CALIFORNIA CLEANER FREIGHT COALITION

MOVING CALIFORNIA FORWARD

Zero and Low-Emissions Freight Pathways

EXECUTIVE SUMMARY

JANUARY, 2014

ABOUT THE COALITION

The mission of the California Cleaner Freight Coalition is to create transformational changes to the freight transportation system in California in order to protect the public's health, clean the environment, and promote social justice and equity. We are a collaborative partnership of organizations committed to an inclusive membership, honest dialogue, respect for differences, and transparent decision-making. The Coalition includes grassroots environmental justice, environmental, science, and health groups.

ACKNOWLEDGEMENTS

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Cover photos, bottom left by East Yard Communities for Environmental Justice. bottom right by Jesse Marquez

Photo courtesy of CALSTART

CALIFORNIA NEEDS TO CLEAN UP ITS FREIGHT SYSTEM. The challenge is to continue moving goods within and through the state while meeting health-based standards for air pollution, protecting the health and well-being of freight-impacted communities, and reducing greenhouse gas emissions. Although freight transport is a vital part of a vibrant economy, the air pollution from freight transport and goods movement has a profoundly negative impact on the health and environment of adjacent communities and on our global climate. While the impacts of freight transport affect the global, regional and local environments, this pollution disproportionately impacts many low income communities and communities of color living in close proximity to freeways, ports, railyards and facilities with significant diesel truck activity. Many of these low income and people of color communities suffer a much higher burden of asthma and other illnesses due to pollution from freight transport and the cumulative impacts of many sources of pollution often present in these vulnerable, at-risk communities.

To better understand local, regional, and statewide opportunities to reduce emissions from the movement of goods in California, the California Cleaner Freight Coalition commissioned a report, ***Moving California Forward: Zero and Low-Emissions Freight Pathways***.[1] The study compares conventional diesel-based transportation to lower emission and advanced technology alternatives for both shorter and longer trips. The analysis helps answer a key question for those planning the future of the state's freight system: what are the alternatives to conventional diesel vehicles that offer the greatest air quality, health and climate benefits, measured in reduced emissions of particulate matter (PM2.5), oxides of nitrogen (NOx) and greenhouse gases (GHG)?[2]

The key report findings include:

- **Cleaner freight alternatives can go well beyond today's cleanest diesel and natural gas powered trucks to reduce PM, NOx and GHG emissions.**
- **Electrification provides the greatest overall reduction in pollutants, and can eliminate tailpipe emissions in communities where freight movement occurs, with electrification most applicable to local and short regional haul freight pathways.**
- **Moving goods by train and ship reduces GHG emissions compared to today's cleanest trucks, but the cleanest engine technologies (Tier 4, zero, or near zero-emissions) must be used to ensure emission reductions across all pollutants and freight pathways. Shifting container movement from truck to rail or water-borne transport must also be done in a way that reduces emissions, exposure and health risk to communities close to rail yards, lines, and shipping lanes.**

This analysis identifies the potential emission reductions that may be achievable from various strategies under specific assumptions. But the impact of freight transportation goes well beyond emissions of NOx, PM, and GHG. In practice, freight strategies must also be evaluated for a much broader set of impacts to public health, local communities, and the environment in order to determine the best solution for a particular freight project.

[1] The consulting firm of Gladstein, Neandross & Associates authored the report under a contract with the California Cleaner Freight Coalition. See the full report for explanations of transportation technologies, examples of use and information on technology maturity, availability, cost examples where available and local considerations.

[2] Emissions estimates are projected for the year 2020. Units are in grams of pollution for every ton of goods hauled one mile: g/ton-mile. In some cases, as marked, units are in grams of pollution per shipping container of goods. All estimates of particulate matter reported here are for PM2.5, fine particles with aerodynamic diameter of 2.5 micrometers or less."

