The Tesla in New Mexico

New Mexico Supercomputing challenge

Final Report

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32

Desert Academy

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Table of contents

Executive Summary

For the 2012-2013 supercomputing challenge, our team decided to focus on green energy solutions. We thought about ways to model energy consumption in the United States, and how electrically powered machines will find power-ups and resources. We finally decided on a program to model the usage and workings of power stations for the Tesla. The Tesla is an electric car created for use through sustainable energy such as solar or wind. We thought it would be helpful for the public to know how these power stations would affect their environment, the economy, and the way people work in their society. To create this model, we researched where the stations would be installed, the amount of time people would have to spend at the power stations, and how frequently one would need to refuel. The program modeled how many stations would be needed to create a working system in New Mexico, and where the stations would be to create the most efficient system. We believe that the Tesla is an important new technology for the modern era, and we feel it is important to foresee the consequences of power stations instead of gas stations. We used net logo to show the effects of the power up station placement.

Introduction

For this model we researched the aspects of the Tesla that would affect speed, recharge time, battery life and charging time, to get a complete idea of the information necessary to create an efficient system of charging stations in New Mexico.

The Problem

If there can be a thriving community of people using environmentally friendly electric cars, then there must be guidelines around how they can be recharged. The recharging stations should be spaced to give the car optimum driving time between charges, and so that people can feel secure driving distances without running out of charge. We needed to find a way to model the way cars drive, so that we could find the places that work best to install charging stations. This takes research and a good program, but we believe that the program can effectively model the Tesla and it's charging stations to reach the highest efficiency of both.

The Solution

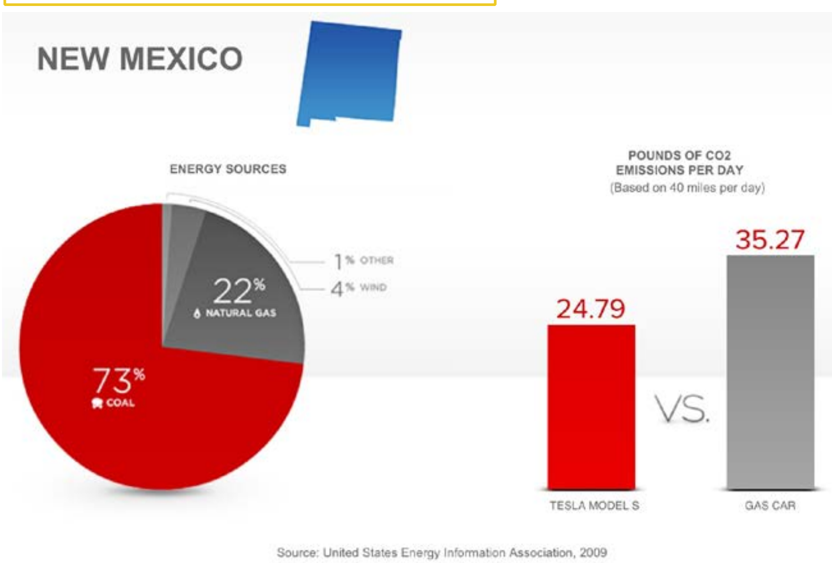
We plan to create a map of New Mexico overlaid with a program that will have cars go on random routes until they are in need of charge. Then the car will go to the nearest charging station. In this way we can model the amount of chargers needed in New Mexico and the placement of these stations so as to achieve maximum efficiency. The changing variables can be the number of Charging stations as well as their position on the map. With this model we will effectively see the chargers needed in New Mexico, including their best placement and location, as well as how many may be needed to support the Teslas in the area.

The Tesla

The Tesla motor company has been a huge change in the auto industry, and has revolutionized the way we see alternatively fueled cars. The company has different models and makes, that are specialized to suit the customer, whatever their needs. Each car runs exclusively on electricity, so that they can have minimal effect on the environment.

