



West Coast Collaborative Marine Vessels & Ports Sector

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Key Regional Air Quality Challenge: Reducing Nitrogen Oxides from Mobile Sources

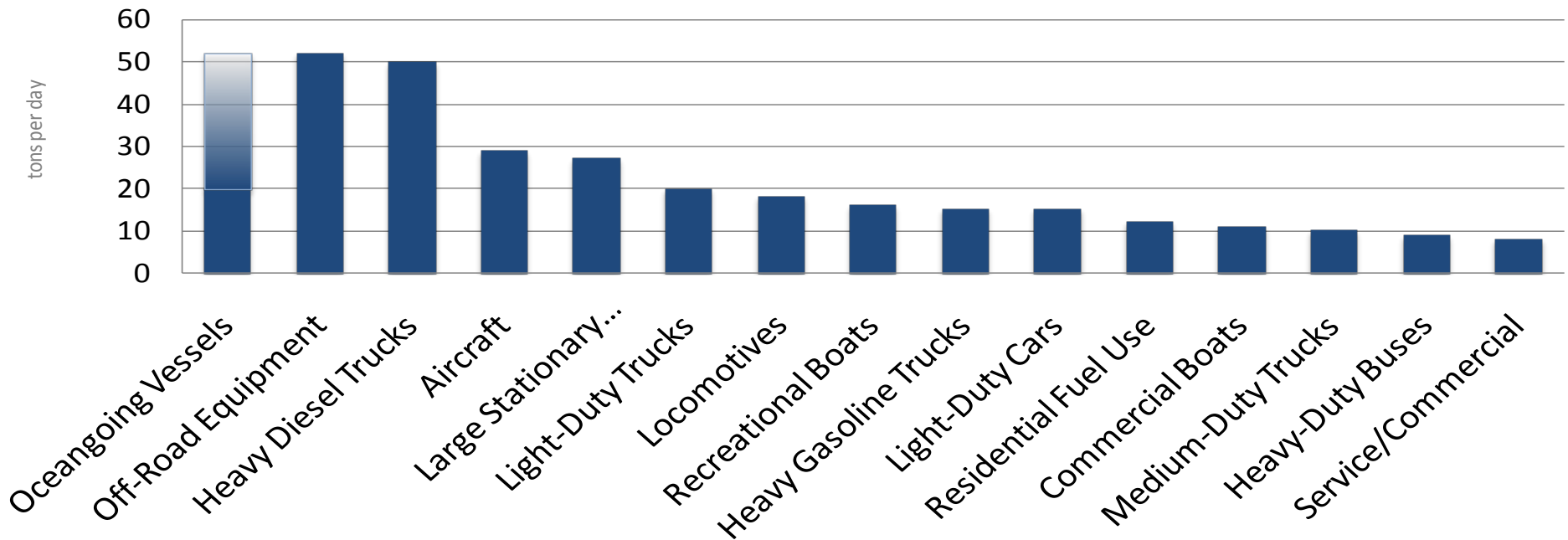
- Attaining federal ozone and PM_{2.5} standards will require substantial NO_x reductions *beyond adopted rules*
- Ozone standard will likely require the greatest reductions
 - Attainment Deadlines:
 - **2023** (80 ppb standard)
 - **2032 timeframe** (75 ppb standard)



