CEE6625: Transportation and Energy

Fall 2016 Midterm Student Presentation Book

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Introduction

CEE6625: Transportation and Energy is a three-credit graduate level course by Dr. Michael Rodgers and Dr. Randall Guensler at Georgia Tech. This course explores the relationships between the transportation infrastructure, technology, and energy consumption, with a focus on the potential impacts of alternative transportation and energy futures. Through the course, students explore the potential changes in well-to-wheel energy consumption and greenhouse gas emissions associated with alternative energy scenarios applied to specific transportation subsectors.

In the midterm, students are randomly assigned into technology groups; three students per group. Each group is asked to prepare a Transportation Subsector Overview as a lectern presentation, and a Fuel Process Flow Diagram (feedstock to final fuel) as a large-format poster presentation:

- **Transportation Sector Presentation:** Each team summarized their assigned transportation sector in a Microsoft PowerPoint® presentation. The slides describe the transportation technology, types of activities undertaken, current fleet composition, and forecasts of future fleet activity. Students also try to identify any major uncertainties and issues that may need to be resolved to properly assess future scenarios. Each group prepared a 15-minutes presentation to other groups and advisors.

- **Fuel Process Flow Diagram:** Each team prepared a process flow diagram as a Microsoft PowerPoint® large-format poster for their assigned energy subsystem. The process flow diagrams follow materials and energy use from feedstock extraction, processing, refinement, and transportation to the final transportation use. In the process flow diagram, students were asked to include all of the materials and energy consumed throughout the processes. Process flow diagram elements included raw materials (e.g. coal, natural gas, biomass, petroleum, etc.), transportation of raw materials, processing and refinement, fuel production and transmission, delivery to the vehicle, and any other elements along the way. Each step in the process is represented by a box in the flow diagram and process-to-process materials movements are labeled with arrows and descriptors. Alternative pathways are also represented. Students presented their posters to the class in an open arena session.

This booklet provides a compilation of the students’ midterm projects. For the final project assignment, each transportation subsector is assigned two alternative fuel options. New three-person student teams are organized such that each group contains one midterm project expert for their assigned transportation sector, and one expert for each of two alternative fuels assigned to that transportation sector. Student teams take their analyses to the next level by conducting energy and emissions analyses using GREET, MOVES, and the Fuel and Emission Calculator. For their final presentations, each group is required to make a policy and technology case for one of their two assigned fuels for their assigned transportation subsector.
Part I: Transportation Sector Presentations

Topics
1: Vanpools to Support a 10% Shift of Coca-Cola Headquarters Employees
2: Delivery of New Cars from Manufacturers to Dealerships in Metro Atlanta
3: Delivery of Diesel for Construction Equipment to Midtown/Downtown Building Construction Sites
4: Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers
5: Pest Control Vehicles Servicing Residential Homes in Cobb County
6: Delivery of Bulk Watermelons from Farm to Kroger Retail Stores
7: Delivery of Aviation Fuels from Refinery to the Nashville, TN Airport
Vanpool in Atlanta: Accommodating a 10% Mode Shift for Coca-Cola

Prepared for CEE 6625
by
Calvin Clark
Daejin Kim
Yu Chen

Outline

• Vanpool System Introduction

• Vanpool System in Atlanta

• Estimations for Coca-Cola Implementation

• Conclusion
Vanpool in Atlanta: Accommodating a 10% Mode Shift for Coca-Cola

Vanpool System Introduction

- Group of people
  - Same Workplace
  - Same Community
  - Same pick-up location

- Van
  - 7-15 passengers
  - Operate weekdays

Types of Vanpool System

- Individual Operations
- Employees rent the van to operate
- Employer rent the van for employees
- Third-Party vanpool provider
  - Assist individuals in finding an existing vanpool or starting their own

Images from GeorgiaCommuteOptions (http://www.georgiacommuteoptions.org/) and LivableBuckhead (http://livablebuckhead.com/commute/commuter-programs/incentives/)
Vanpool in Atlanta: Accommodating a 10% Mode Shift for Coca-Cola

Vanpool System Introduction

• Benefits for Employer
  – Cost Savings
    • Reduce in traffic allowance
    • Reduce in parking needs
  – Stable Team
    • Reduce employee absenteeism
    • Reduce employee turnover

Vanpool System Introduction

• Benefits for Employee
  – Cost Savings
    • Reduce in gas, car maintenance
      – Up to $3000 a year for an employee
  – Time Savings
    • Avoid heavy traffic in peak time
      – HOV lanes may save 15 to 30 minutes each way
  – Reduce in stress
Vanpool System in Atlanta

- Formally began in 1980
- Organizers
  - GBA (Georgia Building Authority) → GRTA (Georgia Regional Transportation Authority)
  - Individual Counties (Douglas and Cherokee)
  - ARC (Atlanta Regional Commission)
- Vanpool Companies
  - Enterprise Rideshare
  - vRide
- 478 vanpools in 2010

Source: Atlanta Regional Commission Regional Vanpool Assessment Report, April 2, 2013
Vanpool in Atlanta: Accommodating a 10% Mode Shift for Coca-Cola

Vanpool System in Atlanta

Source: Atlanta Regional Commission Regional Vanpool Assessment Report, April 2, 2013

Coca-Cola Headquarters in Atlanta

- The Coca-Cola Headquarters is located in midtown Atlanta
- A 29-story, 403 foot (122.8 m) high structure called One Coca-Cola Plaza, built in 1979
- Approximately 12,500 employees at Atlanta headquarters among around the total of 140,000 employees around the world

Goal: Shift 1,250 employees to Vanpool

2 https://commons.wikimedia.org/wiki/File:Coca-ColaHQ.jpg
Vanpool in Atlanta: Accommodating a 10% Mode Shift for Coca-Cola

**Distribution of Coca-Cola headquarters’ employees**

- Estimate the distribution of the employees’ home places by TAZs (transportation analysis zones)

**Distribution of Coca-Cola headquarters’ employees**

- Based on ARC travel demand model estimation results ➔ estimate the employees’ commute trips from home to the Atlanta Coca Cola headquarters

\[
\text{Coca Cola Employees}_{TAZ_i} = 12,500 \times \frac{\text{Employees in TAZ } i}{\text{Total Employees in Georgia}}
\]

\[
\text{Trips}_{\text{headquarters employees, TAZ } i \to j} = \text{Trips}_{\text{total commute trips, TAZ } i \to j} \times \frac{\text{Coca Cola Employees}_{TAZ_i}}{\text{Total Employees}_{TAZ_i}}
\]
Vanpool in Atlanta: Accommodating a 10% Mode Shift for Coca-Cola

**Distribution of Coca-Cola headquarters’ employees**

- Distribution of the estimated employees in each TAZ in Georgia

![Map showing distribution of employees](image)

**Mode share of Coca-Cola employees' commute trips**

- A large share of employees commutes by drive alone

<table>
<thead>
<tr>
<th>Travel modes</th>
<th>Employees (percent)</th>
<th>Average distance to Coca Cola (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive alone</td>
<td>10,139 (81.11%)</td>
<td>13.00</td>
</tr>
<tr>
<td>Shared ride</td>
<td>1,181 (9.44%)</td>
<td>13.60</td>
</tr>
<tr>
<td>Walk</td>
<td>195 (1.56%)</td>
<td>1.06</td>
</tr>
<tr>
<td>Bike</td>
<td>39 (0.31%)</td>
<td>2.54</td>
</tr>
<tr>
<td>Transit</td>
<td>946 (7.57%)</td>
<td>11.44</td>
</tr>
</tbody>
</table>

Estimated mode choice of Coca Cola employees for commuting
Energy and emission analysis

This study estimates fuel consumptions and emissions before and after implementing vanpools by using the average fuel and emission rates, number of trips and trip distances by modes.

