Sustainable Freight Transportation Systems: Operations, Technology and Policy

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Economic, Energy and Environmental Impacts of Freight Transportation

Economic impacts

The prices of all we consume are impacted by freight transportation rates

- Truckers that (have to) drive in congestion experience high operating costs
- Congestion drives away freight activity
  - Increasing the price of goods
  - Reducing the competitiveness of the area

1/10 of employees are in freight / logistics

The cost of transporting goods...

In the US:

5% of the GDP (Kearney, 1976)

In Canada:

6% (smallest cities) to 18% (large cities) of personal income

In Colombia:

22% of the total cost of commodities

Could be 39% for imports and 36% for exports

Freight transportation costs are:

- fuel (37%)
- tolls (17%)
- maintenance and tires (16%)
- wages (11%)
- insurance (7%)
- administration (6%)
- capital (5%)
- others (1%)

In the US...

Transportation consumed:
- 28.5% of the total energy
- 67.9% of the petroleum

Transportation produced:
- 54% of the carbon monoxide
- 36% of the nitrogen oxide
- 22% of the volatile organic compounds
- 1.4% of the sulfur dioxide

In France (Segalou et al. 2003)...

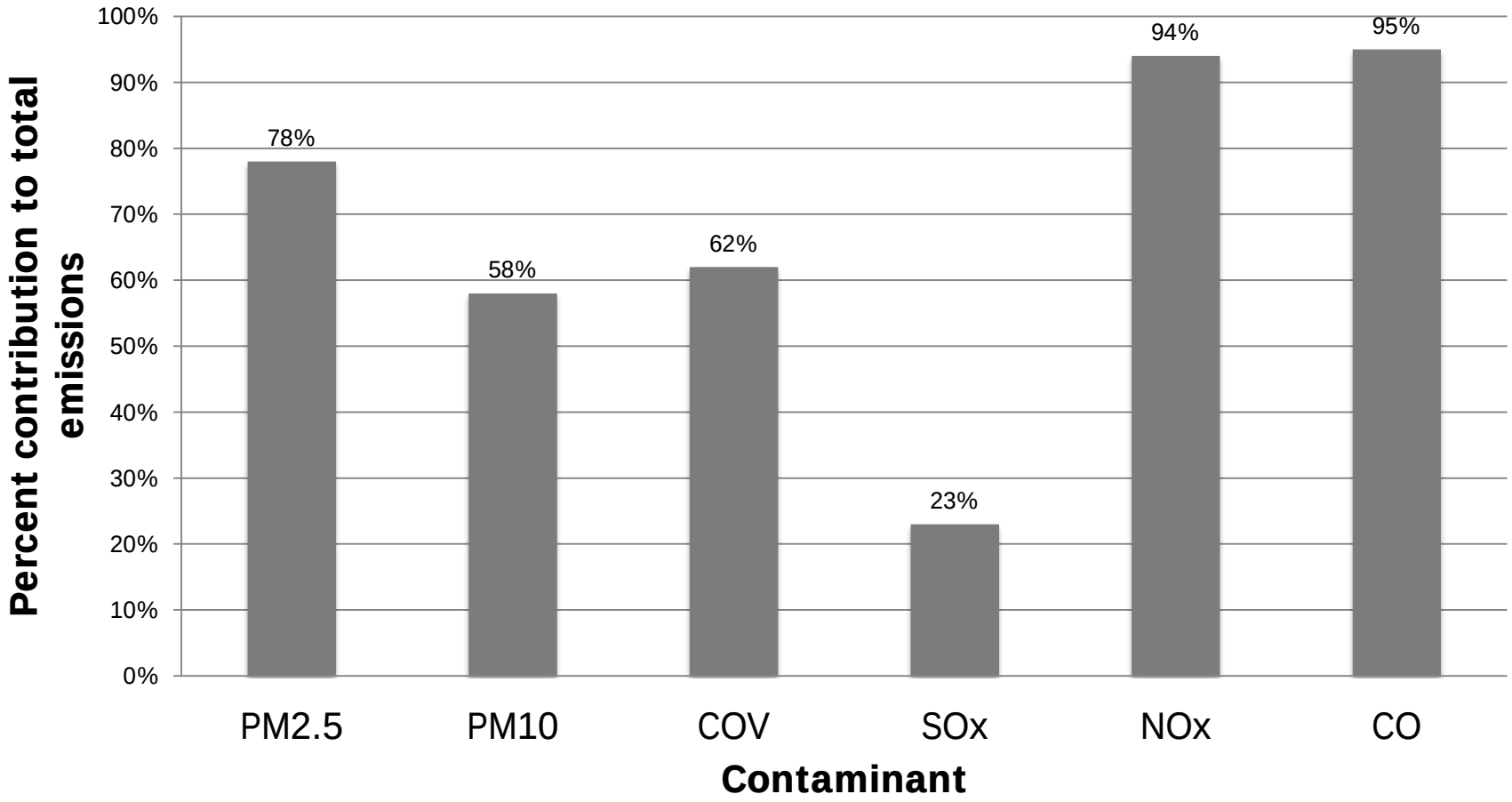
The Laboratoire d'Economie des Transports conducted a comprehensive study in three French cities:

- Dijon (240,000)
- Bordeaux (750,000)
- Marseilles (1,050,000)

	Traffic measured in daily vehicle-km		
Segment of daily traffic on the study area	**Bordeaux**	**Dijon**	**Marseilles**
Pick-ups and deliveries + urban management traffic except shopping trips	623,000	200,600	790,000
%	**4%**	**6%**	**6%**
Shopping trios (inner, entering, outgoing)	1,403,000	236,600	1,750,000
%	**9%**	**7%**	**13%**
% Urban goods movement	**13%**	**12%**	**19%**
Freight through traffic (harbor traffic in the case of Marseilles)	544,000	68,400	180,000
Private individuals trips (other than shopping) (inner, entering, outgoing)	13,360,000	3,020,000	10,500,000
Total	15,930,000	3,525,600	13,220,000

		Marseilles: Peak concentrations (in town center, in µg/m3)					
		CO	**NOx**	**HC**	**PM**	**SO2**	**CO2**
Average daily traffic (ADT)	All traffic	172	17	21	1	0.6	3005
	Private vehicles	150	10	17	0.5	0.4	2140
	UGM	25	7	4	0.5	0.2	826
	FTT (freight through traffic)	0.6	2	0.3	0.1	0.05	178
UGM (Urban goods movement)		**15%**	**41%**	**19%**	**50%**	**33%**	**27%**
(UGM + FTT)		**15%**	**53%**	**20%**	**60%**	**42%**	**33%**

In Medellín...