South Coast Air Basin

Top 15 NO_x Categories: 2023 NO_x Emissions With Adopted Rules

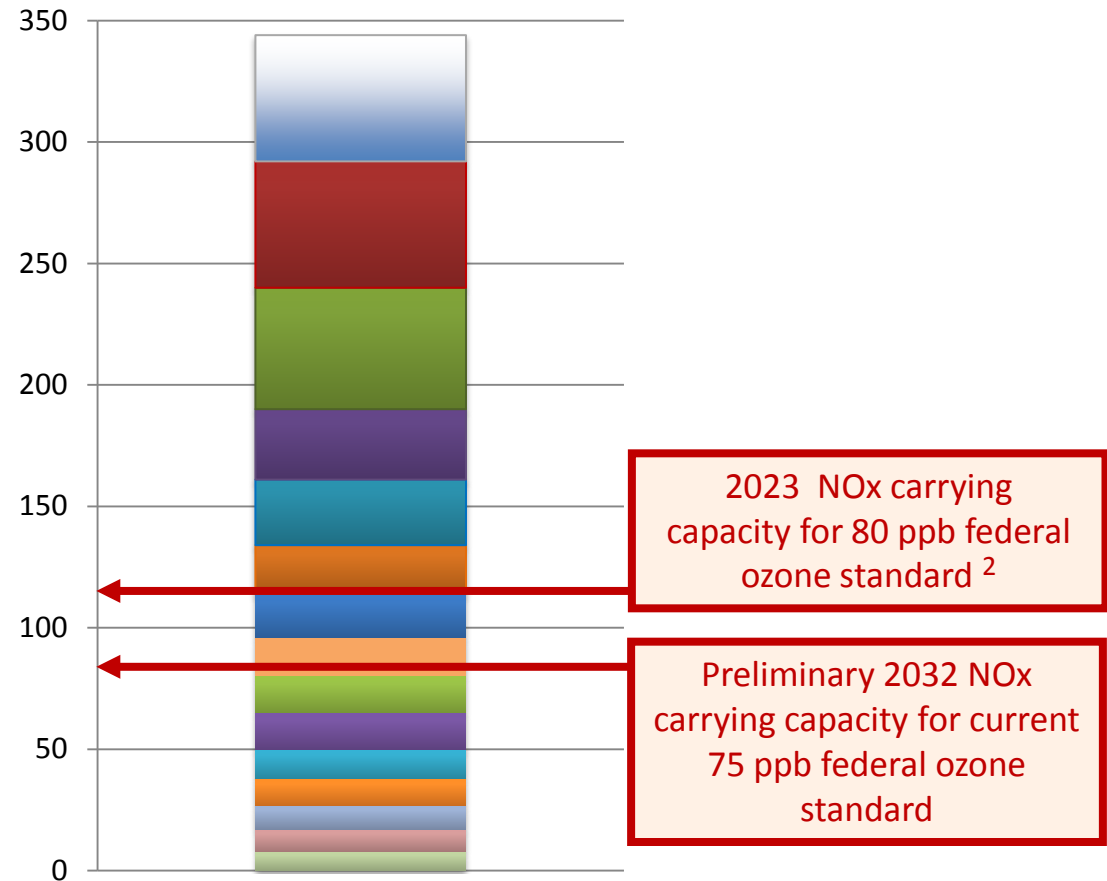
Preliminary SCAQMD Estimates*



* Preliminary emissions estimates based on data updated from 2007 AQMP where available: CARB 2010 emissions projections for trucks and off-road equipment; IMO Tier 1 – 3 for ocean vessels; EPA 2008 rule for locomotives; 2007 AQMP short-term measures for other categories. Range for oceangoing vessels based on varying deployment assumptions for IMO Tier 2 and 3 vessels and range of ports' cargo forecasts.

Top 15 NO_x Categories: 2023 NO_x Emissions With Adopted Rules Preliminary SCAQMD Estimates¹

- Oceangoing Vessels
- Off-Road Eqt
- Heavy Duty Diesel Trucks
- Aircraft
- Large Stationary
- Light Duty Trucks
- Locomotives
- Recreational Boats
- Heavy Duty Gasoline Trucks
- Light Duty Cars
- Residential Fuel Combustion
- Commercial Boats
- Medium Duty Trucks
- Heavy Duty Buses
- Service/Commercial



1. Preliminary emissions estimates based on data updated from 2007 AQMP where available: CARB 2010 emissions projections for trucks and off-road equipment; IMO Tier 1 – 3 for ocean vessels; EPA 2008 rule for locomotives; 2007 AQMP short-term measures for other categories. Range for oceangoing vessels (20 -52) based on varying deployment assumptions for IMO Tier 2 and 3 vessels and range of ports' cargo forecasts.

2. 1997 80 ppb federal ambient ozone standard. Source: 2007 AQMP.

