



Goods Movement Emission Reduction Strategies

Study for the Southern California Association of Governments

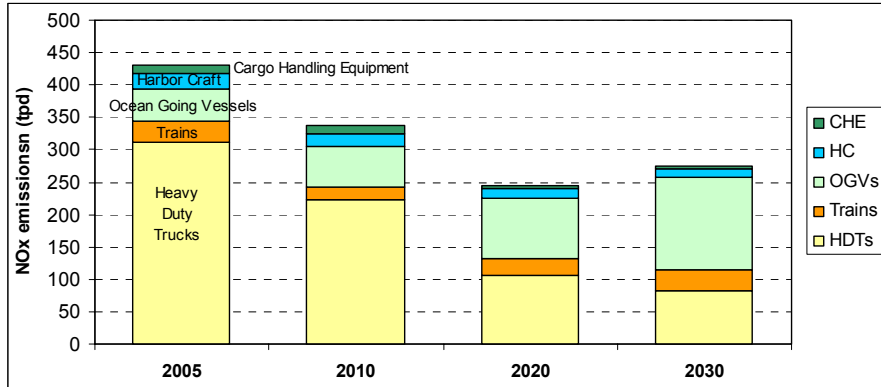
Jeffrey Ang-Olson
Faster Freight Cleaner Air 2008
February 25, 2008

Study Objectives

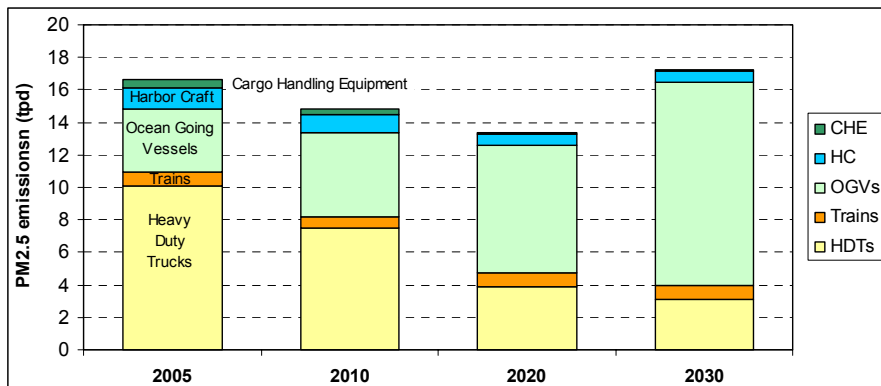


- Identify potential emission reduction strategies for goods movement
- Estimate emission reductions, costs, and cost-effectiveness of each strategy
- Assess feasibility, timeline, barriers to implementation, and acceptability to stakeholders
- Prioritize strategies and quantify what could be accomplished with given investment
- Support achievement of NAAQS; provide input to AQMP and SCAG RTP updates; project-level mitigation

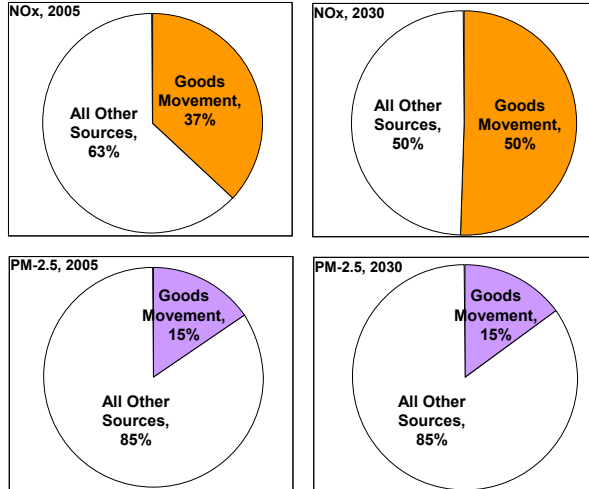
Baseline Goods Movement NOx Emissions (SoCAB)



Baseline Goods Movement PM Emissions (SoCAB)



Baseline Goods Movement Emissions (SoCAB)