Average fuel consumption and emission rates by modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Gal*/passenger-mile</th>
<th>BTU**/passenger-mile</th>
<th>CO2 g/passenger-mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanpool</td>
<td>0.0094</td>
<td>1,300</td>
<td>97</td>
</tr>
<tr>
<td>Car-1person</td>
<td>0.0358</td>
<td>4,939</td>
<td>368</td>
</tr>
<tr>
<td>CarPool-2person</td>
<td>0.0179</td>
<td>2,470</td>
<td>184</td>
</tr>
<tr>
<td>Transit***</td>
<td>0.0125</td>
<td>1,729</td>
<td>200</td>
</tr>
</tbody>
</table>

Passengers-miles by modes

Energy and emission analysis

- Assumptions
  - Only forms a vanpool for commute trips
  - One employee makes two commute trips per day
  - Commute trips by driving alone, shared driving and transit will be shifted, not by walking and bicycling
  - One employee commutes 4.5 days per week\(^1\), 52.14 weeks a year
  - Vanpoolers will be randomly distributed across the TAZs

Travel modes

<table>
<thead>
<tr>
<th>Travel modes</th>
<th>Current trips</th>
<th>Future trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanpool</td>
<td>-</td>
<td>2,500</td>
</tr>
<tr>
<td>Drive alone</td>
<td>20,278</td>
<td>18,211</td>
</tr>
<tr>
<td>Shared ride</td>
<td>2,361</td>
<td>2,120</td>
</tr>
<tr>
<td>Walk</td>
<td>391</td>
<td>391</td>
</tr>
<tr>
<td>Bike</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>Transit</td>
<td>1,892</td>
<td>1,700</td>
</tr>
</tbody>
</table>

\(^1\) ARC (2013) Regional Vanpool Assessment Report

Source: American Bus Association (2014) Updated Comparison of Energy Use & CO2 Emissions From Different Transportation Modes

* Diesel equivalent gallon
** British thermal unit
*** The rates of transit is the average of light rail and transit bus
Energy and emission reduction from vanpooling

- Estimation results of before and after the vanpool implementation
  - 8.6% reduction in weekday fuel consumptions and emissions

<table>
<thead>
<tr>
<th></th>
<th>Gallon* (Thousand)</th>
<th>BTU** (Billion)</th>
<th>CO2*** (Thousand kilogram)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>Vanpool</td>
<td>-</td>
<td>211</td>
<td>-</td>
</tr>
<tr>
<td>Car-1person</td>
<td>13,306</td>
<td>11,976</td>
<td>1,834</td>
</tr>
<tr>
<td>CarPool-2person+</td>
<td>809</td>
<td>728</td>
<td>112</td>
</tr>
<tr>
<td>Transit</td>
<td>432</td>
<td>389</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>14,548</td>
<td>13,303</td>
<td>2,005</td>
</tr>
</tbody>
</table>

* Diesel equivalent gallon  
** British thermal unit  
*** The rates of transit is the average of light rail and transit bus

Next Steps

- Identify structure (individual, employer/partnership, or third-party)  
  - It may not be feasible for Coke to do it all on their own  
- Determine the number of vans needed to service 1,250 employees  
  - How many people will form a vanpool?  
- Identify pickup locations  
  - Where will people be willing to form a vanpool?  
- Who will shift to a vanpool (e.g. people driving alone?, transit users?)
Conclusion

- A vanpool can more economically transport several employees together
- Vanpools have been used in Atlanta, but not officially by Coke
- Coke has 12,500 employees in the Atlanta area
- A shift of 1,250 can result in major fuel and emission reductions
- This change requires the analysis of potential users' travel behavior, and may require cooperation between Coke and other large employers in Midtown
Delivery of new cars from manufacturer to dealerships in Metro Atlanta

_Somdut Roy, Shavi Tolan, Alana Wilson, Jiahui Xia_

**Outline**

- Introduction
- Assumptions
- Delivery
- Reference
INTRODUCTION

- Transportation of vehicles account for a significant amount in expenses. These expenses are then passed to the consumer as a destination charge.
- This study involves understanding the rationale behind choosing each step in auto-transportation while highlighting factors that influence the costs associated with transportation and creating a detailed flowchart involving the transportation of new cars from various domestic and international car manufacturers to Metro Atlanta.

FACTORS AFFECTING TRANSPORTATION COST

MODES OF TRANSPORTATION

I. Car carriers (Trucks): Used for transportation by roadways. Trucks are generally not fuel efficient.

II. Railroads: Used for transportation when roadways may be less reliable. They are more fuel efficient than car carriers.

III. RORO (Roll-on Roll-off) ships: Used for long distance car transfers (mostly intercontinental) and are the most fuel efficient of all three modes. The efficiency of this mode is increased when new cars are carried in bulk.
Delivery of new cars from manufacturer to dealerships in Metro Atlanta

**Modes of Transportation**

- Car Carrier Trucks
- RORO Ships
- Railroad

**Time:** Faster delivery comes with higher travel cost.

**Type of car transported:** Certain cars have special transportation requirements. Eg. Some sports cars may require a customized crate during transportation.

**Miscellaneous:** Vehicle Insurance, Cost of fuel

Delivery of new cars from manufacturer to dealerships in Metro Atlanta

### Loading Process & Car Container Type

- **Loading:**
  - ![Loading Image]

- **Car Container Type:**
  - ![Shipping Container Image]
  - ![Custom Crate Image]

- **Shipping Container (20ft, 40ft & 45ft)**
- **Custom Crate**

### Assumptions for Estimation of Emissions and Cost

- **Dimensions of one car:** Assumed a standard volume of a car in order to calculate the capacity of new cars that are able to fit inside a transporting mode.

- **Weight of a car:** Assumed one uniform average weight for each car.

- **Emissions by auto-transportation mode:** The emissions vary among countries.

- **Fuel Efficiency of Transportation mode:** Assumed a uniform fuel efficiency for calculation purposes. (In reality the efficiency varies with the change in speed among other factors)
Delivery of new cars from manufacturer to dealerships in Metro Atlanta

Cost Considerations

- Time taken to transport each car
- Mode of transportation
- Distance travelled by mode of transportation
- Locations of Ports, Dealerships & Manufacturers
- Type of vehicles being transported
- Price of fuel being used
Delivery of new cars from manufacturer to dealerships in Metro Atlanta

**Distribution of Dealerships Around Metro Atlanta**

- One 20-ft shipping container can hold 1 to 2 cars
- Typical dimensions: 20 ft long x 8 ft wide (height can vary)
- Average capacity of a cargo ship: 4,500 TEU*
- Shipping costs: $0.37/TEU*/Nautical mile (based on data from Clark et. al, 2004)
- Average cost to access a canal (Panama/Suez): $70/TEU*

**Marine Transport Assumptions**

<table>
<thead>
<tr>
<th>Region</th>
<th>Container Handling charges in ports (US$/TEU*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>261.7</td>
</tr>
<tr>
<td>Europe</td>
<td>166.7</td>
</tr>
<tr>
<td>East Asia and the Pacific</td>
<td>150.5</td>
</tr>
<tr>
<td>Latin American and the Caribbean</td>
<td>251.4</td>
</tr>
</tbody>
</table>

* TEU: twenty-foot equivalent unit is the standard unit to describe capacity of shipping containers
Delivery of new cars from manufacturer to dealerships in Metro Atlanta

Calculation Assumptions

- Emission unit: mass of pollutant/10 cars
- Truck and Rail Emissions & Fuel Cost were estimated using the Fuel & Emission Calculator (FEC)
  - Temporal Conditions: Summer
  - Diesel-Electric Train Emission
  - Railroad Emissions are based on Georgia area data
- Average Car Weight: 4000 lbs.
- Distance: Estimations were based on Google Maps
- Time of Rail was calculated by the average speed given by FEC (load and unload not included)
- Marine emissions were estimated using the GREET model

