Electric Vehicle Optimization

Team Number: 2

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Abstract

Dr. Michael Hays of Cummins is directing group 2 in its efforts to maximize the efficiency of an electric vehicle in extreme weather conditions. Group 2 is working in tandem with a group of electrical engineers. The electrical engineers are going to handle battery management of the vehicle, whilst the mechanical engineers are responsible for the rest of the project. Group 2 has conducted research on possible routes for the project but no specific aspects of the assignment have been established pending the delivery of the vehicle.

1 Introduction

The objective of the project is to enhance the system by improving the current range and operable temperatures of an electric vehicle. The team is looking to optimize the vehicle with the potential implementation of a secondary power source, minimizing weight, and ensuring that all of the additions to the vehicle are cost effective. The problem that the group has been faced with is that the vehicle must be operable in very low temperatures and have its range increased beyond its current amount. This is cause for background research on battery technology and ways to regenerate power while in motion in order to meet the necessary design objectives for the vehicle. The team intends to document the current range and operating capacity of the vehicle and then use that data as a benchmark for further improvement.

2 Project Definition

2.1 Background research

2.1.1 History of the Electric Car

The concept of a battery powered vehicle dates back to the 1800's, where inventors from different countries were playing with the idea of electric locomotion. Robert Anderson, a British inventor, is accredited with generating a small scale battery powered vehicle. From there, electric vehicles transformed, and by the 19th century, electric cars were so popular that New York City had a fleet of 60 electric taxis. [1] The movement of the personal car played a big role in this evolution; however the electric car was competing with gasoline powered vehicles. The first vehicles that were developed in the early 1700's either ran off of steam or gasoline. [1] Soon, it was clear that steam would be impractical if applied to a small personal car, however gasoline seemed promising. Nonetheless, electric cars didn't possess the same harmful side effects of gasoline powered vehicles. This includes pollutants from exhaust to the drilling of natural gases and oil. Electric cars provided a quiet, safe, and efficient way to travel around the city on short trips, and with the rise of availability in electricity, electric cars became more readily used. The fall of electric cars came with the production of the Model T. Henry Ford developed a highly efficient manufacturing line that lead to extremely affordable gasoline cars. [1] By 1912, the electric car cost more than double what the Model T did, and with this, the electric car industry took a small fall due to supply and demand. [1] Once oil was discovered in Texas, electric cars began to disappear, and by 1935 there were no electric cars on the roads.

2.1.2 Modern Technology

With the recent shortages in oil reservoirs, electric cars are making a comeback. Clean energy is becoming a highly advanced technology that is being utilized for many applications, including transportation. Some of the leading transportations companies in the United States are moving towards a cleaner, efficient way of travel. With that being said, Cummins has provided the

design team the opportunity to take part in improving the current operation of a small scale electric vehicle. The concept of an electric powered vehicle is not farfetched, given that many companies today have electric cars on the road. However, a big challenge in the design process is the operation of these batteries in low temperatures. The design team was told the vehicle must start and remain fully operation in -40˚F conditions. Current electric vehicles were researched in order to understand how temperature can affect the range of the vehicle. Figure 1 below shows that as the outside temperature decreases so to does the daily range of the vehicle. [2]

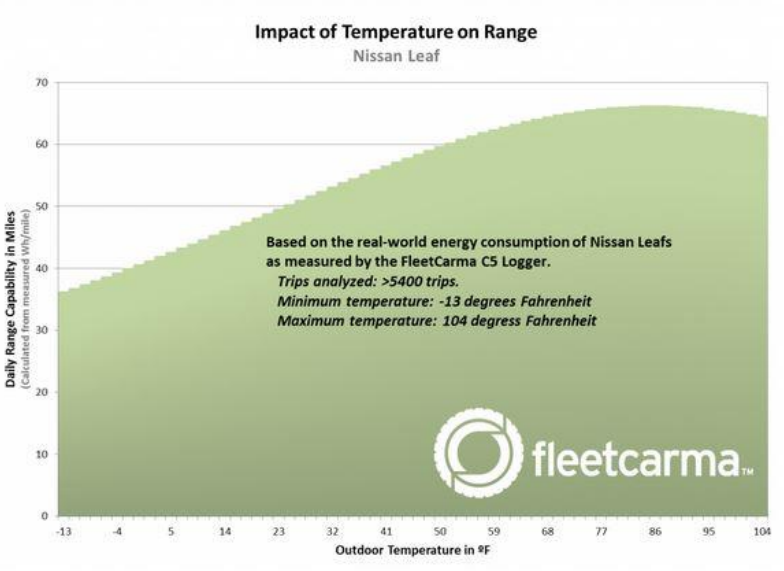


Figure 1. Impact of Temperature on Range tested on a Nissan Leaf.

2.2 Need Statement

This project is sponsored by Cummins under the supervision of Dr. Michael Hayes along with the assistance of Dr. Claus Daniels from Oak Ridge National Laboratory. The team's faculty advisor is Dr. Juan Ordonez. At present the electric vehicle cannot operate at cold temperatures, and its range is more limited that is desired. As such Team 2 has formulated a goal statement for the project:

"The current range and operable conditions of the electric vehicle are unsatisfactory and require improvement."

2.3 Goal Statement & Objectives

Goal Statement:

"Improve the overall range and operable temperatures of the electric vehicle."