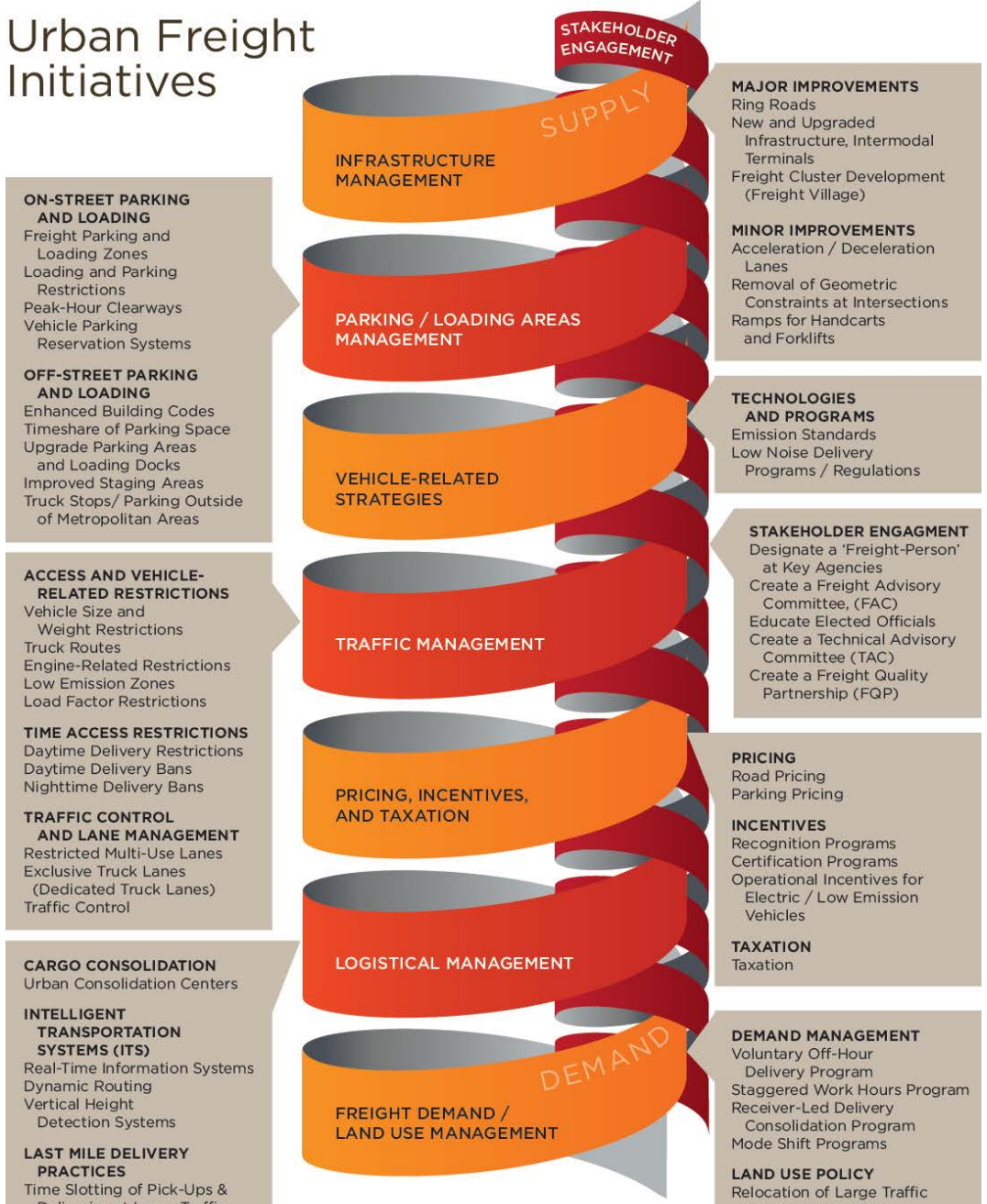


Source: Adapted from the Emissions Inventory 2011

What can we do?

Many solutions for urban freight transport

Urban Freight Initiatives



ON-STREET PARKING AND LOADING
Freight Parking and Loading Zones
Loading and Parking Restrictions
Peak-Hour Clearways
Vehicle Parking Reservation Systems

OFF-STREET PARKING AND LOADING
Enhanced Building Codes
Timeshare of Parking Space
Upgrade Parking Areas and Loading Docks
Improved Staging Areas
Truck Stops/ Parking Outside of Metropolitan Areas

ACCESS AND VEHICLE-RELATED RESTRICTIONS
Vehicle Size and Weight Restrictions
Truck Routes
Engine-Related Restrictions
Low Emission Zones
Load Factor Restrictions

TIME ACCESS RESTRICTIONS
Daytime Delivery Restrictions
Daytime Delivery Bans
Nighttime Delivery Bans

TRAFFIC CONTROL AND LANE MANAGEMENT
Restricted Multi-Use Lanes
Exclusive Truck Lanes (Dedicated Truck Lanes)
Traffic Control

CARGO CONSOLIDATION
Urban Consolidation Centers

INTELLIGENT TRANSPORTATION SYSTEMS (ITS)
Real-Time Information Systems
Dynamic Routing
Vertical Height Detection Systems

LAST MILE DELIVERY PRACTICES
Time Slotting of Pick-Ups & Deliveries at Large Traffic Generators
Driver Training Programs
Anti-Idling Programs
Pick-up/Delivery to Alternate Locations

MAJOR IMPROVEMENTS
Ring Roads
New and Upgraded Infrastructure, Intermodal Terminals
Freight Cluster Development (Freight Village)

MINOR IMPROVEMENTS
Acceleration / Deceleration Lanes
Removal of Geometric Constraints at Intersections
Ramps for Handcarts and Forklifts

TECHNOLOGIES AND PROGRAMS
Emission Standards
Low Noise Delivery Programs / Regulations

STAKEHOLDER ENGAGMENT
Designate a 'Freight-Person' at Key Agencies
Create a Freight Advisory Committee, (FAC)
Educate Elected Officials
Create a Technical Advisory Committee (TAC)
Create a Freight Quality Partnership (FQP)

PRICING
Road Pricing
Parking Pricing

INCENTIVES
Recognition Programs
Certification Programs
Operational Incentives for Electric / Low Emission Vehicles

TAXATION
Taxation

DEMAND MANAGEMENT
Voluntary Off-Hour Delivery Program
Staggered Work Hours Program
Receiver-Led Delivery Consolidation Program
Mode Shift Programs

LAND USE POLICY
Relocation of Large Traffic Generators (LTGs)
Integrating Freight into Land Use Planning Process

California: Technology and Regulations

California

FIGURE 2: Statewide NOx Emissions from Freight Sources
(tons per day)