Emissions /10 Cars /Mile

<table>
<thead>
<tr>
<th>Truck</th>
<th>Diesel</th>
<th>CO₂ (kg)</th>
<th>2.76</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CH₄ (g)</td>
<td>2.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N₂O (g)</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM₂.₅-C (g)</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO (g)</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VOC (g)</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOₓ (g)</td>
<td>2.11</td>
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<td></td>
<td></td>
<td>PM₁₀ (g)</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SO₂ (g)</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel Cost $</td>
<td>0.55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Railroad</th>
<th>Diesel - Electric</th>
<th>CO₂ (kg)</th>
<th>5.18</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>CH₄ (g)</td>
<td>1.87</td>
</tr>
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<td></td>
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<td>N₂O (g)</td>
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<td>CO (g)</td>
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<td>VOC (g)</td>
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<td></td>
<td></td>
<td>NOₓ (g)</td>
<td>4.24</td>
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<td></td>
<td></td>
<td>PM₂.₅ (g)</td>
<td>0.09</td>
</tr>
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<td></td>
<td></td>
<td>PM₁₀ (g)</td>
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</tr>
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<td></td>
<td></td>
<td>SO₂ (g)</td>
<td>1.38</td>
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<td></td>
<td></td>
<td>Fuel Cost $</td>
<td>0.125</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Marine</th>
<th>Residual Oil</th>
<th>VOC (g)</th>
<th>0.33</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>CO (g)</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOₓ (g)</td>
<td>8.82</td>
</tr>
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<td></td>
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<td>PM₁₀ (g)</td>
<td>0.78</td>
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<td></td>
<td></td>
<td>PM₂.₅ (g)</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SO₂ (g)</td>
<td>5.77</td>
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<td></td>
<td></td>
<td>BC (g)</td>
<td>0.11</td>
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<td>OC (g)</td>
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<td>CH₄ (g)</td>
<td>0.003</td>
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<td>N₂O (g)</td>
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<td></td>
<td></td>
<td>CO (g)</td>
<td>338</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GHGs (g)</td>
<td>340</td>
</tr>
</tbody>
</table>

* PM2.5-C is Element Carbon
* Assumes the train has ten cars. (Average emissions would be higher with less cars and lower with more cars)
* Estimation based on Pacific Ocean Traffic conditions at 20 knots
Delivery of new cars from manufacturer to dealerships in Metro Atlanta

Manufacturers within 500 miles of ATL

Distance: 256 miles  
Time: 7 hours & 29 mins  
Fuel Cost/10 cars/trip: $32.00

<table>
<thead>
<tr>
<th>CO2 (kg)</th>
<th>CH4 (g)</th>
<th>N2O (g)</th>
<th>CO (g)</th>
<th>VOC (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1372.1</td>
<td>479.1</td>
<td>1.65</td>
<td>1185.0</td>
<td>123.6</td>
</tr>
<tr>
<td>NOx (g)</td>
<td>PM2.5 (g)</td>
<td>PM10 (g)</td>
<td>SO2 (g)</td>
<td></td>
</tr>
<tr>
<td>1085.4</td>
<td>23.04</td>
<td>25.6</td>
<td>353.0</td>
<td></td>
</tr>
</tbody>
</table>

Car Carrier (Truck)

Distance: 312 miles  
Time: 4 hours & 42 mins  
Fuel Cost/10 cars/trip: $171.55

<table>
<thead>
<tr>
<th>CO2 / kg</th>
<th>CH4 / g</th>
<th>N2O / g</th>
<th>PM2.5-C / g</th>
<th>CO / g</th>
</tr>
</thead>
<tbody>
<tr>
<td>861.9</td>
<td>778.93</td>
<td>2.93</td>
<td>0.34</td>
<td>226.3</td>
</tr>
<tr>
<td>VOC / g</td>
<td>NOx / g</td>
<td>PM2.5 / g</td>
<td>PM10 / g</td>
<td>SO2 / g</td>
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<tr>
<td>85.59</td>
<td>658.92</td>
<td>19.65</td>
<td>23.79</td>
<td>203.34</td>
</tr>
</tbody>
</table>

Manufacturers over 500 miles of ATL

Distance (miles) 805  
Estimated Time (h) 12.25  
Fuel Cost ($) 442.75

<table>
<thead>
<tr>
<th>CO2 (kg)</th>
<th>CH4 (g)</th>
<th>N2O (g)</th>
<th>CO (g)</th>
<th>VOC (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2221.5</td>
<td>2007.6</td>
<td>7.5</td>
<td>583.1</td>
<td>220.6</td>
</tr>
<tr>
<td>PM2.5-C (g)</td>
<td>CO (g)</td>
<td>VOC (g)</td>
<td>NOx (g)</td>
<td>PM2.5 (g)</td>
</tr>
<tr>
<td>0.9</td>
<td>583.1</td>
<td>220.6</td>
<td>1698.2</td>
<td>50.6</td>
</tr>
<tr>
<td>PM10 (g)</td>
<td>SO2 (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61.3</td>
<td>524.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Railroad

Distance (miles) 1145  
Estimated Time (h) 33.5  
Fuel Cost ($) 143.1

<table>
<thead>
<tr>
<th>CO2 (kg)</th>
<th>CH4 (g)</th>
<th>N2O (g)</th>
<th>CO (g)</th>
<th>VOC (g)</th>
<th>NOx (g)</th>
<th>PM2.5 (g)</th>
<th>PM10 (g)</th>
<th>SO2 (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5805.2</td>
<td>916.6</td>
<td>916.6</td>
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Delivery of new cars from manufacturer to dealerships in Metro Atlanta

Manufacturers in Germany to Port

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<th>Emissions</th>
<th>CO2 (kg)</th>
<th>CH4 (g)</th>
<th>N2O (g)</th>
<th>PM2.5 (g)</th>
<th>PM10 (g)</th>
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Europe TO ATL: Port to Port

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<th>CO (kg)</th>
<th>OC (kg)</th>
<th>NOX (kg)</th>
<th>CH4 (g)</th>
<th>PM10 (kg)</th>
<th>N2O (g)</th>
<th>PM2.5 (g)</th>
<th>CO2 (kg)</th>
<th>SOx (kg)</th>
<th>GHGs (kg)</th>
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Delivery of new cars from manufacturer to dealerships in Metro Atlanta

Manufacturers in Mexico

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Emissions

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<tr>
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<th>CH4 (g)</th>
<th>N2O (g)</th>
<th>PM2.5-C (g)</th>
<th>CO (g)</th>
<th>VOC (g)</th>
<th>NOx (g)</th>
<th>PM10 (g)</th>
<th>SO2 (g)</th>
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<tr>
<td></td>
<td>794.4</td>
<td>718.6</td>
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Mexico to ATL: Port to Port

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Emissions

<table>
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<th>BC (kg)</th>
<th>OC (kg)</th>
<th>NOX (kg)</th>
<th>CH4 (kg)</th>
<th>PM10 (kg)</th>
<th>N2O (kg)</th>
<th>PM2.5 (kg)</th>
<th>SOx (kg)</th>
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<tbody>
<tr>
<td></td>
<td>0.46</td>
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<td>0.02</td>
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Delivery of new cars from manufacturer to dealerships in Metro Atlanta

Manufacturers in Japan to Port

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<tr>
<th>Railroad</th>
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<tr>
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<tr>
<td>CO (g)</td>
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<td>VOC (g)</td>
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<tr>
<td>VOC (g)</td>
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<td>PM10 (g)</td>
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Japan to ATL Route 1: Port to Port

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Delivery of new cars from manufacturer to dealerships in Metro Atlanta

### Japan to ATL Route 2: Port to Port

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Delivery of new cars from manufacturer to dealerships in Metro Atlanta

References

Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

CEE 6625
Transportation and Energy

Transportation Sector

Delivery of Diesel
— for Construction Equipments —
to Downtown Construction Site

Spandana Anand
Han Kim
Vaidheeswara Ganesan

Content

- Introduction
- Stages of transportation
- Assumptions
- Energy calculations
- Discussion
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

Introduction

Construction Equipments

- Earth Moving Equipment
  - Skid Steer Loaders
  - Trenchers
  - Motor Graders
  - Motor Scrapers
  - Wheeled Loading Shovels
- Construction Vehicles
  - Excavators
  - Rollers
  - Loaders
  - Bull Dozers
- Material Handling Equipment
  - Dumpers
  - Tankers
  - Tippers
  - Trailers
  - Conveyors
  - Forklifts
  - Hoists
- Construction Equipment
  - Tunneling & Handling Equipment
  - Stone Crushers
  - Road Rollers
  - Concrete Mixers
  - Hot Mix Plants
  - Spraying & Painting Machines
  - Road Making Machines
  - Heavy Duty Pumps
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

**Diesel Classification**

On road or Clear diesel:
It is a vehicle grade fuel that is available for sale to the public at gas stations. It is meant for everyday light use vehicles like cars, trucks and SUV’s.