2011 AQMD Priorities

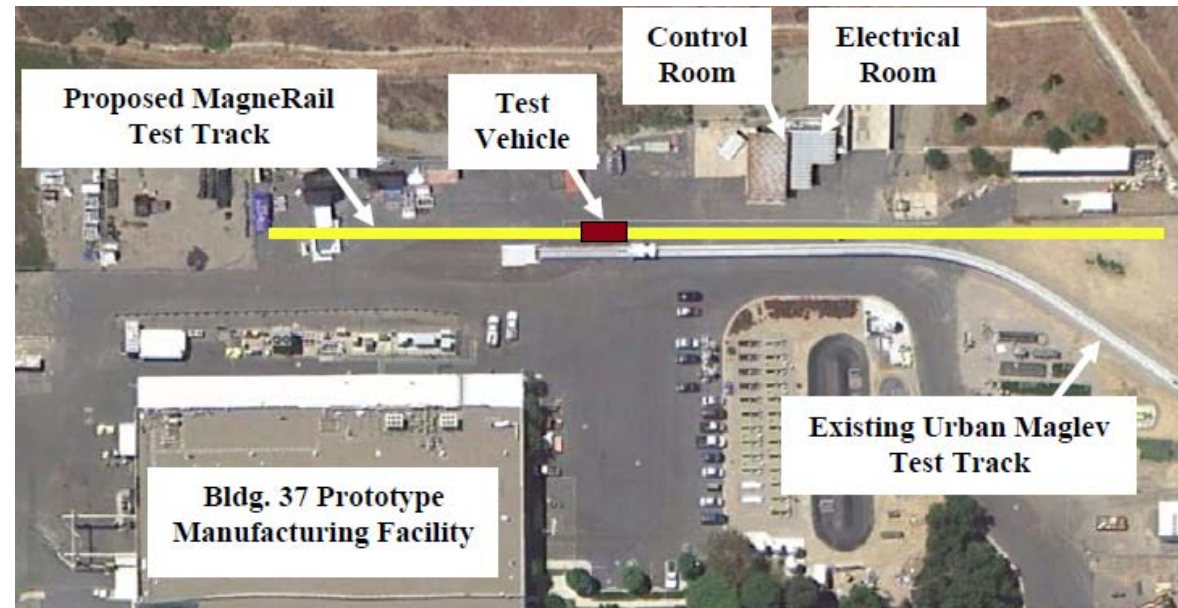
1. Commence demonstration/deployment of a zero-emission cargo container movement system.
2. Incentivize five megawatts of in-basin renewable distributed electricity generation and storage to support electric technology applications.
3. Make substantial progress in creating programs to facilitate construction of new and modified stationary sources in areas where the supply of emissions offsets is limited, consistent with AQMD's clean air objectives.

Proposed Zero Emission Goods Movement Projects

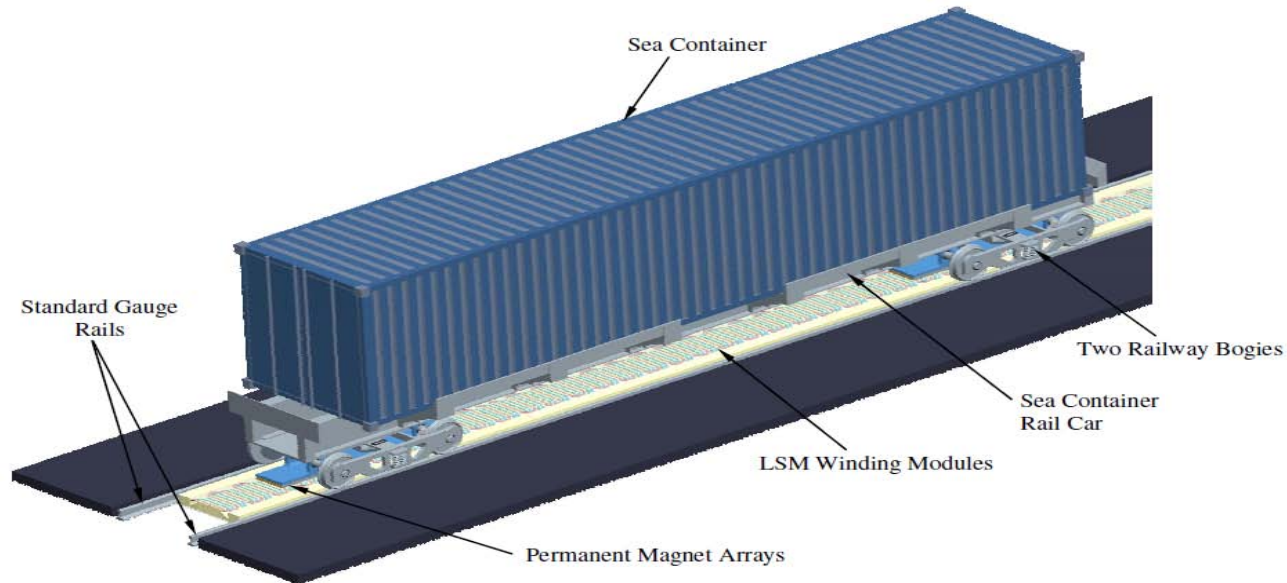
- Locomotive
 - Linear Synchronous Motor
- Trucks
 - Hybrid Electric