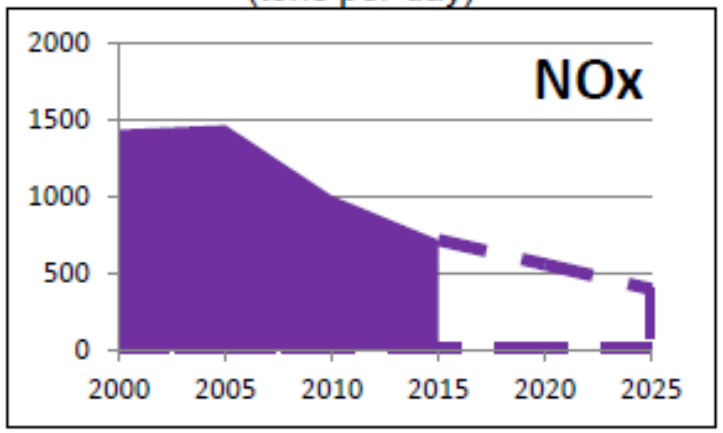


FIGURE 3: Statewide SOx Emissions from Freight Sources
(tons per day)

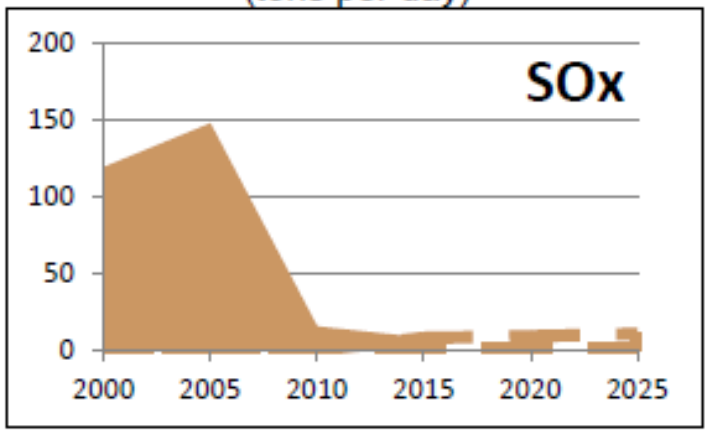


FIGURE 4: Statewide PM2.5 Emissions from Freight Sources
(tons per day)

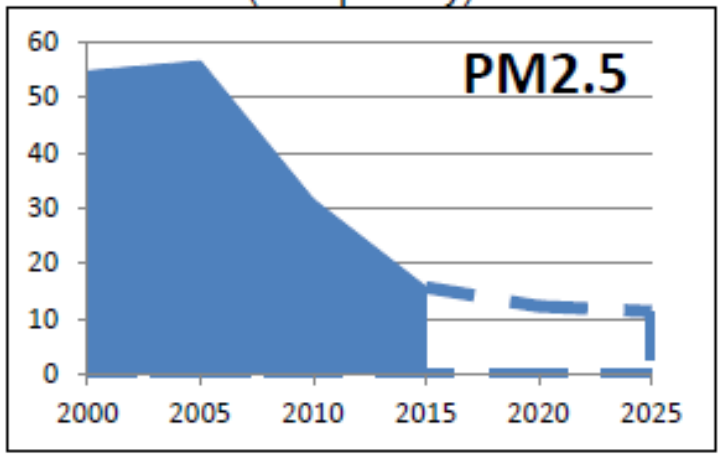
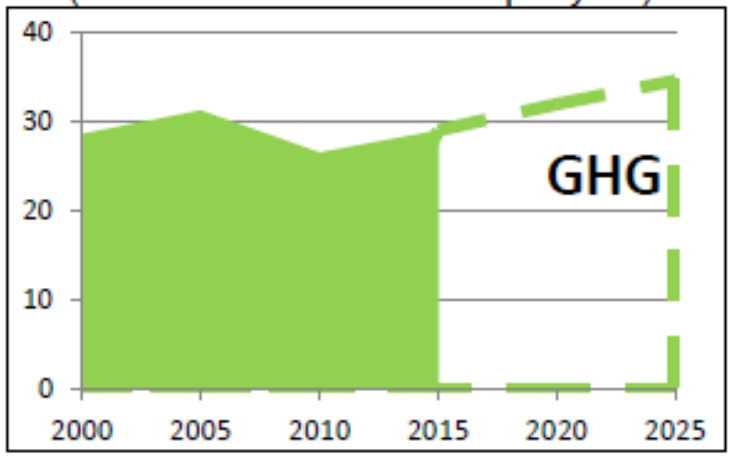


FIGURE 5: Statewide GHG Emissions from Freight Sources
(million metric tons CO2-e per year)



Source:

California Air Resources Board (2015). Sustainable Freight: Pathways to Zero and Near-Zero Emissions. Discussion Draft

New York: Off-Hour Deliveries

Off-hour delivery program in New York City

Implementing various forms of off-hour delivery in Manhattan leads to:

- Travel time savings to all highway users of about 3-5 minutes per trip
- Travel time savings to carriers that switch to the off-hours of about 48 minutes per delivery tour
- Savings in service times (per tour) could be up to 1-3 hours