Off road or Dyed diesel:
It is dyed red to distinguish its use only in heavy vehicles such as farm tractors, generators and construction equipments. It’s price is lower as compared to on road diesel as it is not taxed.

**Diesel Transportation**
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

**Process of Diesel Transportation**

1. **Refineries**: Diesel from the refineries gets transported by pipelines, barges, or rail to terminals near major consuming areas.
2. **Terminals**: Tanker trucks are used to transport diesel from terminals to retail service stations across the region.
3. **Construction Equipment**: Mobile refuelling trucks then deliver diesel from the retail station to the various construction sites.
4. **Construction site**: Fuel is then pumped into construction equipment.
5. **Retail Stations**: Refineries

http://www.eia.gov/Energyexplained/index.cfm?page=diesel_where

Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

Colonial Pipeline begins in Houston, Texas and ends in Linden, New Jersey, traversing 11 other states along the way. Our system includes 5,500 miles of pipe, services 7 airports directly and provides fuel to multiple Department of Defense installations each day. We have 15 storage tank locations strategically positioned along the pipeline to serve our customer’s needs and connect to more than 260 terminals.

All diesel fuel refined and marketed by Hunt Refining Company in the Southeast region meets Colonial ULSD specifications. From the refinery, truck and rail rack, Hunt Refining markets both clear (on-road) and dyed (off-road) ULSD. Clear (on-road) ULSD is also marketed from the Mobile, Alabama, terminal facility. The company also sells ULSD into the Colonial Pipeline.

Ultra-low-sulfur diesel

All diesel fuel refined and marketed by Hunt Refining Company in the Southeast region meets Colonial ULSD specifications. From the refinery, truck and rail rack, Hunt Refining markets both clear (on-road) and dyed (off-road) ULSD. Clear (on-road) ULSD is also marketed from the Mobile, Alabama, terminal facility. The company also sells ULSD into the Colonial Pipeline.

Ultra-low-sulfur diesel

Colonial Pipeline Company

http://www.colpipe.com/home/about-colonial/system-map

Diesel suppliers around Atlanta
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

Construction activities in Downtown of Atlanta

How many gallons of diesel needed for a construction site?
Variability in estimating diesel requirement

Diesel requirement greatly varies between construction projects and the table illustrates this clearly. This is mainly owing to the fact that different construction projects need the use of various different construction equipment and their diesel requirements and energy efficiency vary greatly. Another concerning factor is how greatly the actual value differ from the reported value.

Using the construction equipment diesel requirement data for heavy construction, we try to assess the average amount of diesel consumed per day.

**Diesel requirements** = 2012.94 gal/day

Steps:

- Calculate total number of days from total hours and number of equipment and hours per day
- Find the proportion of each equipment’s days used to the total number of days
- Multiply this value with each equipment’s gal/day to get amount of gallons used per day on average
- Sum this value for all equipment to get total diesel consumed per day.
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

Refinery(A) to Terminal(B):
- Distance: 119 miles

Terminal(B) to Diesel Supplier(C) to construction site(D):
- Distance from Terminal(B) to Diesel Supplier(C): 3.1 miles
- Distance from Diesel Supplier(C) to construction site(D): 5.7 miles
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

## Amount of energy consumed in Delivery

<table>
<thead>
<tr>
<th>Stages</th>
<th>Refinery to terminal</th>
<th>Terminal to station</th>
<th>Stations to construction site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Pipeline</td>
<td>Tank Truck</td>
<td>Refuel truck</td>
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<tr>
<td>Capacity</td>
<td>25000 bbl</td>
<td>12000</td>
<td>550</td>
</tr>
<tr>
<td>Fuel Economy</td>
<td>-</td>
<td>4 to 8</td>
<td>6 to 12</td>
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<tr>
<td>Distance</td>
<td>119 miles</td>
<td>3.1</td>
<td>5.7</td>
</tr>
<tr>
<td>Energy per unit (BTU)</td>
<td>40 BTU/bbl-mile</td>
<td>36.4 MJ/liter</td>
<td>36.4 MJ/liter</td>
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<td>Energy consumption (MJ)</td>
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<td>Energy per gallon</td>
<td>0.041</td>
<td>0.012</td>
<td>0.316</td>
</tr>
</tbody>
</table>


## Energy consumed in pumping

The transport of fuel to large off-highway vehicles and other equipment is via tanker vehicles where it may be pumped directly into the equipment or into a storage tank, either above-ground or under-ground. Transport to small off-highway equipment is by portable equipment (e.g., a “gas can”).

Using the pump at the truck island is efficient. A fully functional truck pump is rated at 60 gallons per minute. That is six times faster than those at the typical gas station.

- 60 gallons per minute
- For 2012.94 gallons it takes around 35 mins
- Plus 10 mins for changing.
- Gross Weight Range (lbs.) of a tanker vehicle is 26,001 - 33,000.
- 0.675 gallon needed for pumping the diesel into all equipment.
- Which converts to roughly 24.3 MJ of energy per day

http://www.aboutirving.com/rv-topics/fueling-up-at-truck-pumps/
## Total Energy Consumed

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Total Diesel</td>
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<tr>
<td>Energy per gallon</td>
<td>0.369 MJ/gallon</td>
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<td>Energy for transporting diesel</td>
<td>742.77 MJ/day</td>
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<tr>
<td>Energy for pumping</td>
<td>24.3 MJ/day</td>
</tr>
<tr>
<td>Total energy</td>
<td>767.07 MJ/day</td>
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</tbody>
</table>

**Discussion**
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

Further data required for analysis

- Reported diesel consumption values for a real life atlanta project
- Clearer information regards to the various modes of transports and their energy efficiency
- A lot depends on schedule planning and diesel management
- Storage facility options

Assumptions

- Diesel is transported via road on tank trucks
- The closest terminal and refinery deliver the diesel for Atlanta
- All vehicles transport diesel upto their full capacity and all of that diesel is used
- Extra energy consumption when driving through city ignored

Discussion

- Better estimation of requirement can lead to better planning and much fewer trips hence improving energy efficiency
- Storage of diesel at the construction site
- Reduction in idle time/start stop traffic conditions will greatly help improve fuel efficiency
- Other transportation modes like use of pipelines might greatly increase efficiency for the first stages of diesel transport
- Alternative fuels - Biodiesel, Electric and Hybrid equipment
Delivery of diesel for construction equipment to Midtown/Downtown building construction sites

References


Q & A
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

CEE 6625
David Ederer, Jamie Kono, Emilee Woods
Fall 2016

Source: Katoen Natie
Polyethylene Pellets

- Thermoplastic
- Broad range of uses
  - Plastic bottles, piping, food storage, plastic lumber
- “Downstream petroleum product”
  - Production has increased
- Industry in United States
  - Mostly produced on the Gulf Coast

Source: California EPA

Simplified Look at Pellet Transportation
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

Transport Preparation

Pellets can be:

- Loaded into hopper cars, shipping containers and trucks directly
- Stored in silos for several months
- Stored in transit in a rail yard
- Eventually transferred to a bagging facility
  - Packed into large bags and placed on pallets
  - 50 bags per pallet

