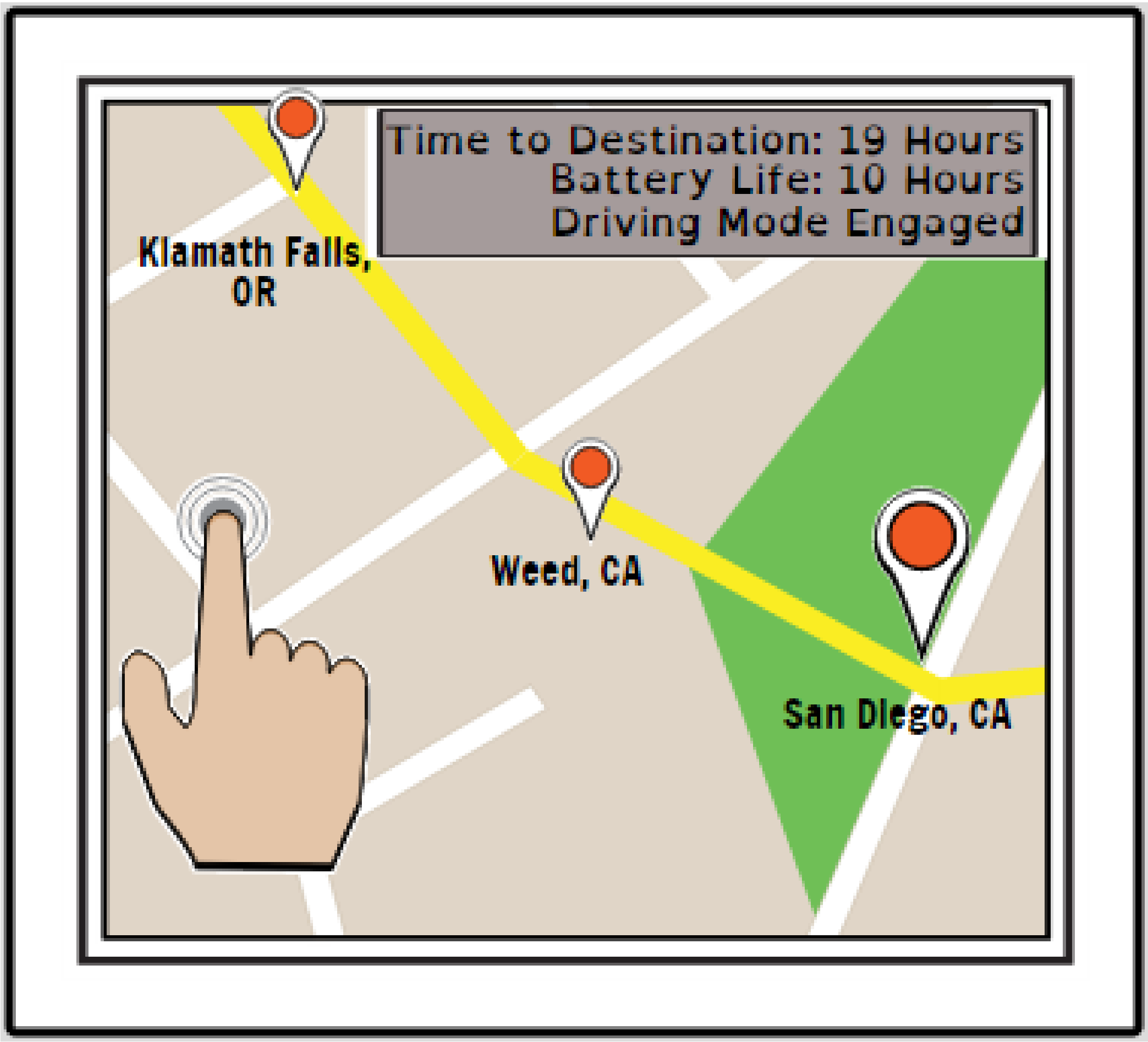
Appendix H: Storyboard



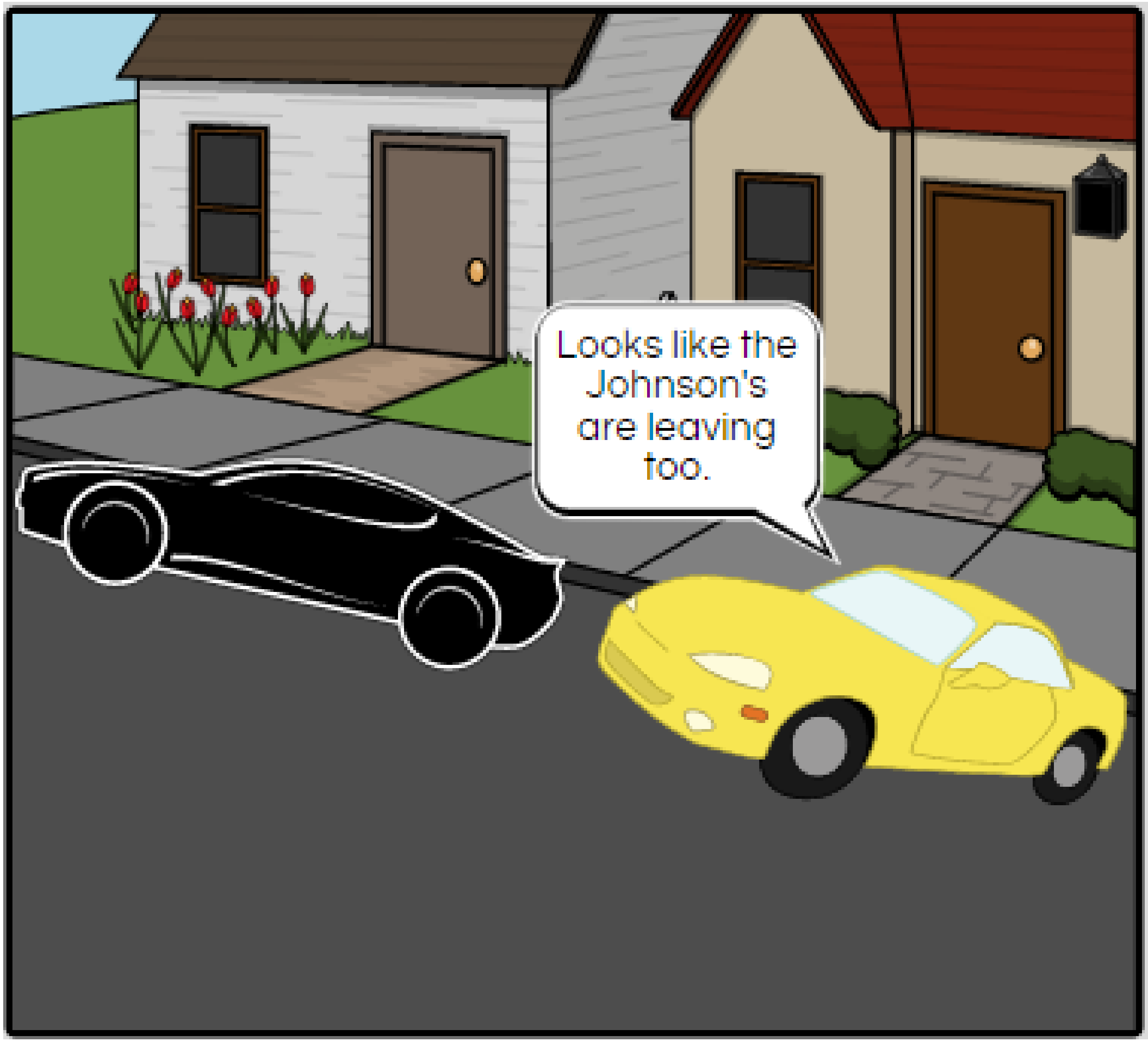
With his new Phoenix Charge, Drew finally has enough confidence to complete one of his goals: to road trip to Comic-Con. Drew tells his fiancée Nagheen to pack her bags, they're going to Comic-Con.



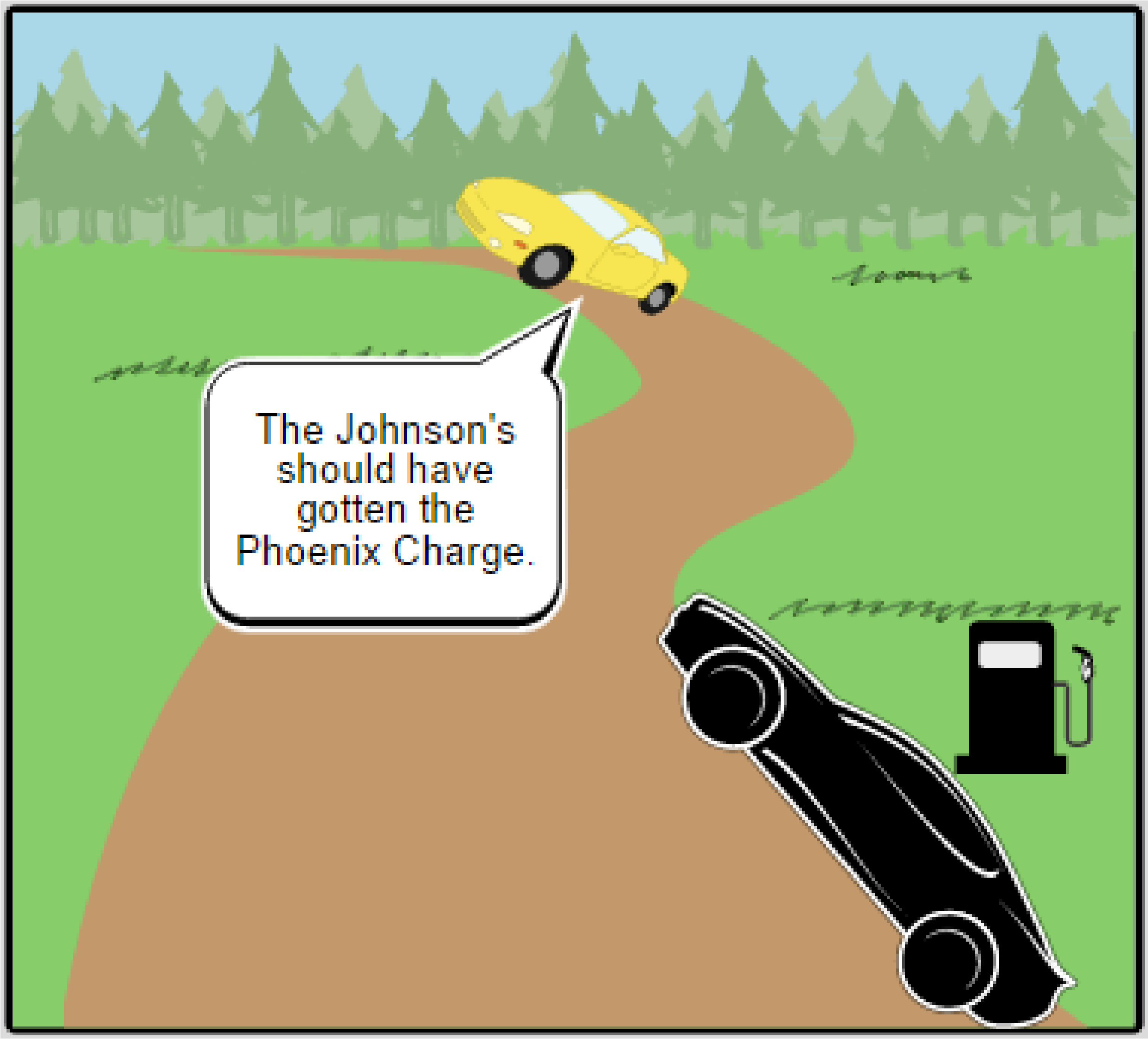
Drew turns on car and ChargED activates. He inputs his destination, Comic-Con into the built in GPS, automatically scheduling charging station stops.



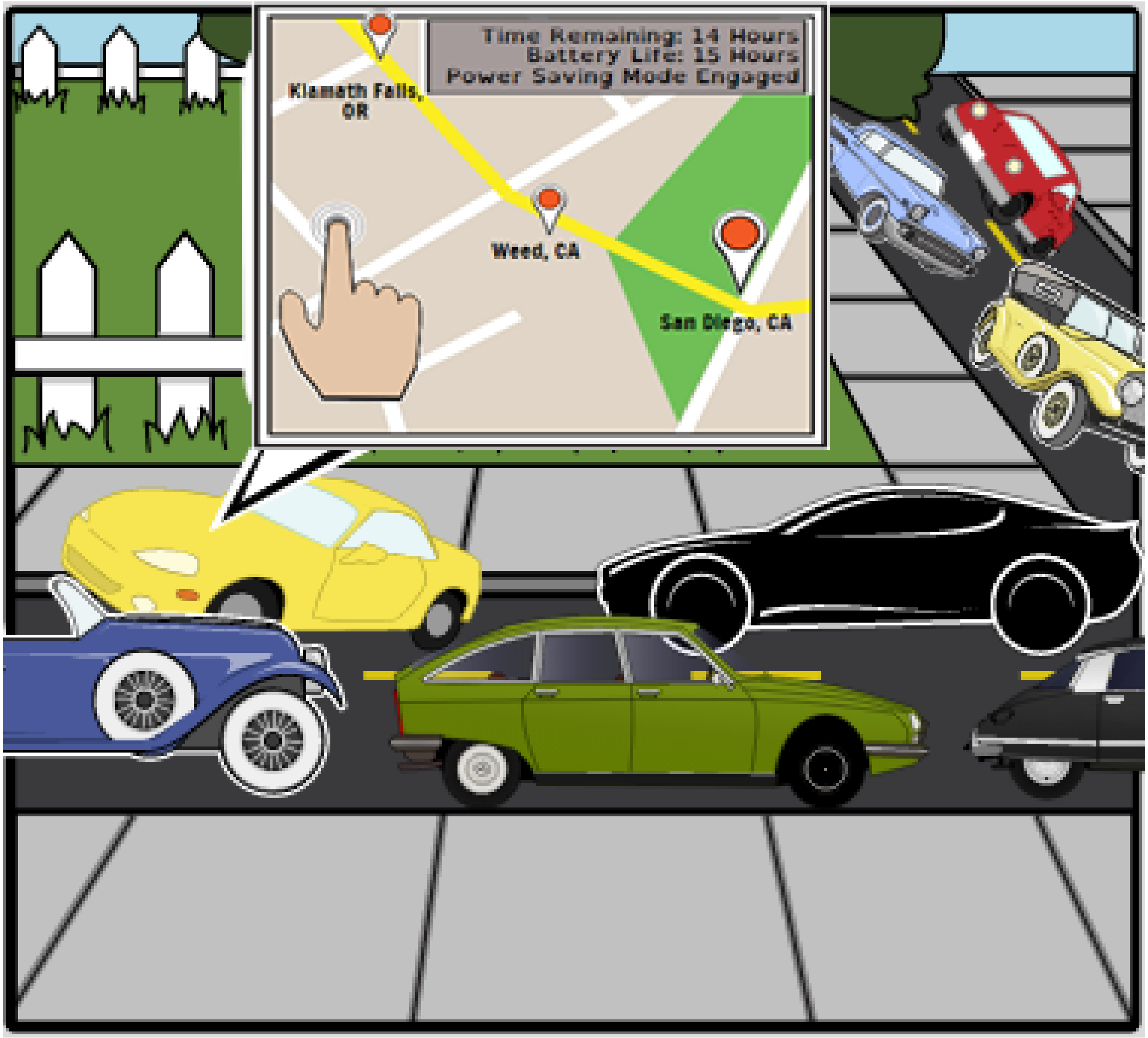
Drew uses the ChargEd system to pre-programs their schedule for getting to San Diego, including two side stops: 1 to Klamath Falls, Oregon and another to Weed, California. Automatically planning the trip with scheduled stops to charging stations.



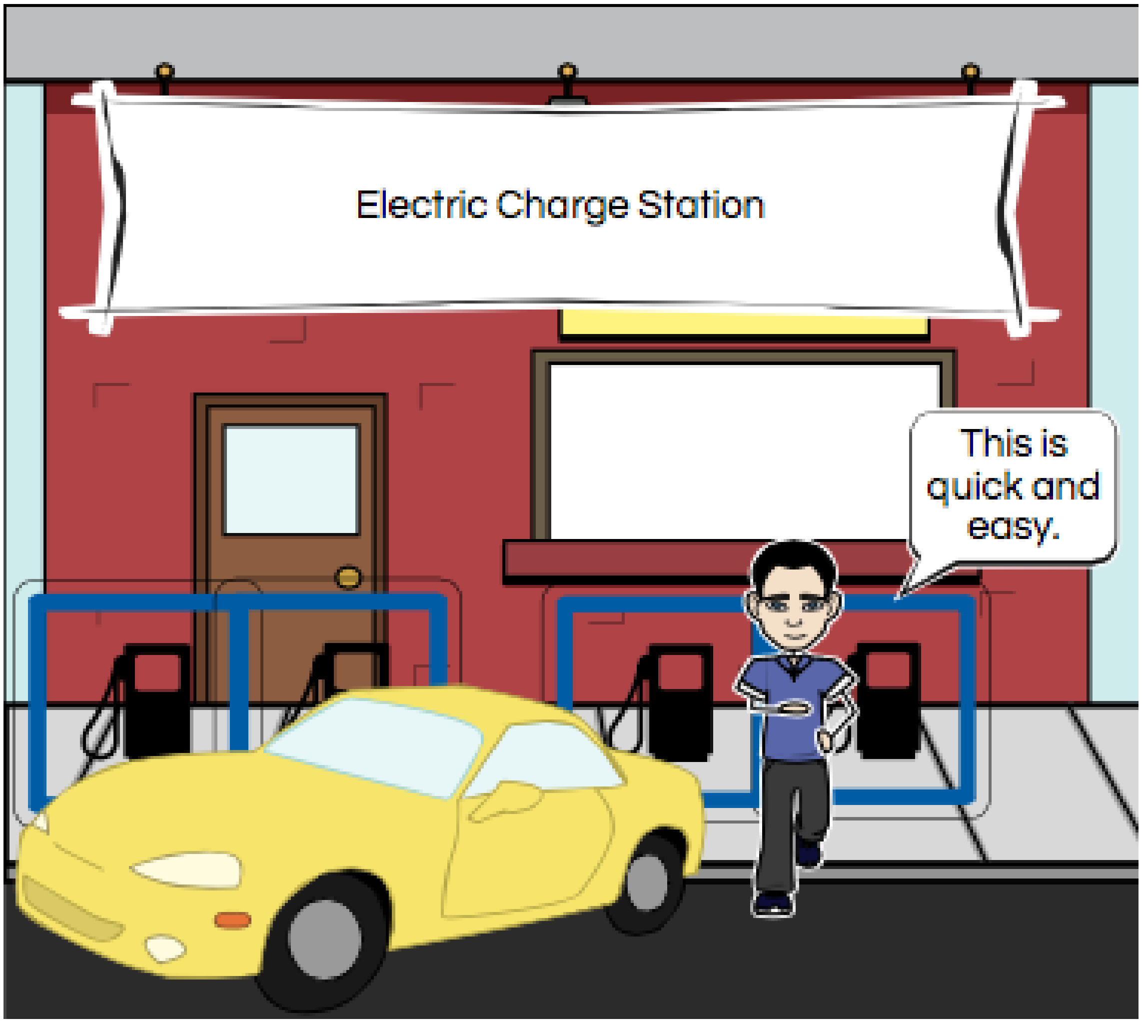
Their road trip begins the same time as their neighbors the Johnson's who are also going to Comic-Con.