Economic savings could be between $100 and $200 million/year

Environmental Pollution Reductions: Simulations

TOTAL/YEAR				
Scenario % OHD	CO (tonnes)	HC (tonnes)	NOx (tonnes)	PM_{10} (kg)
6.49%	101.20	24.05	3.00	20.29
14.10%	169.58	28.53	8.22	48.81
20.90%	202.75	39.97	11.82	69.99
25.34%	253.14	56.56	15.04	90.09
29.07%	383.81	55.76	26.33	149.86

PER RECEIVER/YEAR

% OHD	VMT (veh-mi)	VHT (veh-hrs)	CO (kg)	HC (kg)	NOx (kg)	PM10 (kg)
6.49%	348.93	438.20	19.56	3.19	0.58	0.0039
14.10%	549.40	207.09	14.90	1.81	0.72	0.0043
20.90%	551.69	195.51	12.05	1.88	0.70	0.0042
25.34%	542.89	233.92	12.41	2.12	0.74	0.0044
29.07%	1,052.06	244.31	16.40	1.41	1.13	0.0064

Key participants

- Sysco:
  - 31 OHD routes/week (18% of their routes, 171) delivering to 140 unassisted off-hour delivery customers
- Wakefern:
  - 5 OHD routes/day (25% of their total)
- Duane Reade:
  - Approximately 120 of their 160 Manhattan stores receive OHD on a regular basis
- Dunkin Donuts:
  - 72 stores out of 121 in Manhattan
- Beverage Works (Red Bull):
  - Has approximately 130 routes in the NY Metro, 22% are OHD