LOCAL HAUL

THIS STUDY DEFINES A LOCAL HAUL FREIGHT PATHWAY as one where freight is moved a short distance (e.g., 80 miles per work shift), typically by trucks, between freight hubs. Examples of local haul include moving containers from a port facility to a local warehouse, across the U.S.-Mexico border, from airport cargo terminals to local warehouses, from marine port terminals to off-dock railyards, etc. The analysis shows that the short distances of these pathways make electrification a viable option for heavy-duty truck trips, and that, in certain areas, on-dock rail can eliminate local freight truck hauls altogether.

As compared to conventional diesel trucks meeting EPA's 2010 highway standards:

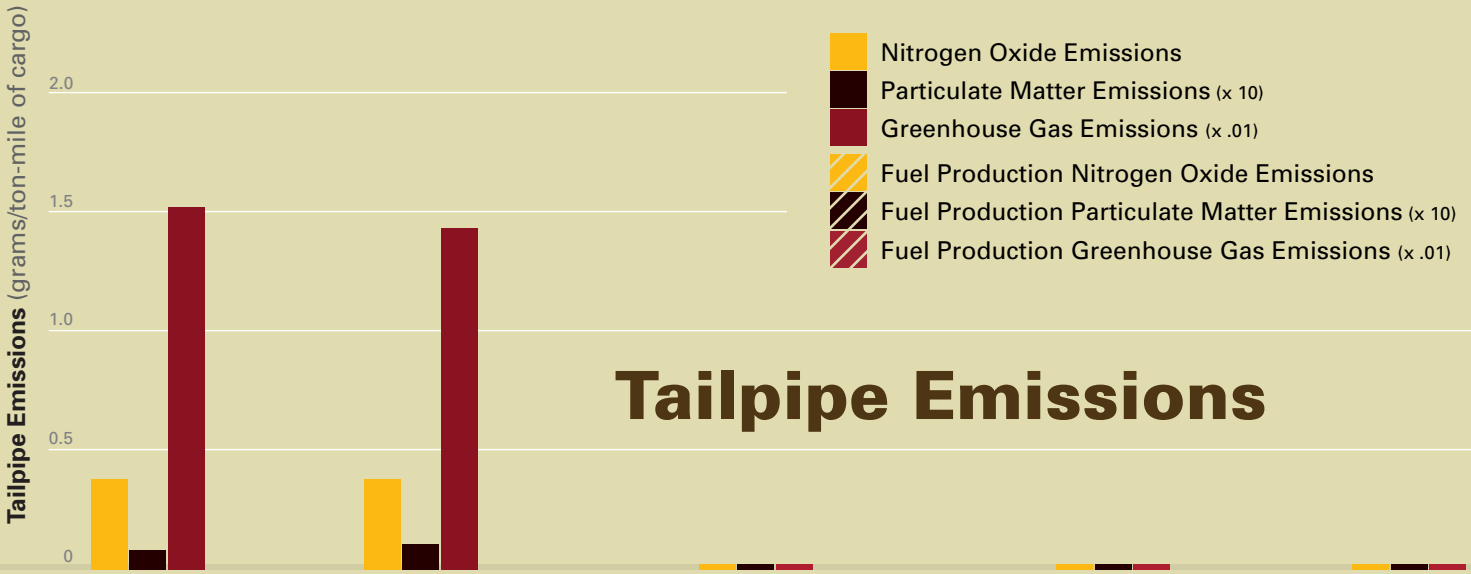
- Several electric and fuel cell technologies would have zero tailpipe emissions:[3] battery electric, plug-in hybrid electric,[4] fuel cell, electrified freight shuttle or fixed guideway and catenary electric trucks.
  - Even considering upstream emissions from power generation providing the electricity, the electric technologies would still reduce emissions roughly 90 percent or more for PM, NOx and GHGs.[5] Further, as the state moves to higher and higher levels of generation from renewable power, these emission reductions will grow.
  - Fuel cell trucks that use hydrogen produced primarily from natural gas show only slightly lower net PM emissions (11 percent) relative to new diesel trucks, largely due to the steam reformation process to produce hydrogen from natural gas; NOx emissions are reduced 84 percent in total and GHGs are cut in half. Greater use of renewable hydrogen or improved hydrogen production methods could cut fuel cell emissions relative to conventional technology.
- Natural gas trucks meeting the latest heavy-duty engine standards can reduce net PM emissions (22 percent) but do not significantly reduce NOx emissions levels (6 percent decrease). The reductions stem from differences in upstream emissions for natural gas and diesel, as natural gas and diesel trucks are subject to the same engine standards for criteria pollutants. Natural gas trucks, while having lower tailpipe CO_2 emissions, are estimated to have similar net GHG (4 percent greater) emissions as diesel over the full fuel cycle.

