Freight Vehicles Life-Cycle Emissions Assessment

presented to

Talking Freight

presented by

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CAMBRIDGE SYSTEMATICS

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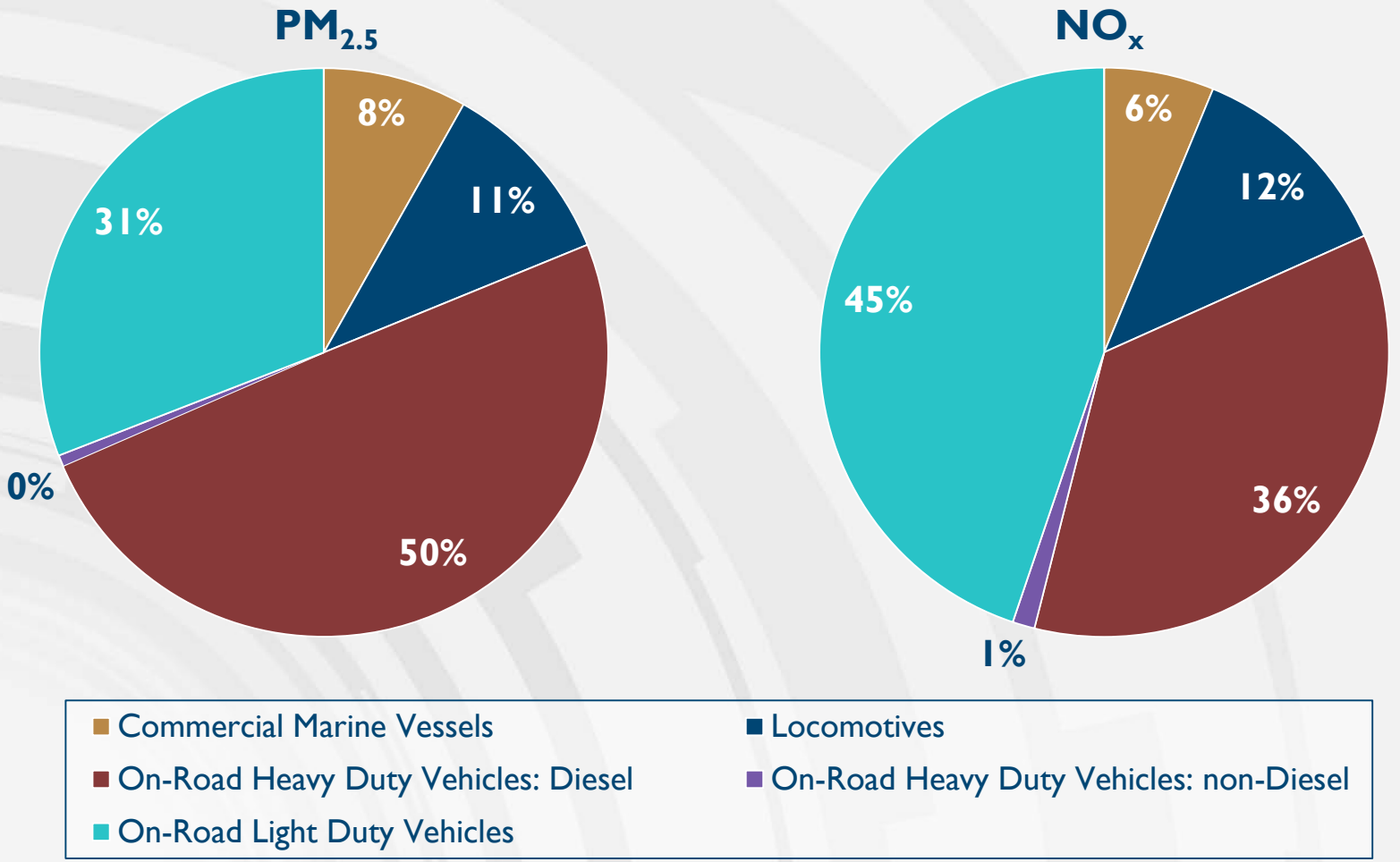
Agenda