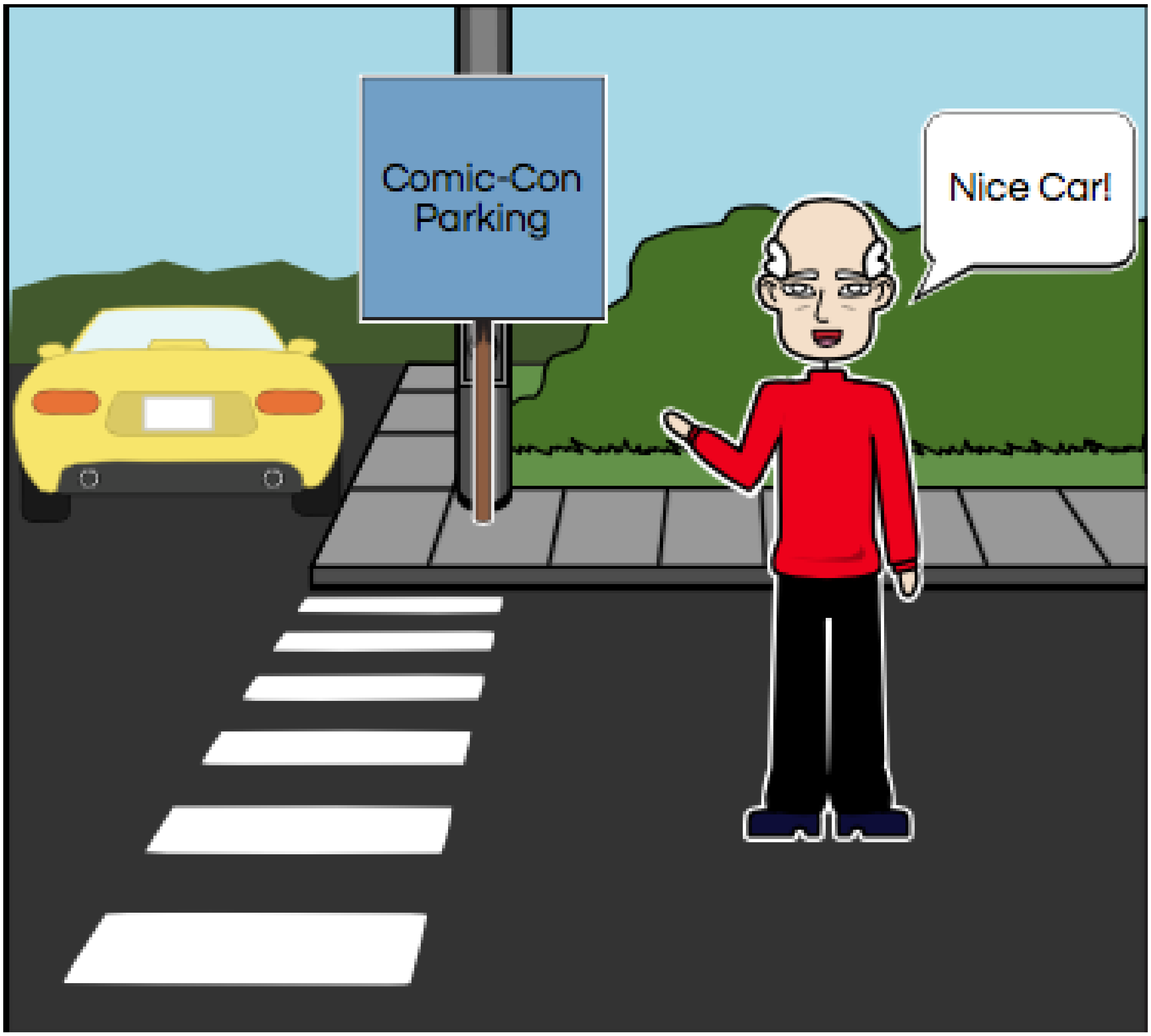
Them passing their neighbor at a gas station, shows their charging stations and how long the car will go



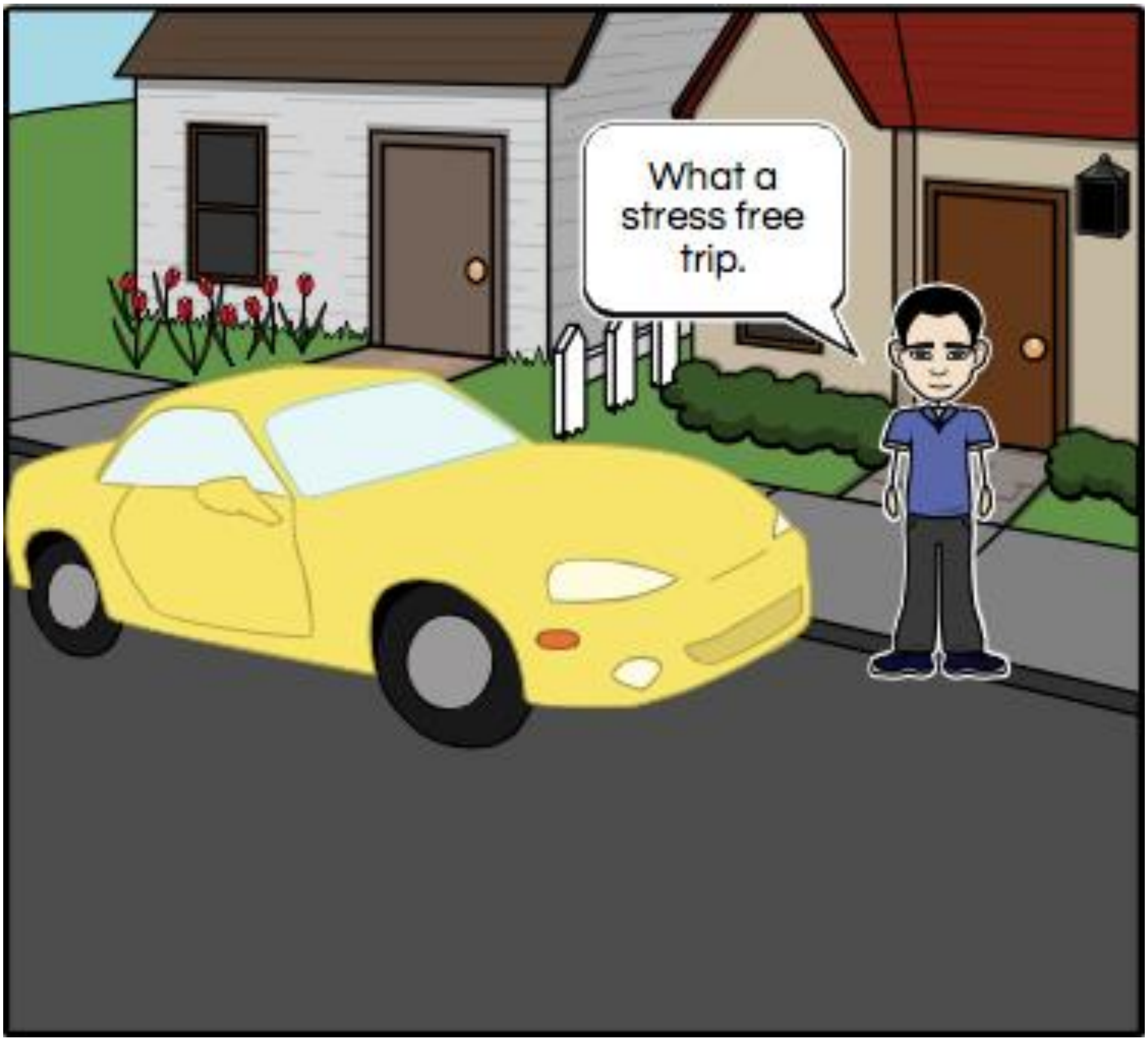
They hit traffic in Klamath Falls, so Drew switched the car to power saving mode.



With the help of ChargEd Dave is easily able to locate a nearby charge station and drive to it. He is impressed with how quick and easy the entire process is.



Dave and Nagheen arrive to Comic-Con with the help of ChargEd. As they pull into the parking lot they see Patrick Stewart walking into the facility. He was impressed by the uniqueness of the electric car and says “Nice Car”.



They finally make it home after a long trip to Comic-Con. Dave was very relieved that he did not have to stress about his car's power since ChargEd helped him every step of the way. He gains huge confidence in his vehicle.

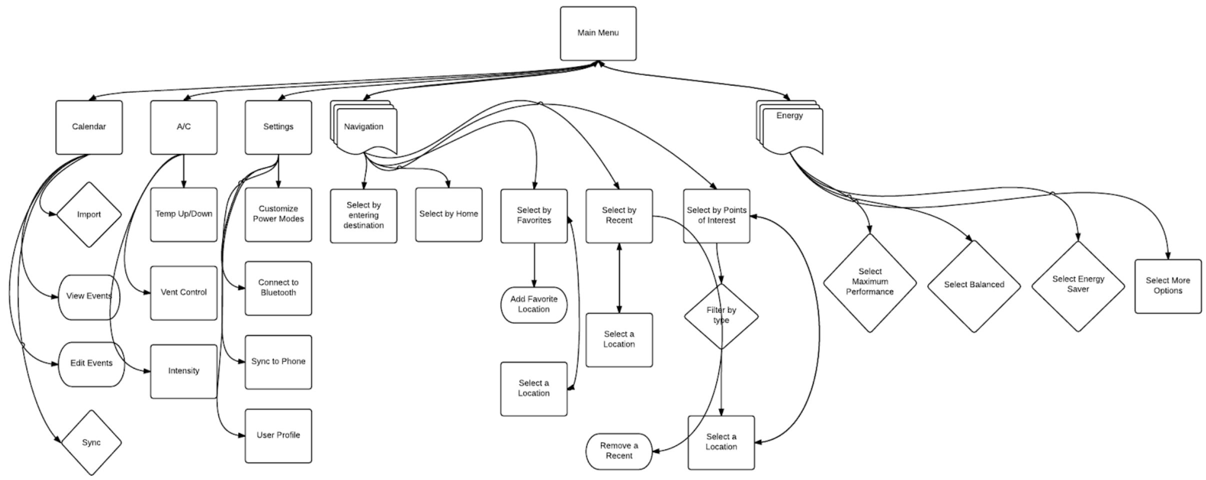
Appendix I: Task Analysis

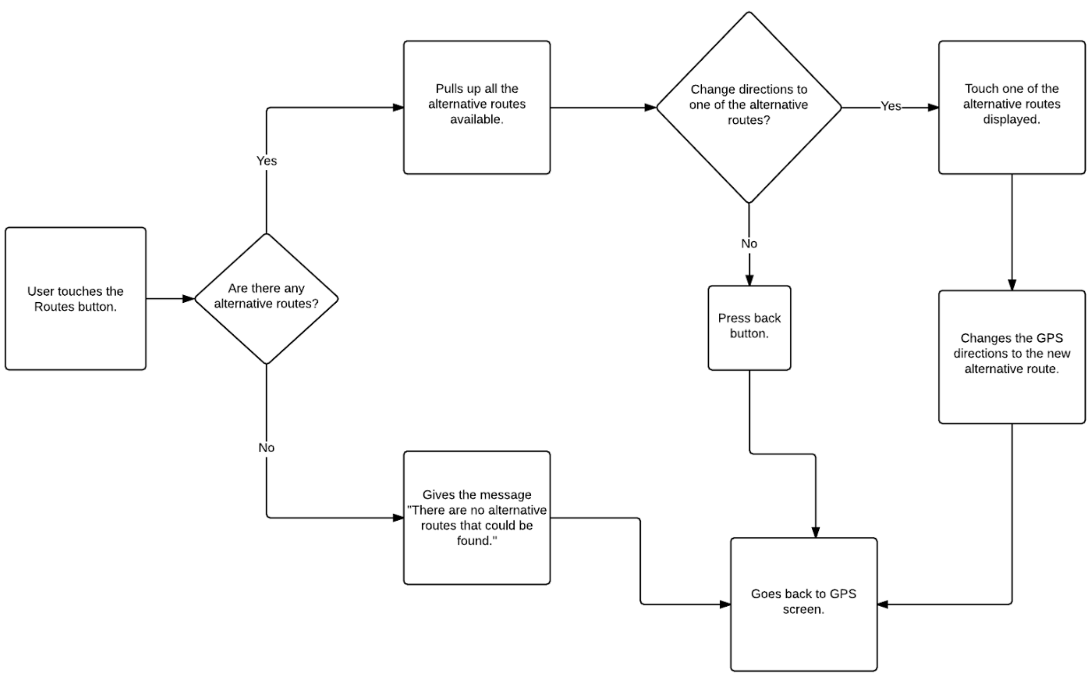
Step #	Step to be Performed	What Information Does the User Need to Know	How do They Know it	What Specific Actions Does the User Need to Take to Perform Step	Feedback from System
Task 1: User inputs their driving destination					
1.1	Chooses to enter direction (a to b) or multiple destinations	Needs to understand they want to select directions if they want directions and how to select it	It is clearly written on the home screen of the interface	Touches the direction button	
1.2	View the options on the directions screen which include search, places of interest, previous locations, saved locations	Needs to know if they want to search a new destination or use a previous/pre-saved location. Or if they want to look up places of interest.	They wil use their intuition while viewing the option. Also, it will say 'select option' somewhere on the screen	Touches the option they want to use	
1.3	Select an option, user selects search	Need to know to use touch pad to select an option.	They pick whatever option they want	Select search to enter a destination	
1.4	Enter the address in the search bar	Need to know the address and how to use the keyboard controls.	The keyboard will show on the screen and it will say 'enter destination/address'.	The keyboard comes to the screen. The user types in the address of the location they want to go.	
1.5	Once selected, directions appear and the route begins	Need to understand how to view the on-screen map and follow the route given.	The directions will be entered into the system.	Has to decide if they have other addresses or if they are ready to begin the route.	The interfaces asks if there are more destinations to be entered or if the user is ready to go.
	Decides there is another destination to enter, repeat steps 1-5.	Once multiple addresses have been entered the system will autoadjust. The user has to understand that autoadjust is occuring and not panic as the map changes.	It will ask if another address is needed, the user decides if they have other places to enter.	Fill in other destinations and begin driving.	
Task 2: User preprograms custom power saving mode					
3.1	User chooses the	Need to know that this is	Experience and	Touch 'Settings'	A new list appears

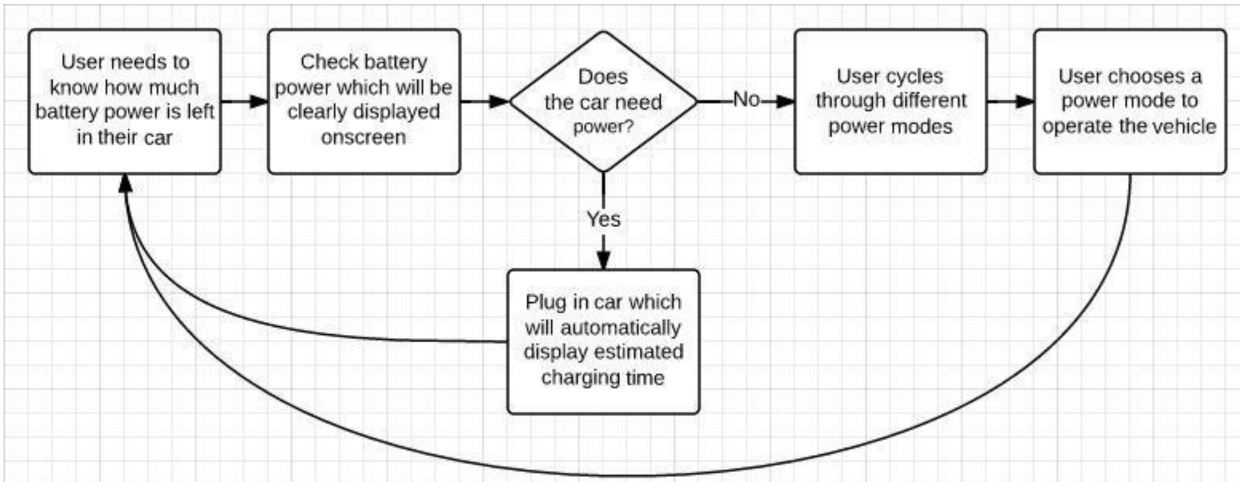
	settings option	the search path for creating a new power mode	Spending time discovering the system. Additionally, they have a need for a custom power mode	button	with all the Settings Options
3.2	User chooses 'Customize Power Mode' from the options list			Touch 'Customize Power Mode' button, Choose 'Create New' button.	A new page appears with options to create a new mode or edit existing modes.
3.3	Chooses non-essential power consuming options they want kept on in this mode	What each of the options is and how it will effect their drive experience if they turn if off		Touch individual radio buttons with the options they want to keep on, press 'Next' button	Radio buttons have a highlighted fill color appear when touched. When the user presses next, a new page appears for step 3.4.
3.4	Chooses what actions cause the mode to be activated	The circumstances the mode will be activated for in the lanauge of ths system.	Clear and descriptive wording for each of the options	Sets dials for speed, battery power %, time of day, etc that will control when the mode is activated. Press 'Finish' button	Each dial responds to user touch and displays their chosen information. A pop up box appears prompting the user to name their mode
3.5	Enters custom name for this power mode	How to name it such that it is identifiable.	Whatever memonic works for them	Enters mode name in pop up text box. Press 'Done' button	The user is taken to the Power Modes List. Their new mode is highlighted with the option to edit it.
Task 3: User views metrics on battery power and charging times					
4.1	User needs to know how much battery power is left in their car		Experience driving and estimating power needs	Assess the current level of power in the car	
4.2	Check battery power which will be clearly displayed onscreen	Where to locate battery power on the display	It will be predominantly displayed	Locate the area on the screen that displays battery power	
4.3	If charge is necessary, plug in car which will automatically display estimated charging time	Whether or not the battery power left is sufficient. Also where to plug into and where charging time will be displayed	By plugging in a destination to GPS, estimated power duration will appear. Plugging into the car will be covered in the manual	Take the charge extension from the charging port and plug into car, check area onscreen for charging time	The system will alert you if you have enough power or not

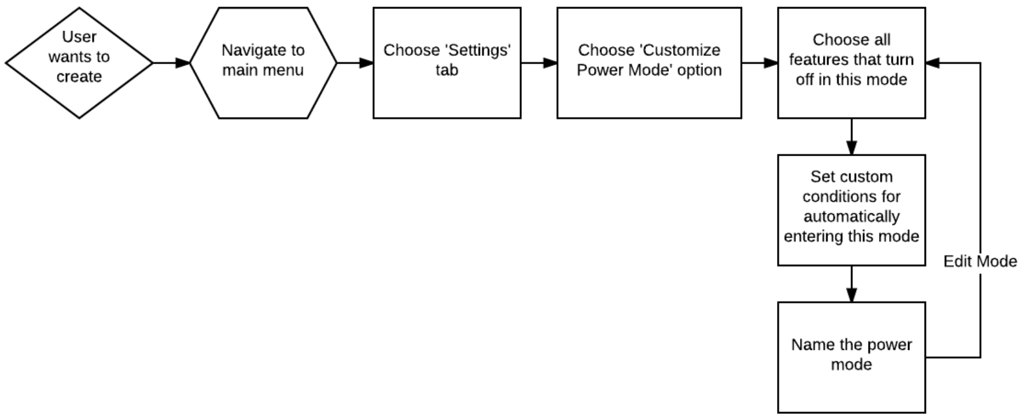
4.4	User cycles through different power modes	What type of modes there are and where to find them	They will be displayed on the menu	Use buttons on screen to locate modes and cycle through options	Battery power will automatically adjust and be displayed onscreen
4.5	User either chooses a power mode to operate the vehicle or plugs into charging port	What type of mode will best serve their travel plans	By assessing the calculations presented ot them by the operating system	Press the select button when the desired mode is highlighted or repeat steps for charging car	
Task 4: User chooses different routes to the same destination (Energy Efficiency vs Time)					
5.1	Touch the Routes button	Where the Route button is	There is always going to be a route button on the left side of the energy management system UI	Press the button, also it sometimes pops up when there is a detour or events that happen that may need you to reroute to get to your destination.	Goes to Route screen interface
5.2	Pulls up all the routes available	That information is currently being gathered to find all the routes available	A loading animation	They must have pressed the route button, then press find all available routes button.	Attempts to find routes available
5.3	View the routes loaded	These are all the routes that are available for the user to take.	A list of routes with the information will pull up in the "GPS' section of the interface	Look at the routes available	It will show all the routes available
5.4	User selects a route that they want	The information they need to know is that the information shown are differences between each route (How long it will take to get to the destination, how much energy will they use, will they need to charge more because of this route)	It will say select a route on the top.	select/press a route	it will input the route they chose into the GPS. It will start guiding them immediately in the GPS screen