[3] Electric vehicles with zero tailpipe emissions would still generate fugitive dust emissions from re-entrained roadway dust, and brake and tire wear.

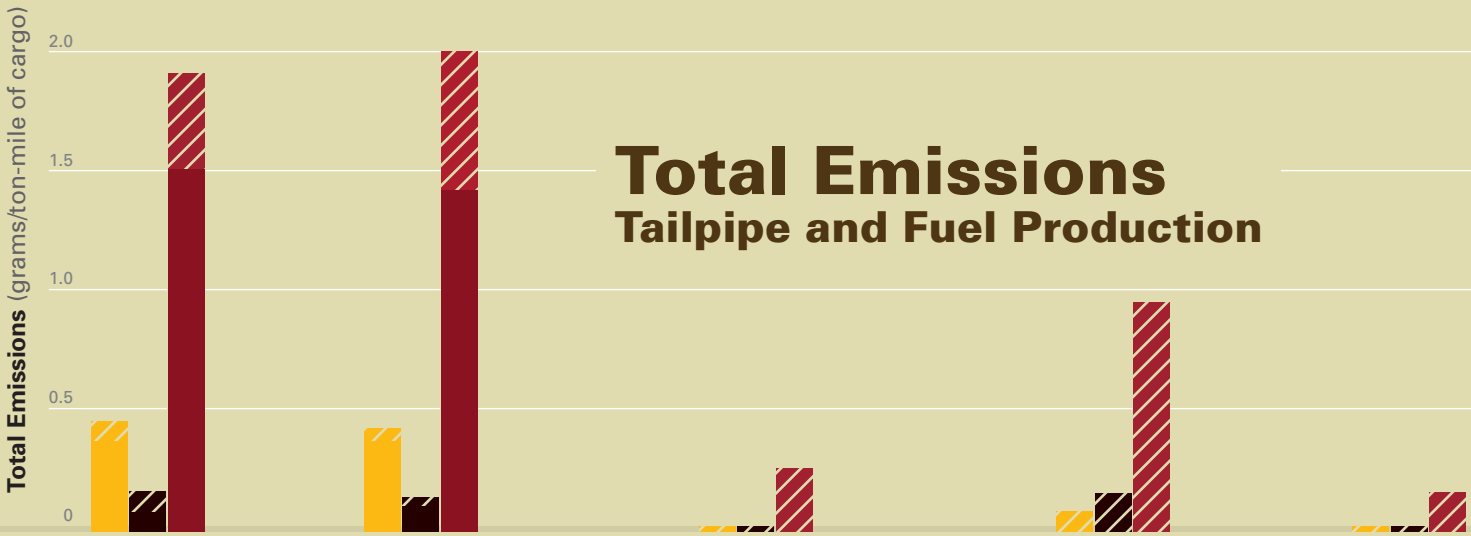
[4] Plug-in hybrid electric trucks would have zero tailpipe emissions in the short-haul setting because they would be operating within the range of their electric batteries; they may rely partly on a fossil fuel powered motor if operated beyond that range.

[5] Emission rates for electricity generation are based on projections for 2020 by the Air Resources Board.