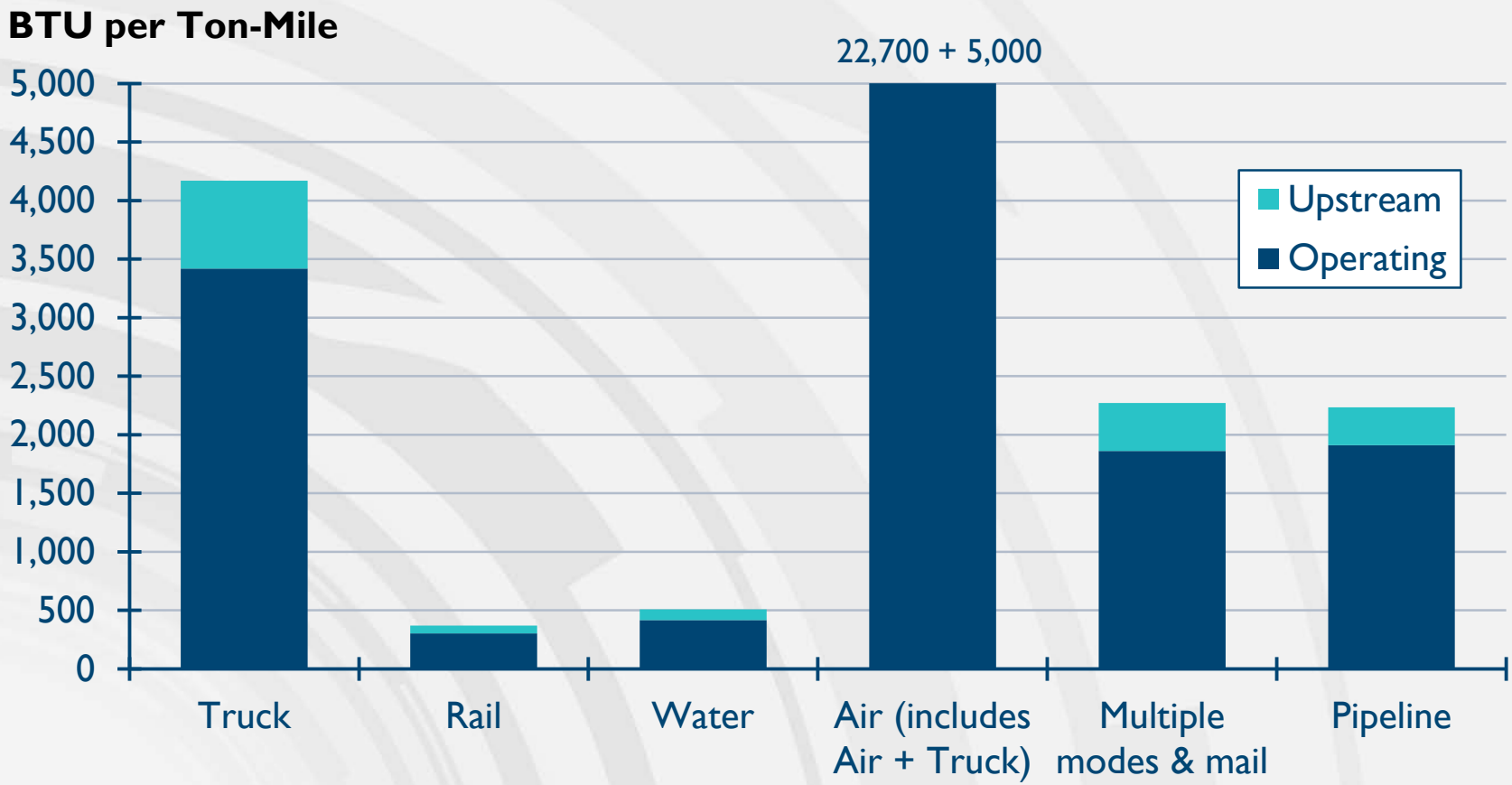
- Freight's contribution to transportation emissions
- Forecasts and trends
- Vehicle and fuel technology strategies
- Operational strategies
- Demand management and mode shift
- Policies by control scope
- Conclusions

Freight Contribution to Transportation Emissions



Source: U.S. EPA National Emissions Inventory, 2011.