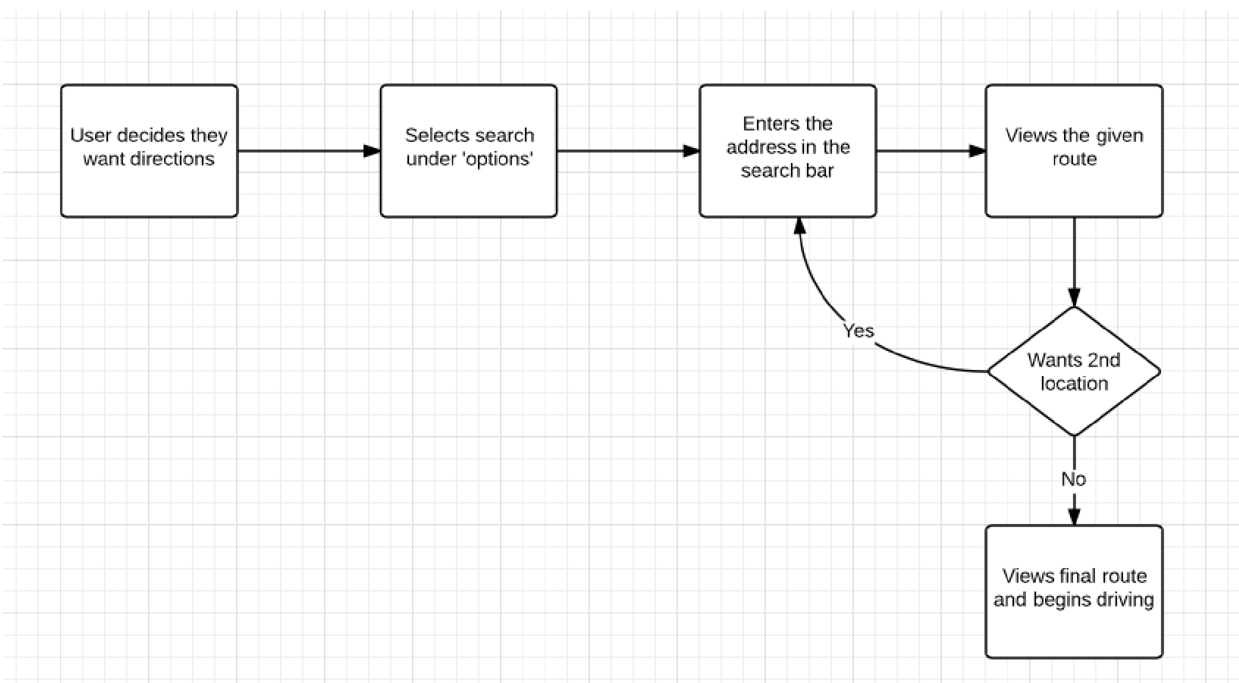
Appendix J: System Map






User needs to know how much battery power is left in their car
Check battery power which will be clearly displayed onscreen
Does the car need power?
No
User cycles through different power modes
User chooses a power mode to operate the vehicle
Yes
Plug in car which will automatically display estimated charging time

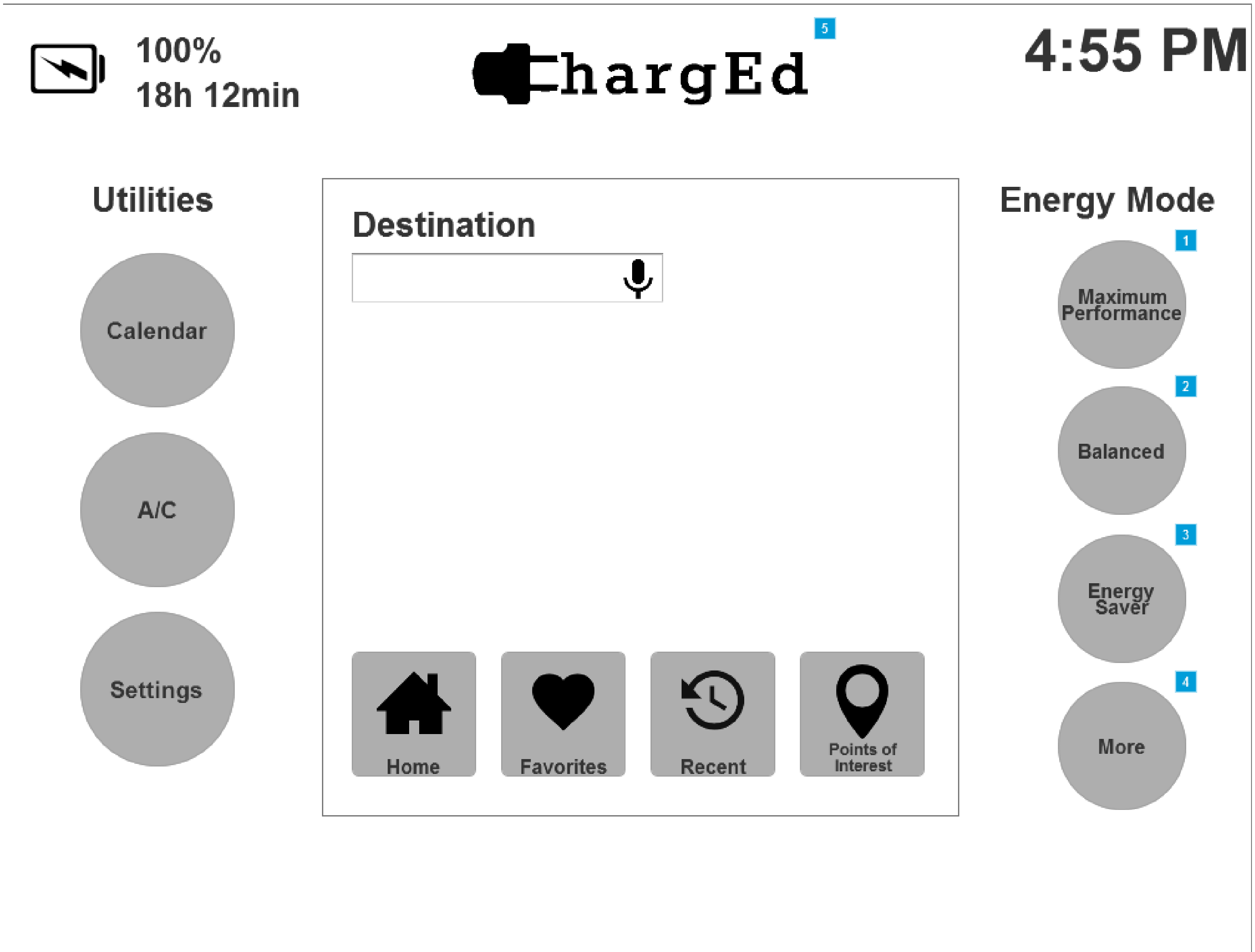

User wants to create
Navigate to main menu
Choose 'Settings' tab
Choose 'Customize Power Mode' option
Choose all features that turn off in this mode
Set custom conditions for automatically entering this mode
Name the power mode
Edit Mode


User decides they want directions
Selects search under 'options'
Enters the address in the search bar
Views the given route
Wants 2nd location
Yes
No
Views final route and begins driving

Appendix K: Flipbook Iteration 1

1.1. Home

1.1.1. User Interface



1.1.2. Widget Table

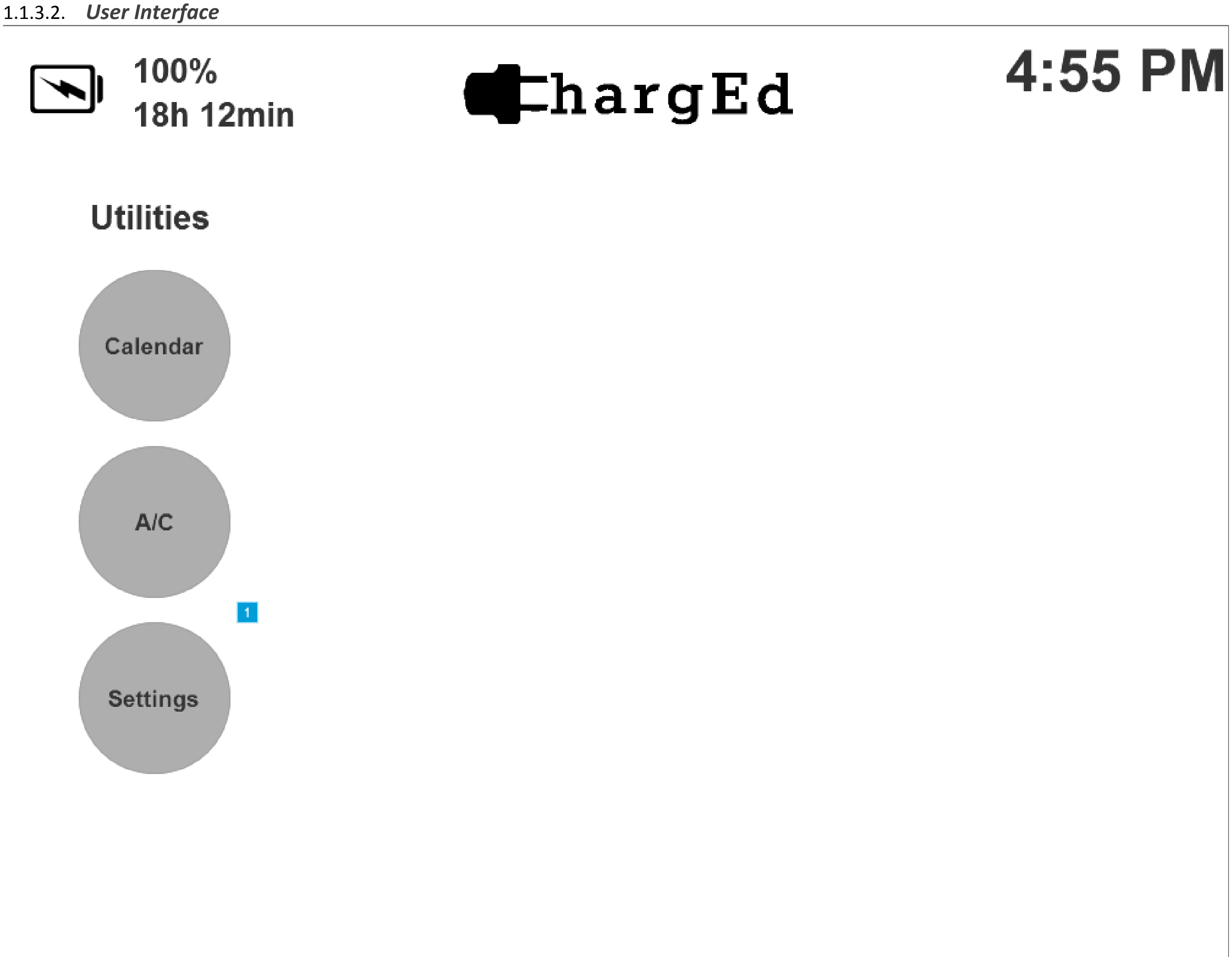
Footnote	Name	Interactions
1		OnClick: Case 1: Set Performance to Maximum Performance
2		OnClick: Case 1: Set Performance to Balanced
3		OnClick: Case 1: Set Performance to Energy Saver