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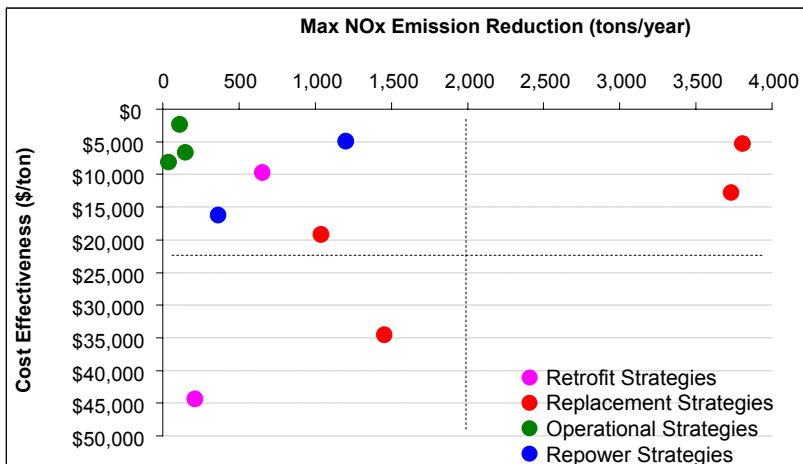
Truck Emission Reduction Strategies



Strategy Type	Examples
Truck Replacement	<ul style="list-style-type: none"> Replace 1999-2006 trucks with 2010+ Replace 2007-2009 trucks with 2010+ Replacement with hybrids
Repowering	<ul style="list-style-type: none"> Repower pre-1994 truck with 1994-2006 engine
Retrofits	<ul style="list-style-type: none"> DOC (25% PM reduction) FTF (50% PM reduction) DPF (85% PM reduction); DPF+LNC (85% PM and 25% NOx reduction)
Alternative Fuels	<ul style="list-style-type: none"> Biodiesel LNG (with truck replacement)
Operational Strategies to Reduce VMT	<ul style="list-style-type: none"> Virtual container yard
Operational Strategies to Reduce Congestion	<ul style="list-style-type: none"> Truck incident management PierPass expansion
Infrastructure Projects	<ul style="list-style-type: none"> Dedicated truckways On-dock or near-dock rail expansion

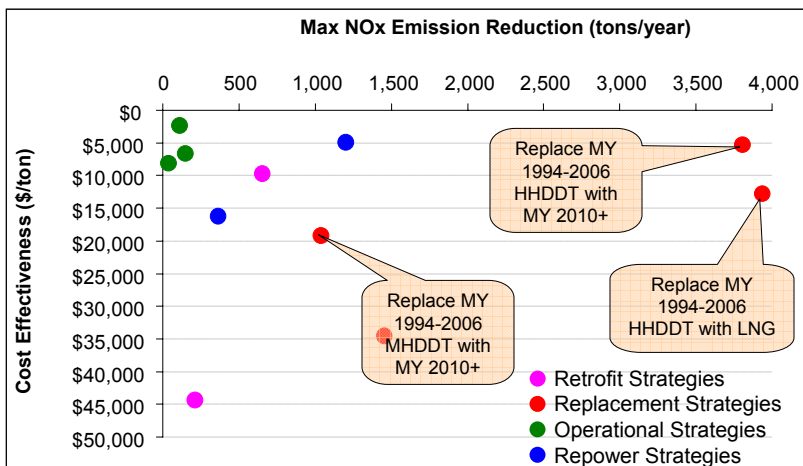
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NOx Reductions – Truck Strategies (2010)