Direct versus Life-Cycle Emissions by Mode



Source: CS and EERA for NREL Transportation Energy Futures Study Freight Analysis Tool, 2012 (based on 2007 FAF and GREET1_2011).

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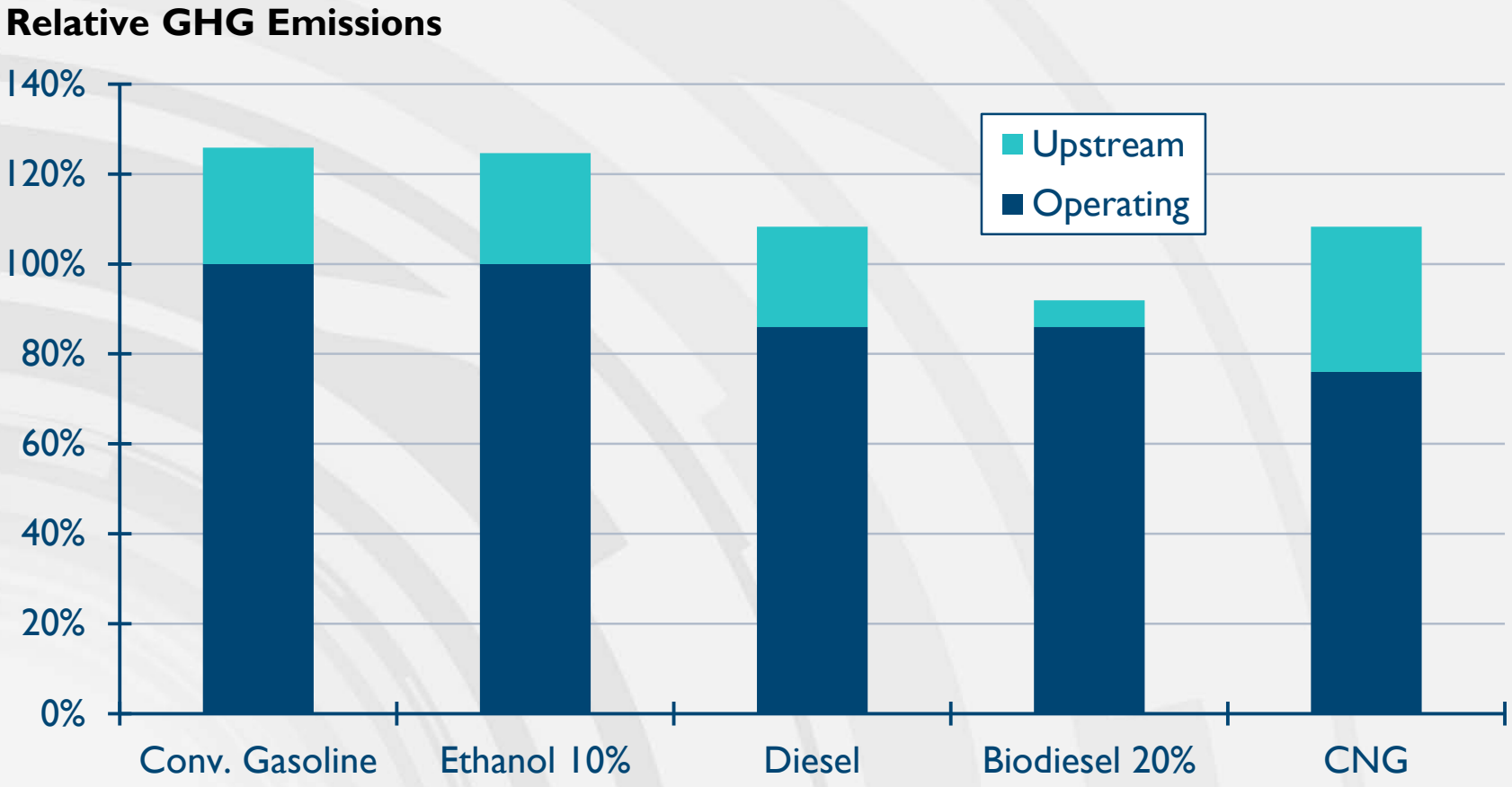
Direct versus Life-Cycle Emissions by Fuel Type



Source: CS for NREL Transportation Energy Futures, 2012 (based on GREET1_2011).