4		OnClick: Case 1: Set Middle Panel to Energy Options
5	ET Phone Home	OnClick: Case 1: Set Middle Panel to Home

1.1.3. Performance

1.1.3.1. *State1*

1.1.3.2. *User Interface*

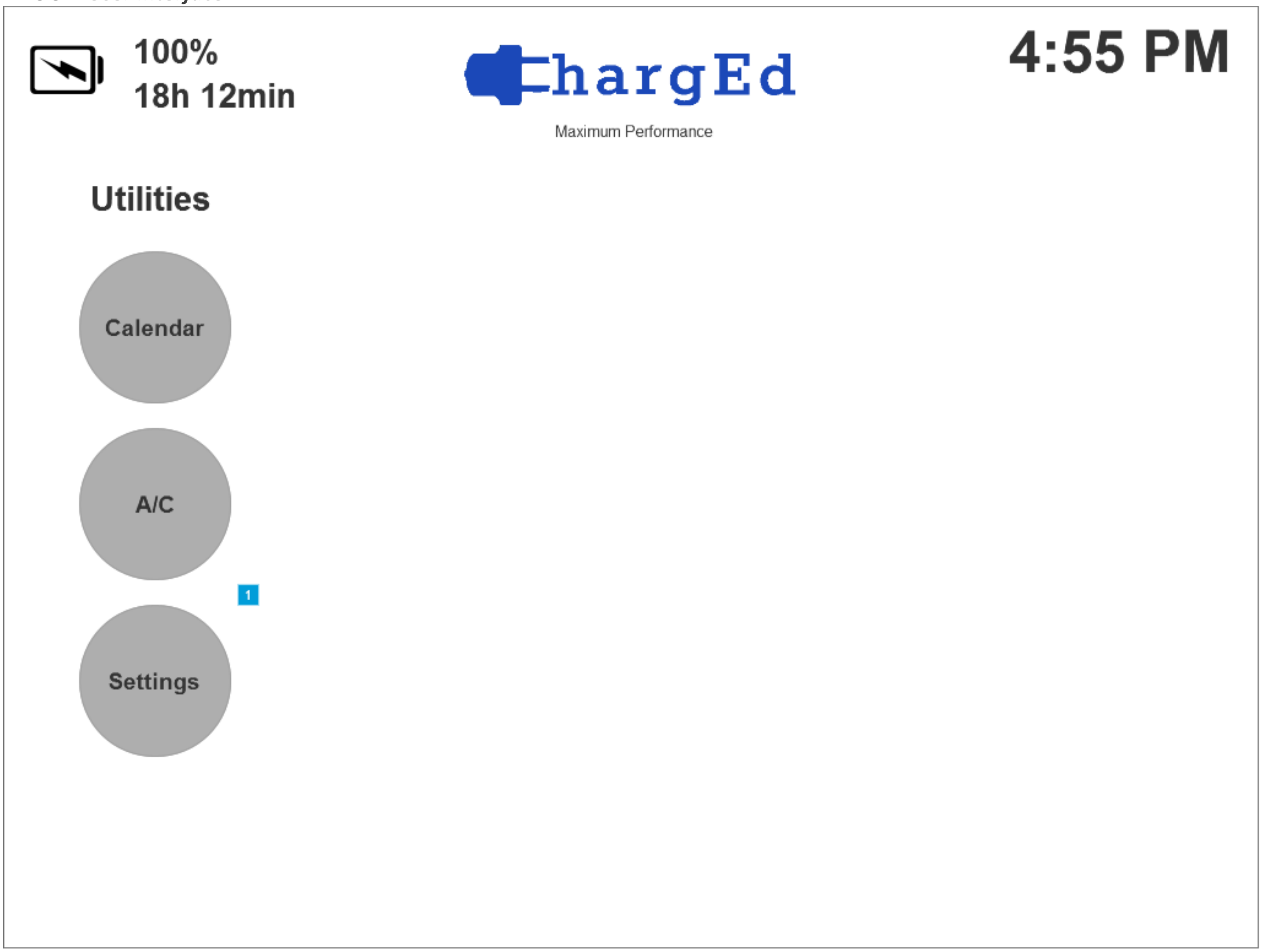


1.1.3.3. *Widget Table*

Footnote	Interactions
1	OnClick: Case 1: Set Middle Panel to Settings

1.1.3.4. *Maximum Performance*

1.1.3.5. *User Interface*

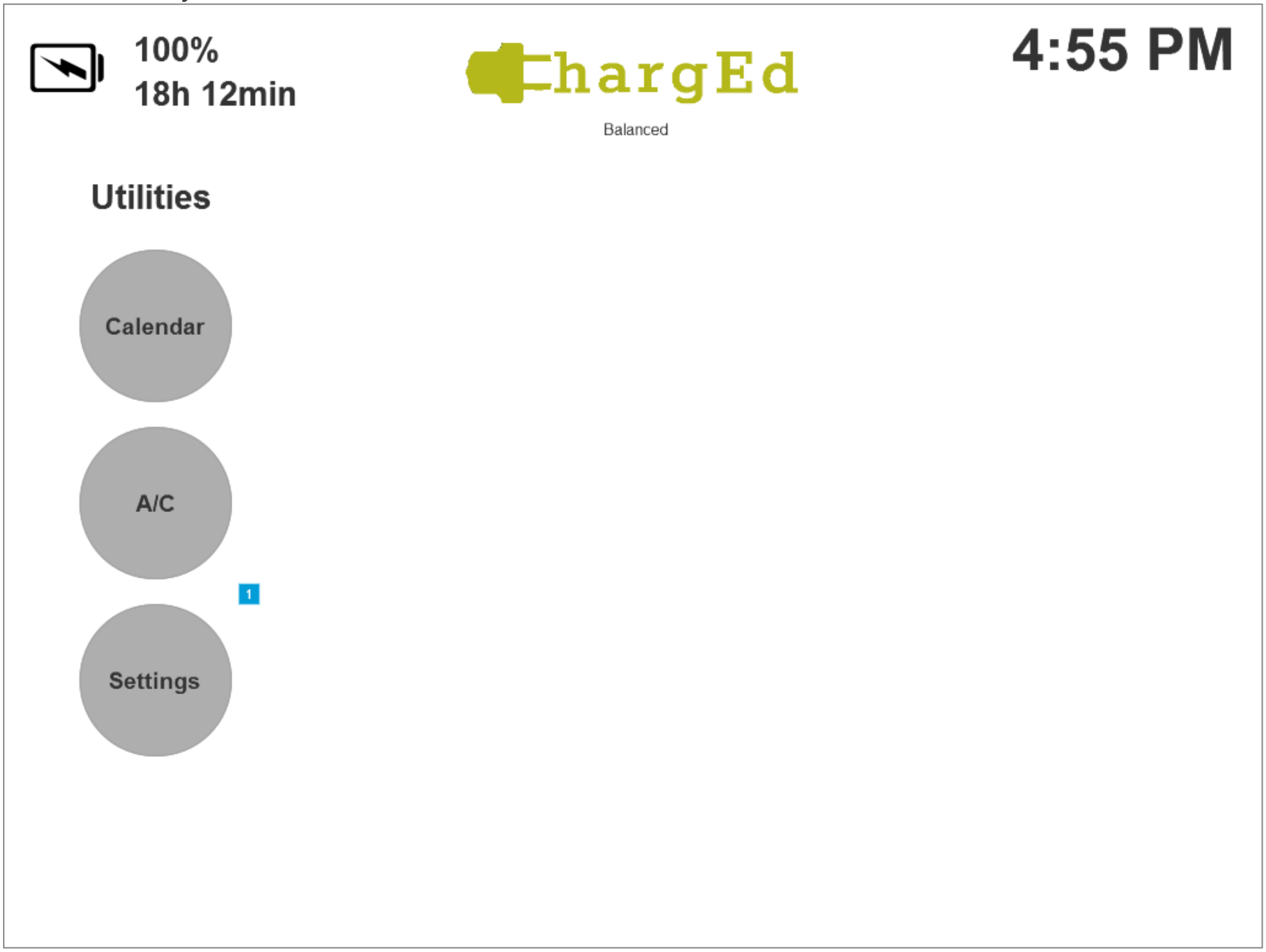


1.1.3.6. *Widget Table*

Footnote	Interactions
1	OnClick: Case 1: Set Middle Panel to Settings

1.1.3.7. *Balanced*

1.1.3.8. *User Interface*

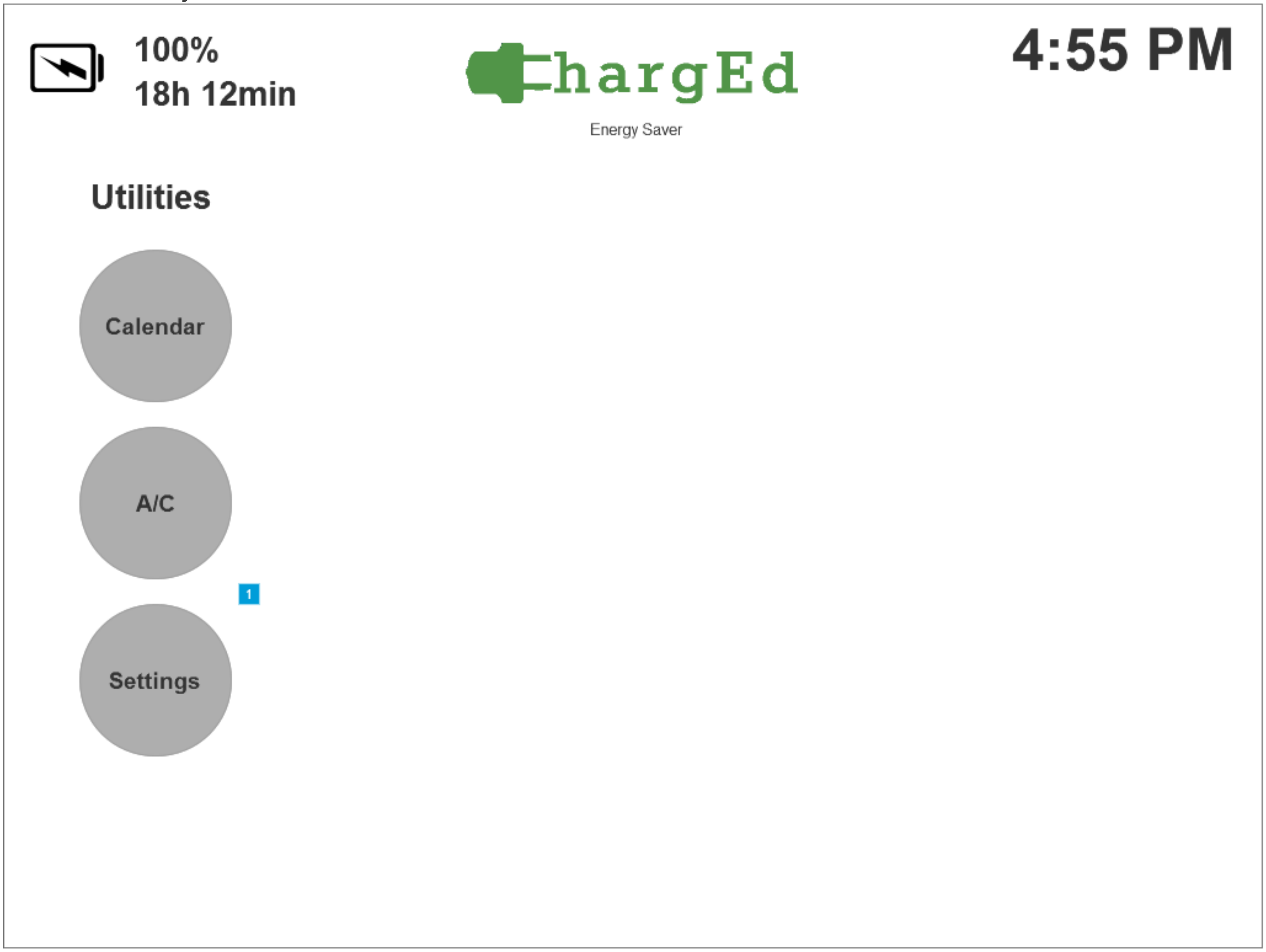


1.1.3.9. *Widget Table*

Footnote	**Interactions**
1	OnClick: Case 1: Set Middle Panel to Settings

1.1.3.10. ***Energy Saver***

1.1.3.11. ***User Interface***

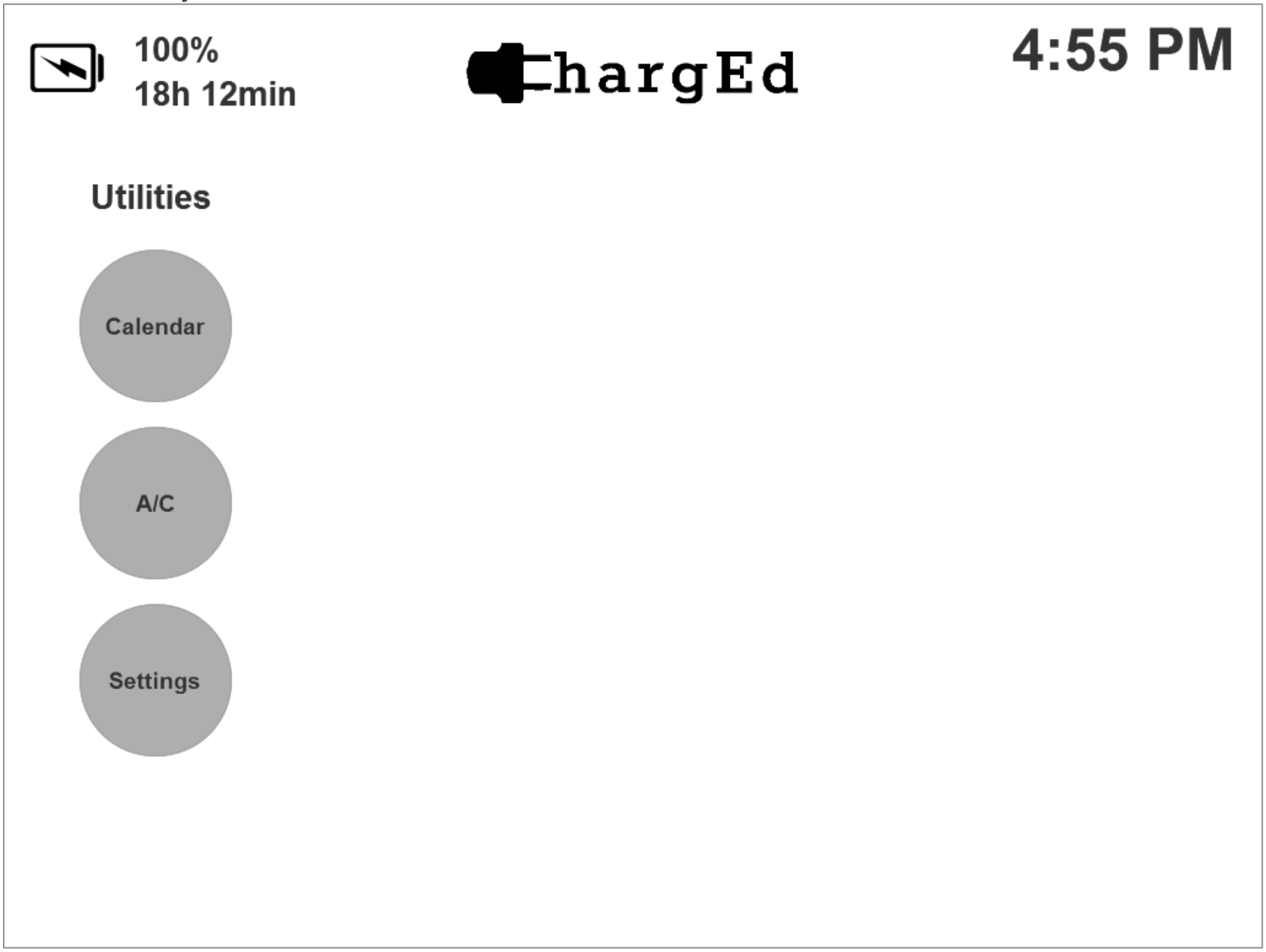


1.1.3.12. ***Widget Table***

Footnote	**Interactions**
1	OnClick: Case 1: Set Middle Panel to Settings

1.1.3.13. ***Custom 1***

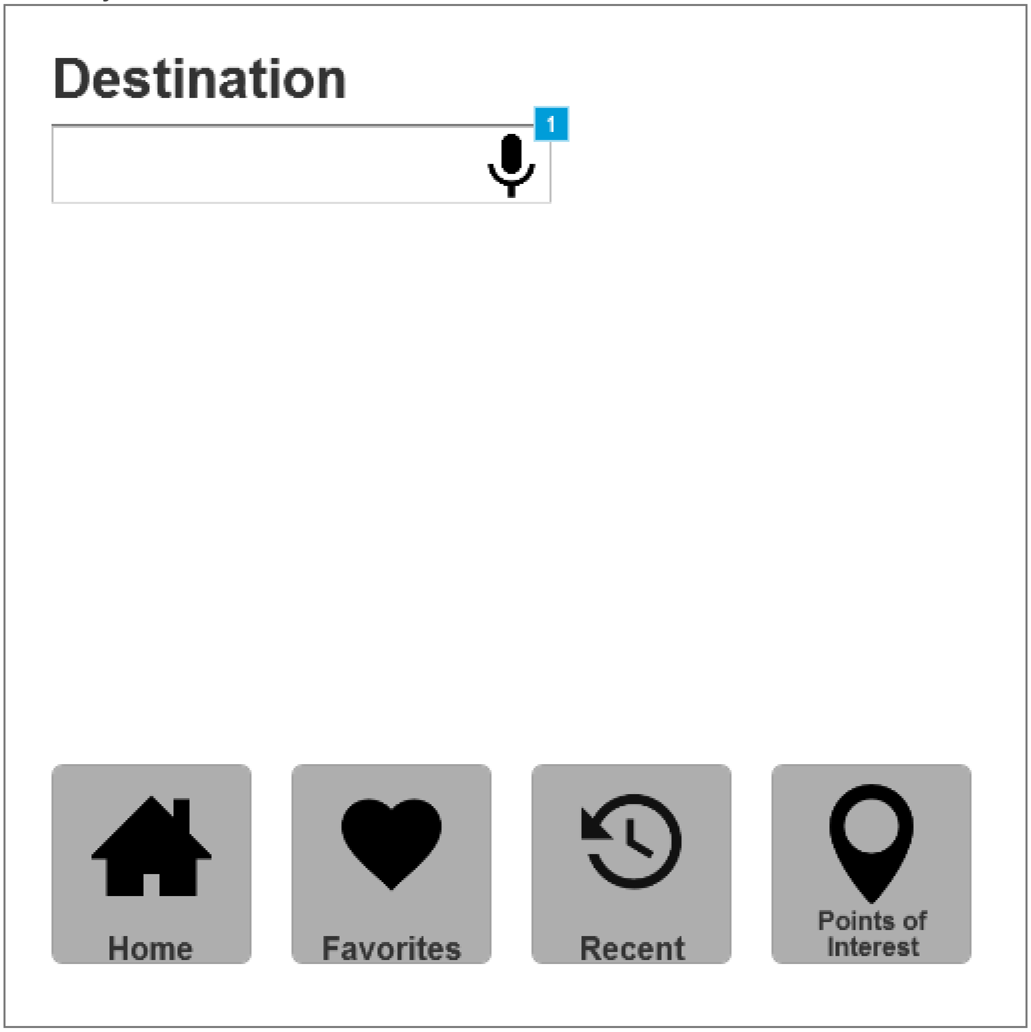
1.1.3.14. ***User Interface***



1.1.4. Middle Panel

1.1.4.1. *Home*

1.1.4.2. *User Interface*

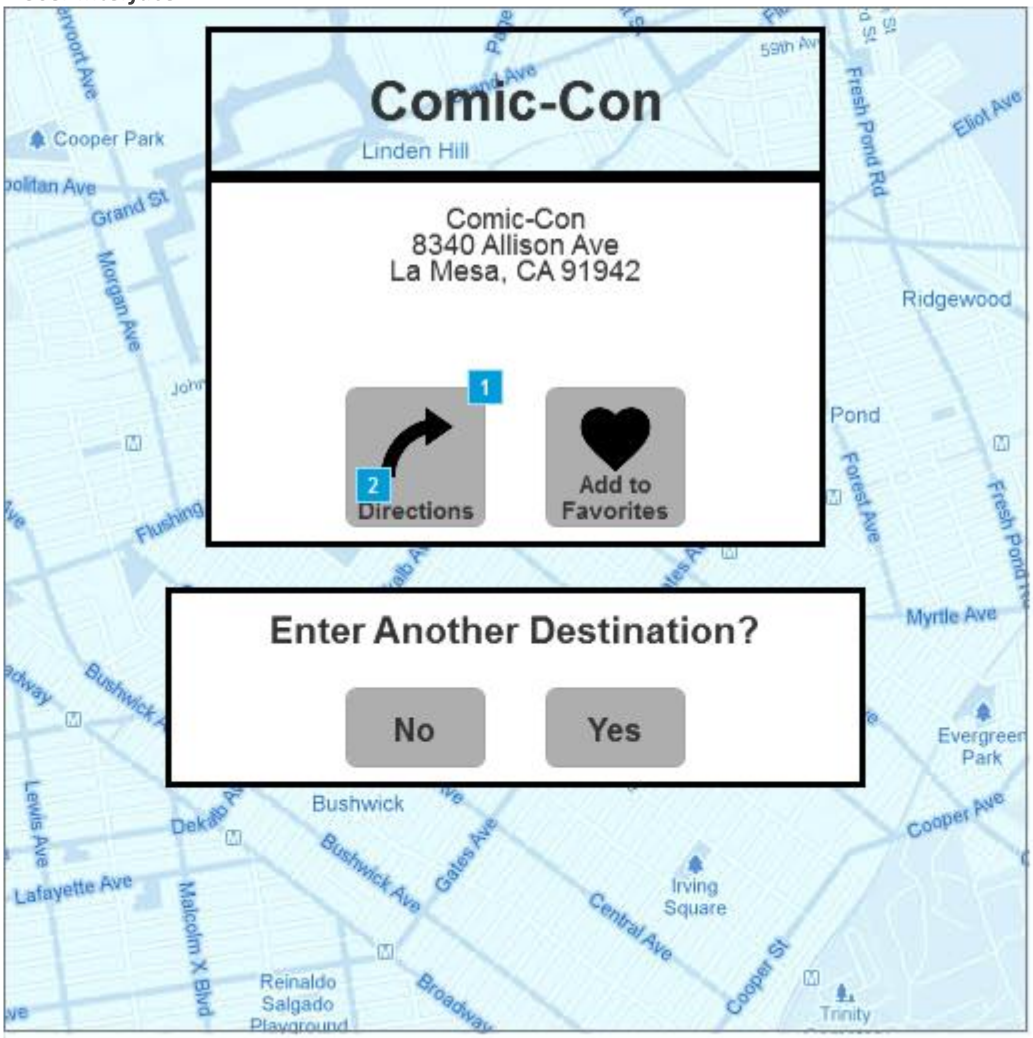


1.1.4.3. *Widget Table*

Footnote	Name	Interactions
1		OnTextChange: Case 1: Set Dropdown to State1

1.1.4.4. *Map*

1.1.4.5. *User Interface*

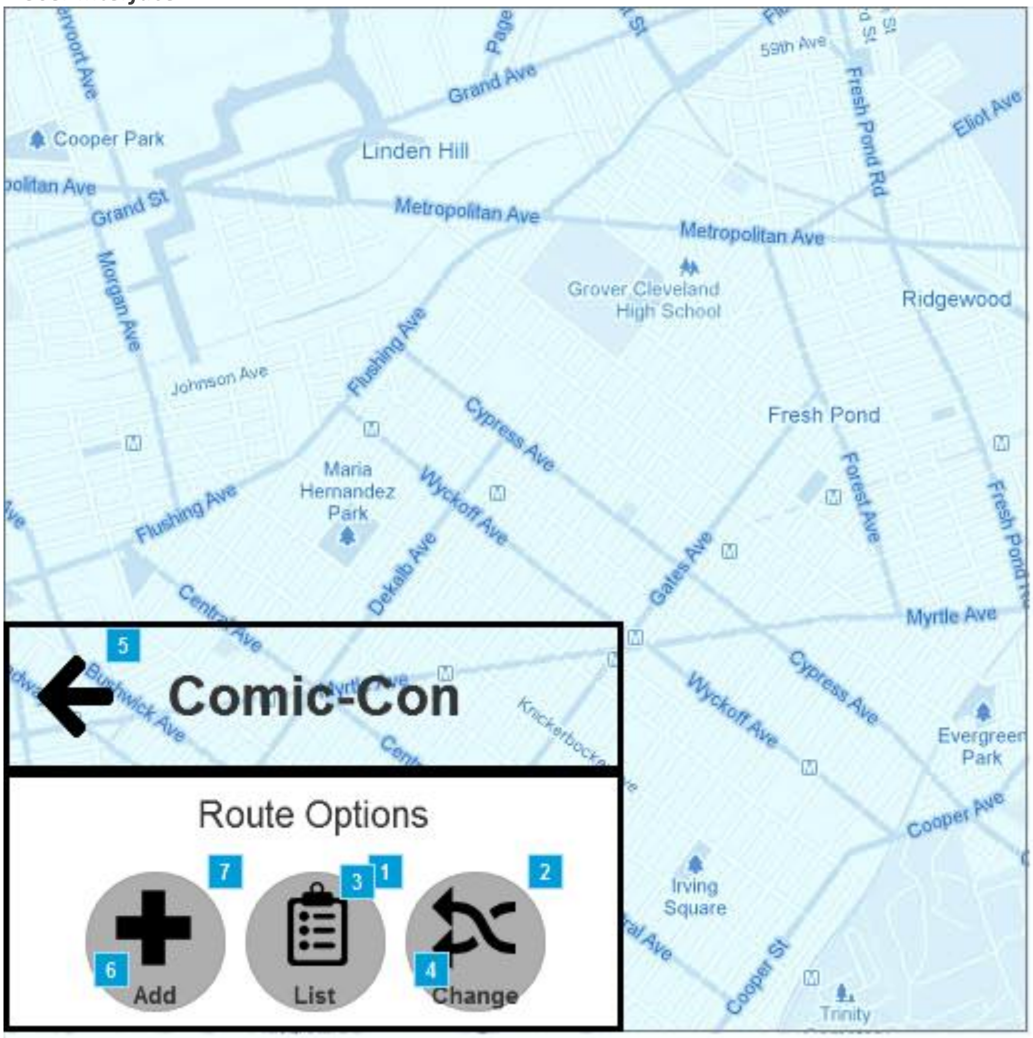


1.1.4.6. *Widget Table*

Footnote	Name	Interactions
1		OnClick: Case 1: Set Middle Panel to Map Multi List
2		OnClick: Case 1: Set Middle Panel to Map Multi List

1.1.4.7. *Map Multi Destination*

1.1.4.8. *User Interface*



1.1.4.9. *Widget Table*

Footnote	Name	Interactions
1		OnClick: Case 1: Set Middle Panel to Map Multi List
2		OnClick: Case 1: Set Middle Panel to Home
3		OnClick: Case 1: Set Middle Panel to Map Multi List
4		OnClick: Case 1: Set Middle Panel to Home
5		OnClick: Case 1:

		Set Middle Panel to Map
6		OnClick: Case 1: Set Middle Panel to Add Destination
7		OnClick: Case 1: Set Middle Panel to Add Destination

1.1.4.10. ***Add Destination***

1.1.4.11. ***User Interface***

1.1.4.12. ***Widget Table***

Footnote	Name	Interactions
1		OnClick: Case 1: Set Middle Panel to Map Multi Destination