Even if no solar panel or wind turbine is used to harness the electricity that runs the vehicle, the consumer impact on the environment, and carbon footprint is still drastically reduced. This is because a percentage of the electricity used in the United States comes from alternative energy sources. Some states like Idaho, who get eighty percent of their energy from hydroelectric, have a much higher percentage of electricity gained sustainably than others, though in all states the impact on climate change and the destruction of our planet is limited through the reduction of petrol and gasoline. New Mexico uses more fossil fuels to generate electricity than most states, at seventy three percent coal and twenty two percent natural gas, though more than four percent of the energy that New Mexico uses comes from wind energy, a small percentage with a big impact. (1) Even with the inflated use of fossil fuels for electricity, the Tesla would still save more than ten pounds of carbon dioxide emissions per month per car, based on driving forty miles per day, as opposed to the average car being driven in new mexico which uses gasoline to operate.

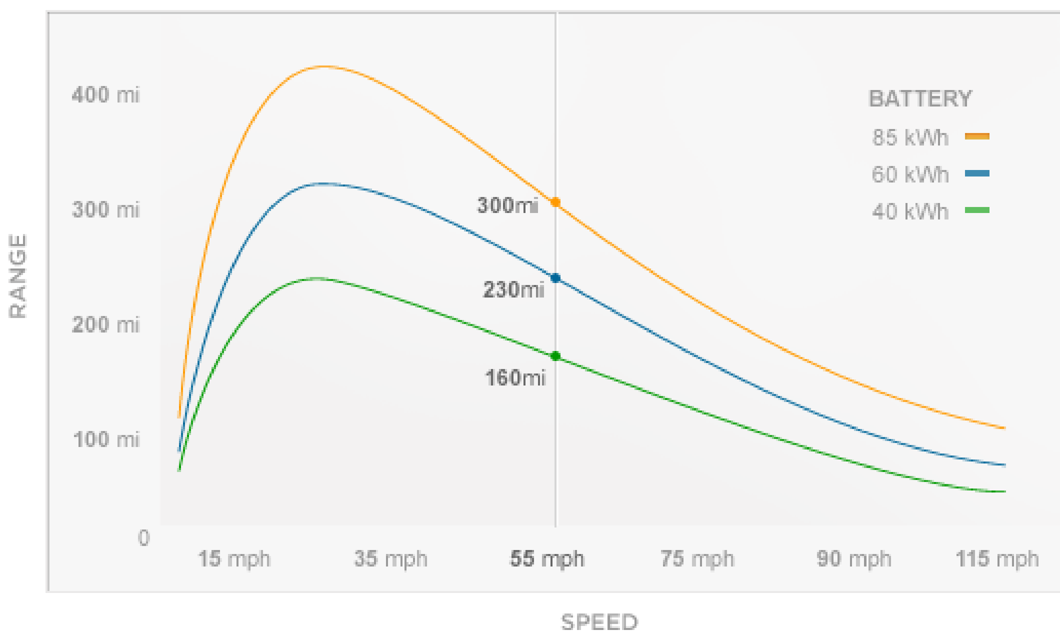
Figure1. (1)



One of the main problems with the Tesla as a mainstream American vehicle, is the charging. This used to be a much bigger problem for the company, but they have refined the process now so that the charging time is shorter and the battery lasts longer. Tesla provides three battery options first, the forty volt battery that can go up to one hundred and sixty one miles per full battery charge, second, the sixty volt battery that can go up to two hundred and thirty miles on a full battery, and finally, the eighty five volt battery that can go up to three hundred miles on a full battery. (1) With the highest powered charger available from Tesla and the best battery available, the car can go up to three hundred miles per hour of charging. However, if no "super charger" is available, then a Tesla can be powered by a standard 220 volt outlet, but it will only be able to travel five miles per hour of charging.

Our project focuses on the logistics of implementing these high powered chargers so that the public would have access, similar to gas stations, so that the inconvenient and slow standard outlets would not be the main resource for the owners of the Tesla. The Tesla also tracks the efficiency of the driver, so that the battery will not run out of charge without warning. (1) This wonderful program makes it possible for drivers to go long distances, because if there is a danger of running low, through tracking individual driving styles, it is able to warn the driver before there is a probability of getting stranded without charge.