LSM Project Proposal

- Design, construct and test Linear Synchronous Motor (LSM) technology for locomotives
- Phase 1 demonstration
 - 600 ft test track at GA
 - Retrofit railcar
- Move and control fully loaded 67,000 lb 40-ft container
- Phase 2 later on longer track and more containers



LSM Technology Overview



- LSM motor windings encased in concrete modules attached to railroad ties
- Permanent magnet at the bottom of a rail car interacts with electro-magnetic field from the LSM modules

More Conventional Technologies

- Request for information: freight and passenger locomotive manufacturers
- Scope, cost, schedule and market
- Technologies to include, but not limited to
 - Catenary
 - Hybrids: battery + genset
 - Battery “tender car”
 - Dual mode

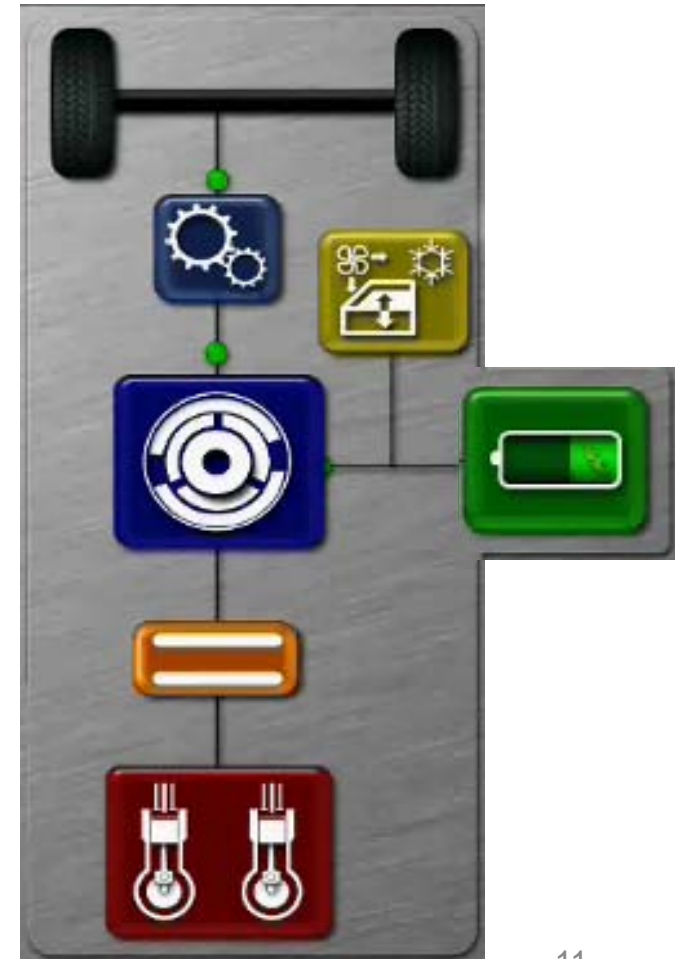
Volvo Project Proposal

- Develop a class 8 prototype parallel hybrid truck for drayage and regional delivery applications
- Engine downsizing in heavy haul applications
- Plug-in & charging technology to enable short distance zero emission driving
- 5 to 15 miles of potential all electric range