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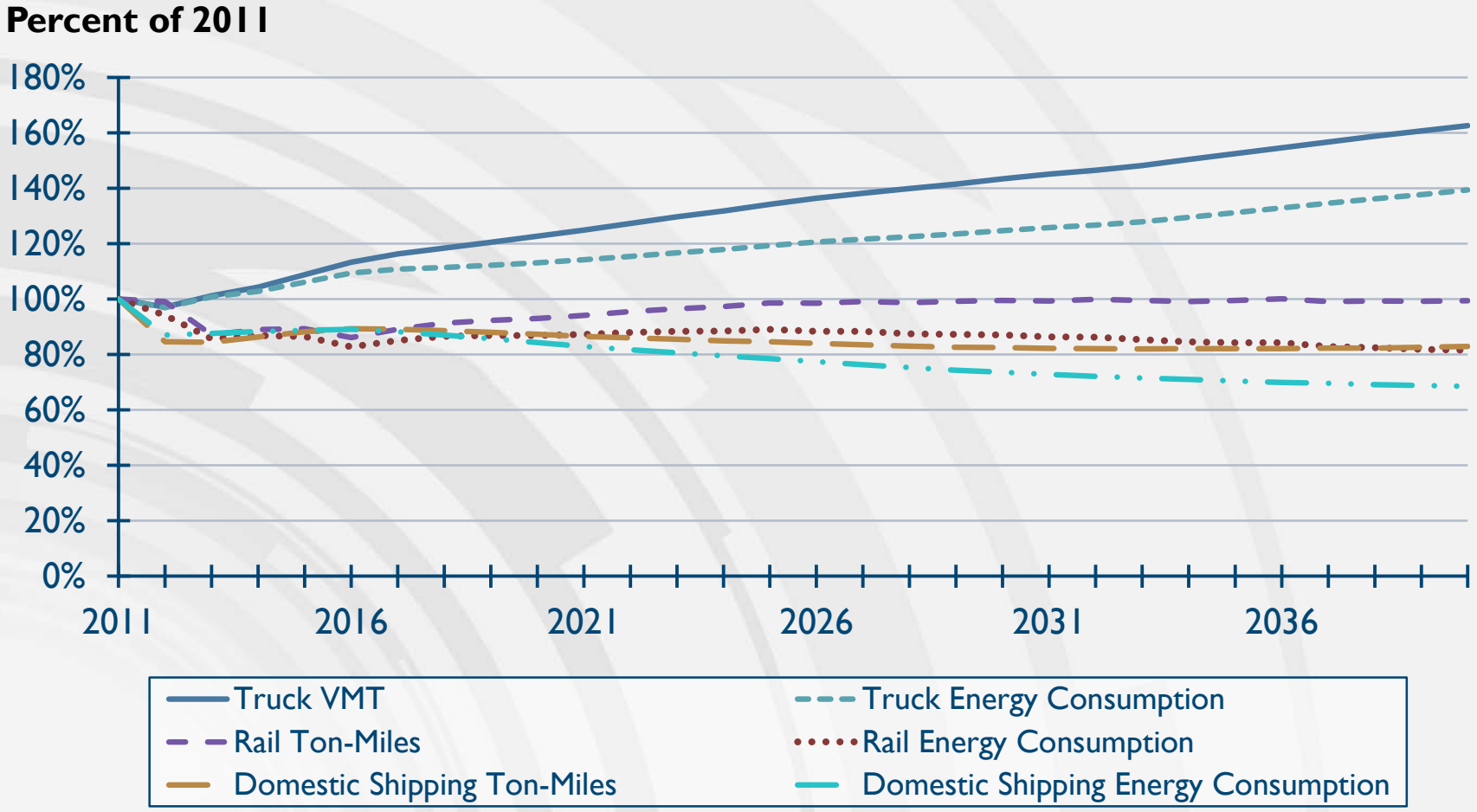
Freight Forecasts



Source: U.S. DOE Annual Energy Outlook, 2014 Reference Case.