Objectives:

- **Explore possible addition of secondary power source (i.e. solar panels, generator etc.).**
- **Document performance and range of the vehicle.**
- **Minimize weight of modifications.**
- **Ensure improvements are cost effective.**

2.4 Constraints

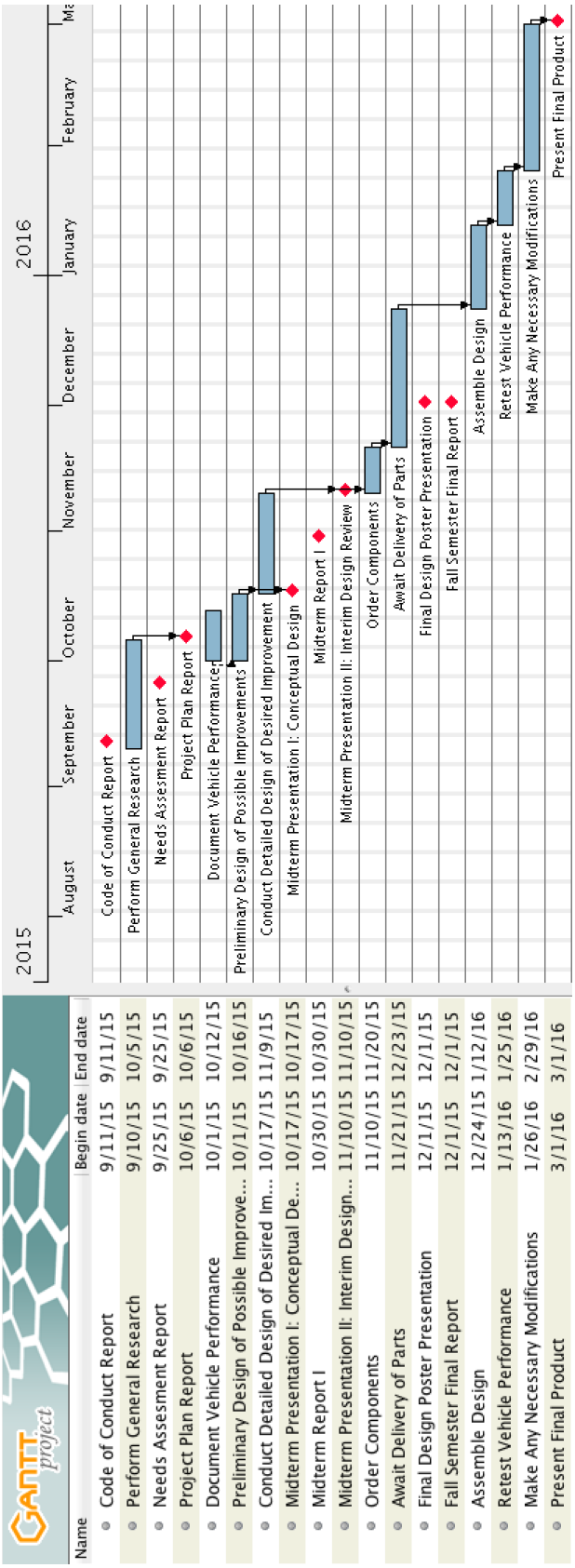
- **The system must operate at -40˚.**
- **Project budget is $2000.**
- **Primary power source must be the battery.**

2.5 Methodology

In order to improve the overall range of the vehicle, a methodology of how to accomplish the ultimate goal was developed. The steps in the process are highlighted below.

- **Perform general research on charge while running and low temperature operable batteries.**
- **Document performance of the vehicle.**
- **Generate possible improvements.**
- **Determine which improvements to implement.**
- **Conduct extensive analysis of improvements.**
- **Procure components.**
- **Assemble prototype.**
- **Document final performance of the vehicle.**
- **Make any additional adjustments to achieve the goal.**

2.6 Schedule


GANTT project
2015
2016
August
September
October
November
December
January
February
Name
Begin date
End date
Code of Conduct Report 9/11/15 9/11/15
Perform General Research 9/10/15 10/5/15
Needs Assesment Report 9/25/15 9/25/15
Project Plan Report 10/6/15 10/6/15
Document Vehicle Performance 10/1/15 10/12/15
Preliminary Design of Possible Improve... 10/1/15 10/16/15
Conduct Detailed Design of Desired Im... 10/17/15 11/9/15
Midterm Presentation I: Conceptual De... 10/17/15 10/17/15
Midterm Report I 10/30/15 10/30/15
Midterm Presentation II: Interim Design... 11/10/15 11/10/15
Order Components 11/10/15 11/20/15
Await Delivery of Parts 11/21/15 12/23/15
Final Design Poster Presentation 12/1/15 12/1/15
Fall Semester Final Report 12/1/15 12/1/15
Assemble Design 12/24/15 1/12/16
Retest Vehicle Performance 1/13/16 1/25/16
Make Any Necessary Modifications 1/26/16 2/29/16
Present Final Product 3/1/16 3/1/16

3 Conclusion

The objective of the project is to enhance the system by improving the current range and operable temperatures of an electric vehicle. The given constraints will be optimized and will allow the design team the opportunity to progress the electric vehicle.

4 References

[1] The History of Electric Car. The United States Department of Energy. September 15, 2014. energy.gov/articles/history-electric-car

[2] How do Extremely Cold Temperatures Effect the Range of an Electric Car. Megan Allen. January 31, 2013. www.fleetcarma.com/electric-car-range-in-bitter-cold/