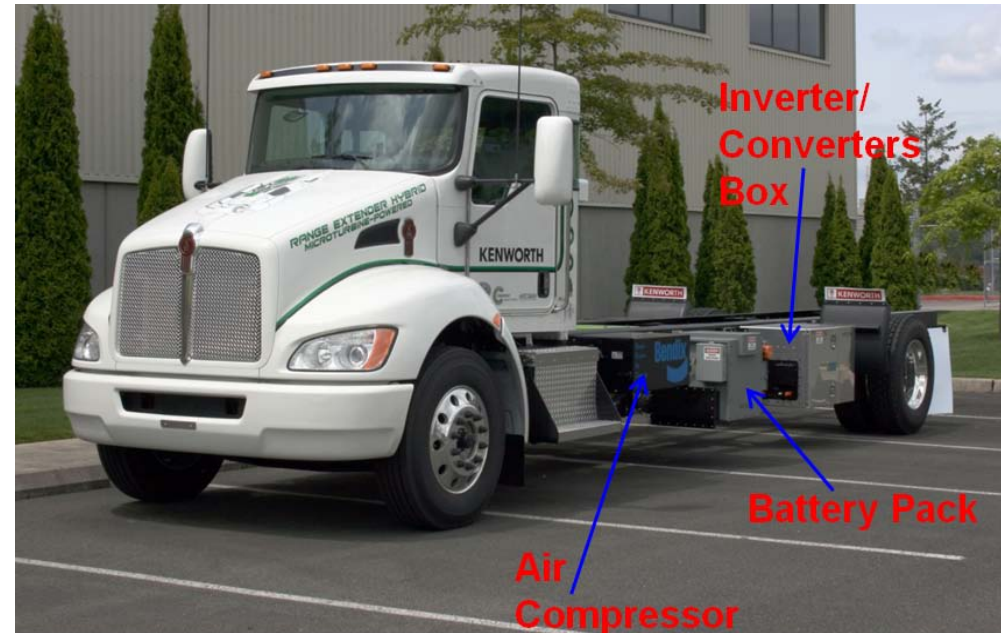
Volvo PHEV Technology

- Grid-charged electrical energy storage
- Regenerative braking
- Further potential evolution to a wayside power connection



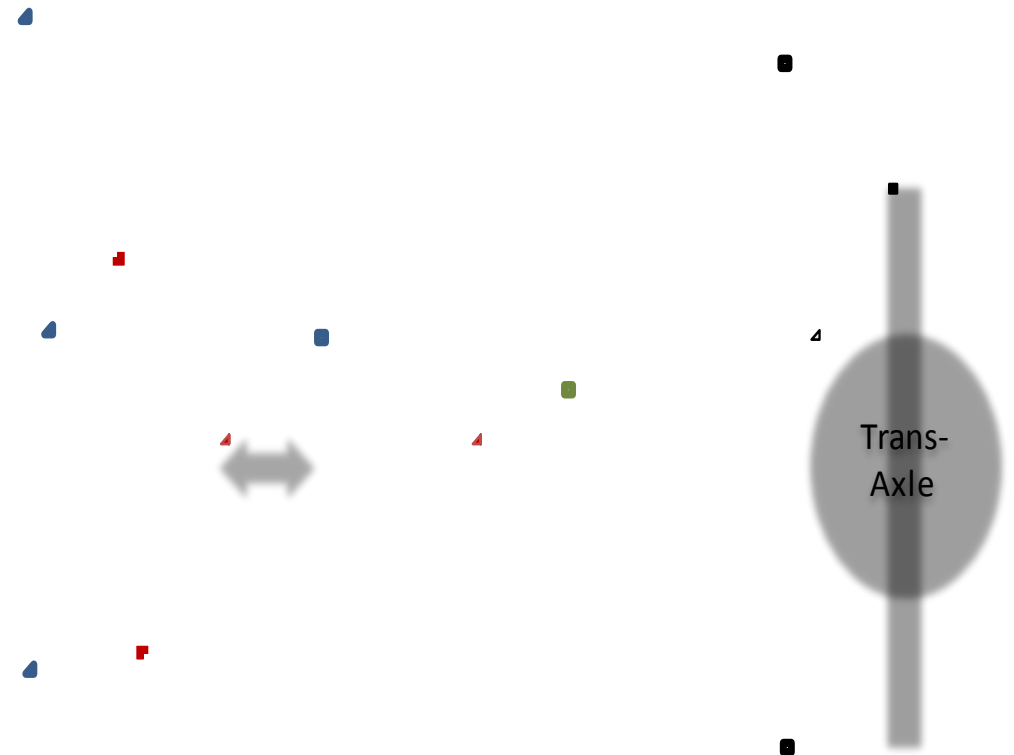
Capstone/Kenworth Project Proposal

- Validation of series hybrid system on a Class 7 refrigeration truck
- Optimize larger battery pack for 10 miles all electric range
- Quantify emissions and fuel consumption
- Costco fleet operation
- Investigate different fuels



Capstone/Kenworth Series Hybrid

- Plug-in series hybrid
- Up to 10 miles all electric range
- Microturbine for range extension
- NOx & PM emissions ~4x below 2010 standards
- Potential evolution to wayside power connection



TransPower Heavy Duty Electric Truck

- A zero-emission battery-electric drive system will be installed by TransPower into two Class 8 truck tractors
- The trucks will be placed into service moving containers at the Ports and intermodal facilities
- Demonstrate 100 mile round trip range
- Project will be springboard for rapid commercialization of a modular electric drive system



Figure 1. Conceptual layout of TransPower electric drive system in Navistar Class 8 truck.

TransPower Project Status Report

- Drive Train Component Selection, Sourcing And Procurement Continues
- Battery Testing And Sub System Development is Progressing
- Power Electronics Supplier Progresses in Design Of Inverter Charger
- Working Prototype Scheduled For October