The Global Supply Chain and Greenhouse Gases: a North American Perspective

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Texas Transportation Institute
Summary

- Background
- Foundation Paper
- Greening North American Transportation Corridors
Background

- TTI conducted two projects for the tri-national Commission for Environmental Cooperation (CEC)

  - **Foundation Paper**
    - Part of larger CEC report under Article 13 “Towards Sustainable Freight Transportation in North America”
    - freight transportation system in North America as it relates to greenhouse gas (GHG) emissions
    - state-of-the-practice in measurement/estimation of GHGs
    - available GHG mitigation strategies
    - opportunities for GHG mitigation on a NA front

- **Greening North American Transportation Corridors**
  - developed methodology to measure corridor level emissions
  - issues and opportunities to improve air quality
  - case study determined the air quality impact of truck and rail freight movement along the Mexico City to Montreal corridor
Foundation Paper

Overview

- Transportation is one of the major contributors to the release of GHGs in the atmosphere, producing more than 1/3 of the total GHGs released in North America.

- Canada is #1 US trading partner and Mexico is #3 US trading partner.

- Truck is the dominant mode for goods movement between the three countries.

**US Land Trade with Canada and Mexico (billion US$)**

- Rail
- Truck
Cross-Border Trade

- Approximately 50% of the total truck and rail traffic by value in North America was handled by 3 land ports of entry.
- At the US-Canadian border, more than 75% of the surface trade was handled by 5 land ports of entry.
- At the US-Mexican border, 75% of the total trade was handled by 4 ports of entry.
Correlation between Freight Transportation and GHGs

- The primary fuel of freight truck and rail is diesel—a petroleum product i.e. a fossil fuel
- GHGs are byproducts of combustion of fossil fuels e.g. oil and coal
- Direct positive relationship between fossil fuel use and GHG production—the more the fuel burned the more the GHGs produced
- GHGs emitted by freight rail and truck consist of 96% carbon dioxide (CO$_2$) by volume. The remaining GHGs are methane (CH$_4$), nitrous oxide (N$_2$O), and fluorinated gases (HFCs, PFCs, SF$_6$)
## Freight Transportation GHGs in NA

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Light Duty Gasoline Vehicles</td>
<td>620.9</td>
<td>41.1</td>
<td>-</td>
</tr>
<tr>
<td>Light Duty Diesel Vehicles</td>
<td>4.1</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Light Duty Gasoline Trucks</td>
<td>493.9</td>
<td>45.0</td>
<td>-</td>
</tr>
<tr>
<td>Light Duty Diesel Trucks</td>
<td>26.9</td>
<td>2.3</td>
<td>-</td>
</tr>
<tr>
<td>Heavy Duty Gasoline Vehicles</td>
<td>35.6</td>
<td>6.6</td>
<td>-</td>
</tr>
<tr>
<td>Heavy Duty Diesel Vehicles</td>
<td>371.3</td>
<td>40.1</td>
<td>-</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>2.0</td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>On-road Subtotal</td>
<td>1,554.7</td>
<td>135.9</td>
<td>101.9</td>
</tr>
<tr>
<td>Railways</td>
<td>46.0</td>
<td>7.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Domestic Marine</td>
<td>8.1</td>
<td>6.1</td>
<td>2.3</td>
</tr>
<tr>
<td>Domestic Aviation</td>
<td>185.2</td>
<td>7.8</td>
<td>6.3</td>
</tr>
<tr>
<td><strong>Total Transportation</strong></td>
<td><strong>1,794.0</strong></td>
<td><strong>156.8</strong></td>
<td><strong>112.0</strong></td>
</tr>
</tbody>
</table>

*MtCO2e = Metric Tons of Carbon Dioxide Equivalent

- Denotes no data availability

**On-road includes light duty gasoline and diesel trucks and vehicles, motorcycles, and heavy duty gasoline and diesel vehicles**

***Data for all three countries in the same year were not available***

****Table only includes vehicle classes for which data in all three countries were available****
Freight Transportation GHGs in the USA

- US transportation GHG emissions are 12x Canada’s and 16x Mexico’s.
- Trends in the U.S. and Canada are similar:
  - GHGs from passenger cars and trucks have been decreasing
  - GHGs from freight trucks have been increasing in recent years
Foundation Paper

GHG Emission Reduction Challenges & Strategies

Reducing GHGs from freight modes may be more challenging than reducing GHGs from passenger modes or stationary sources

- Little or no discretionary freight movement
- Implications for the economy and global competitiveness
- Slower freight vehicle fleet turnover so slower rate of introduction of new technologies
- Due to economic competition, freight carriers already have significant incentive to minimize fuel costs and GHGs
- Freight VMT expected to grow faster than passenger VMT

Source: AASHTO
Greening NA Transportation Corridors

Case Study:
Mexico City to Montreal Corridor

Study Corridor Distance by Country and Mode (miles)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Canada</th>
<th>U.S.</th>
<th>Mexico</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>531</td>
<td>1,624</td>
<td>693</td>
<td>2,847</td>
</tr>
<tr>
<td>Rail</td>
<td>575</td>
<td>1,903</td>
<td>717</td>
<td>3,194</td>
</tr>
</tbody>
</table>