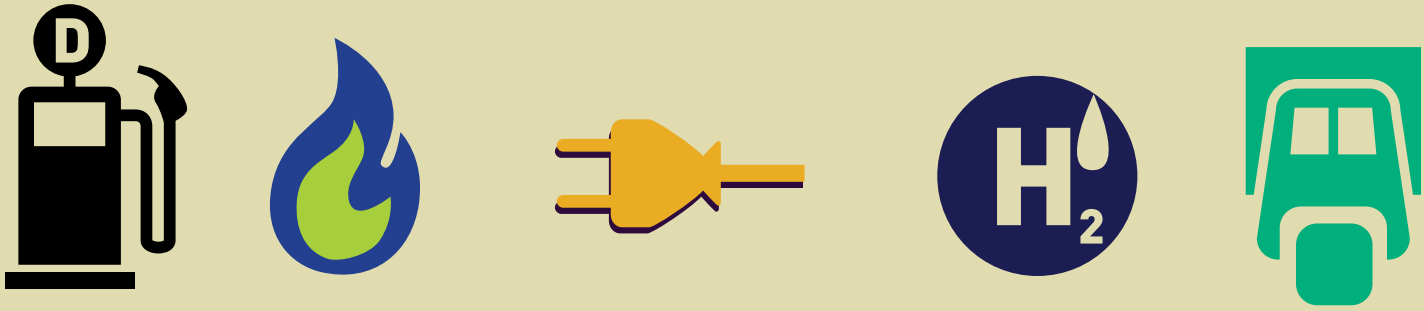
POLLUTION FROM LOCAL HAUL TRUCKING



Tailpipe Emissions



Total Emissions
Tailpipe and Fuel Production



DIESEL
2010 standards
(Low Carbon Fuel Standard compliant 2020 diesel fuel)

NATURAL GAS
2010 standards
(100% fossil fuel)

ELECTRIC
Battery Electric, Plug-in Hybrid Electric or Catenary
(100% Electric Operation, CA 2020 Grid Mix)

HYDROGEN FUEL CELL
(80% Natural Gas, 20% Renewables)

ELECTRIC FREIGHT SHUTTLE
(CA 2020 Grid Mix)

NOTE: Three local trucking technologies have zero tailpipe emissions – Electric, hydrogen and freight shuttles; although these technologies lead to some emissions for electric power and/or fuel production, these emissions are likely to occur outside of freight-impacted communities. Emissions estimates are for the year 2020. Emissions for diesel and natural gas trucks meeting model year 2010 engine standards trucks were estimated using the EMFAC 2011 model which includes reductions in future diesel fuel carbon intensity consistent with the Low Carbon Fuel Standard and other state and federal regulations. Tailpipe emissions estimates do not account for possible variations in emissions certification testing data between natural gas and diesel engines. Diesel and natural gas fuel production emissions are based on GREET 2012 v2. It should be noted that GHG emissions estimates for natural gas production were adjusted downward in the latest update to the GREET model which occurred after this analysis was completed; this continues to be an on-going area of research. Emissions for electricity and hydrogen powered solutions are based on Air Resources Board estimates from Vision for Clean Air: A Framework for Air Quality and Climate Planning analysis. The data in these charts is from the full report, figures 2, 3 and 4; See full report for further details.

- Fossil fuel (diesel and natural gas) powered trucks may be able to meet more stringent NOx standards in the future. The CA Air Resources Board has just adopted voluntary NOx emission certification levels from 50 to 90 percent below current 2010 standards.[6] However, there are no current proposals to further reduce tailpipe PM emissions beyond current 2010 emissions standards.