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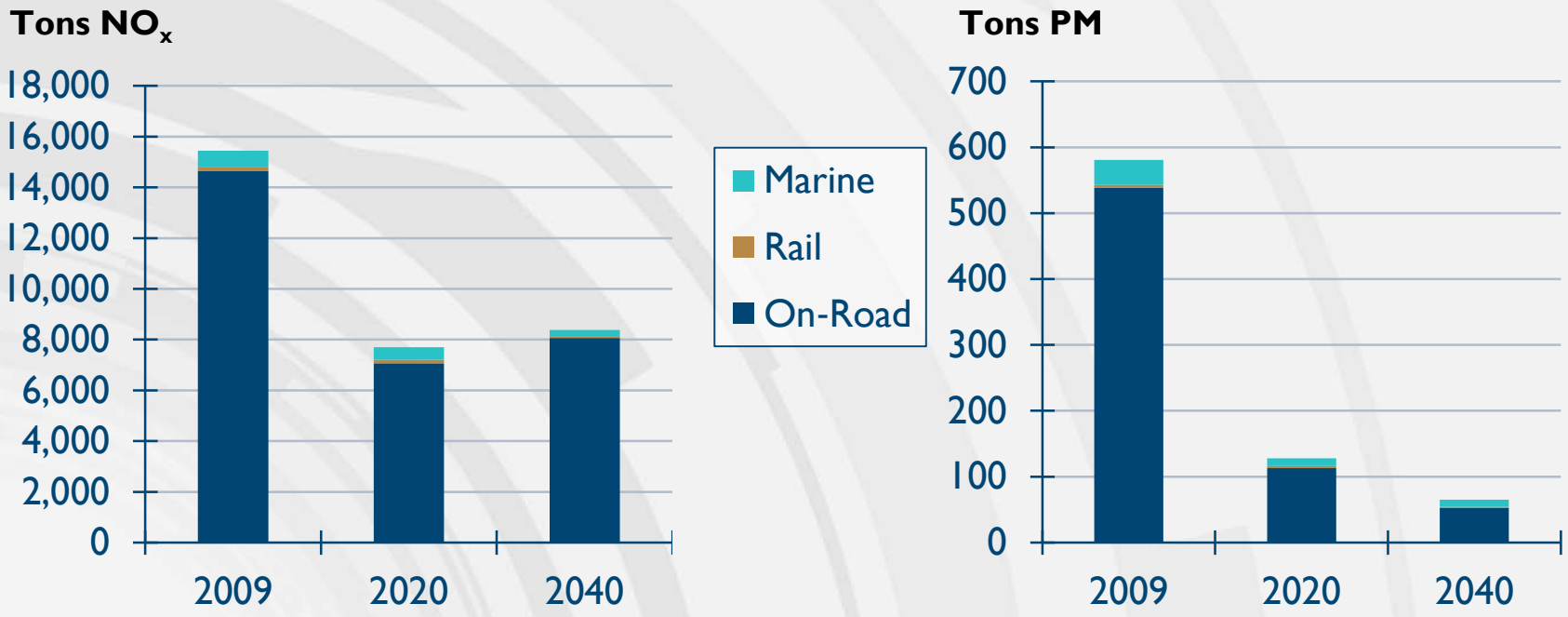
Freight Emissions Controls

- Example from Connecticut
- 2020 versus 2009: 25% increase in truck VMT, 50% NO_x reduction, >80% PM reduction



Source: de la Torre Klausmeier Consulting, CS, and ERG for Connecticut Department of Energy and Environmental Protection, 2013.

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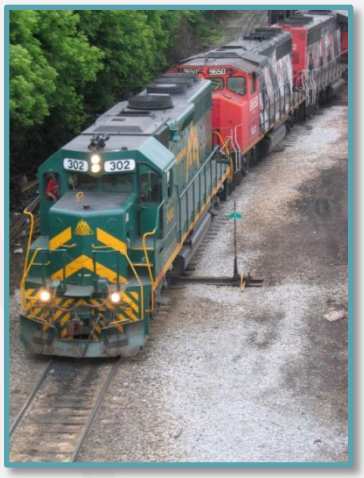
Freight Emission Reduction Strategies