Mexico City: Freight Demand Management

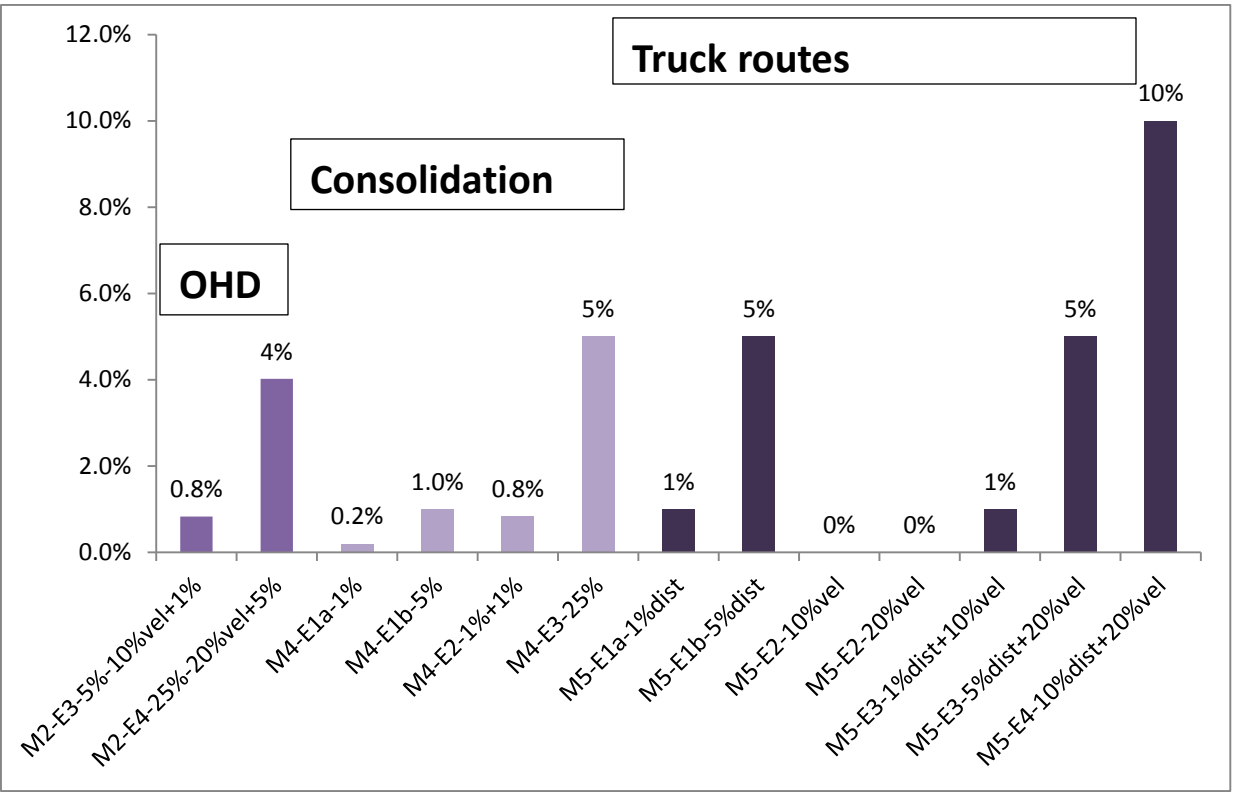
In Mexico

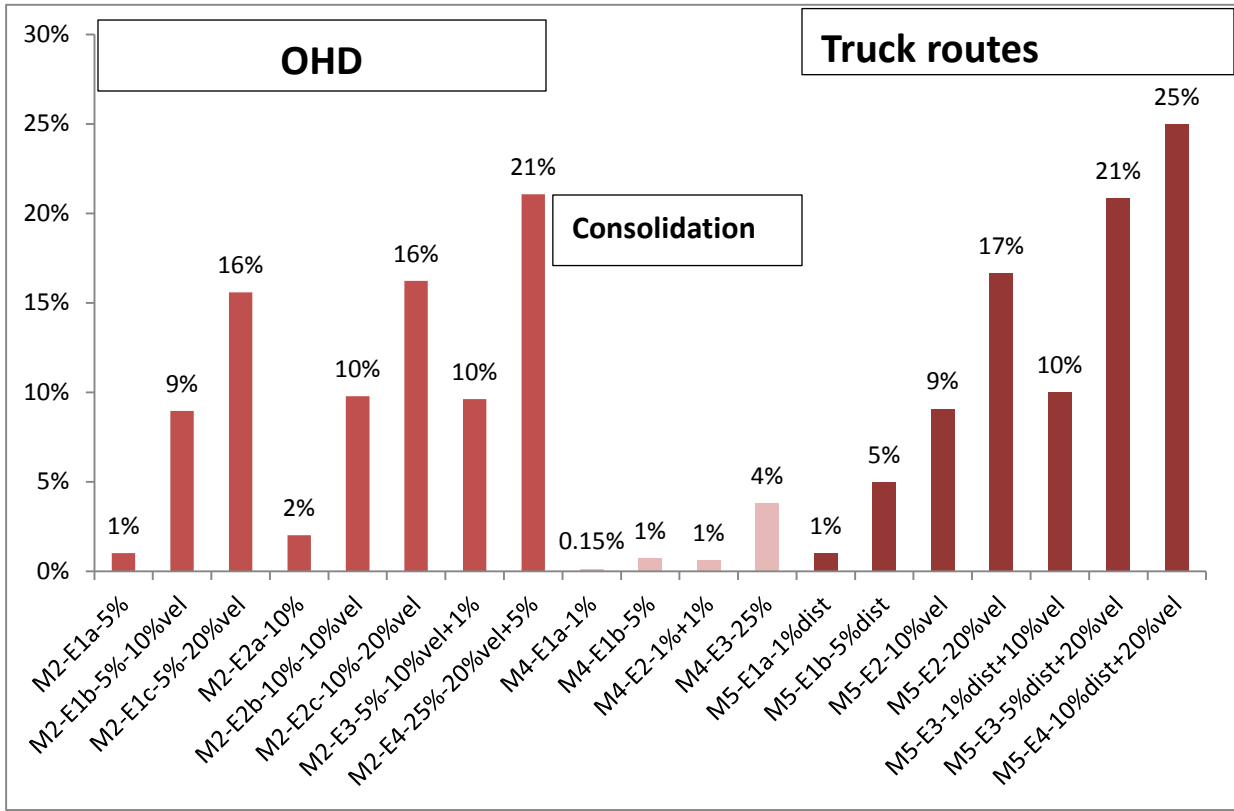
Scenarios			Coding	*
Off-hour deliveries	1	a) 5% shift	M2-E1a-5%	
		b) 5% shift + 10% speed	M2-E1b-5%-10%vel	
		c) 5% shift + 20% speed	M2-E1c-5%-20%vel	
	2	a) 10% shift	M2-E2a-10%	
		b) 10% shift + 10% speed	M2-E2b-10%-10%vel	
		c) 10% shift + 20% speed	M2-E2c-10%-20%vel	
	3	5% shift + 10% speed + 1% increase stops per tour	M2-E3-5%-10%vel+1%	✓
	4	25% shift + 20% speed + 5% increase stops per tour	M2-E4-25%-20%vel+5%	✓
Empty trips	1	a) 1% decrease empty trip distances	M4-E1a-1%	✓
		b) 5% decrease empty trip distances	M4-E1b-5%	✓
	2	1% decrease empty trip distances + 1% increase stops per tour	M4-E2-1%+1%	✓
	3	25% decrease empty trip distances	M4-E3-25%	✓
Truck routes	1	a) 1% decrease travel distance	M5-E1a-1%dist	✓
		b) 5% decrease travel distance	M5-E1b-5%dist	✓
	2	a) +10% speed	M5-E2a-10%vel	
		b) + 20% speed	M5-E2b-20%vel	
	3	a) 1% decrease travel distance + 10% speed	M5-E3a-1%dist+10%vel	✓
		b) 5% decrease travel distance + 20% speed	M5-E3b-5%dist+20%vel	✓
	4	10% decrease travel distance + 20% speed	M5-E4-10%dist+20%vel	✓