- On-dock rail is a strategy at marine terminals that can eliminate traditional cargo handling and local haul trucking where containers are headed for "near-dock" railyards, significantly reducing emissions at the terminals if done properly.
  - When containers are loaded directly from ship to rail (with Tier 4 locomotives) instead of being trucked and lifted onto rail cars at an off-site rail yard, those efficiencies reduce all emissions by roughly 70 percent or more.[7]
  - On-dock rail as it is currently done at many ports can include some inefficiencies such as unloading containers from ships, transporting them to terminals and separately loading them to railcars in other areas. This still saves a longer truck trip to an off-site rail yard but can limit the emission savings of the effort. However, even this type of on-dock rail operation provides many non-emissions related benefits by limiting truck traffic to port terminals, including reduced local traffic congestion and reduced truck parking or queuing in nearby neighborhoods. Direct comparisons are difficult due to insufficient emissions data from on-dock rail operations.

[6] The South Coast Air Quality Management District currently has a project to develop natural gas trucks that reduce NOx 90% below 2010 EPA standard. See SCAQMD Governing Board meeting, 10/4/13, Agenda Item No. 9.

[7] GRID Logistics is another technology that could eliminate the need of drayage trucks between port terminals and local railyards or warehouses. See http://s474091609.onlinehome.us/gridweb/

REGIONAL FREIGHT PATHWAYS

REGIONAL FREIGHT PATHWAYS capture the movement of goods across or between regions within the state, and may be carried out by trucks, rail, or ships. Examples of these pathways include transporting containers from a port terminal to a distribution center or rail yard via either rail or trucking;[8] sending agricultural products on a barge from Stockton to Oakland for export, and putting a truck trailer on a flatbed railcar for transit through the Central Valley.

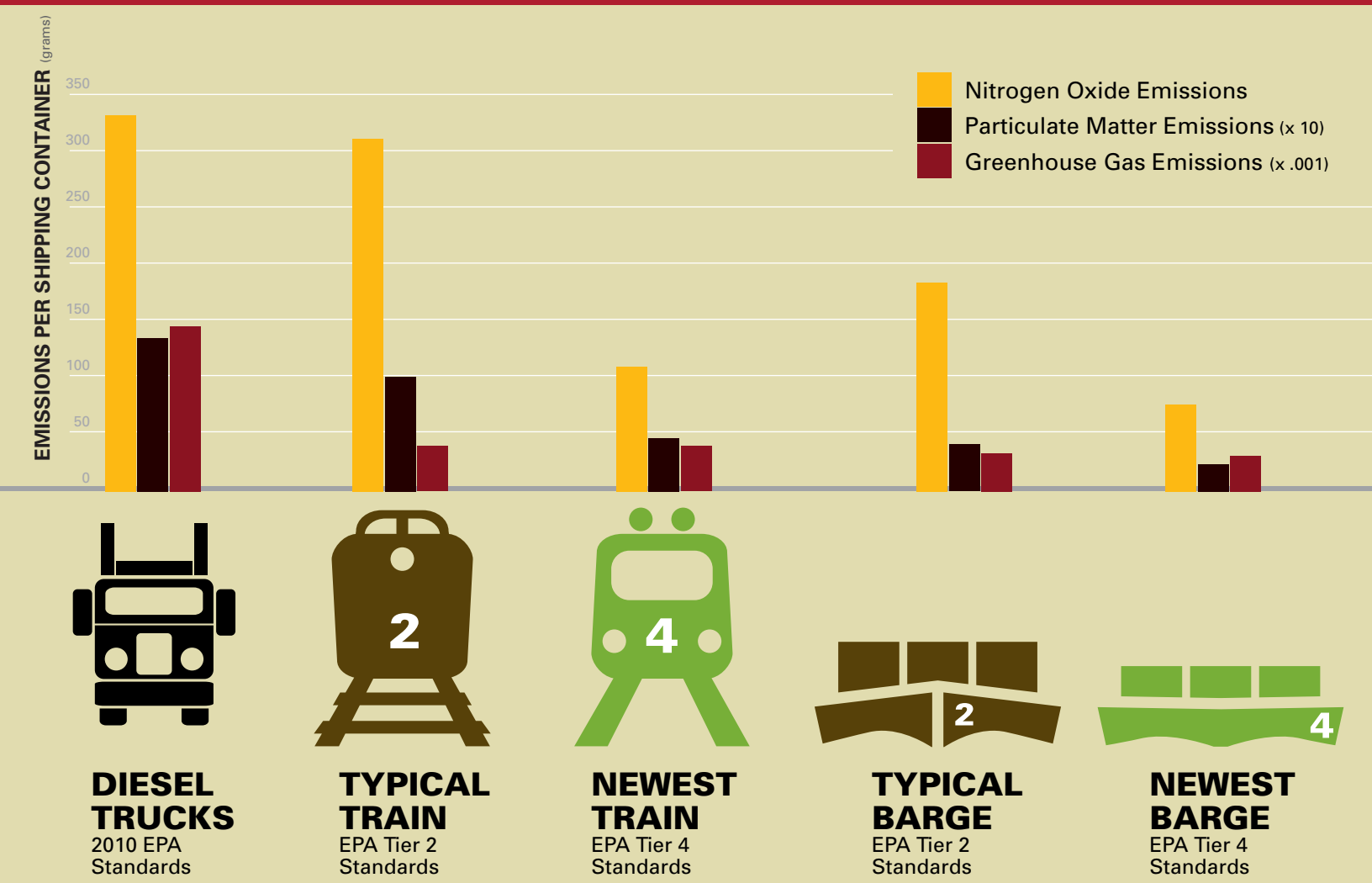
The analysis finds the following relative to conventional diesel trucks meeting EPA's 2010 highway standards:

- Transporting containers by rail can dramatically reduce emissions if containers are double-stacked on railcars. For example:
  - Diesel locomotives can reduce GHGs by 84 percent. Depending on whether older switcher and line haul locomotives (Tier 2) are used or newer (Tier 4) locomotives, PM and NOx reductions range from 40 to 77 percent and 20 to 79 percent respectively.
  - Electrifying the rail line (e.g., the Alameda Corridor in Southern California) would bring local tailpipe emissions to zero, with total emission reductions of 94 to 99 percent.[9]
- Short-sea shipping (on barges), where possible, can result in significant emission reductions of all pollutants. In California, such an option is available in the San Francisco Bay-Delta area and would allow for transport of agricultural and other commodities between the ports of Oakland, Stockton and West Sacramento. Note: This scenario is shown in the figure on page 6.
  - Using a barge instead of a new truck to transit the 70 to 80 miles between the Ports of Oakland and Stockton can reduce PM emissions by 70 to 84 percent, NOx emissions by 46 to 80 percent and GHGs by 76 percent, depending on the age of the barge.
  - Compared to rail transport along the same route using a new locomotive (Tier 4), a new barge (Tier 4) will cut NOx and PM emissions by 50 to 60 percent and GHG emissions by 33 percent. In contrast, using a Tier 2 barge would significantly diminish the benefits of short-sea shipping compared to Tier 4 rail and is estimated to result in greater NOx emissions.

[8] A 25-mile distance for this pathway is modeled in this analysis.

[9] Note that the very small remainder of emissions from electric rail comes from the power generation of electricity used by the locomotives.

FREIGHT POLLUTION FROM REGIONAL TRUCKS, TRAINS AND BARGES



NOTE: Emissions estimates include both those from the tailpipe and from fuel production. For rail and barge estimates, emissions related to cargo equipment used to load containers onto the barges and trains are included. These estimates assume 70 miles of travel by truck and 80 miles of travel by rail or barge and are applicable to freight pathways such as transporting containers from a port terminal to a distribution center or rail yard via either rail or trucking or sending agricultural products on a barge from Stockton to Oakland for export. Emissions data comes from U.S. EPA, the CA Air Resources Board, a Port of Long Beach emissions inventory and a Texas Transportation Institute study of short-sea shipping. The data in these charts is from the full report, Figure 13. See full report for further details.