PE Pellet Numbers

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>US consumption of PE is</td>
<td>100lb/person/year</td>
</tr>
<tr>
<td>Atlanta consumption</td>
<td>600 million lb/year</td>
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<tr>
<td>Volume</td>
<td>15 million cf/year</td>
</tr>
<tr>
<td>Train cars of PE Pellets</td>
<td>2300 per year</td>
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</table>

\[
(5.6 \text{ million Atlanta residents}) \times \left( \frac{1 \text{ cup}}{\text{person-day}} \right) \times \left( \frac{1 \text{ gallon}}{16 \text{ cups}} \right) \times \left( \frac{60 \text{g PE}}{1 \text{ gallon jug}} \right) = 21,000 \text{kg PE/day} = 31 \text{m}^3 = 1095 \text{cf}
\]
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

Energy Efficiency by Mode

<table>
<thead>
<tr>
<th>Mode of Transportation</th>
<th>Number of Miles/Gallon Carrying One Ton of Cargo</th>
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</thead>
<tbody>
<tr>
<td>Ship</td>
<td>514 miles/gallon</td>
</tr>
<tr>
<td>Train</td>
<td>202 miles/gallon</td>
</tr>
<tr>
<td>Truck</td>
<td>59 miles/gallon</td>
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</table>

Source: Tennessee-Tombigbee Waterway, 2016

Tons of Cargo by Mode

<table>
<thead>
<tr>
<th>Mode of Transportation</th>
<th>Tons of Cargo</th>
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</thead>
<tbody>
<tr>
<td>Barge</td>
<td>1,500 tons</td>
</tr>
<tr>
<td>One Rail Car</td>
<td>100 tons</td>
</tr>
<tr>
<td>100-car Train Unit</td>
<td>10,000 tons</td>
</tr>
<tr>
<td>Large Semi</td>
<td>25 tons</td>
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</tbody>
</table>

Source: Tennessee-Tombigbee Waterway, 2016
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

Source: Georgia Logistics Report, 2013
**Limitations of Truck Travel**

- Limited capacity
  - Typically 1600 cf capacity on trucks
- Energy
- Labor and cost intensive
  - Drivers, insurance, fuel
- Less fuel efficient (compared to barges and trains)
- Potential highway congestion

**Railroad Network Challenges**

- [Map of Union Pacific](image)
- [Map of Norfolk Southern](image)

Source: Wikimedia Commons User NE2
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

**Railroad Challenges**

- Railroad services network divide
  - Splits Baton Rouge and Atlanta
- Limited to four cities for train transfer
- Must physically transfer pellets between railcars during a train transfer
  - Energy and labor intensive, time consuming, loss of product, chance of contamination of product

*Source: Hulcher Services*

---

**Map:**
- **Baton Rouge, LA**
- **Atlanta, GA**
- **Memphis**
- 382 miles by barge
- 384 miles by train
- **Barge and Train**
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

Barge Transport

- Port of Greater Baton Rouge to Memphis
  - Inland Rivers Marine Terminal is a domestic barge terminal that can ship cargo, short sea shipping containers, bagged goods, and polyethylene pellets
  - Can ship large quantity at once, and with different packaging options
- Shipping containers can carry loads of about 59,000 lbs
  - Trucks have limited load capacities, depending on number of axles

Barge Characteristics

- Container on barge
  - One barge carries equivalent of 70 trucks or 16 rail cars
- Dry cargo barge
  - Capacity varies from 1500 tons (dry cargo barge) to 3000 tons (tanker barge)
- Travel time between Memphis and Baton Rouge is about 3-5 days depending on traffic and shipping times
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

Barge to Train Transfer

- Memphis Intermodal Gateway (CSX) and Norfolk Southern Regional Intermodal can unload and transfer to rail
- Unloading stations and lattice boom crawler for containers
- Pellets could also be vacuumed or funneled onto transfer conveyors and then funneled back into train hoppers
  - Pellets vacuumed into drayage trucks and funneled back into train hoppers

Fleet- Flatbed Railcars

- Intermodal containers come in many sizes, but 20’ and 40’ containers are common
- 20’ container volume is about 1300 ft$^3$
- 40’ container volume is about 2700 ft$^3$
- May load 2 containers on top of one another
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

**Fleet- Hopper Railcars**

- Variety of lining configurations
- Variety of capacities available
- Lightweight polyethylene pellets utilize largest capacity cars
  - Up to 6,500 cf

Source: Atlanta Regional Commission, 2015
Transfer from Railcar to Truck

- Bulk transfer from hopper railcar to truck
- Hose connection from railcar hatch to trailer tank
- Pump creates a vacuum to transfer pellets to the trailer
- One hopper railcar fills four trailers

Source: Heavy Duty Trucking

Fleet- Vacuum Trailers

- Typical 1600 cf capacity
- Cooling capabilities to prevent product melting
- Ability to load/unload to and from rail cars

Source: St. Joseph Plastics
Technology

- **Integral Coolers**
  - Air travels through heat exchanger
  - Equipped with two fans powered by tractor’s electrical system
  - Automatic pressure sensor controls fans

- **Pneumatic Transfer Systems** - move pellets utilizing either positive or negative atmospheric conditions
  - Vacuum = Negative pressure differential causing flow and moving air from high pressure to low pressure

**Forecast of Future Activity**

- Potential increase in pellet transport demand
  - Current global demand is 81.5 million metric tons, and is expected to grow to 102.9 million metric tons by 2018 (IHS, 2013)
  - More than 24 million metric tons of new production capacity of polyethylene will be added to the market by 2020, with ⅓ of that capacity coming from the United States (IHS, 2013)
  - US production of pellets is rising slowly (American Chemistry Council 2013)
  - Atlanta’s employment is growing, suggesting greater need for PE pellets in the manufacturing/goods sector (BLS 2016)

- Potential saturation of rail networks (Hillestad 2009)
Uncertainties and Issues to be Resolved

- Possible government regulation to make rail market more competitive (American Chemistry Council 2013)
  - Rail regulations could also decrease competition
- Expanded Panama Canal
  - Increase in Gulf Coast cargo
  - Unknown impacts to empty container availability for shipping pellets
- Future demand
  - Natural gas extraction may become more competitive
  - Other countries may increase natural gas extraction
Movement of Polyethylene Pellets from Baton Rouge to Atlanta Plastics Manufacturers

References

Pest control servicing residences in Cobb county, GA

Fariha Islam, Qidi Sun, Shuqi Xu

Assumptions:
Diesel Fueled Tanker trucks for pesticide transport
Pest Control Company
Use of CNG for Pest Control vehicles
Pest control servicing residences in Cobb county, GA

Cobb County Pest Control Demand Overview

- Cobb County has a total 285,273 of housing units, and a total 258,710 of occupied housing units.
- The most cost-effective pest control service is bi-monthly (one service every two months).
- Assume that 2/3 household need pest control service every two months.
- Cobb County needs \((258,710 \times 2/3 \times 6)/12 = 14,373\) pest control service/month = 2,835 pest control service/day
- The average opening hour is 7.20 hr/day
- Thus, the Cobb County needs 394 services per hour.
- A peak hour factor of 1.5 was applied to calculate the peak hour service demand.

Sources: U.S. Census Bureau 2016; Yelp.com; Google Map

Pest Control Companies Overview in Cobb County

- Weight (%): GIS Estimated vs Obtained from Google
- Avg. Service Hours (hr/day)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td>5%</td>
<td>6</td>
<td>6%</td>
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<td></td>
</tr>
<tr>
<td>Orkin 2</td>
<td>18%</td>
<td>6</td>
<td>6%</td>
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<td>12%</td>
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<td>5.71</td>
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<tr>
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<td>6.43</td>
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<tr>
<td>SWAT Termite &amp; Pest</td>
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<td>Barnes Termite &amp; Pest</td>
<td>7%</td>
<td>5.57</td>
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</tbody>
</table>

Legend:
- Inside Cobb County
- Outside Cobb County

Source: Created by Authors based on Census truck GIS source: https://www.census.gov/
Pest control servicing residences in Cobb county, GA

**Service Coverage Calculations**

According to the popularity from “Yelp”, we roughly classified the Pest control company into two type. Assume that the service radius of superior ones are 10 miles, while the interior ones’ service radius are 5 miles so that the whole pest control services can cover the whole County. While, one of the pest control company's service radius is assigned to 6 miles to include one centroid of the analysis area which will be outside the coverage when it's 5 miles.