1.1.4.13. ***Map Multi List***

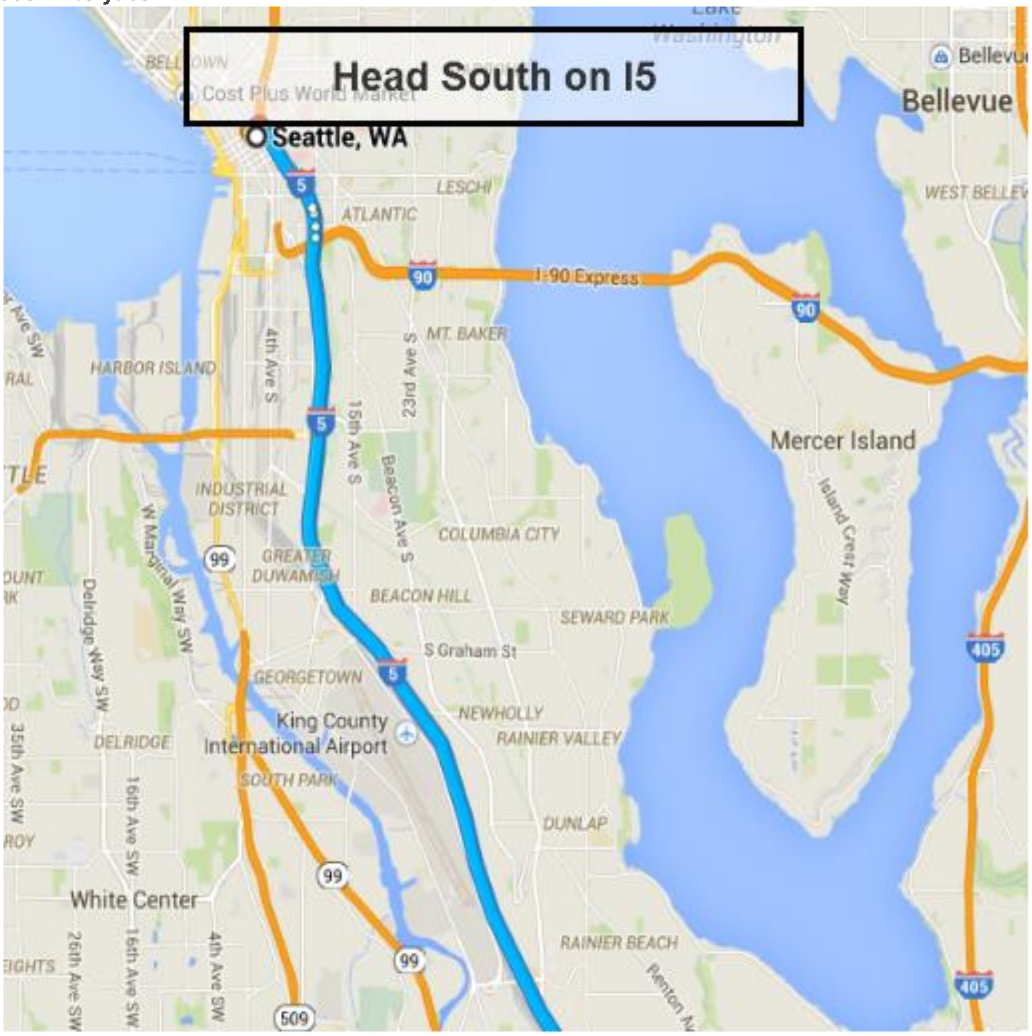
1.1.4.14. ***User Interface***

1.1.4.15. ***Widget Table***

Footnote	Interactions
1	OnClick: Case 1: Set Middle Panel to Map
2	OnClick: Case 1: Set Middle Panel to Map Multi List 2

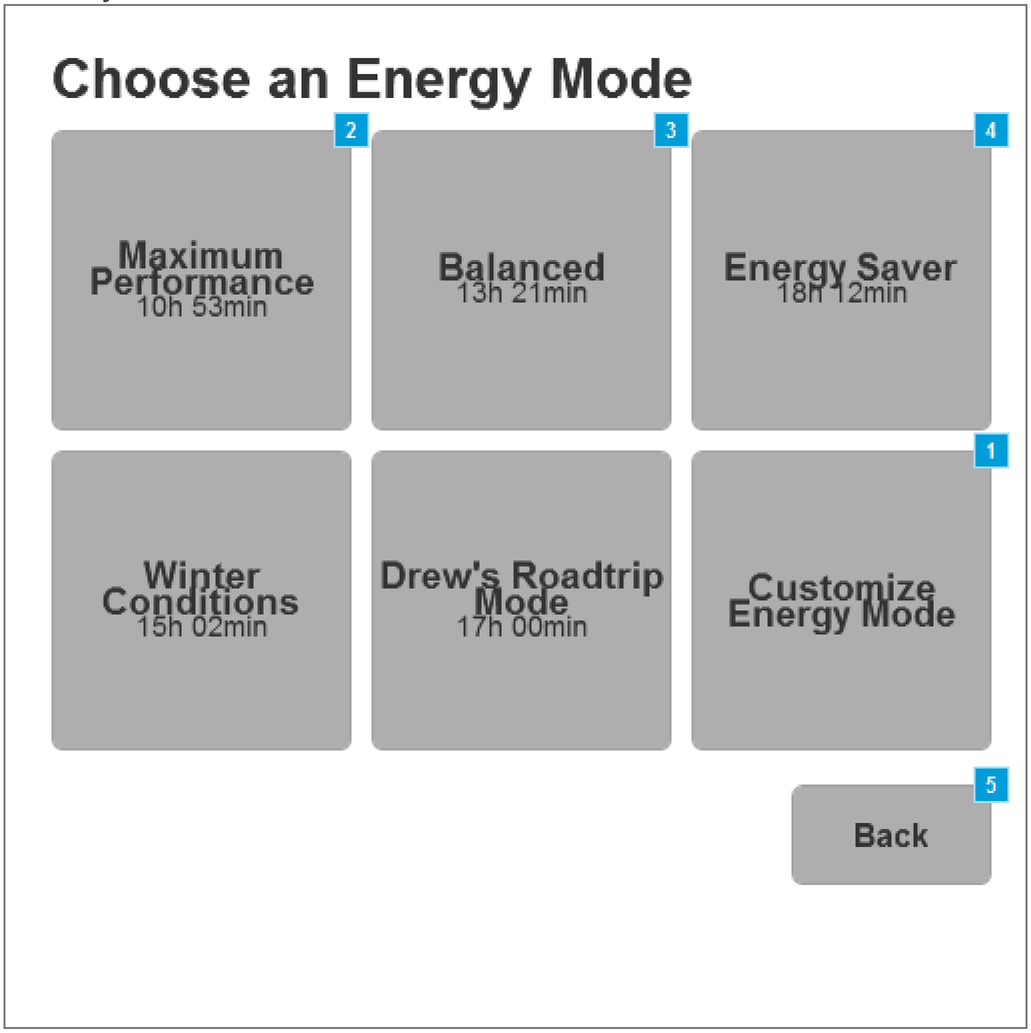
1.1.4.16. ***Map Multi List 2***

1.1.4.17. ***User Interface***



1.1.4.18. *Energy Options*

1.1.4.19. *User Interface*

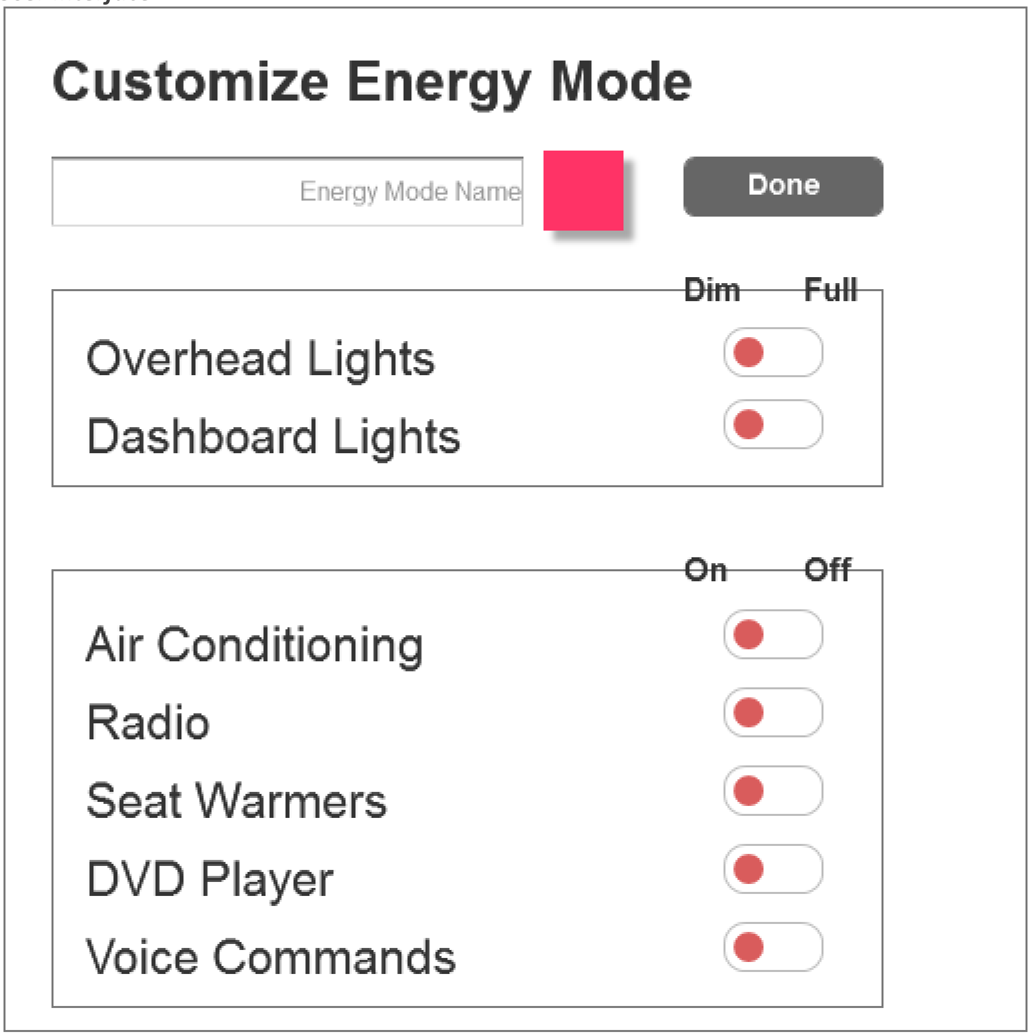


1.1.4.20. *Widget Table*

Footnote	Interactions
1	OnClick: Case 1: Set Middle Panel to Customize Energy Options
2	OnClick: Case 1: Set Performance to Maximum Performance
3	OnClick: Case 1: Set Performance to Balanced
4	OnClick: Case 1: Set Performance to Energy Saver
5	OnClick: Case 1: Set Middle Panel to Home

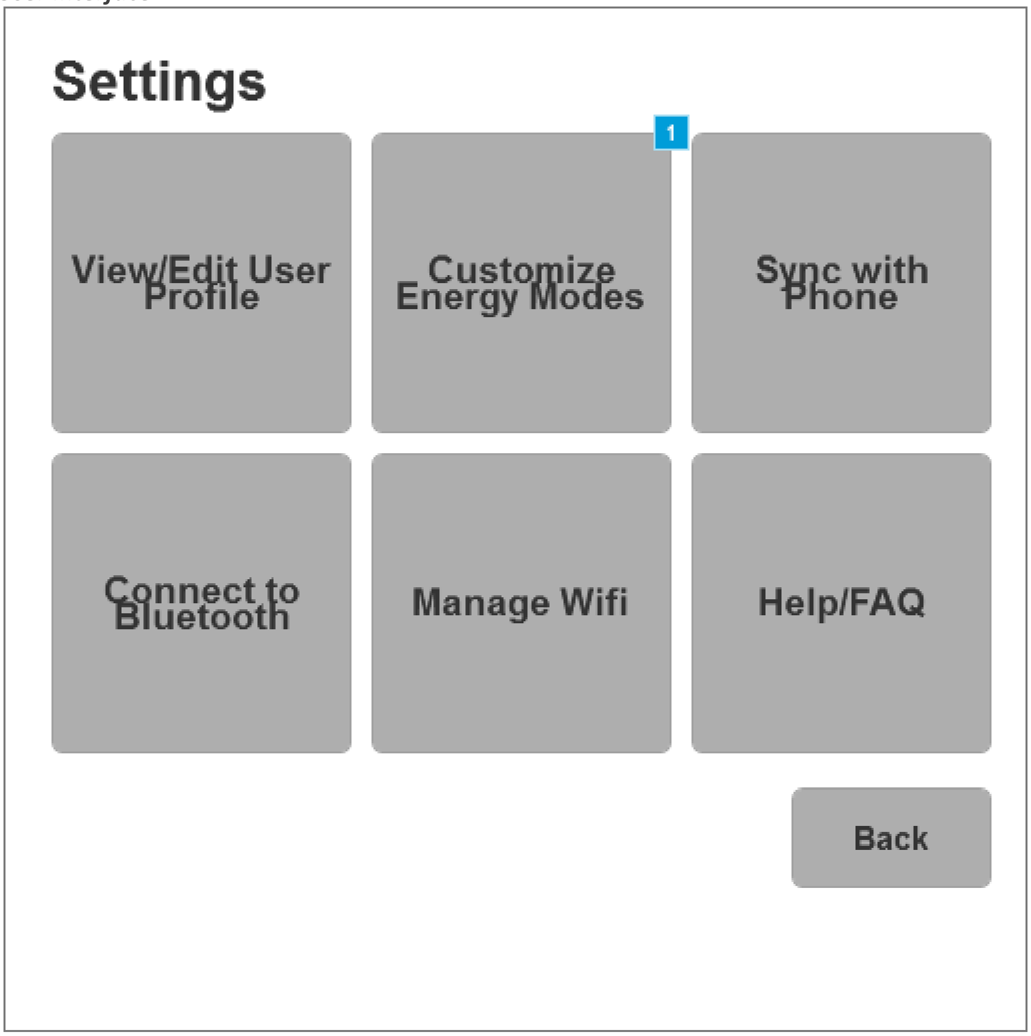
1.1.4.21. ***Customize Energy Options***

1.1.4.22. ***User Interface***



1.1.4.23. ***Settings***

1.1.4.24. ***User Interface***

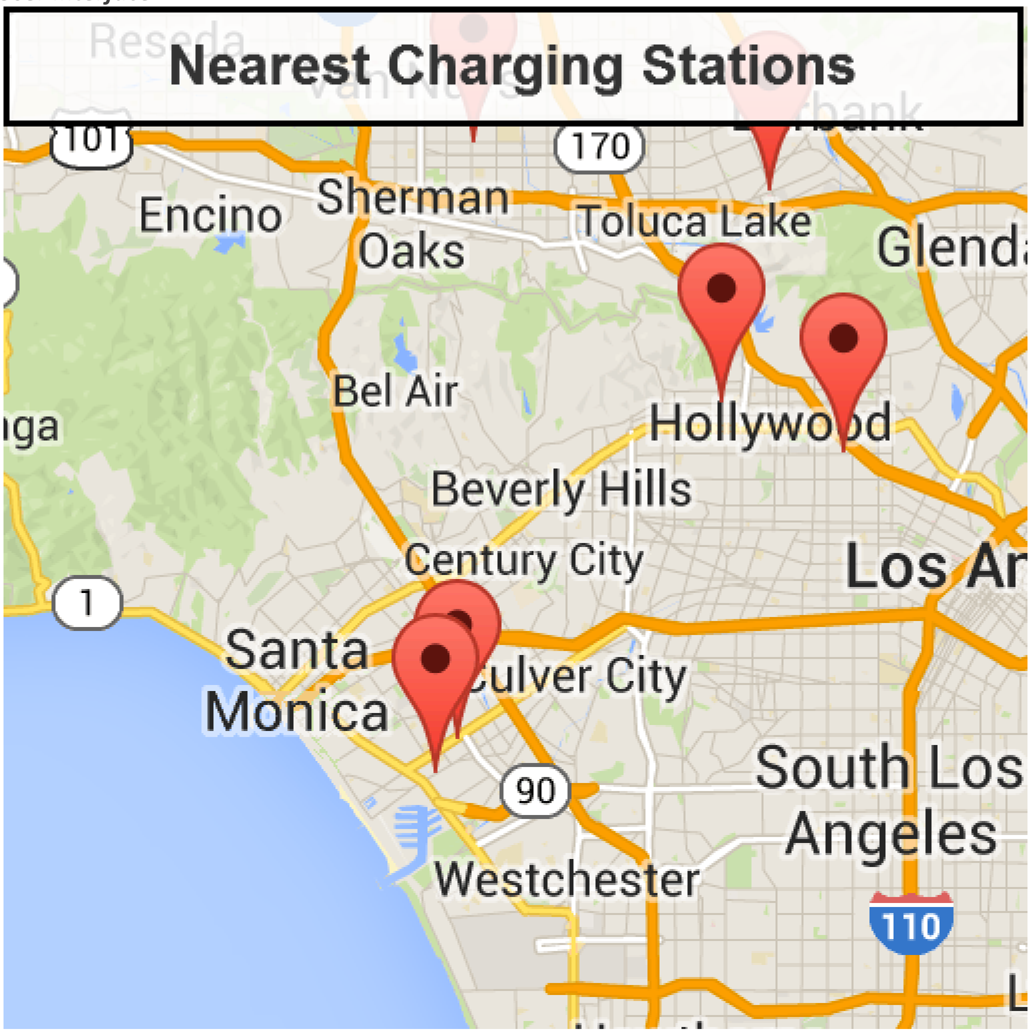


1.1.4.25. ***Widget Table***

Footnote	**Interactions**
1	OnClick: Case 1: Set Middle Panel to Customize Energy Options

1.1.4.26. ***State1***

1.1.4.27. ***User Interface***



1.1.5. Dropdown

1.1.5.1. ***State1***

1.1.5.2. ***User Interface***

Comic-Con, 8340 Allison Ave, La Mesa, CA 91942
Comics and Cons, 43 Toledo Drive, Souix Falls, Idaho 84991
Comic Convention Hall, 1 Main Street, Grantville, Delaware 00123