Freight Transportation in Mexico City

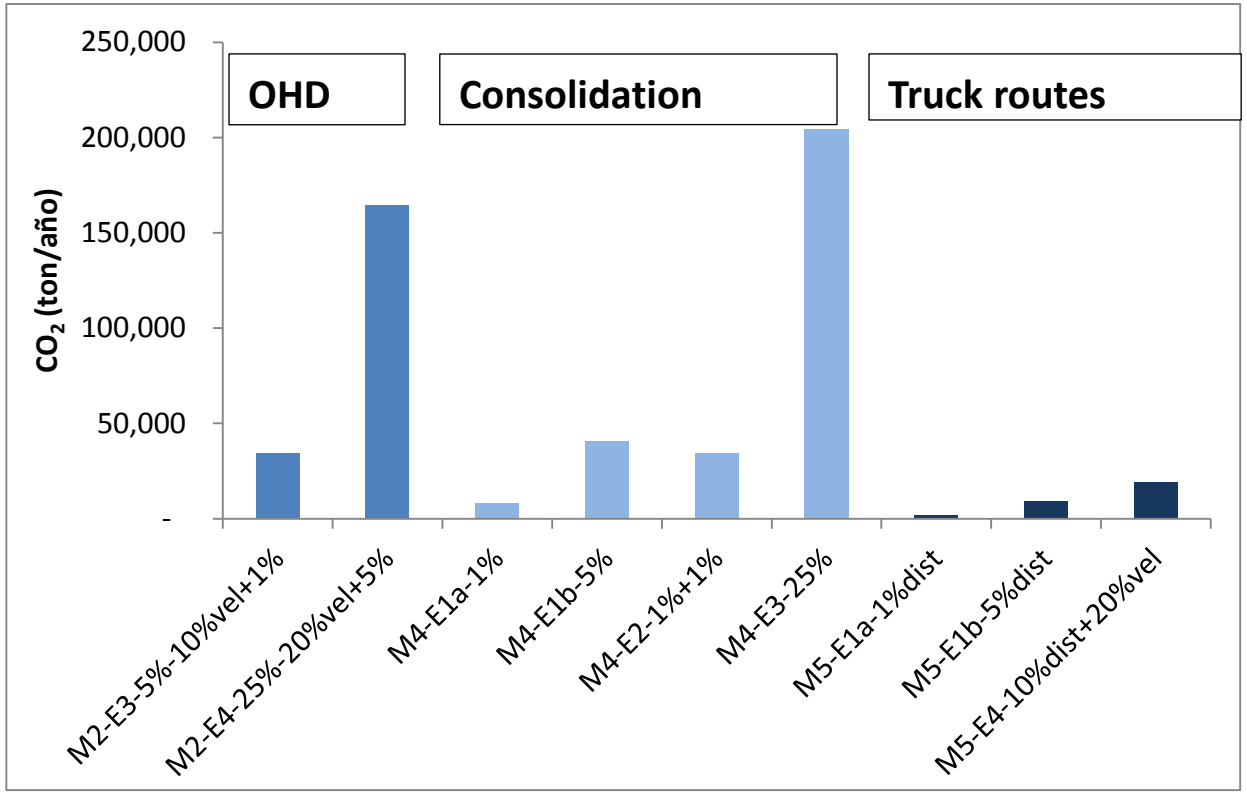
Type of service	Average stops	Average tour length	Kms/ stop	Number of vehicles	Total yearly travel distances
Federal public	2.10	62.80	29.90	104,631	1,042,215,375
Local public	1.80	49.60	27.56	33,220	154,807,413
Mercantile private (< 100 vehicles)	3.80	70.60	18.58	375,022	5,607,436,695
Mercantile private (100-500 vehicles)	23.80	56.50	2.37	62,897	752,630,700
Mercantile private (>500 vehicles)	22.20	48.10	2.17	49,224	501,451,334
Total				**624,995**	**8,058,541,517**