**Pest Control Services Estimations**

Assumption: Each vehicle can provide with two services per hour due to the relative high residential density in some community areas in the Cobb County.
Pest control servicing residences in Cobb county, GA

**Possible CNG-fueled Vehicles for Pest Control Services**

**Light-Duty Vehicles**

Such as pick ups, taxi cabs, UPS delivery vans

Energy consumption factors: vehicle fuel economy passenger behavior and vehicle use

**Heavy-Duty Vehicles**

Such as transit buses, street sweepers

Energy consumption factors: vehicle efficiency, load factors, weight, driving behavior, and vehicle technology

---

**Energy Consumption Estimations**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<td>Inside Cobb County</td>
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<tr>
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<td>1481.51</td>
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<td>Swatt Services Termite &amp; Pest Control</td>
<td>664.37</td>
<td>31.64</td>
<td>949.10</td>
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<td>Baines Termite &amp; Pest Control</td>
<td>888.96</td>
<td>42.33</td>
<td>1269.94</td>
<td>2831.96</td>
<td></td>
</tr>
</tbody>
</table>

Legend

Inside Cobb County

Outside Cobb County

- Assume all the vehicle that pest control company owned are light-duty CNG vehicles
- The MPG of an NGV: 2011 CNG Tahoe—21 mile/gge
- Georgia’s current CNG price is 2.23 $/gge

Sources: [https://www.fueleconomy.gov/feg/extremeMPG.jsp](https://www.fueleconomy.gov/feg/extremeMPG.jsp); [http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm](http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm)
Pest control servicing residences in Cobb county, GA

**INTERMODAL Tank Transport**

- Use of tank truck to transport chemical called Termidor (used primarily by Orkin)
- Assume tank holds 2000 gallons of chemical
- Classified as HDDV (Heavy-duty diesel vehicle)
- Emissions of this vehicle include 3.503 g/hr VOC and 19.055 g/hr CO

Emission rates of HDDV Tank Trucks based on class

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Units</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>VIIIa</th>
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<tbody>
<tr>
<td>VOC</td>
<td>g/hr</td>
<td>1.465</td>
<td>1.555</td>
<td>2.025</td>
<td>2.120</td>
<td>2.300</td>
<td>3.503</td>
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<tr>
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<td>g/min</td>
<td>0.024</td>
<td>0.026</td>
<td>0.034</td>
<td>0.035</td>
<td>0.047</td>
<td>0.058</td>
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<td>THC</td>
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<td></td>
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<td>0.025</td>
<td>0.026</td>
<td>0.034</td>
<td>0.036</td>
<td>0.048</td>
<td>0.059</td>
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<tr>
<td></td>
<td>g/min</td>
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<td>0.220</td>
<td>0.253</td>
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<td>NO₂</td>
<td>g/hr</td>
<td>12.668</td>
<td>13.530</td>
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<td>24.325</td>
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<td>0.311</td>
<td>0.465</td>
<td>0.506</td>
<td>0.596</td>
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<tr>
<td>PM₁₀</td>
<td>g/hr</td>
<td>1.103</td>
<td>1.010</td>
<td>1.065</td>
<td>1.088</td>
<td>1.069</td>
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<td>g/min</td>
<td>0.018</td>
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<td></td>
<td>g/min</td>
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<td>0.018</td>
<td>0.019</td>
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<td>0.019</td>
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Source: EPA [https://www3.epa.gov/otaq/consumer/420f08025.pdf]

**INTERMODAL Tank Transport**

Fuel efficiency of Heavy Duty Vehicles

<table>
<thead>
<tr>
<th>Class</th>
<th>Applications</th>
<th>Gross Weight Range (lb)</th>
<th>Empty Weight Range (lb)</th>
<th>Typical Payload Capacity Max (lb)</th>
<th>Typical Fuel Economy Range (mph)</th>
<th>Typical Fuel Consumed (gallons per thousand ton-miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>City Bus, Refrigerate, Refuse, Fuel Tanker, Dump Tow, Tractor Trailer</td>
<td>26,001-33,000</td>
<td>11,500-14,500</td>
<td>18,500</td>
<td>4-8</td>
<td>18.2</td>
</tr>
</tbody>
</table>


- 12 hours from Houston to Marietta
- 840 miles from Winfield to Marietta
- 15.3 gal/ton for traveling 840 miles
- Assume 15 ton truck
- 230 gal consumed to deliver to Cobb County
Pest control servicing residences in Cobb county, GA

**Fuel Vehicle at CNG Station**

- 1853 CNG stations (951 for public use) in U.S.
- 53 CNG stations (25 for public use) in GA
- 12 CNG stations (10 for public use) in Atlanta.

Source: [http://www.afdc.energy.gov/fuels/natural_gas_locations.html](http://www.afdc.energy.gov/fuels/natural_gas_locations.html)

**Comparison of CNG Stations**

Pest control servicing residences in Cobb county, GA

**PRIVATE CNG FUELING FACILITY**

Time-fill stations are used primarily by fleets and work best for vehicles with large tanks that refuel at a central location every night. Time-fill stations can also work well for small applications.

It is possible and economical for some companies to own their private time-fill facilities. Analysis was conducted to estimate the return periods.

The one-time cost of owning a medium-size CNG fueling facility is around 500,000 dollars.

CNG commercial price can be as low as 1.08 dollars/gge.

http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

---

**PRIVATE CNG FUELING FACILITY (cont.)**

As estimated, for those companies who have high service demand, it is feasible to consider owning private CNG facilities with an acceptable return period of about 3–4 years.

When used as a vehicle fuel, natural gas can offer life cycle greenhouse gas (GHG) emissions benefits over conventional fuels.

For light-duty vehicles based on Argonne National Laboratory's GREET model, natural gas emits approximately 6%-11% lower levels of greenhouse gas than gasoline throughout the fuel life cycle.
Pest control servicing residences in Cobb county, GA

And then to service Cobb County homes....

QUESTIONS?

Thank you
Pest control servicing residences in Cobb county, GA

REFERENCES

- https://www.google.com/search?q=pest&rlz=1C1CHZL_zh-CNUS706US706&espv=2&biw=1366&bih=613&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj0oLe6gpPPAhUCSD4KHaqBDbsQ_AUIBygC#tbm=isch&q=pest+control+vehicle
Delivery of bulk watermelons from farm to Kroger retail stores

Boyu Cheng
Tu Xu
Jiaying Wang

U.S. Watermelon Production overview

- The production of watermelon across the U.S. is shown below:
  - Florida had the highest watermelon production in 2015 with 5,880,000 cwt.
  - Georgia was ranked no.4 watermelon production in 2015 with 5,510,000 cwt, account for 16% through the Country.
  - The total production of watermelon in U.S. in 2015 was 35,104,000 cwt.
Watermelon consumption in Atlanta

- The total watermelon consumption in Atlanta is estimated by the population in Atlanta and the national statistic of watermelon consumption.
- From the national statistic of watermelon consumption from 2000 to 2014, the average watermelon consumption per capita is 12.8 lbs.
- From the census in 2010, the estimation of population in Atlanta is 5,268,860.
- The total watermelon consumption in Atlanta is estimated to be 67,441,408 lbs per year.

Watermelon sales in Kroger in Atlanta

- The estimation of watermelon sales in Kroger in Atlanta is based on the market share in 2015.
- The market share of Kroger in 2015 is 14.6% base on the statistics, therefore we assume that 14.6% of watermelons were sold by Kroger in Atlanta which were 866,895 lbs.
- There are 186 Kroger retails stores in Atlanta from the Kroger 2015 Fact Book.
Delivery of bulk watermelons from farm to Kroger retail stores

Suppliers Information

- Based on the Kroger’s 2015 Fact Book, the Kroger chooses local farms as the suppliers.
- From the Georgia Grown, there are 10 watermelon farms near Atlanta. They are all within 50 miles from Atlanta.
- We assume that, all the raw watermelons are delivered from these farms to Kroger retail stores in Atlanta. Therefore, the total deliver distance is about 326 miles.