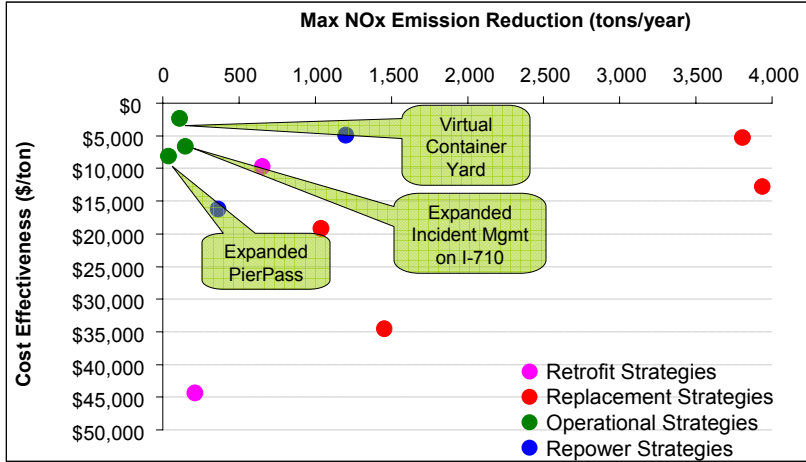
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NOx Reductions – Truck Strategies (2010)

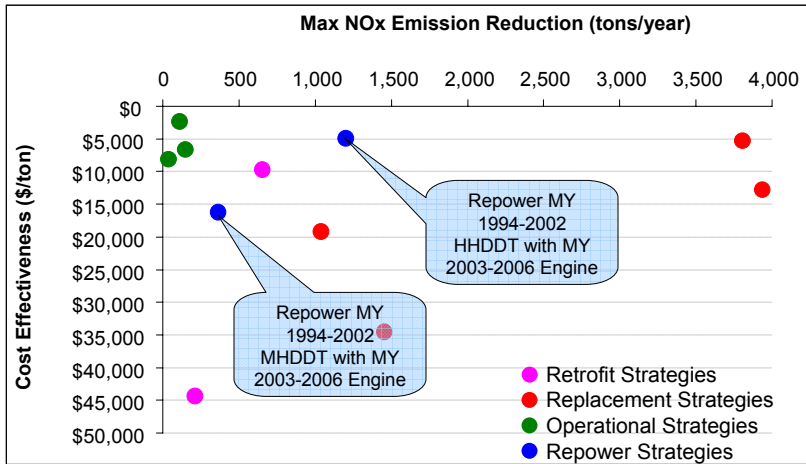


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NOx Reductions – Truck Strategies (2010)



NOx Reductions – Truck Strategies (2010)



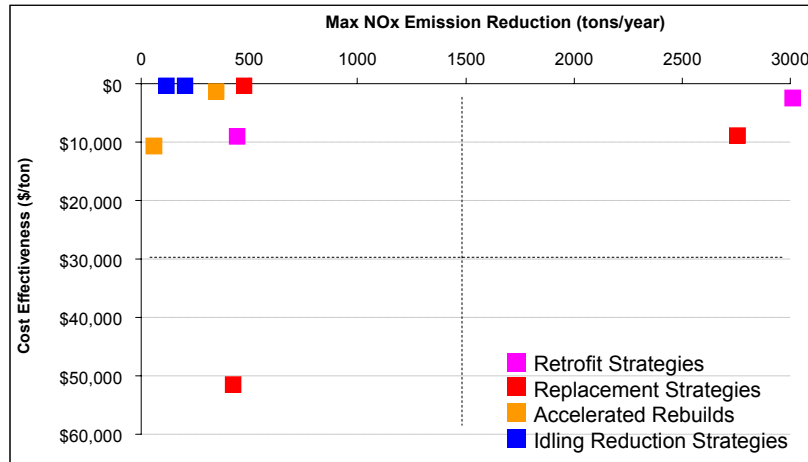
Major Implementation Challenges

- Widely dispersed ownership
- Limited resources to owner-operators and small fleet owners
- Large operating range for some HHDTs
- Participation rates for voluntary programs

