GE Project

EDSGN 100
Section 005
Team 7: SQUAD

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Abstract

The team’s objective for this project was to develop a system for reducing the amount of smog resulting from freight transportation in the city of “Pittsdelphia,” while maintaining, if not increasing, freight capacity. Meeting EPA requirements, and basic necessities of the citizens were the main focus. After extensive research into different options, solutions were chosen based on economic feasibility, pollution production, and other considerations such as timeliness and efficiency.

Mission Statement

The team’s mission was to develop a transportation system for “Pittsdelphia” that will reduce the pollution emitted by locomotives to an EPA required level, while maintaining, if not improving, efficiency.

Introduction

The city of “Pittsdelphia” is in need of improvements in its transportation of freight. Its locomotives do not meet the EPA required tier 3 levels for pollution, which will rise to a required tier 4 as of 2015. A solution is needed in which EPA requirements are met, while also meeting the demands of the citizens, which include, but not limited to, cost efficiency and maintained/increased freight capacity. Our plan is to sell the existing fleet of locomotives, and replace it with GE Evolution Series Tier 4 Locomotives. This plan takes into consideration the short-term and long-term needs of the city, and is, according to the team’s analysis, the most viable and productive option of the many extensively researched possibilities.
Customer Needs Analysis

The customer requires that emission of NOx and smog be reduced when transporting resources into the city of “Pittsdelphia”. It also must meet EPA standards by having a locomotive of Tier 3 or higher. This is accomplished due to a new system created by GE for the production of trains and other locomotives known as the Tier IV locomotive, the emission levels of NOx would decline. Thus allowing each locomotive to smoothly bring in resources in an efficient and cost effective manner to the city.

Concept Generation

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Exhaust Gas Recirculation (EGR)</th>
<th>Turbo-chargers</th>
<th>Variable Speed Auxiliaries</th>
<th>Tier 4 Locomotive</th>
<th>12-cylinder EVO engine</th>
<th>Advanced air-to-air cooling system</th>
<th>AC individual -axle traction control</th>
<th>Dynamic braking technology</th>
<th>Computer controlled architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs</td>
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<tr>
<td>Reduction of Pollution</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Meet Epa Standards</td>
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<tr>
<td>Bring in Freight and Minerals</td>
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<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Cost Effective</td>
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<td>X</td>
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<td>Time Efficient</td>
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<td>Fuel Efficient</td>
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</table>

External Research

Shipping cargo can be accomplished by various means of transportation. Rail, air, sea, truck and airship are among the most common. CO2 emissions are a huge part of deciding
which mode of transportation to utilize. Airships are the cleanest in terms of CO2 emissions only emitting 50 grams per metric ton of freight and per kilometer of transportation, while airplanes are the least efficient producing 500 grams of CO2. Rail cars come in the middle producing between 30 and 100 grams of CO2. The amount of cargo that is able to be moved in one trip is also highly considered for determining type of transport. One rail car can move 10,000 tons of cargo per trip, compared to a single truck’s ability to only move a measly 26 tons in a single trip.

According to energy.gov, the average life expectancy of a modern locomotive is about 20 years. This is significant because the current locomotives in Pittsdelphia are Tier 2 locomotives, meaning that they are at least ten years old. Since they are already half way through their lifespan, investing in upgrades for the existing locomotives would not be economically advantageous.

By using exhaust gas recirculation, there are several advantages that come along with it. For instance, there is reduced NOx through lowered oxygen concentrations and heat absorption. Also, this process improves engine life through reduced cylinder temperature allowing for more trips. However, there is another option. The alternate option would be the Variable Valve Timing (VVT) with no EGR valve. This has the same effect as any valve, but reacts to engine loads more quickly and precisely. In some ways it is actually better than the EGR because it prevents carbon buildup and valve sticking or failure.

For a diesel locomotive, the fuel cost per trip is $31,914.89. The fuel cost per return trip is $3,427. 900 grams of NOx are produced per hour. 24,750 grams of particulates are produced per hour. 270 grams per hour of NOx are saved, while 7,425 grams per hour of particulates are saved.
CO₂ emissions emitted per metric ton of freight and per km of transportation

<table>
<thead>
<tr>
<th>Mode of Transportation</th>
<th>Tons of Cargo</th>
<th>Bushels of Cargo</th>
<th>Gallons of Cargo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modern lorry or truck</td>
<td>60 to 150 g</td>
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<td></td>
</tr>
<tr>
<td>Modern train</td>
<td>30 to 100 g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modern ship (sea freight)</td>
<td>10 to 40 g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airship (Zeppelin, Cargolifter) as planned</td>
<td>55 g</td>
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</table>

Concept Selection
Design

Conclusion

Throughout the course of our research we found that there are many factors that need to be accounted for when designing a new transportation system. After understanding the needs of Pittsdelphia, it became clear that the top priorities were meeting EPA requirement, reducing smog and maintaining freight capacity, followed by many more. After deep research and analysis into the possible options, it has been concluded that the purchasing of new GE Tier 4 locomotives is the best option due to its low emissions, maintained freight capacity, and long term potential. While other options, namely freight ships, have benefits of their own, they were outweighed by the many advantages of GE’s Tier 4 locomotives.

References

http://www.gettransportation.com

http://www.aa1car.com/library/egr.htm

http://timeforchange.org/co2-emissions-shipping-goods


(Freight, Fuel, & Emissions EDSGN 100, GE Transportation & PSU, October 13, 2015.)