1.1.5.3. ***Widget Table***

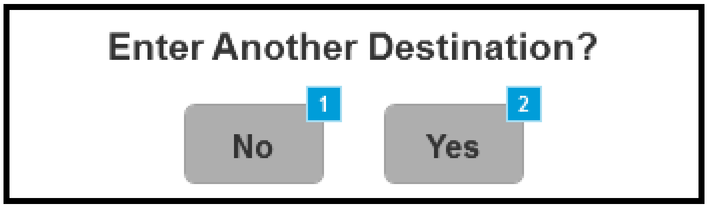
Footnote	Interactions

1	OnClick: Case 1: Set Middle Panel to Map

1.1.6. Enter 2nd Destination

1.1.6.1. *State1*

1.1.6.2. *User Interface*



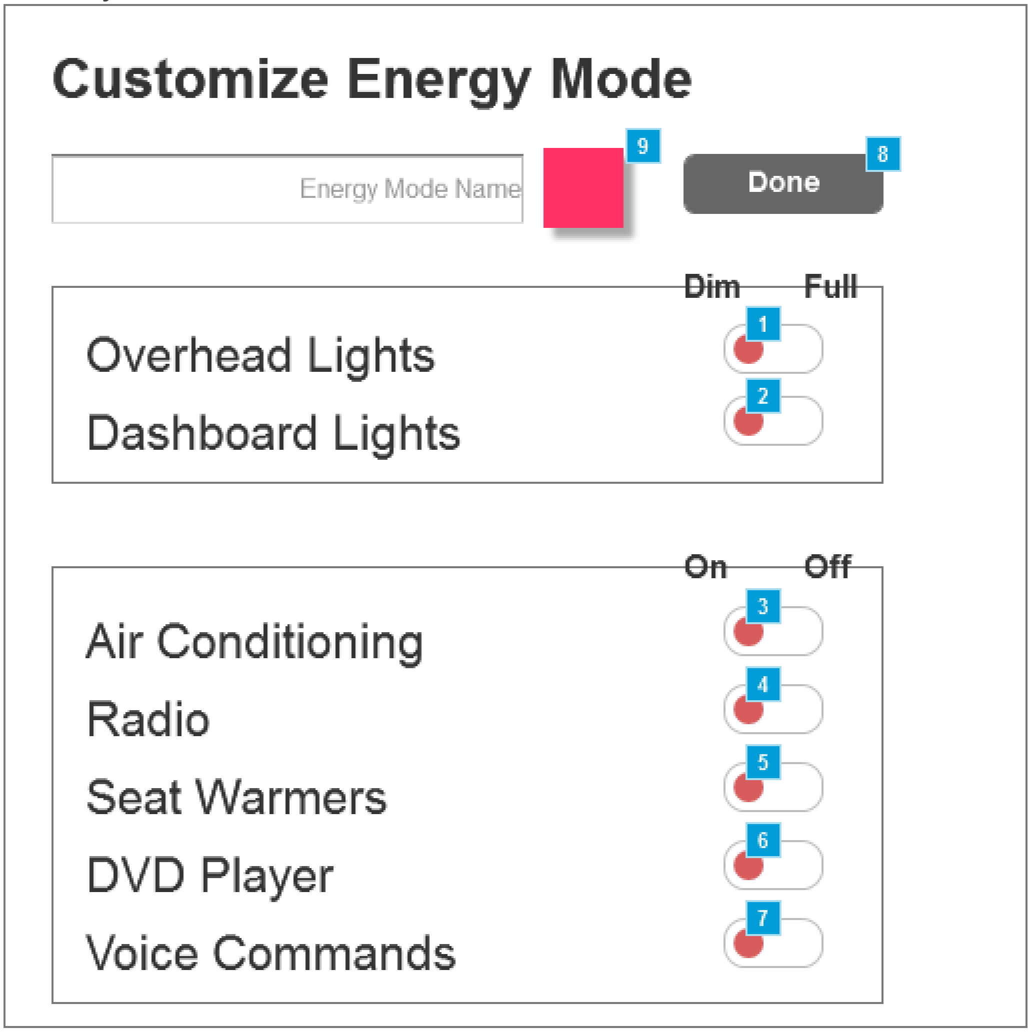
1.1.6.3. *Widget Table*

Footnote	Interactions
1	OnClick: Case 1: Set Enter 2nd Destination to State2
2	OnClick: Case 1: Set Middle Panel to Map Multi Destination

1.1.7. Controls and Popup

1.1.7.1. *Controls*

1.1.7.2. *User Interface*



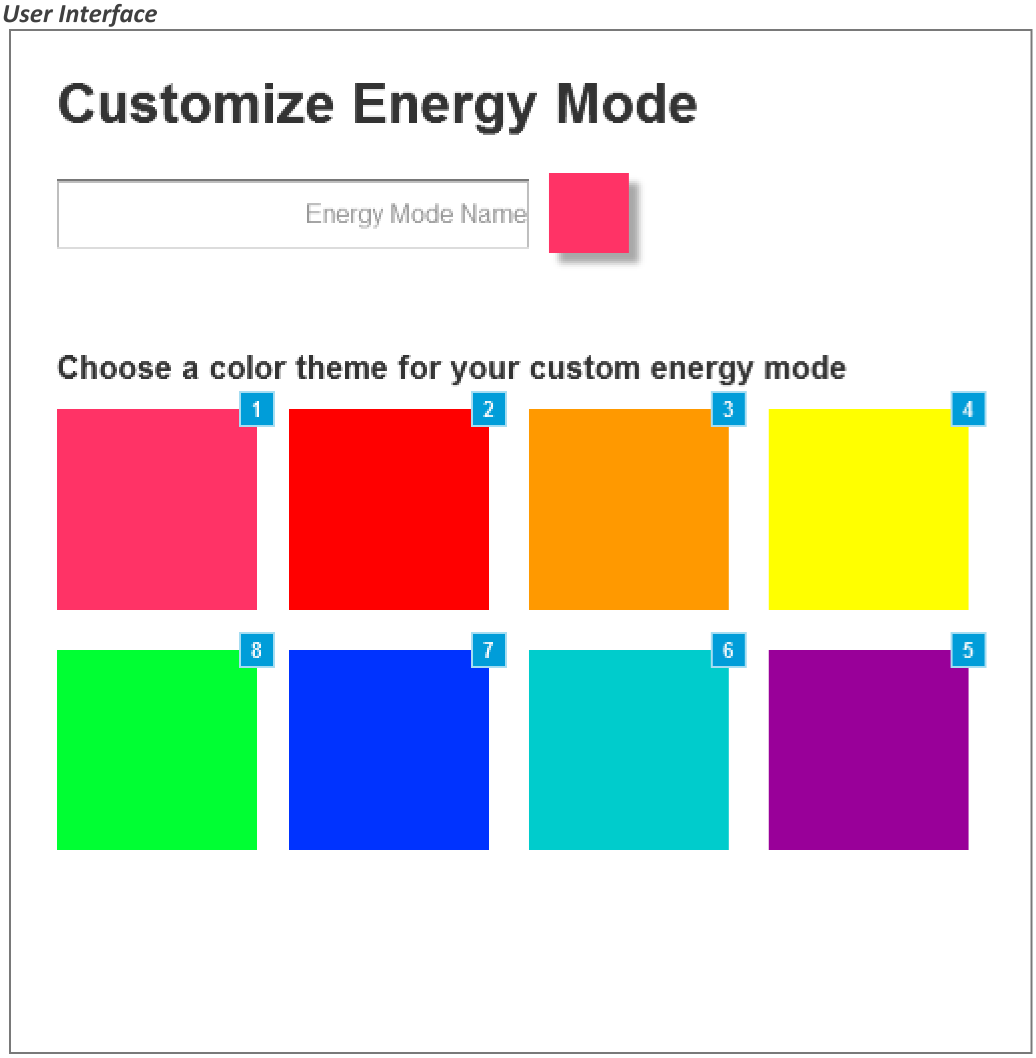
1.1.7.3. *Widget Table*

Footnote	Interactions
1	OnClick: Case 1: Set (Dynamic Panel) to Next wrap
2	OnClick: Case 1: Set (Dynamic Panel) to Next wrap
3	OnClick: Case 1: Set (Dynamic Panel) to Next wrap
4	OnClick: Case 1: Set (Dynamic Panel) to Next wrap
5	OnClick: Case 1:

	Set (Dynamic Panel) to Next wrap
6	OnClick: Case 1: Set (Dynamic Panel) to Next wrap
7	OnClick: Case 1: Set (Dynamic Panel) to Next wrap
8	OnClick: Case 1: Set Middle Panel to Energy Options
9	OnClick: Case 1: Set Controls and Popup to Popup

1.1.7.4. *Popup*

1.1.7.5. *User Interface*



1.1.7.6. *Widget Table*

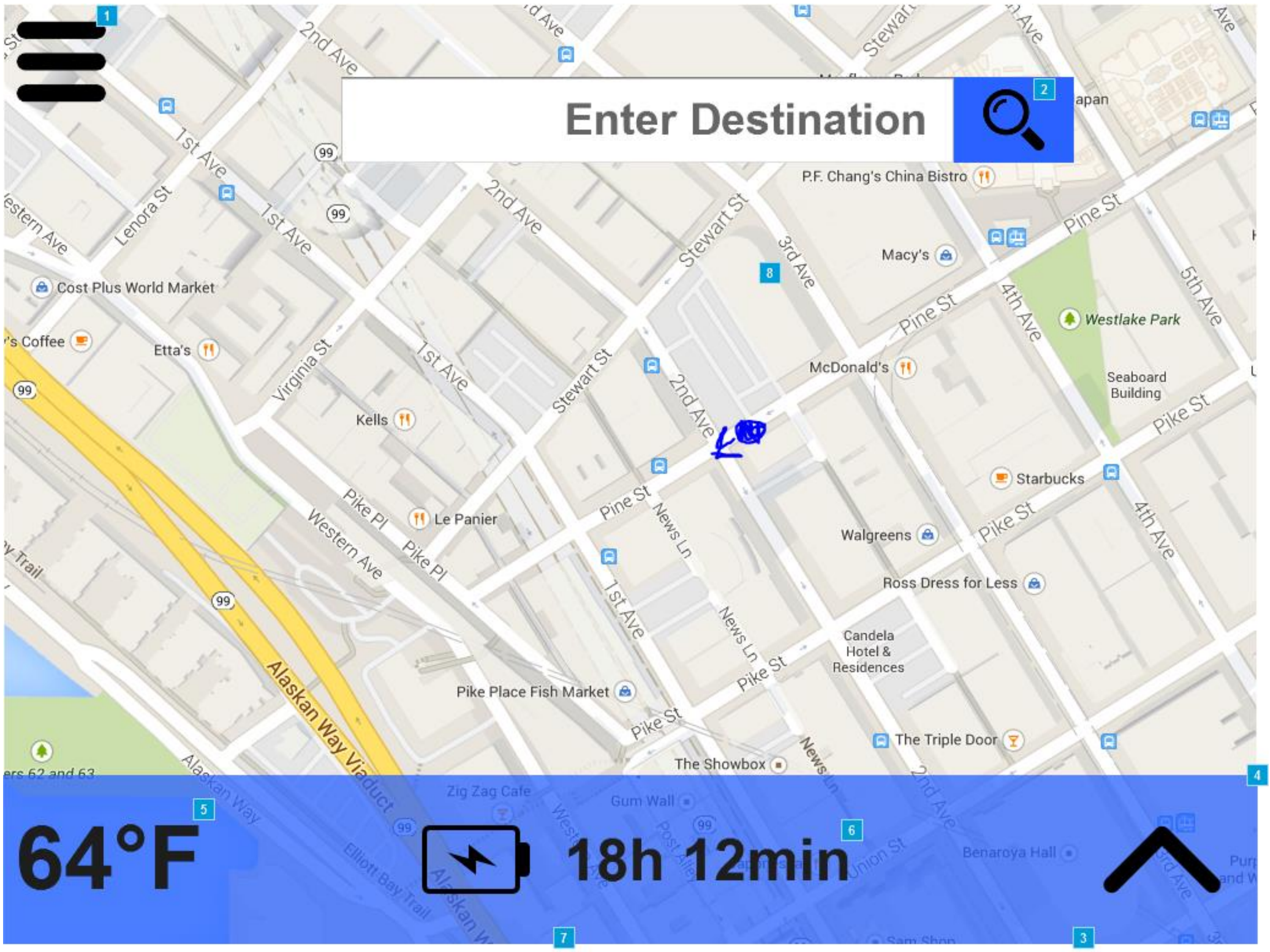
Footnote	Interactions
1	OnClick: Case 1:

	Set Controls and Popup to Controls, Color Chooser/Color Chooser to Pink, Color Chooser/Color Chooser to Pink
2	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Red, Color Chooser/Color Chooser to Red
3	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Orange, Color Chooser/Color Chooser to Orange
4	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Yellow, Color Chooser/Color Chooser to Yellow
5	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Purple, Color Chooser/Color Chooser to Purple
6	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Light Blue, Color Chooser/Color Chooser to Light Blue
7	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Dark Blue, Color Chooser/Color Chooser to Dark Blue
8	OnClick: Case 1: Set Controls and Popup to Controls, Color Chooser/Color Chooser to Green, Color Chooser/Color Chooser to Green

Appendix L: Flipbook Iteration 2

1.1. Home Dos

1.1.1. User Interface



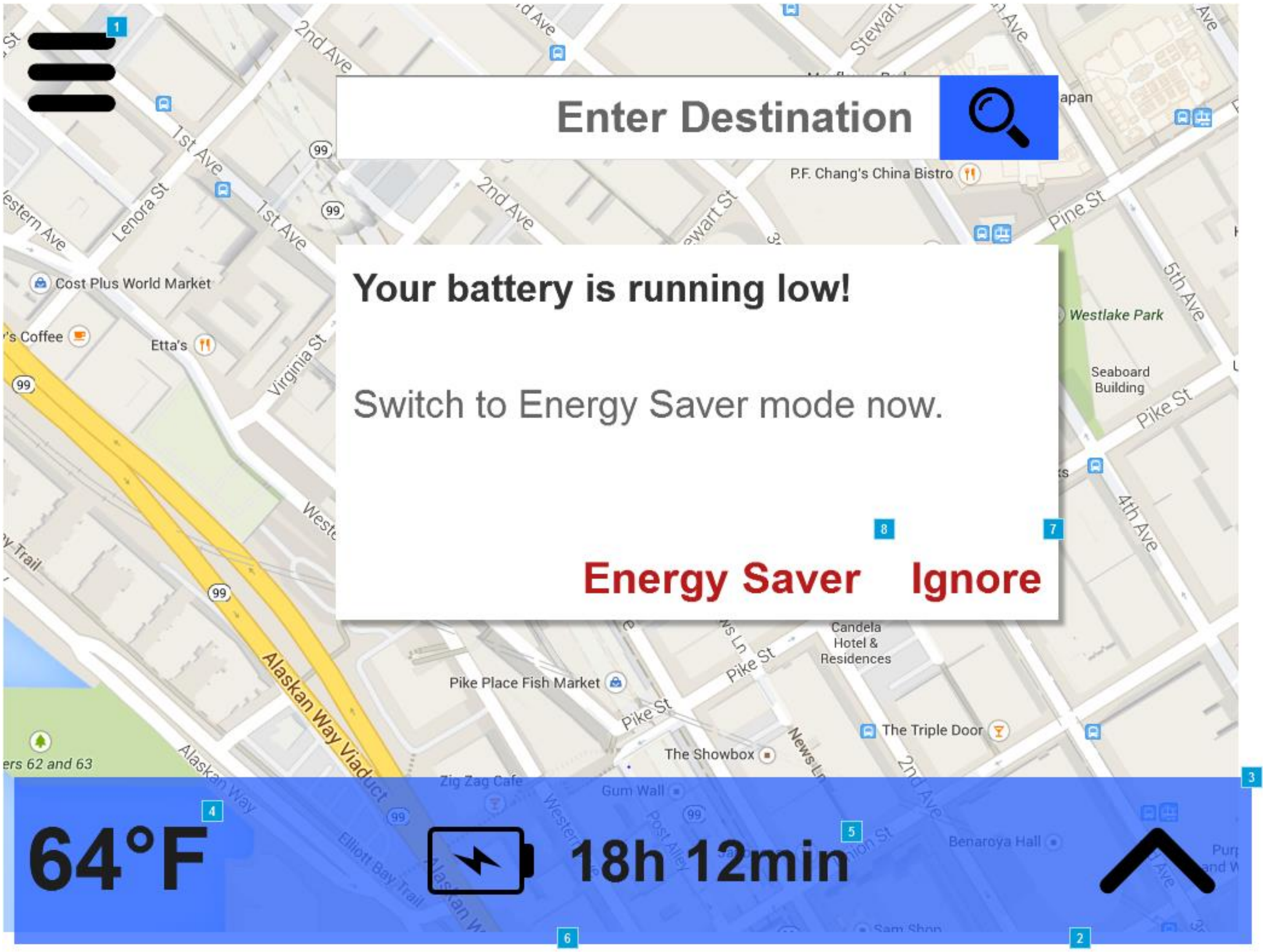
1.1.2. Widget Table

Footnote	Name	Interactions
1	Menu	OnClick: Case 1: Open HomeII w/Menu in Parent Frame
2		OnClick: Case 1: Open Comic Con in Parent Frame
3		OnClick: Case 1: Open Energy in Parent Frame

4		OnClick: Case 1: Open Energy in Parent Frame
5		OnClick: Case 1: Open Energy in Parent Frame
6		OnClick: Case 1: Open Energy in Parent Frame
7		OnClick: Case 1: Open Energy in Parent Frame
8		OnClick: Case 1: Open Low on Power in Parent Frame

1.2. Low on Power

1.2.1. User Interface



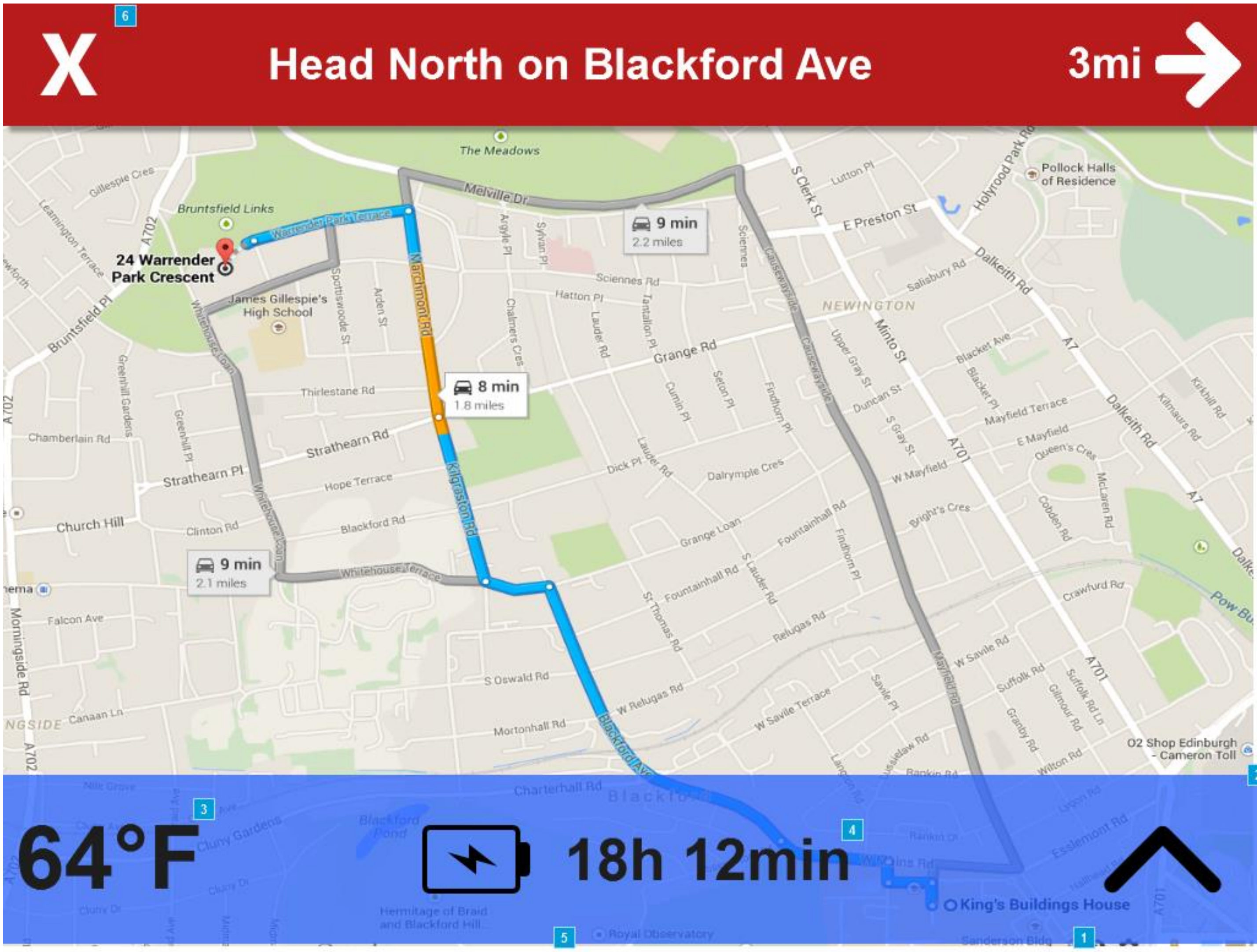
1.2.2. Widget Table

Footnote	Name	Interactions
1	Menu	OnClick: Case 1: Open HomeII w/Menu in Parent Frame
2		OnClick: Case 1: Open Energy in Parent Frame
3		OnClick: Case 1: Open Energy in Parent Frame
4		OnClick: Case 1: Open Energy in Parent Frame
5		OnClick: Case 1:

		Open Energy in Parent Frame
6		OnClick: Case 1: Open Energy in Parent Frame
7		OnClick: Case 1: Open Home Dos in Parent Frame
8		OnClick: Case 1: Open Energy Saver in Parent Frame

1.3. Nav Home

1.3.1. User Interface



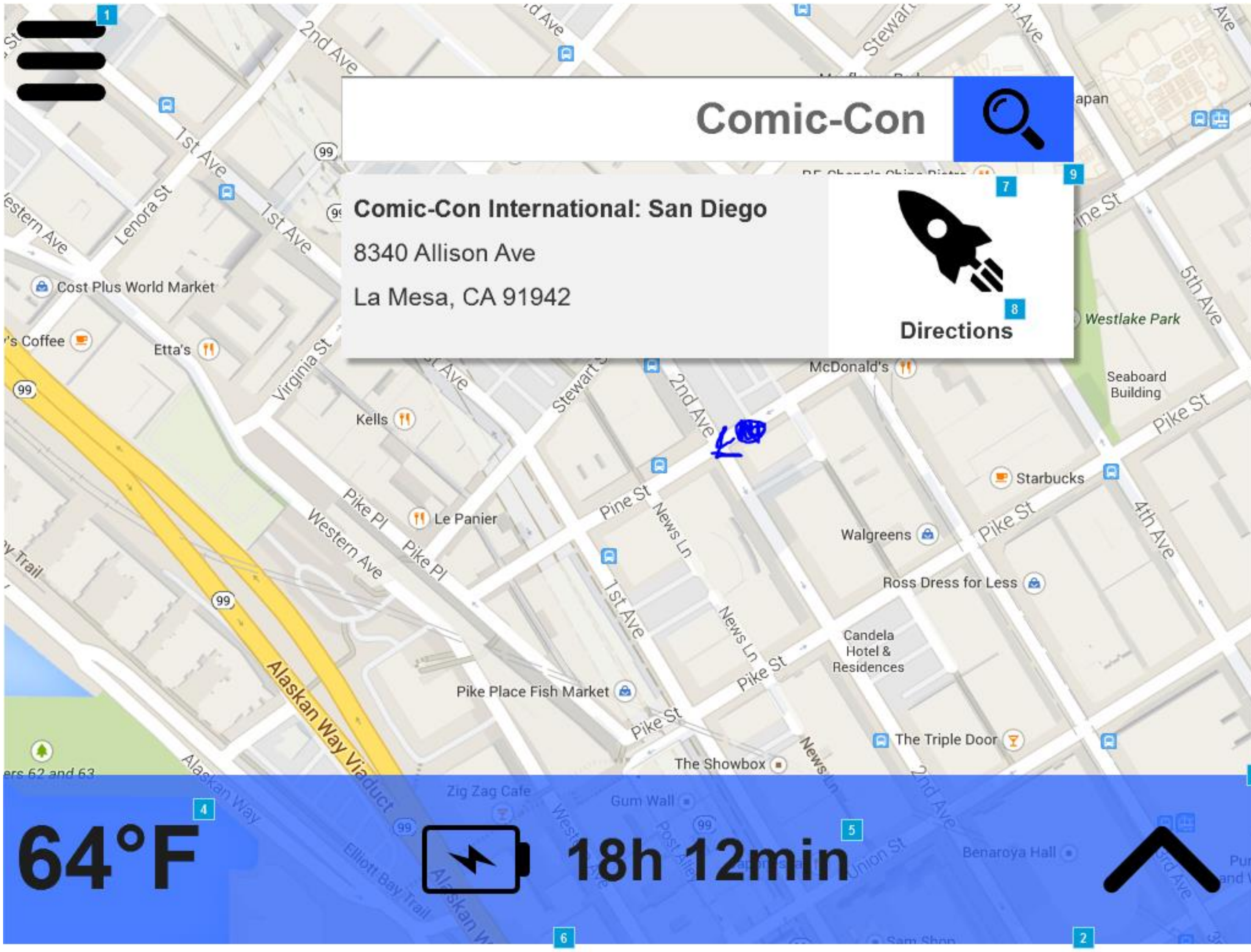
1.3.2. Widget Table

Footnote	Interactions
1	OnClick: Case 1: Open Energy in Parent Frame
2	OnClick: Case 1: Open Energy in Parent Frame
3	OnClick: Case 1: Open Energy in Parent Frame
4	OnClick: Case 1: Open Energy in Parent Frame
5	OnClick: Case 1:

	Open Energy in Parent Frame
6	OnClick: Case 1: Open Home Dos in Parent Frame

1.4. Comic Con

1.4.1. User Interface



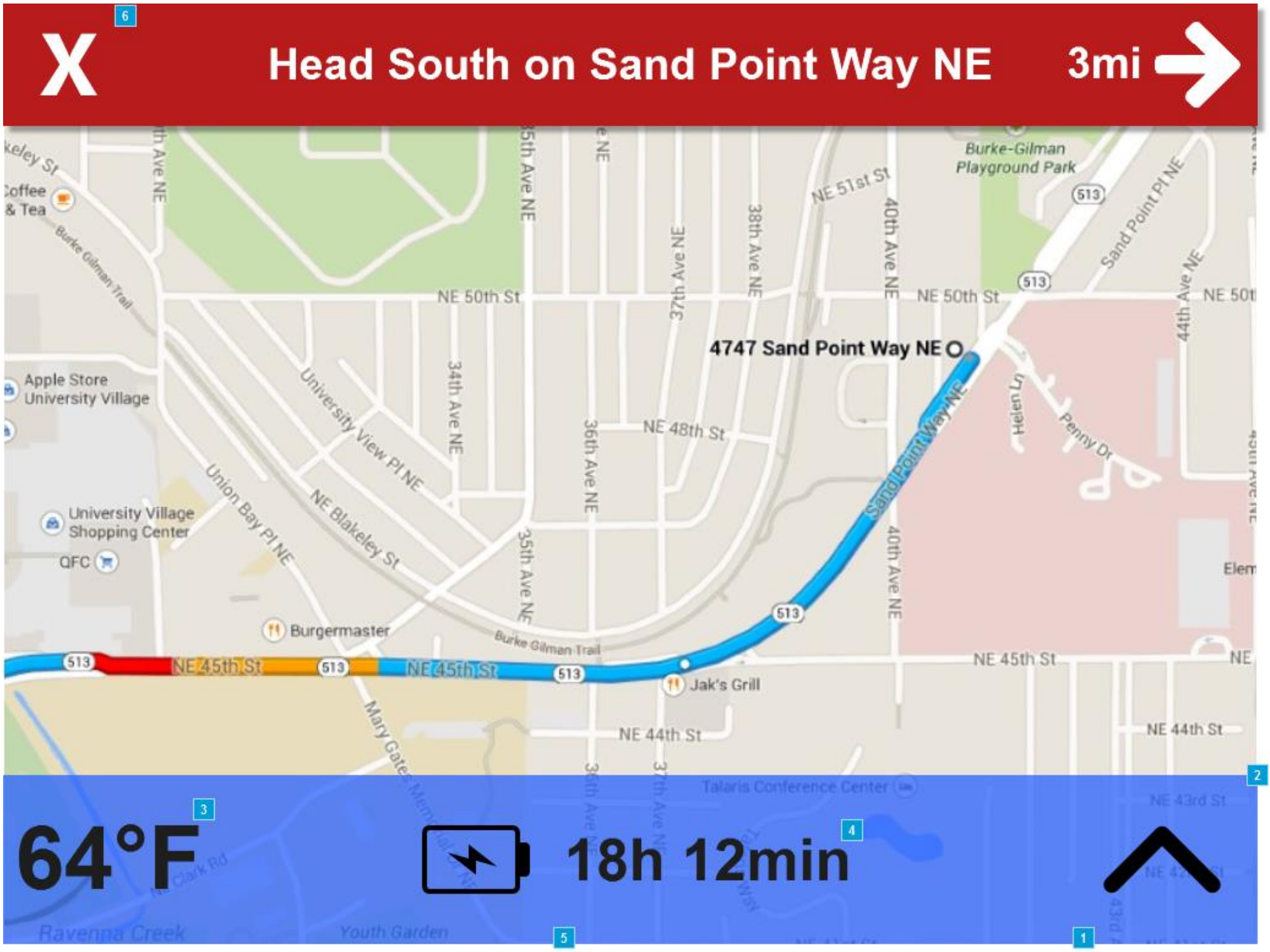
1.4.2. Widget Table

Footnote	Name	Interactions
1	Menu	OnClick: Case 1: Open HomeII w/Menu in Parent Frame
2		OnClick: Case 1: Open Energy in Parent Frame
3		OnClick: Case 1: Open Energy in Parent Frame
4		OnClick: Case 1: Open Energy in Parent Frame
5		OnClick: Case 1:

		Open Energy in Parent Frame
6		OnClick: Case 1: Open Energy in Parent Frame
7		OnClick: Case 1: Open Directions in Parent Frame
8		OnClick: Case 1: Open Directions in Parent Frame
9		OnClick: Case 1: Open Directions in Parent Frame

1.5. Directions

1.5.1. User Interface



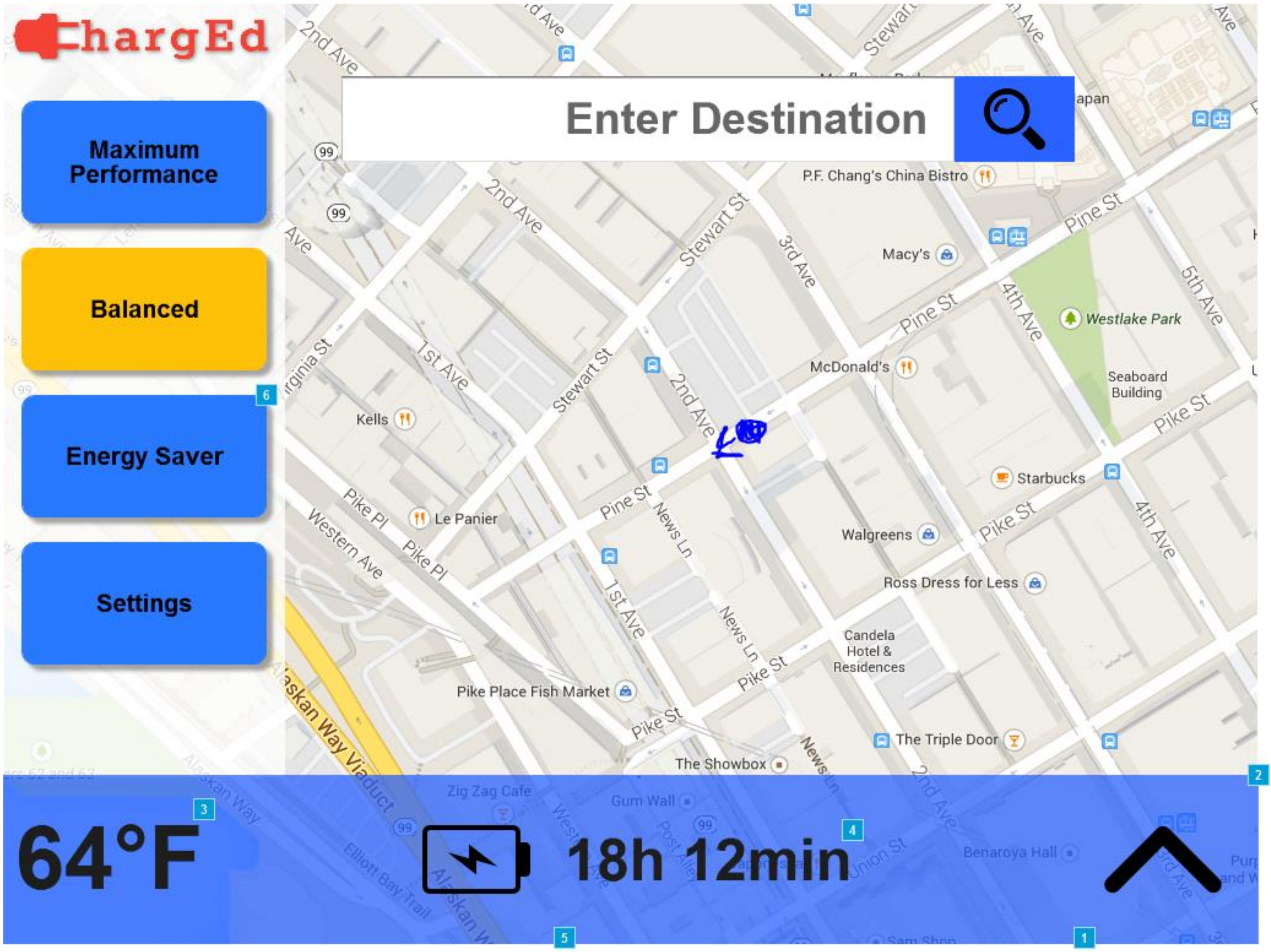
1.5.2. Widget Table

Footnote	Interactions
1	OnClick: Case 1: Open Energy in Parent Frame
2	OnClick: Case 1: Open Energy in Parent Frame
3	OnClick: Case 1: Open Energy in Parent Frame
4	OnClick: Case 1: Open Energy in Parent Frame
5	OnClick: Case 1:

	Open Energy in Parent Frame
6	OnClick: Case 1: Open Home Dos in Parent Frame

1.6. HomeII w/Menu

1.6.1. User Interface



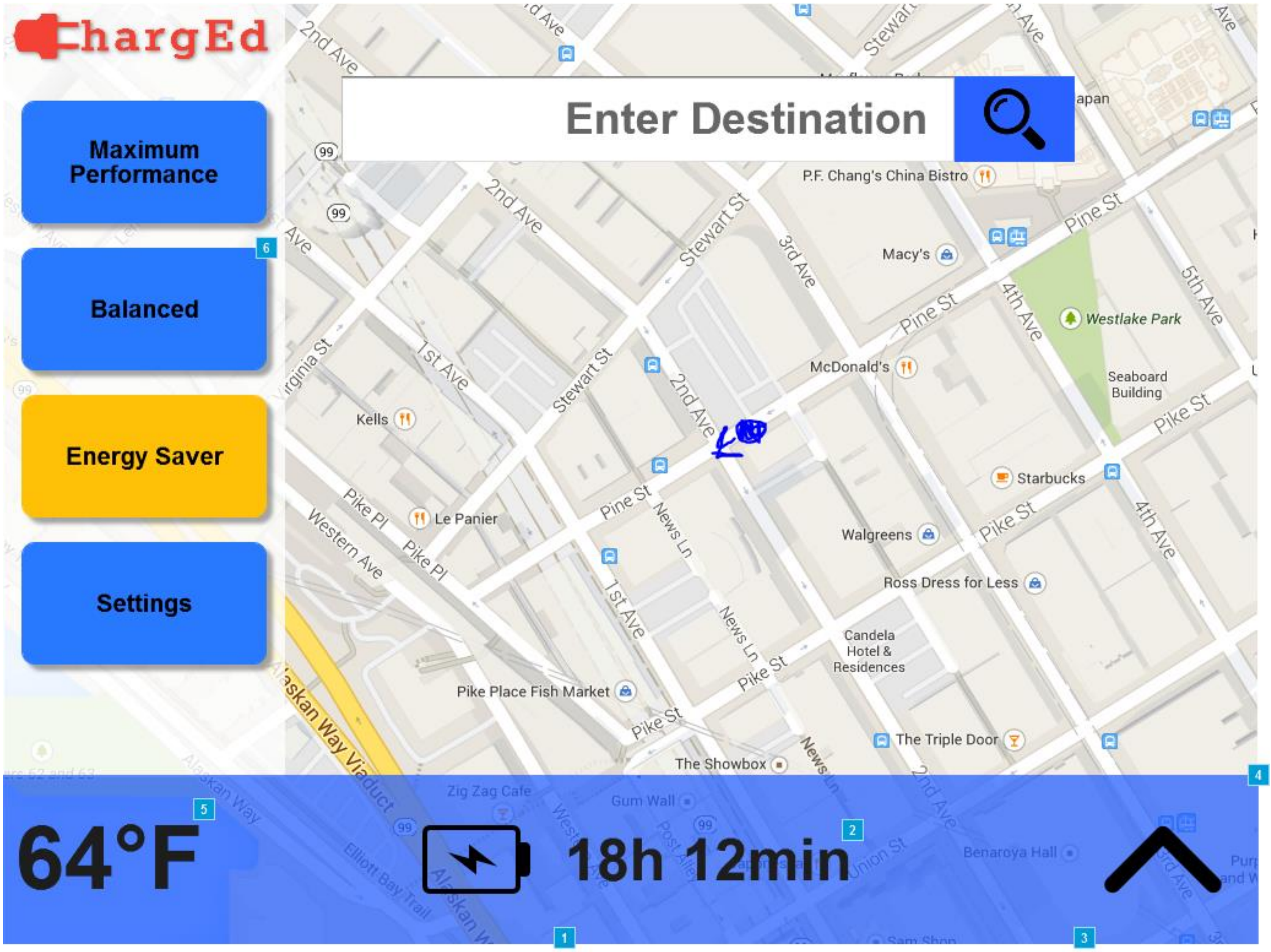
1.6.2. Widget Table

Footnote	Interactions
1	OnClick: Case 1: Open Energy in Parent Frame
2	OnClick: Case 1: Open Energy in Parent Frame
3	OnClick: Case 1: Open Energy in Parent Frame
4	OnClick: Case 1: Open Energy in Parent Frame
5	OnClick: Case 1:

	Open Energy in Parent Frame
6	OnClick: Case 1: Open HomeII w/Menu in Parent Frame