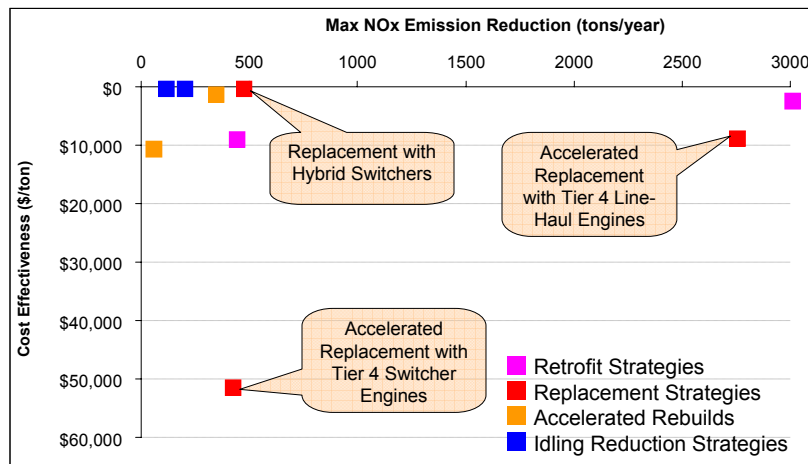
Locomotive Emission Reduction Strategies

Strategy Type	Examples
Locomotive Replacement	<ul style="list-style-type: none"> • Replace Tier 2 locomotives with Tier 4
Repowering	<ul style="list-style-type: none"> • Repower old Tier 0 engines with Tier 2 engines
Accelerated Rebuilds	<ul style="list-style-type: none"> • Rebuild Tier 2 engines to new Tier 2/3 standards
Retrofits	<ul style="list-style-type: none"> • DOCs • DPFs • SCR systems
Hybrid and GenSet Switchers	<ul style="list-style-type: none"> • Green Goat
Idle Reduction	<ul style="list-style-type: none"> • AESS devices • Company policy and operator training
Electrification	<ul style="list-style-type: none"> • Alameda Corridor • Entire mainline system
Infrastructure Projects	<ul style="list-style-type: none"> • Mainline capacity expansion • On-dock or near-dock rail expansion

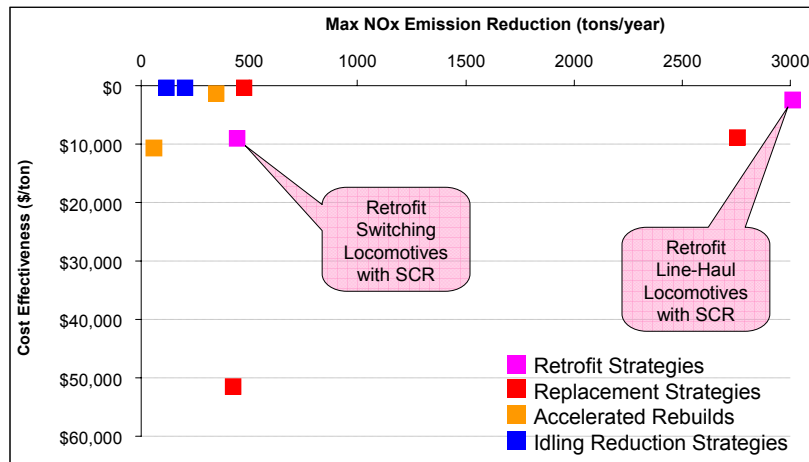
NOx Reductions – Rail Strategies (2020)



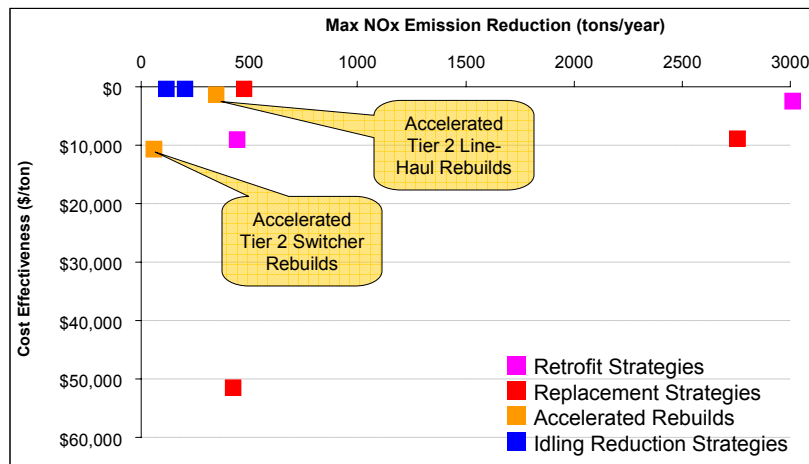
NOx Reductions – Rail Strategies (2020)