Fleet composition

- Kroger owns 70% of the trailers and 40% of the tractors used for store deliveries. The remaining demand is met by dedicated contract carriers.
- 8,000 store deliveries each day through the country.
- Approximately 3,200 tractors and 12,000 trailers.
- Refrigerated Trailers are used to deliver watermelons to keep fresh.
Delivery of bulk watermelons from farm to Kroger retail stores

Fleet composition

- **Freightliner Day Cab Truck Tractor**
- **53’ Reefer Trailers.**

- **Horsepower:** 350-600 HP
- **Torque:** Up to 1850 lb-ft
- **GVW:** 60,600 lbs
- **Engines:** Detroit DD13, or Detroit DD16, or Detroit DD15, or Cummins ISX15.
- **Fuel type:** Diesel
- **MPG:** 7.4

- **53’ Reefer Trailers:**
  - **Length:** 53’0”
  - **Overall Height:** 13’6”
  - **Insulation Type:** Polyurethane Insulation Foam-In-Place LED light
  - **Air Ride System:** Hendrickson ULTRA-K Air Ride/Slider System
  - **Capacity:** 16,000 lb

Assumptions

1. The model type of the Day Cab Truck Tractor is Freightliner Cascadia.
2. The model of the 53’ Reefer Trailers is UTILITY 3000R.
3. The weight of a watermelon is 22.5 lbs.
4. The volume of a watermelon is 0.8 cubic feet.
5. The distance traveled by fleets is estimated based on the distance from farms in Georgia to Atlanta.

Types of Activities
Delivery of bulk watermelons from farm to Kroger retail stores

Transportation Technology

- **Network-based transportation management systems:**
  The technology to improve utilization of its delivery fleet. It will provide real-time visibility of store deliveries in route.

- **Fleet capacity management tool:**
  To maximize coordination, utilization, and to manage transportation flowing inbound in supply chain.

- **Data analytics:**
  Improve cost reductions in transportation network.

Supply Chain:

- 36 distribution centers through the country. (Georgia has 4)

- Include product handling systems, refrigeration, temperature and lighting controls.

Three-Tier Distribution Network:

- First tier: include local dry grocery, perishables and freezer facilities. Usually within a 200-mile radius. Watermelon should be delivered to first tier distribution centers.

- Second tier: include slower turn pharmaceuticals, health and beauty care items and dry grocery merchandise. Usually within 350-mile radius.

- Third tier: include seasonal, promotional and other general merchandise products. May be imported from oversea.
Future activity

1. Equip with liquefied natural gas trucks.
   - Liquefied natural gas is natural gas in liquid form, and it is clear, colorless, odorless, non-corrosive, and non-toxic.
   - The energy density of LNG is 2.4 times greater than compressed natural gas.
   - The price of LNG is determined by the market indexed contracts used in the US and the UK. The formula is: \( CP = BP + \beta X \). BP is constant part or base price, \( \beta \) is gradient, and X is indexation.

Future activity

- LNG is considered as the most environmentally friendly fossil fuel. It has lowest CO2 emissions per unit of energy.
- The price of LNG is lower than traditional fuel.
- 31 liquefied natural gas trucks have been equipped in Fred Meyer division in Kroger.
- Model type: Freightliner M2 112 Natural Gas, and Freightliner Cascadia Natural Gas.
Future activity

Freightliner M2 112 Natural Gas:
• Horsepower: 260-329 HP.
• Torque: up to 1000 lb-ft.
• GVW: 62,000 to 80,000 lbs.
• Engine: Cummins Westport ISL G.

Future activity

Freightliner Cascadia Natural Gas:
• Horsepower: 400 HP.
• Torque: up to 1450 lb-ft.
• GVW: 80,000 lbs.
• Engine: Cummins Westport ISX12 G.
Future activity

2. Expanding the usage of multi-temperature truck to transport frozen, refrigerated or dry goods in one trailer.
3. Improving the fleet efficiency.
   • The fleet efficiency is measured by cases shipped per gallon used.
   • The fleet efficiency is improved by 51% in 2015 over 2008 baseline.
4. Increasing truck capacity.
   • The truck capacity is measured by cube per load.
   • The truck capacity is improved by 13% in 2015 over 2014 baseline.
5. Improving Ton Miles Per Gallon by 20% by 2020 over 2010 baseline.

Uncertainties and Issues

• 1. The number of tractors and trailers in Kroger Atlanta Division
• 2. The MPG of the tractors.
• 3. The quantity of watermelon in each fleet delivery trip.
• 4. The frequency of delivery.
• 5. The power cost of reefer trailers.
• 6. The salary of truck drivers.
• 7. Actual distance traveled.
Conclusion

• The fleet composition of Kroger to deliver watermelon includes tractors and trailers.
• The route for delivery starts from the farms then to the distribution centers owned by Kroger and finally to the Kroger’s retail stores.
• Transportation technologies like Network-based transportation management systems, Fleet capacity management tool and Data analytics have been applied in delivery fleet.
• The LNG becomes a prospective fuel for trucks in the future.
• Supply chain and logistics are important parts in delivery, technologies like Three-Tier Distribution Network have been applied.

Reference


Introduction

Types of aviation fuel
  Aviation gasoline
  Jet fuel
  Compressed natural gas
  Liquified natural gas
  Other
Overview of Aviation Fuel Production

• The output of production of aviation fuel is about 50000 barrels per day

• There are four steps in Chevron Pascagoula Refinery to process crude oil: distillation, cracking, removing impurities, reforming.

• About 65 percent of products leave the refinery by way of marine shipments and 30 percent via a pipeline that runs from the refinery to Collins, Mississippi, where it connects with two major pipeline systems. The remaining 5 percent of products are shipped by truck and railroad.


Transportation Fleet Composition

Marine shipments

Oil truck

Pipeline

Railroad
Requirements of Transporting Aviation Fuel

Expertise includes:
- Large scale integrated logistics, optimized to serve local and global customers (ship, barge, rail, road)
- Full understanding of the risk of aviation fuel

Facilities includes:
- Factory provides storage for crude oil and refining equipment
- Dedicated rail roads, ports and other transportation infrastructure

Transportation Method

Original and Destination of Pipeline:
the distance is about 786 km.

Nashville international’s aviation fuel is mainly supplied by pipeline systems.

The satellite maps show that it is possible to transport the fuel by water transportation.

However, before utilizing the transportation method we need to compare these two transportation methods.
About Ship Cargo Transportation

Delivery of aviation fuel from refinery to Nashville Airport using ship cargo:

**Route:** Chevron Pascagoula Refinery---Mississippi River---Ohio River---Tennessee River---Kentucky Lake---Barkley Canal---Cumberland River---Lake Barkley---Cumberland River---Nashville International Airport

The total distance is roughly 1062.44 miles. According to the price of international ship cargo, the cost of moving fuel from Chevron Pascagoula Refinery to Nashville International Airport is 57.55 dollar per ton.

**Reasoning:** Google Maps show the rivers between two places are connected. In addition, the rivers are suitable for navigation. It is reasonable for us to utilize these rivers in aviation fuel deliverying because we do not need to build any infrastructures for using ship cargo. Besides, normally the cost of using ship cargo is low.

About Pipeline Transportation

- America depends on a network of more than 185,000 miles of liquid petroleum pipelines.
- There are approximately 95,000 miles of refined products pipelines nationwide.

The amount of aviation fuel of each batch usually exceeds 400,000 gallons.

Pipeline distribution
Aviation Fuel Transportation Method

Transportation mode comparison

<table>
<thead>
<tr>
<th></th>
<th>Ship Cargo Transportation</th>
<th>Pipeline Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation economic</td>
<td>0.30$ /gallon</td>
<td>0.161$/gallon</td>
</tr>
<tr>
<td>Efficiency</td>
<td>unpredictable</td>
<td>82h</td>
</tr>
<tr>
<td>Flexibility</td>
<td>average depth of water 2.75m</td>
<td>huge system internet</td>
</tr>
<tr>
<td>shipping weight</td>
<td>&lt;=2000 ton</td>
<td>durable supply</td>
</tr>
</tbody>
</table>

Conclusion:
The pipeline transportation mode have more advantages than water transportation
1. The huge amount of the shipment batch require high capability of transportation method.
2. The availability of pipeline is certified by the system network. But the path of cargo is not for sure.
3. The efficiency is higher.