- Vehicle and fuel technology
- Vehicle operations
- Demand and mode shift



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Vehicle and Fuel Technology

Strategy	Effectiveness	Cost
Reduce or Eliminate Extended Idling	High	Low/net savings <$1,000-4,000/ton NO_x
Remote OBD I/M	Medium-High for NO_x, PM	Low-medium $1,700-$3,500/ton NO_x
Convert to Natural Gas	Low for No_x Moderate for CO_2	Low/net savings
Accelerated Retirement for Drayage	High	$4,000-$32,000/ton No_x May be net savings for trucks>15 years old
SmartWay Retrofits (aero/rolling)	Medium for NO_x, CO_2	Low/net savings
Diesel Retrofits	High for NO_x, PM	$11,000-$70,000/ton PM

Source: de la Torre Klausmeier Consulting, CS, and ERG for Connecticut Dept. of Energy and Environmental Protection, 2013; CS and ERG, NCHRP 25-25 Task 59 Report, 2010.

Vehicle and Fuel Technology
Rail and Marine

Strategy	Benefits	Costs
Repower yard or line-haul with Tier 2-4	20-60%+ NO_x, 70%+ PM 10-30% CO_2	
Genset yard locomotives	60-90% NO_x, 80% PM 35% CO_2	$3,800/ton NO_x
Hybrid line haul locomotives	50% NO_x, 10% PM 15% CO_2	
Reduced speed zones at ports		20% reduction in speed = 40% reduction in emissions
Auxiliary engine fuel requirements		
Cold ironing		$15,000 to $30,000/ton of NO_x

Source: de la Torre Klausmeier Consulting, CS, and ERG for ConnDEEP, 2013.

Freight Operations

Strategy	Effectiveness	Cost
Empty backhaul reduction	Medium?	Low
Increasing load limits	Low	Low/net savings
Electronic screening	Low	Net savings
Truck parking and routing info	Low	Unknown
Delivery restrictions (location, time of day)	Low (localized)	
Queue management at ports/ terminals	Medium (localized)	

Source: de la Torre Klausmeier Consulting, CS, and ERG for ConnDEEP, 2013; and CS assessment.