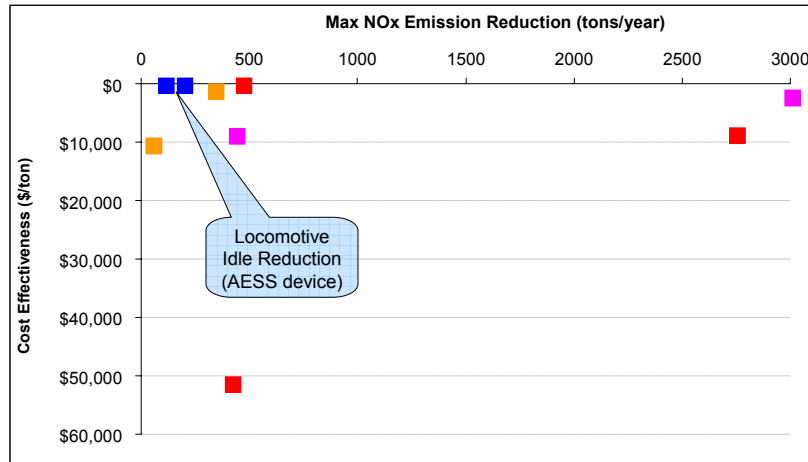
NOx Reductions – Rail Strategies (2020)



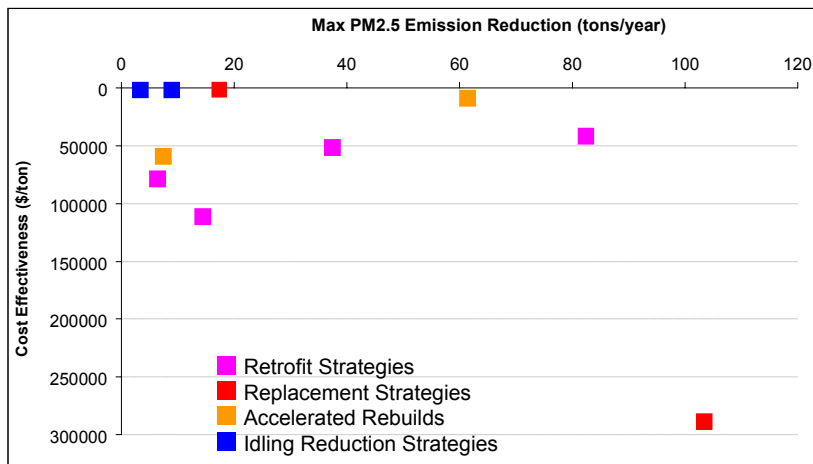
NOx Reductions – Rail Strategies (2020)



NOx Reductions – Rail Strategies (2020)



PM Reductions – Rail Strategies (2020)



Major Implementation Challenges

- Retrofits not yet proven, verified
- Large operating range for most line-haul locomotives
- Cost of new locomotives (>\$2M for line haul)
- Relatively low production volumes

Infrastructure Strategies Examined

- On-dock rail expansion
- Near-dock rail expansion
- Mainline rail capacity expansion
- Electrification of Alameda Corridor
- Electrification of entire regional rail mainlines

On-Dock Rail Expansion



- Methodology and Key Assumptions
 - By 2020, 72 additional trains/weekday carrying on-dock cargo
 - Shift from near-dock
 - Impacts on truck trips estimated using QuickTrip (2.8 trk trips eliminated per 40-ft container)
 - Increase in locomotive emissions based on train fuel efficiency and avg train weight
 - Costs: \$1 billion