Legend
- Truck Corridor
- Railroad
- Urban Area
- Border Crossing
- Highway Network
- State / Province

[Image of map showing transportation corridors]
# Greening NA Transportation Corridors

## Data Requirements for Corridor Level Air Quality Analysis of Freight Movement

<table>
<thead>
<tr>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Freight Activity</strong></td>
<td><strong>Freight Activity</strong></td>
</tr>
<tr>
<td>- Annual truck VMT on each link (from annual truck volume)</td>
<td>- Annual ton-mile commodity flow between each major origin-destination pair</td>
</tr>
<tr>
<td>- Annual truck volumes at ports of entry</td>
<td></td>
</tr>
<tr>
<td>- Fleet characteristics e.g. age distribution, VMT share</td>
<td></td>
</tr>
<tr>
<td>- Speed profile for trucks crossing US ports of entry</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Emission Rates</strong></th>
<th><strong>Emission Rates</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Aggregated exhaust emission rates based on vehicle registration data and MOBILE6.2</td>
<td>- Exhaust emission rates based on national average rates</td>
</tr>
<tr>
<td>- PEMS measurements</td>
<td></td>
</tr>
</tbody>
</table>
Analysis Process for Emissions along the Corridor

**Truck**

1. Highway Link and Truck Data
   - Select and Export Study Corridor Data
   - Calculate Emissions (Truck Flow Emission Rates)
   - Annual Truck Emission Dataset
   - Join and Classify Emissions Data
   - Final Maps for Annual Truck Emissions

2. Emission Rates by Type

3. FAF Network GIS Base Map

**Rail**

1. Rail Freight Movement Data
   - Sort and Export Data for Major Cities
   - Calculate Emissions (Commodity Flow Emission Rates)
   - Annual Rail Emission Dataset
   - Join and Classify GIS Data
   - Final Maps for Annual Rail Emissions

2. Emission Rates by Type

3. National Rail Network

4. Rail Network GIS Base Map
Greening NA Transportation Corridors
Greening NA Transportation Corridors
## Greening NA Transportation Corridors

### Total Annual Freight Emissions on the Mexico City to Montreal Corridor

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
<th>$\text{CO}_2$ (kt)</th>
<th>CO (metric ton)</th>
<th>NOx (metric ton)</th>
<th>THC (metric ton)</th>
<th>PM (metric ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Truck</strong></td>
<td>2010</td>
<td>13,508</td>
<td>10,746</td>
<td>76,733</td>
<td>2,231</td>
<td>713</td>
</tr>
<tr>
<td></td>
<td>2035</td>
<td>32,218</td>
<td>4,209</td>
<td>17,015</td>
<td>3,730</td>
<td>217</td>
</tr>
<tr>
<td><strong>Rail</strong></td>
<td>2010</td>
<td>177</td>
<td>480</td>
<td>2,866</td>
<td>161</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>2035</td>
<td>278</td>
<td>756</td>
<td>2,821</td>
<td>177</td>
<td>113</td>
</tr>
</tbody>
</table>
Greening NA Transportation Corridors

Data Requirements and Data Sources

Corridor data are highly uncertain, or even non-existent

**Freight Data Sources**

- FHWA/BTS databases most reliable sources
- Canadian and Mexican data difficult to obtain e.g. Transport Canada data & Canadian data sharing rules
- Data collection efforts & level of granularity vary in each country
Greening NA Transportation Corridors

Data Requirements and Data Sources (cont.)

**Trucking Activity**
- FAF truck volume data do not include vehicle weight or load factor
- EPA *Smartway* fleet performance data not publicly available
- Uncertainty in emissions estimates: emissions rates of empty trucks might be underestimated

**Network and Routing Data**
- GIS network data for highway and rail are publicly available
- Truck volume data: publicly available hence higher reliability
- Rail routing & movement data: proprietary hence greater uncertainty
Greening NA Transportation Corridors

Data Requirements and Data Sources (cont.)

*Truck Emissions Rates*

- MOBILE6.2 truck emissions rates are aggregate distance-based rates for different average speeds
- Suitable for medium- and large-scale analyses; not sensitive to changes in driving conditions at constant average speeds
- CO₂ and PM rates in M6.2 are not sensitive to speed; not very suitable for link level analyses
- EPA’s newest model MOVES is capable of fine-scale analyses
- Requires disaggregate activity data not currently available; no standard collection procedures developed yet
Greening NA Transportation Corridors

Data Requirements and Data Sources (cont.)

Freight Rail Movement and Emissions

- High levels of uncertainty in freight rail movement data
- Available emissions estimation methods are aggregate procedures based on national average values that consider the total weight of hauled cargo to obtain fuel consumption and emissions
Overall Conclusions & Opportunities

Short Term
- More rigorous public investment
  - Catalyst to lower tech cost; large & small operators
- Freight-specific GHG regulation
  - Fuel efficiency standards for heavy duty trucks
- Cooperation with private sector
  - Tri-partisan relationship with tech R&D and operators
- Technology & Expertise Transfer in NA
  - Development & standardization in data & methods
  - Development of NA level GHG performance measures

Medium-Long Term
- Feasible alternative energy sources for freight modes
- Carbon emissions pricing (cap and trade, carbon pricing...)

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