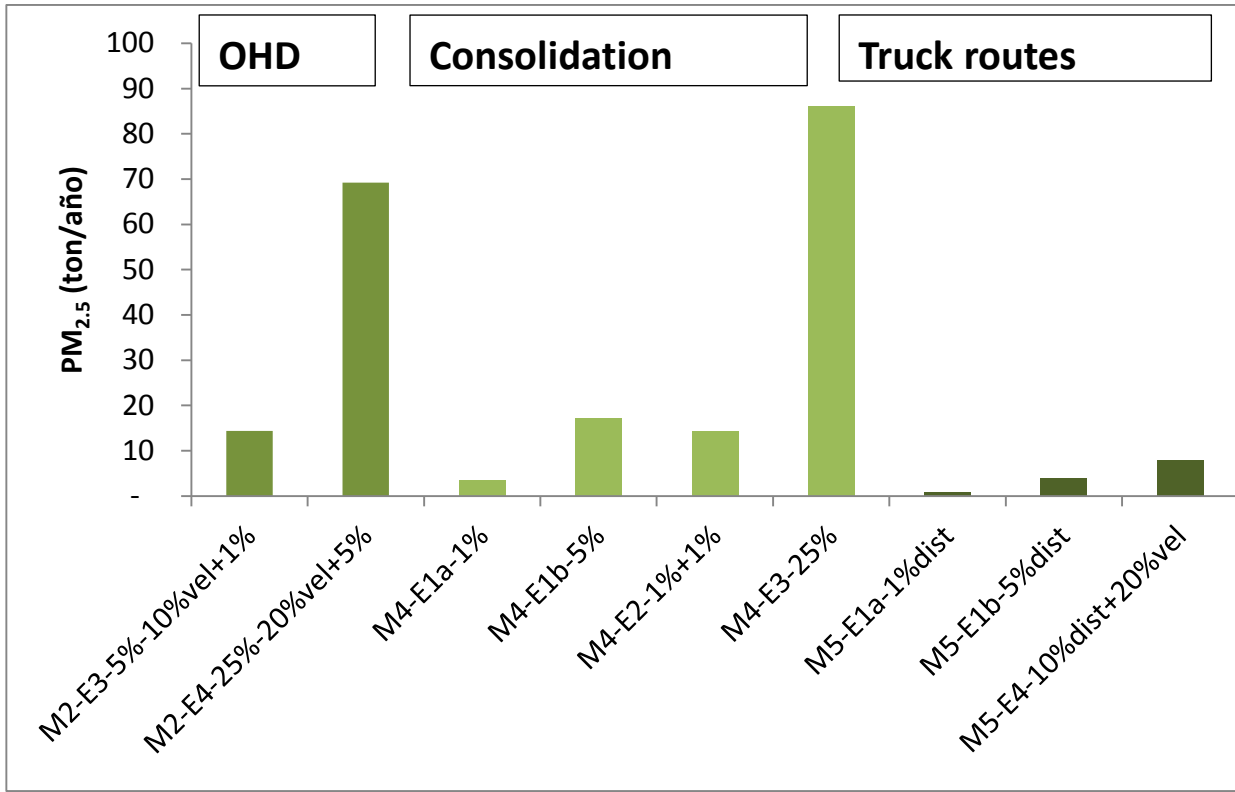
Traveled distances and times





Emissions


OHD
Consolidation
Truck routes
CO_2 (ton/año)
250,000
200,000
150,000
100,000
50,000
-
M2-E3-5%-10%vel+1%
M2-E4-25%-20%vel+5%
M4-E1a-1%
M4-E1b-5%
M4-E2-1%+1%
M4-E3-25%
M5-E1a-1%dist
M5-E1b-5%dist
M5-E4-10%dist+20%vel


OHD
Consolidation
Truck routes
$PM_{2.5}$ (ton/año)
100
90
80
70
60
50
40
30
20
10
-
M2-E3-5%-10%vel+1%
M2-E4-25%-20%vel+5%
M4-E1a-1%
M4-E1b-5%
M4-E2-1%+1%
M4-E3-25%
M5-E1a-1%dist
M5-E1b-5%dist
M5-E4-10%dist+20%vel

Final Thoughts

Negative Impacts

- Freight traffic is a major consumer of resources and a major producer of environmental externalities
- Transportation consumed:
  - 28.5% of the total energy and 67.9% of the petroleum
- Transportation produced:
  - 54% of carbon monoxide and 36% of nitrogen oxide
  - 22% of volatile organic compounds
  - 1.4% of the Sulfur dioxide
- Freight transport contributes a large portion of these numbers

Operations, Technology and Policy

- Can help reduce the impact of urban freight transport
  - Technology and vehicle improvements need to be combined with operational measures
  - These can help reduce a considerable amount of externalities

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Thank you!
Questions!
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