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Near-Dock Rail Expansion



- Methodology and Key Assumptions
 - Based on impact of SCIG
 - Shift trips from Hobart terminal (3 mi vs. 20 mi)
 - Impacts on truck trips estimated using QuickTrip (1.7 trk trips shifted per 40-ft container)
 - Increase in locomotive emissions based on train fuel efficiency and avg train weight
 - Costs: \$200 million

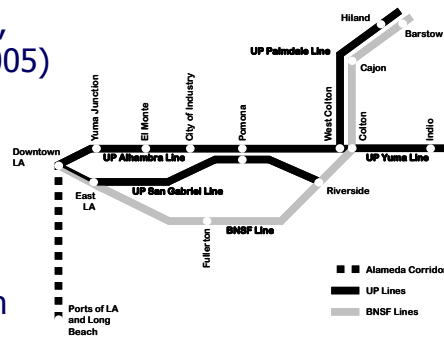
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Inland Railroad Capacity Expansion



- Methodology and Key Assumptions

- Rail simulation modeling, from Leachman et al (2005)
- Benefits:
 - Smoother train flows
 - Grade separation
- Costs: \$2.3 - \$2.6 billion



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Electrification of Alameda Corridor



- Methodology and Key Assumptions

- Estimate annual locomotive-miles by rail segment for entire region
- Alameda Corridor is 10.9% of total locomotive-miles: assume proportional to mainline emissions
- Estimate incremental electric power demand – assume all generation in SoCAB
- Cost: \$233M for infrastructure, \$24M for engines

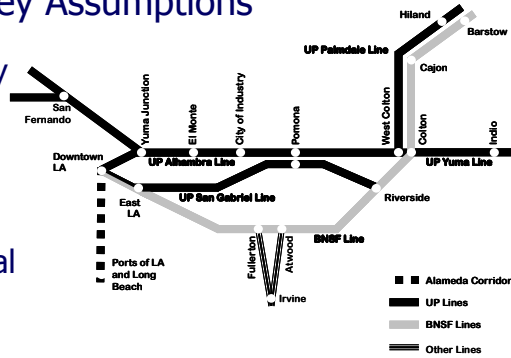
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Electrification of Regional Rail Mainlines



Methodology and Key Assumptions

- Locomotive-miles by segment
- 99% of mainlines electrified
- Estimate incremental electric power demand
- Cost: \$4.9B for infrastructure, \$1.5B for locomotives



Summary of Infrastructure Strategies



Strategy	Emission Reduction (tons/yr)		Cost Effectiveness (\$/ton)	
	NOx	PM2.5	NOx	PM2.5
On-dock rail expansion	516	23	\$100,000	\$2,243,000
Near-dock rail expansion	112	5	\$63,000	\$1,413,000
Railroad mainline capacity expansion	2,069	69	\$42,000	\$1,371,000
Alameda corridor electrification	831	26	\$9,000	\$304,000
Total mainline railroad electrification	7,557	236	\$25,000	\$847,000

Infrastructure Strategies: Limitations and Research Needs



- Source of diversion for incremental on-dock, near-dock moves
- Relationship between railroad capacity, train speeds, and emissions
- Operational feasibility of electrification

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Strategy Benefits as Percent of AQMP Reductions for PM2.5 Attainment (2014)



	NOx	PM2.5
Replace MY 1994-2006 HHDDTs w/ 2007+ (10%)	5%	4%
Retrofit MY 1993-2003 HHDDTs w/ DPF+LNC (10%)	1%	2%
Expanded Incident Management for Trucks on I-710	0%	1%
Retrofit Line-haul Locomotives w/ SCR (50%)	4%	0%
Retrofit Line-haul Locomotives w/ DPF (50%)	0%	2%
Accelerate Tier 2 Line-haul Locomotive Rebuilds (50%)	0%	1%
Accelerate Tier 4 Line-haul Locomotive Replacement (50%)	4%	2%
On-dock rail expansion	1%	0%
Railroad mainline capacity expansion	3%	1%
Alameda corridor electrification	1%	1%
Total mainline railroad electrification	11%	5%

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Questions or Comments?

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