Innovative Approaches for Reducing Freight Transportation Emissions

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Freight emissions impact air quality, health, and climate change
Freight is a significant source of emissions
New technologies to reduce GHG emissions from trucking
Truck GHG emissions are a growing problem

- Trucks emit the majority of freight emissions
  - 70% of freight GHGs
  - 20% of all transportation GHGs

- Truck fuel efficiency (per ton-mile) dropped by 10% from 1990 to 2005.

- New federal fuel economy standards for trucks are coming
Opportunities to reduce truck GHG emissions

- **Current efficiency programs**
  - EPA: SmartWay
  - Rocky Mountain Institute: North American Council for Freight Efficiency
  - DOE SuperTrucks

- **New technical and operational innovations**
  - New vehicle tech: transmission adjustment and throttle controllers
  - New logistics strategies: product design and packaging strategies
Strategy: transmission adjustment and throttle controllers

- New vehicle technologies lead to more efficient operation and less GHGs

- **Transmission adjustments**
  - Adjust shift points for automatic transmissions
  - Keep engine operating at the most efficient RPMs

- **Throttle controllers (governors)**
  - Cap engine power at low & moderate speeds
  - Saves fuel, cuts acceleration from a stop

- **Benefits and challenges**
  - Reduce GHGs 10-15%
  - But... drivers often resist changes that hurt performance
Strategy: logistics, product design and packaging strategies

- **Increase “value density” of freight. $$ per ton**

- **Product design – reduce volume**
  - Concentrated laundry detergent, windshield washer fluid

- **Packaging**
  - Better packaging – less volume needed
  - New pallets reduce weight: plastic, corrugated cardboard

- **Supply chain placement**
  - Bring manufacturing, distribution centers close to customers
  - Examples: Amazon fulfillment warehouses, Netflix DVD centers
  - Shorter trips = fewer GHG emissions, faster delivery
Reducing rail GHG emissions through corridor analysis
Approaches to reducing rail emissions

**Standard approaches:**
- Locomotive & train based.
- Locomotive technology: greater engine efficiency
- Train and consist technology
  - Aerodynamic fairings
  - Improved bearings & journals
- Driver training, fuel efficiency improvements

**Alternative approach: Corridor Analysis**
- Examines fuel economy for each route, based on route characteristics and consist type
- Demonstrates great variability in GHG emissions by route and load
- Allows users to choose the best routes for a green supply chain
Fuel economy varies greatly by commodity type and rail corridor properties.
Factors in corridor GHG emissions

- **Route characteristics are summarized by the grade profile and speed profile**
  - **Grade profile: altitude at each point of a route.**
    - Rail grade (slope) at each point
    - Determines fuel used to overcome elevation changes
  - **Speed profile: speed at each point of a route.**
    - Train speed and acceleration at each point
    - Determines air resistance, rolling resistance, and fuel used for acceleration
Example: grade profiles and fuel economy

**Route A:**
- 362 ton-miles per gallon
- 37 lbs CO$_2$ per 1,000 ton-miles

**Route B:**
- 498 ton-miles per gallon
- 26 lbs CO$_2$ per 1,000 ton-miles
Rail corridor analysis is an innovative tool for reducing rail freight emissions

**Corridor analysis:**
- is an innovative modeling approach to determining fuel economy along a rail corridor
- places emphasis on route selection and corridor properties, rather than locomotive technology
- reveals stark differences in fuel economy across different routes
- can inform decisions on choosing the most efficient supply chain

**The relevant properties of a corridor can be summed up as grade profile and speed profile, allowing for a streamlined modeling approach**
Innovative strategies to reduce emissions on inland waterways
Tugboat are significant sources of emissions along inland waterways

- **Harborcraft are heavy polluters**
  - Tugboat fleet is old; many 30+ years
  - Vessels have large engines; 1,500-3,000 HP

- **Harborcraft emissions are largely unregulated**
  - Engine standards only apply to new ships
  - Fleet turnover is very slow

- **Harborcraft emissions endanger health**
  - Line-haul tugs travel through urban areas along Mississippi
  - Hotspots are created in inland ports like St. Louis
New, innovative strategies can reduce tugboat pollution in the short term

- EPA marine regs apply to new vessels, and will take decades to penetrate the fleet
- New tugboat vessel designs
  - Diesel electric
  - Articulated tug-bridge (ATB)
  - Controlled pitch propellers
- Operational strategies
  - Speed reduction / reduced speed zones
  - Emission control areas
  - Incentive programs
- Strategies can be implemented by vessel operators, ports, or gov’t agencies
Strategy: New tugboat designs

**Diesel-Electric**
- Supplemental electric motor and battery pack.
- Reduce idling, reduce peak power loads.

**Articulated Tug-Barge (ATB)**
- Tugboat and barge are coupled as one unit
- Streamlined profile, less friction when moving barge = up to 50% fuel savings

**Controlled-Pitch Propellers**
- Adjust the angle and rotation of each propeller blade
- Use optimum propeller design for a given load and speed
- Operate engine at lower power settings
**Strategy: New operation procedures**

- **Reduced speed zones (all pollutants)**
  - Does not require new technology or capital costs
  - Fuel savings are offset by additional operating time
  - Implemented at Los Angeles Ports for ocean-going vessels

- **Fuel Switching (PM, SO$_x$)**
  - Switch to lower-sulfur or bio diesel
  - Implementation cost depends on if vessel equipment must be upgraded
  - 2010: ultra-low-sulfur diesel mandated for nonroad, locomotive, and marine use.

- **Port Incentive Programs (all pollutants)**
  - Reduced port fees for vessels meeting environmental requirements
  - Can be cost-effective: Operators can choose cheapest upgrade path to qualify
Summary: innovative approaches to reducing emissions

- **Technological solutions:**
  - New technology research and development
  - Deployment and market acceptance of new technology
  - New engines, fuel types, aftertreatment devices

- **Operational strategies:**
  - More efficient freight facilities
  - Idle reduction
  - Supply chain improvements

- **Modeling techniques:**
  - New tools for modeling emissions and reduction strategies
  - Fuel economy and GHG modeling
Cleaner freight contributes to a greener future
Thank you for your attention

Questions? Answers!

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