Figure 2. (1)



Another important aspect of the Tesla is its speed. Because of the amazing aerodynamics of the car, there is very little wind resistance, so there can be even better "gas mileage." (1) This also has a wonderful effect on the way the mileage changes with speed, because of the innovative design, the efficiency is barely affected by how fast the car is going, this is another way that the company is able to warn a driver before the car is empty, because "twenty miles left" is not drastically changed if the car is going twenty miles per hour, or fifty miles per hour.

The Model

To model our project we used Python, an high-level programming language and networkx, a python library for networks. We used more efficient data storage in python provided numpy, a python library for scientific computing. We used openstreetmap, a community driven map project that was based on GIS data. We used the osm4routing python tool to convert a data dump from openstreetmap to a csv file that is then imported into python.

The model first chooses a target location and calculates the most optimal path to the target. It does so using Dijkstra's algorithm for search with the weight being the time calculated by length/speed limit. Dijkstra's algorithm for search works by getting a node with the lowest weight value from a list then if it is what we are looking for returns it. Otherwise, it adds all the neighbors of the current node that is has not already looked at to the list with their weight being the distance from the original node to the neighbor and repeats.

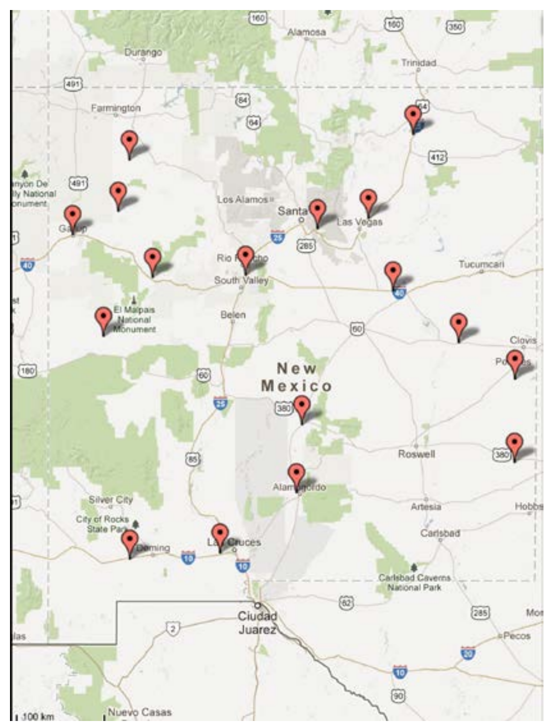
The Model then walks the path to the target, decreasing the fuel level according to the distance of each edge. When the fuel level goes below 50 miles, it searches for a fuel station with Dijkstra's algorithm. If it cannot find one within a reasonable amount of time, it will continue on it’s path.

If it runs out of fuel, it will mark a station. When it comes across a fuel station, accidentally or not, it will refuel if it has less than 100 miles of fuel remaining. After it gets above 50 miles of fuel remaining, it will continue towards it's target location. When it reaches its target, it will choose a new target.

The limitations of this model were that we didn't have any sort of population or traffic data to determine the destination selection or which roads were used.

The Conclusion

To complete the data, we ran the program fifteen times in order to come up with the most effective uses of the charging stations, and created a map of the reoccurring coordinates for the placement of the charging stations. The coordinates that were yielded from the model seemed to be logical, and could be implemented immediately with positive effects. The program was effective, and simple enough to expand upon if traffic data and population data were added. The average number of charging stations was fifteen, and the stations appeared most frequently in heavily traveled areas like Albuquerque and Santa Fe. The larger roads usually have charging stations as well, and the program created data that would work for larger or smaller numbers of people with Teslas in New Mexico. The program focuses on distance between charging stations rather than number of cars that could be supported, so that



the amount of stations could be enlarged or mitigated depending on the need, but the model will always put out the locations of charging stations that would create the least amount of stranded cars.

The Acknowledgments

Our team would like to acknowledge our teachers Ms. Comstock and Mr. Mathis. They helped us stay on track and always gave us good ideas. Our team would also like to acknowledge Christa Brelsford who gave us helpful advice for approaching some of the problems we ran into with our model, and the other helpful scientists who helped us develop the idea from New Mexico Tech. Thank you also to Taylor Bacon who gave our team advice for writing the final report.

Data

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