1.7. Energy Saver

1.7.1. User Interface



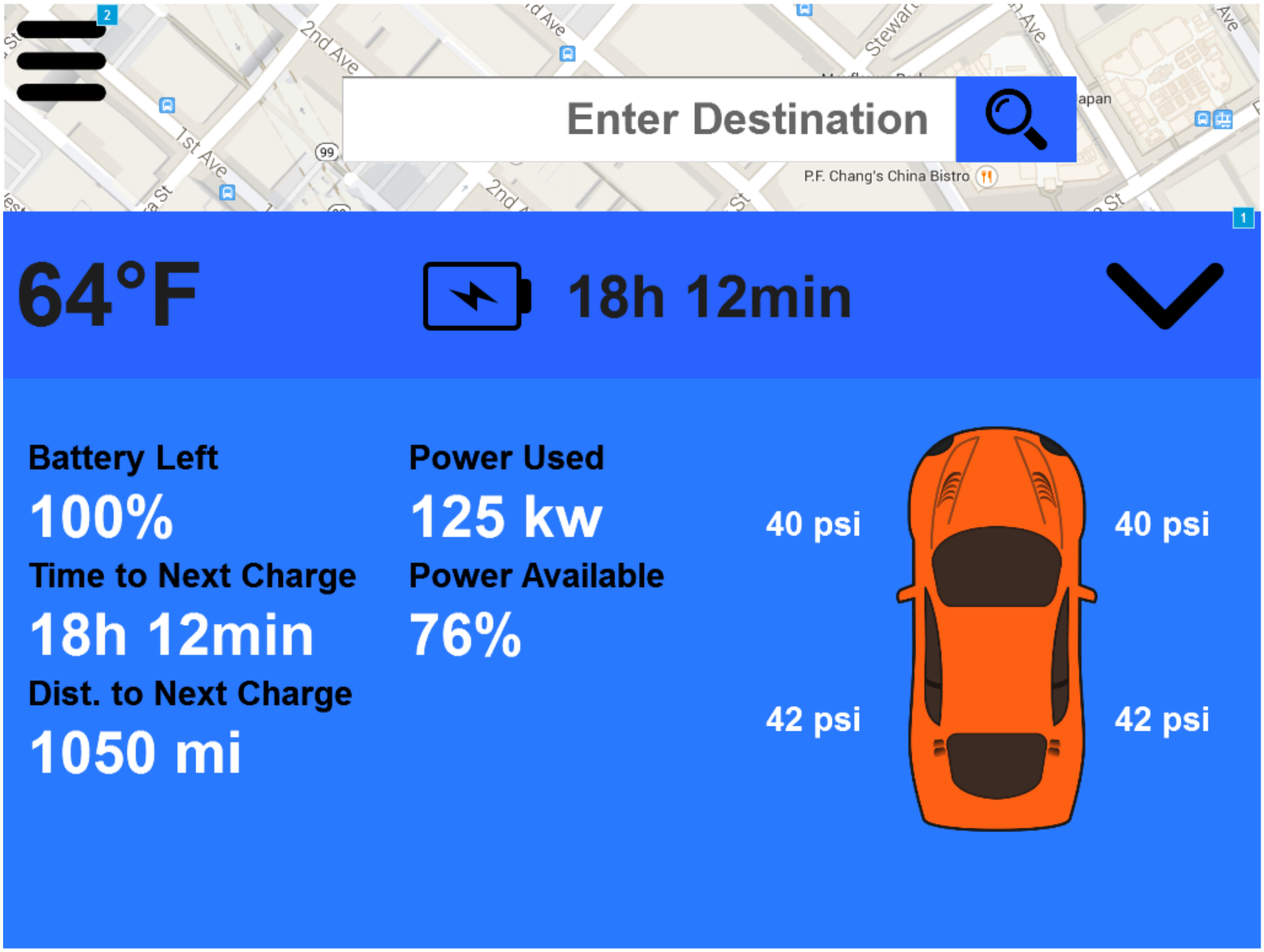
1.7.2. Widget Table

Footnote	Interactions
1	OnClick: Case 1: Open Energy in Parent Frame
2	OnClick: Case 1: Open Energy in Parent Frame
3	OnClick: Case 1: Open Energy in Parent Frame
4	OnClick: Case 1: Open Energy in Parent Frame
5	OnClick: Case 1:

	Open Energy in Parent Frame
6	OnClick: Case 1: Open HomeII w/Menu in Parent Frame

1.8. **Energy**

1.8.1. **User Interface**

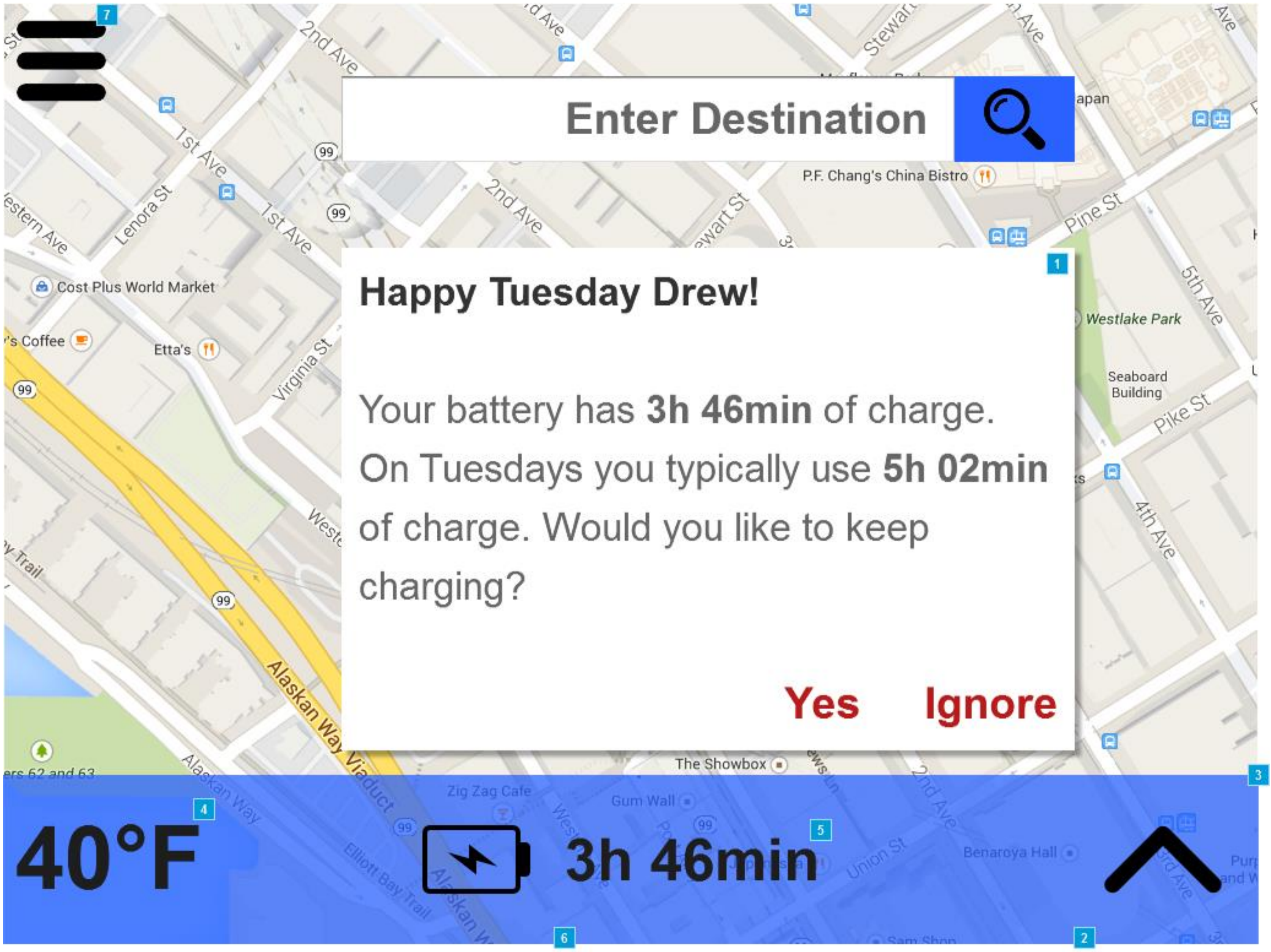


1.8.2. **Widget Table**

Footnote	Name	Interactions
1		OnClick: Case 1: Open Home Dos in Parent Frame
2	Menu	OnClick: Case 1: Open HomeII w/Menu in Parent Frame

1.9. **Starting Message**

1.9.1. **User Interface**

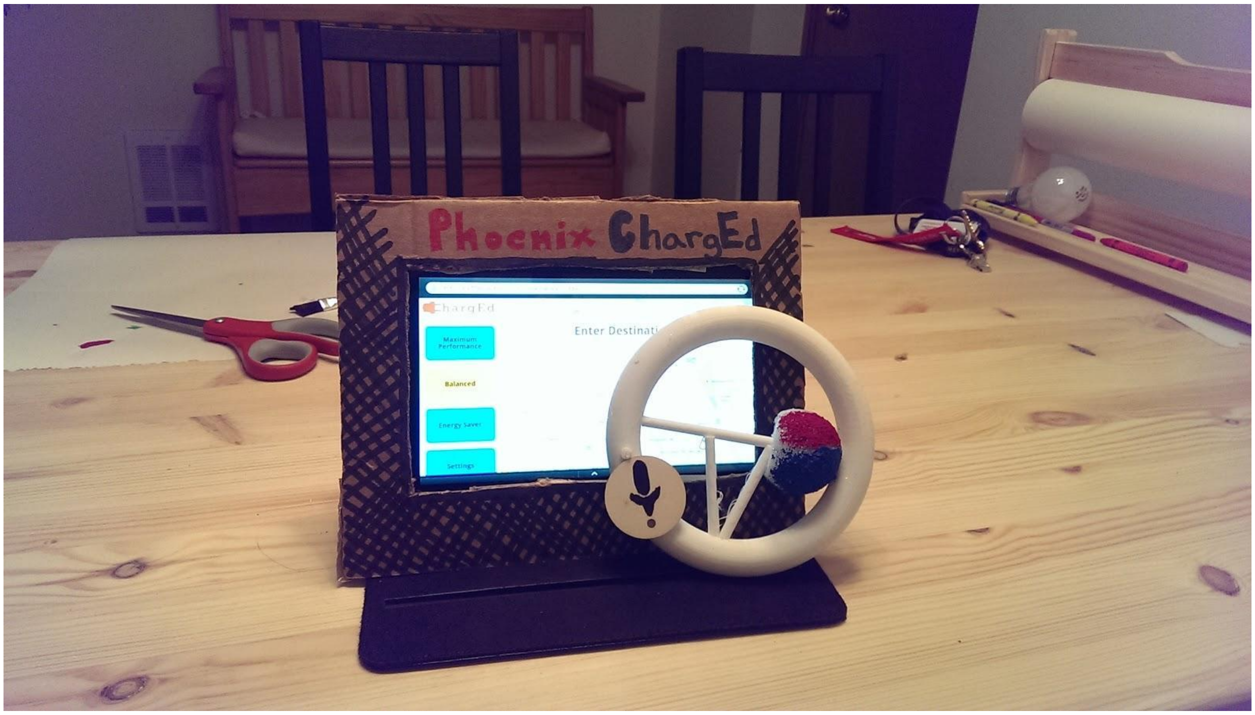


1.9.2. **Widget Table**

Footnote	Name	Interactions
1		OnClick: Case 1: Open Home Dos in Parent Frame
2		OnClick: Case 1: Open Energy in Parent Frame
3		OnClick: Case 1: Open Energy in Parent Frame
4		OnClick: Case 1: Open Energy in Parent Frame
5		OnClick: Case 1:

		Open Energy in Parent Frame
6		OnClick: Case 1: Open Energy in Parent Frame
7	Men u	OnClick: Case 1: Open HomeII w/Menu in Parent Frame

Appendix M: Physical Prototype

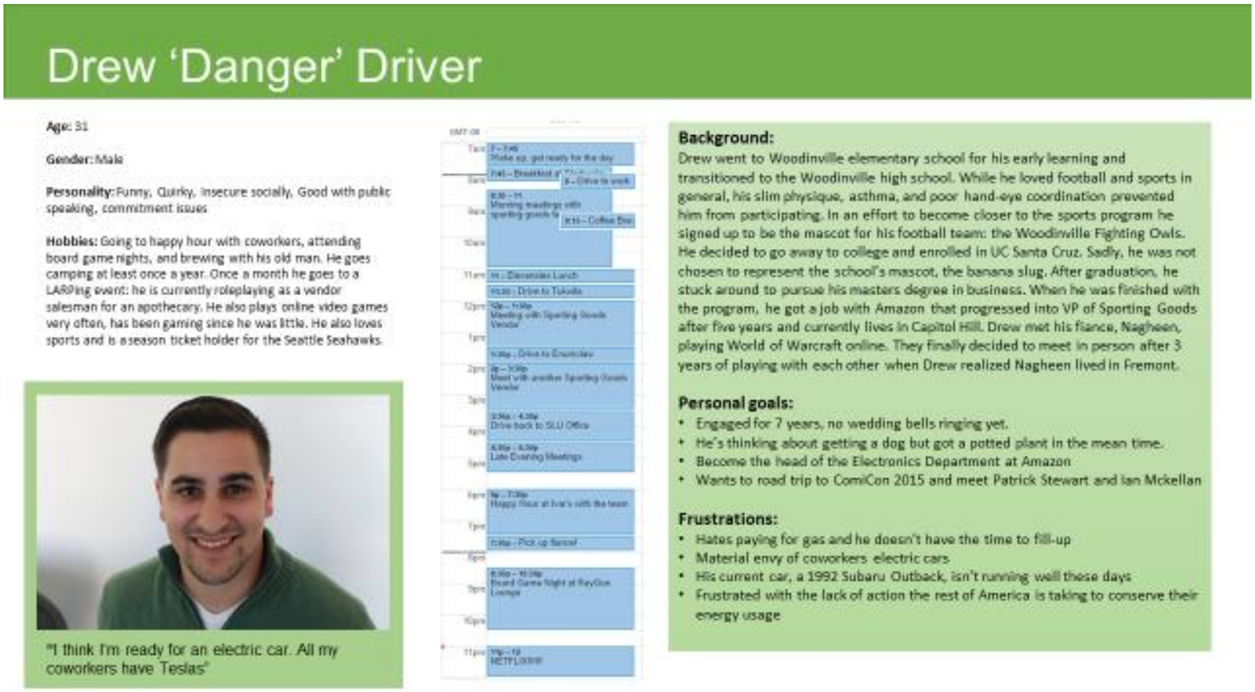


Appendix N: User Study

Participant	1	2	3	4	5	6	7	8	9	Average	StDev
Task 1: Get directions and start navigating to Comic-Con											
Time (s)	24.15	23.22	30	20	18	7	13	21	10	18.4855555 6	7.33100455 4
Likeability	1	3	1	1	2	1	1	1	4	1.66666666 7	1.11803398 9
Ease of Use	3	2	1	3	1	1	1	2	3	1.88888888 9	0.92796072 71
Errors	0	0	0	0	0	0	0	0	0	0	0
Task 2: Find statistics on energy consumption for the car											
Time (s)	5	20	59	5	10	19	19	16	8	17.8888888 9	16.5563012 5
Likeability	1	3	7	1	3	2	4	3	1	2.77777777 8	1.92209376 6
Ease of Use	1	3	2	2	2	1	1	2	1	1.66666666 7	0.70710678 12
Errors	0	1	5	0	1	2	1	1	0	1.22222222 2	1.56347192
Task 3: Change the power mode from Balanced to Energy Saver											
Time (s)	27.79	23	6	45	7	5	5	4	10	14.7544444 4	14.2216446 9
Likeability	2	3	1	5	1	1	1	1	1	1.77777777 8	1.39443337 8
Ease of Use	2	4	1	4	1	1	1	1	1	1.77777777 8	1.30170827 9
Errors	0	1	0	2	0	0	0	0	0	0.33333333 33	0.70710678 12
Overall											
Improvements	overall its good because	overall - its good the		overall - put battery	overall - battery confusion			overall - the menus	overall - bar icon bigger		

	its ubiqituous	**familiarity is good**		**energy option on the battery icon.**	**with the statistic.**			**need work on icons translating what is gonna happen when they press that button.**	**target area.**		

Appendix O: Persona Presentation



Appendix P: Flip Book Report

ChargEd

User Interface Evaluation

Team ChargEd:
Jonas, Erin, Nick, Hary

ChargEd

Report Card

	Average Seconds for Completion	Average Ease of Use	Average Likeability	Average Errors	Average Emoji
Task 1	41.125	6.75: Somewhat Easy	6: Somewhat Liked	1.625	
Task 2	40.625	5.25: Neither Easy nor Difficult	4.75: Neutral	2.25	
Task 3	55.125	6.25: Somewhat Easy	6.375: Somewhat Liked	1.75	

Key Findings

What they liked

- Being able to customize a lot of the settings, especially their own energy settings.
- Large button size on menus
- Battery icon showing % power

What they didn't like

- The home screen, it had too many buttons/functions.
- Not having voice control, people were hesitant to use a touchscreen too much while driving.
- Participants wanted a map at all times showing where the driver is.

Next Steps

- Large map with geolocate always showing position
- Utilizing the wheel more for easier interaction with the interface
  - Voice activation, it can be activated on the wheel
- Only 3 energy modes that can be edited in settings, have these be easily activated through the wheel.
- Take out extraneous dashboard features/functions that are not necessary or is not relevant to energy management.
- Focus on 'getting home to charge' not finding a charging station

Appendix Q: Team Identity

Project: Electric Car Energy Monitor
Team Members: Erin McLean, Jonas Nocom, Harry Tumber, Nick Picatti
Team Name: ChargEd
Tagline: Prius to Meet You!
LOGO:

Mission Statement: Our mission is to get people from their beginning to end destination using the most efficient methods possible in order to keep America and the world moving toward a better, cleaner tomorrow.
Vision Statement: Our vision is to help create a cleaner atmosphere and safer driving experience by improving the use of energy in electric cars.
Values:
1. Creativity
2. Innovation
3. Passion
4. Intelligence
5. Respect (for the Environment, for the Future, for Drivers)
6. Utility

Appendix R: Prototype Report

ChargEd

Erin, Hary, Jonas, Nick

Results Comparison

	Average Time for Completion (s)		Average Likeability		Average Ease of Use		Average Errors	
	6a	6b	6a	6b	6a	6b	6a	6b
Task 1	41.125	18.49	6: Somewhat Liked	9.33: Very Likable	6.75: Somewhat Easy	9.12: Very Easy	1.625	0
Task 2	40.625	17.89	4.75: Neutral	8.23: Very Likeable	5.25: Neither Easy nor Difficult	9.78: Very Easy	2.25	1.22
Task 3	55.125	14.75	6.375: Somewhat Liked	9.23: Very Likeable	6.25: Somewhat Easy	9.23: Very Easy	1.75	.33
	Faster Task Completion		More Likeable		Easier to Use		Fewer Errors	

Potential Improvements

- Finding the menu for changing energy modes was somewhat difficult. Participants suggested having the battery icon lead to the energy modes or including the menu in the bottom pull out tab.
- Participants would like a larger target area for the side pull out menu icon.

Appendix S: Final Presentation

ChargEd

Energy Management System for Electric Cars

Erin, Hary, Jonas, Nick

Problem

Today's electric automobiles are unreliable and out of touch with their operators.

Solution - Our Design

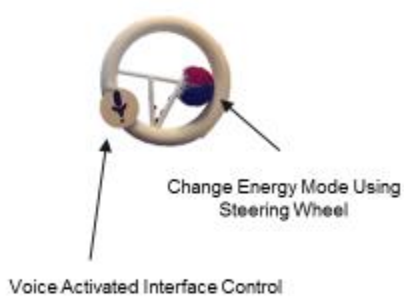
- Energy Management UI in the dashboard.
- Hands **<u>On</u>** the Wheel
  - Voice control
  - Switch energy modes from the wheel
  - Large target areas on dashboard
- Intelligent battery monitoring system
- Focus on getting the user home
  - “I don’t want to wait 3 hours at a charging station”

Our Design

Our Design

Our Design

Our Design



VIDEO HERE

https://www.youtube.com/watch?v=INHPcGBWRA0

Findings

	Average Time for Completion (s)		Average Likeability		Average Ease of Use		Average Errors	
	6a	6b	6a	6b	6a	6b	6a	6b
Task 1	41.125 ± 13.26	18.49 ± 7.33	6 ± 1.85 Somewhat Liked	9.33 ± 1.12 Very Likable	6.75 ± 1.28 Somewhat Easy	9.12 ± 0.93 Very Easy	1.63 ± 2.07	0
Task 2	40.625 ± 9.15	17.89 ± 16.56	4.75 ± 2.19 Neutral	8.23 ± 1.92 Very Likeable	5.25 ± 1.75 Neither Easy nor Difficult	9.78 ± 0.71 Very Easy	2.25 ± 1.83	1.22 ± 1.56
Task 3	55.125 ± 67.77	14.75 ± 14.22	6.38 ± 2.56 Somewhat Liked	9.23 ± 1.39 Very Likeable	6.25 ± 2.43 Somewhat Easy	9.23 ± 1.30 Very Easy	1.75 ± 2.76	0.33 ± 0.71
	Faster Task Completion		More Likeable		Easier to Use		Fewer Errors	

Findings- Improvement

- Begin with one main menu with energy modes
  - Menu in bottom tab
  - Battery icon
- Larger target area for pull out menu

Future Iterations

- Self-driving electric car that can route for complex itineraries while still getting the user home to charge
- Mobile app that connects to in-car dashboard
- More smart recommendations based off energy usage statistics
- Biofeedback to adjust temperature and dashboard lighting

Questions?