Process Overview

Industry

- Crude oil
  - Pipelines
- Refining Plant
  - Refining
- Aviation fuel
  - Loading
- Production

Industry to Airport

- Pipeline network
- Mississippi
  - Tennessee
    - Nashville
      - Airport

- Truck

- Pipeline
Aviation Fuel Transportation Method

Source: http://www.pipeline101.com/How-Do-Pipelines-Work/What-Is-The-Transportation-Process

Source: Overview of Airport Fueling System Operation, page 19
Storage

Settling Tank

• Settling time is the length of time the industry has established for allowing sediment and moisture to settle to the bottom of a fuel.

Aboveground and Underground Tanks

• Jet fuel storage tanks have a floating suction tube that draws fuel from several inches below the upper surface of the fuel. Avgas tanks draw from several inches above the bottom of a tank.

• The storage of a particular fuel necessitates keeping it segregated from other types of fuels, keeping it free of contamination, and having adequate amounts of fuel to meet the needs of the airport users.

Source: Overview of Airport Fueling System Operation, page 26

Airport Receiving and dispensing
Aviation Fuel Transportation Method

Tank

- Piping filter assemblies and pump equipments
- Control room and containment dike and bund
- Detector device
- Security system
- Rack system

Source: Overview of Airport Fueling System Operation, page 31

Refueling device

- Pipe system
  - Higher delivery capability
  - 8-22 diameters
  - 4.5-5 millions gallons/day

- Refuel truck:
  - 15000 gallons
  - 200 gallons per minute
  - Extra requirement

Source: Overview of Airport Fueling System Operation, page 27-29
Future improvement of pipeline transport efficiency

Economy efficiency: It relies on providing the lowest delivered cost to customers.

Transportation efficiency: It is measured in terms of fuel or electric power burned per unit of throughput.

Improving Efficiency
• Upgrading engines
• Upgrading compressors
• Replacing restrictions
• New technologies: waste heat recovery, magnetic bearings, GIS

Questions?
Part II: Fuel Process Flow Diagram

Topics
1: Natural Gas from North American Shale Gas
2: Biodiesel from Camelina
3: Liquefied Natural Gas from Bio-compost and Manure
4: Electricity from Natural Gas Combined Cycle Generation
5: Compressed Natural Gas from Non-North American Sources
6: Biodiesel from Soybeans
7: Ethanol from Sugar Cane
Biofuel Production from Camelina Sativa
Samdut Roy, Shavi Tolan, Alana Wilson, Jiahui Xia

Introduction
Camelina is an oilseed crop that is a member of the mustard family. It has a unique fatty acid profile that makes it a viable candidate for the production of biofuels. The oil content of Camelina seeds ranges from 32% - 46%. Camelina meal produced from the extraction process has been approved as livestock and poultry feed. Camelina oil is mainly used in conjunction with petroleum fuels to make jet fuel. Camelina jet fuels are classified as ‘green’ jet fuels. In March 2016, United Airlines became the first commercial airline in North America to commit to general flight operations using jet fuel derived from Camelina oil.

Legend: Transportation Mode
- [Green] On Road Vehicles
- [Red] Railway
- [Blue] Pipeline

Camelina plants take 85 – 100 days to mature. The seeds are ready to be harvested once the pods begin to turn golden brown.

Camelina seeds are found in the pods of the plant. There are approximately 350,000 seeds per pound of pods.

Raw Materials Production
- Grain Drilling Camelina Seeds in early Spring (March)

Case Study: Camelina Production Potential in the Pacific Northwest
- Lucrative in areas with 19 - 38 cm of rainfall annually
- 2.1 million acres in the PNW that meet criteria
- Production Capability: 442.7 million L biodiesel/year
- Energy Input: 9.1 MJ/L of biodiesel
- GHG Emissions: 912 g CO2e GHG/L biodiesel

Biodiesel Transportation:
- Feedstock Transport: $2.25 per kl/L of biodiesel/km
- Biodiesel Transport: $3.89 per kl/L of biodiesel/km
- Emissions: 90 g CO2e GHG/MJ used for transport

Camelina Biofuel Uses
- Japan Airlines (JL)
- U.S Air Force
- U.S Navy
- United Airlines

Invested Companies
- Sustainable Oils
- Great Plains – The Camelina Company
- AltAir Fuels
- Honeywell UOP
LIQUIFIED NATURAL GAS FROM ORGANIC WASTE

**BIOGAS PRODUCTION**
- Animal Waste
- Organic Waste
- Vegetable and Meat Waste

**Anaerobic Digestion**
- Bacteria
- Biogas

**Raw Biogas**
- CO₂
- CH₄

**PURIFICATION**
- Removal of Impurities
- H₂O
- Sulfides
- CO₂
- Amine scrub
- Chemical Adsorption

**Storage**
- Fabrics, HDPE, LDPE, and other flexible membranes

**Compression**
- Small Scale Liquefaction
- Compressors
- Refrigerants
- Cryogenic LBM
- 70% of gasoline

**Transportation**
- Trailers
- Pipeline

**USES**
- Vehicles
- Stations
- Equipments
- High pressure
- Low pressure
- Ambient Vaporizers
- Cryogenic Pumps

**Examples**
- California Cattle farms: Huge dairy farms with around 8,000 cows present a great opportunity for biogas production.
- San Antonio water system: Wastewater treatment plants can also produce biogas from the organic waste; This has been implemented successfully across the country.

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CNG From Non-North-America

Liquified Natural Gas Production

- Natural Gas Extraction
  - Pipeline
  - Emission (Greenhouse Gas)
  - Acid Gas Removal
  - Dehydration
  - Mercury Removal
  - Regeneration Gas
- Pretreatment
  - Pipeline
- Liquification
  - Trinidad
  - Norway
  - Yemen
  - Liquification Plants
  - Pipeline
  - Storage
  - Burge

Liquified Natural Gas Transmission

- Import in Elba Island, GA (Southern LNG)
  - As of February 24, 2014

Fuel Consumption

- Fast-fill
  - Fuel-Fill Station
- Combination-fill
  - Dispenser
- Time-fill
  - Time-Fill Station

CNG Production & Distribution

- LNG Regasification to CNG
  - Pipeline
  - CNG Pipeline System
  - CNG Station

Legend

- Energy Input
- Emission
- Natural Gas Flow

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Ethanol from sugar cane

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**Sugar Cane Cultivation and Processing**
- Cultivation
- Washing and Cutting
- Extracting Sugar Juice
- Juice Purification
- Evaporating and Concentration
- Molasses

**Processing**
- Molasses Pre-Treatment
- Using malt to break complex carbohydrates into simpler ones
- Add yeast (enzymes) and the mixture is kept warm until fermentation is complete

**Fermentation**
- Main Chemical reactions
  - \( C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{Enzymes}} 2C_6H_{12}O_6 \)
  - \( C_6H_{12}O_6 \xrightarrow{\text{Yeast}} 2CH_2CHOH + 2CO_2 \)

**Storage and Transportation**
- Ethanol Biorefinery Distribution
  - Long-term
  - Short-term
  - Train
  - Truck
  - Pipe
- Huge quantity
- Small quantity
- Varied quantity

**Fuel Consumption**
- E85 Ethanol Fulling Stations
- Ethanol Fuel Market
- 2776 ethanol stations in the United States
- Active ethanol market

**Emissions**
- Greenhouse Gas: \( CO_2, N_2O, CH_4 \)
- Air Pollution: \( CO, SO_x, NO_2, PM \)

**Energy Input**
- Pipeline
- Truck
- Train

**Lines:**
- Greenhouse Gas
- Air Pollution
- Energy Input

**Car works using ethanol**
- Water
- Heat