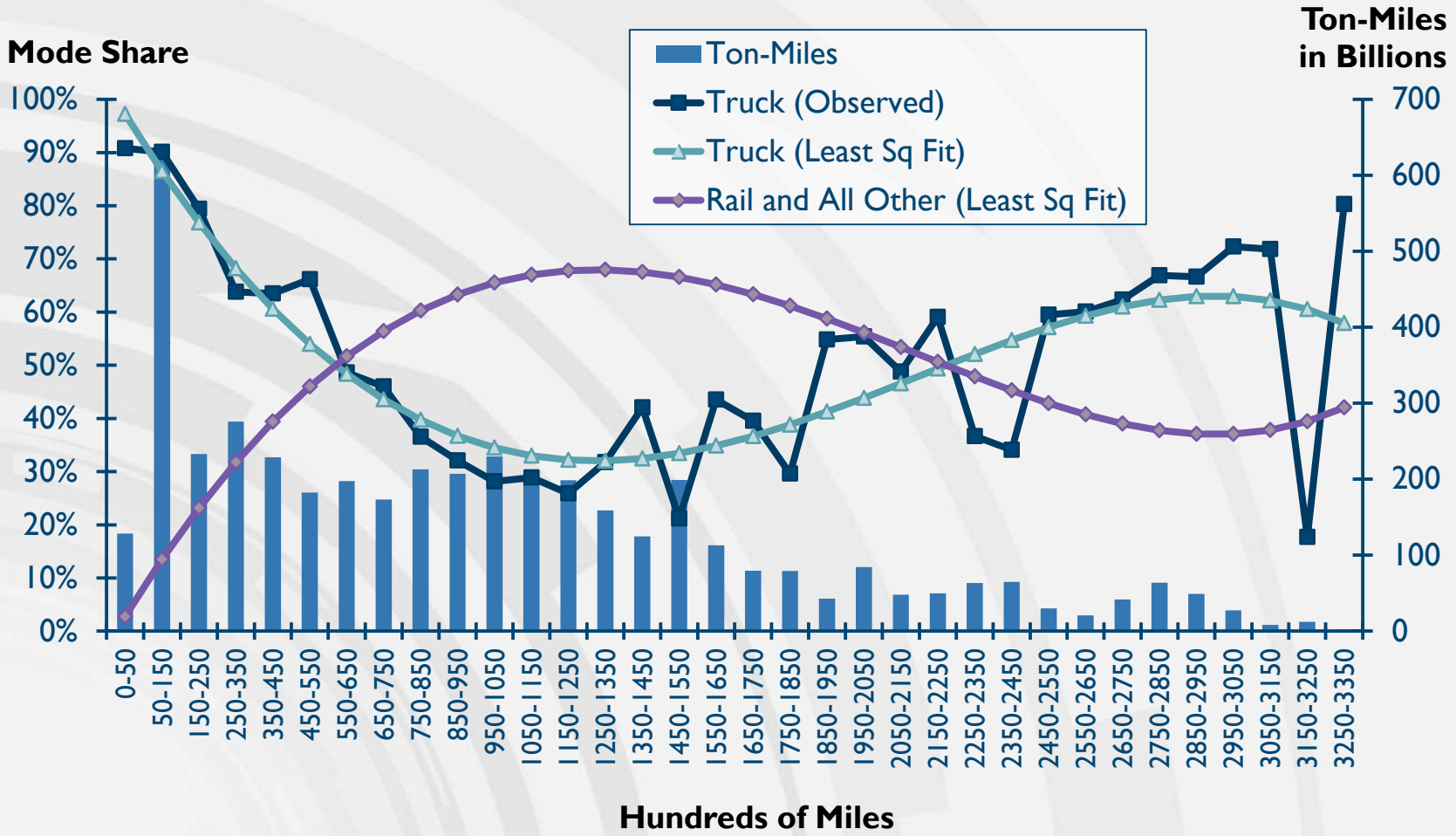
Demand Management and Mode Shift

Strategy	Effectiveness (mode shift %)	Cost[a]
Freight rail and waterway infrastructure improvements and expansion	High (10-20%)	High
Freight re-regulation	Medium-high (<10%)	Low
Truck size and weight regulation	Medium (<5%)	Low
Fuel tax, GHG pricing, user fees	Medium (<5%)	Low/net revenue
Truck hours-of-service regulation	Low (2-3%)	Low
Short-sea shipping	Low	?

[a] Public-sector costs only.

Source: CS for NREL Transportation Energy Futures Study, 2013.

Demand Management and Mode Shift *(continued)*



Source: CS for NREL Freight Analysis Tool (2012) & FAF 3.2.

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Evaluation Tools

Source	Tool	Uses
EPA CARB	MOVES emission factor model EMFAC model	Accelerated retirement, diesel retrofits, starts and hoteling, vehicle activity
EPA	SmartWay Drayfleet Model	Drayage fleet equipment and operations
EPA	SmartWay Fleet Performance Model	Performance of fleet (truck) operations
EPA	Diesel Emission Quantifier	Diesel truck retrofit or rebuild
U.S. DOT	Freight Routing and Emissions Analysis Tool	Comparing land-side and water-side routes
U.S. DOT/ FHWA	Freight Analysis Framework	Freight flows by commodity & mode (base + forecast)
USDOE/ NREL	Freight Analysis Tool	Modal shift, commodity flow, and demand impacts
USDOE/ ANL	GREET Fleet Footprint Calculator	Life-cycle petroleum and GHG footprints
Plus various private tools…		

Strategies by Control Scope

National

- Fuel economy and emissions regulations
- Vehicle and fuel standards
- Regulations and incentives pertaining to long-haul truck activity and equipment

State and Metro

- Drayage truck retrofit and replacement
- Truck parking and idling
- I/M programs
- Alt fuels for local fleets

Regional (multistate)

- Rail, marine, and intermodal infrastructure investment
- Corridor strategies (e.g., fueling stations)

Carriers

- Vehicle replacement, engine retrofit, alternative fuels
- Supply chain/logistics efficiency
- Aero/rolling retrofits

Conclusions

- Expect significant declines in criteria pollutants due to recent standards
- Expect increases in CO_2 emissions – freight traffic growth more than offsetting efficiency improvements
- Some control strategies that can be implemented locally or regionally
- What will change in the future?
  - » Economic growth and/or structure?
  - » Fuel prices – market- or policy-driven?
  - » Further regulations? (emissions, GHG)
  - » New technologies?