- Trucks on rail flatcars can significantly reduce all pollutants when using the cleanest rail technology for containers transiting through the San Joaquin Valley. (Note: This scenario is not pictured in the figure above.)
  - Compared to new trucks, locomotives meeting Tier 4 standards cut NOx and PM emissions by more than half for trips through the San Joaquin Valley using truck trailers on flatbed railcars. CO2 is reduced by almost 70 percent.
  - Where rail is used, it is critical to use the cleanest (Tier 4) locomotives. Although most trains in operation today (meeting Tier 2 standards) would substantially reduce GHGs, they would emit more PM and NOx (23 percent and 59 percent respectively) than 2010 trucks.
- In order to meet health-based clean air standards and reduce health risks in local communities, locomotive technologies need to go beyond Tier 4 standards, and the state should start planning this transformation now.[10]

[10] California Air Resources Board, Public Review Draft, Vision for Clean Air: A Framework for Air Quality and Climate Planning, at 27, June 27, 2012, available at http://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf.

STATEWIDE FREIGHT PATHWAYS

THE ANALYSIS ALSO LOOKS AT OPTIONS for improving freight movement efficiency more generally. The report explores the benefits of logistics and efficiency improvements like Virtual Container Yards and shifting container transport to more efficient modes (e.g. truck to rail). The analysis concludes:

- System-wide logistics and efficiency improvements can be an effective way to reduce truck traffic and pollution, but these benefits are difficult to quantify.
  - Virtual Container Yards are online managements systems that connect trucking companies that have empty containers with those nearby who could use them, which reduces empty container transport. Several studies have estimated that up to 10 percent of container truck traffic could be reduced in Southern California by 2020 with the use of VCYs.
  - The City of Fukuoka in Japan reported a 67 percent reduction in freight trips and 87 percent reduction in freight miles on the road after taking a centralized approach to consolidating and managing logistics of urban delivery and freight traffic.

- Shifting containers from truck to rail transport must be done with very careful consideration of residential proximity to rail yards, rail lines, and shipping channels because of the potential for heightened emissions in nearby neighborhoods. Any increase in rail transport must be accompanied by use of the cleanest equipment including zero and near-zero technology where feasible.
  - Over long distances, for example considering a 400-mile route, double-stacked trains can substantially reduce NOx, PM and CO2 emissions compared to diesel trucks.
  - Where Tier 4 locomotives are used, whether diesel or natural gas powered, the NOx, PM and GHG emissions are reduced roughly 80 percent compared to diesel trucks meeting the latest emission standards (over a 400 mile route).
  - Even greater reductions would be possible with electrified rail lines.

California Department of Transportation

THIS ANALYSIS PROVIDES AN IMPORTANT PICTURE of emissions savings potential from various freight pathway alternatives.[11] We can conclude with confidence that cleaner freight alternatives can be deployed that go well beyond today's cleanest diesel and natural gas powered trucks to reduce PM, NOx and GHG emissions. But it is important to note that emissions estimates were limited to NOx, PM and GHGs. Building on this research, a broader assessment of the impacts of freight transportation is necessary. For example: short-sea shipping may cause significant impacts to water quality or fragile ecosystems, and higher rail utilization could increase vehicle congestion if new grade separations are not built. Moreover, different strategies will impact different areas. Thus, the geographic location of the emissions is critical to assessing the health impacts to affected communities. Specific freight projects or strategies must be examined in greater detail and breadth to fully understand the range of impacts.

What is clear from this analysis is that a system-wide overhaul of our current freight system to incorporate advanced clean technology and more efficient logistics could dramatically reduce air pollution and improve public health in the freight impacted communities that need those benefits the most.

[11] Note however, that there are several additional freight strategies that were not considered within the scope of the study. For example, the analysis did not include an examination of low-carbon, non-food based biofuels, or operational changes in the trucking sector, such as higher weight limits, classification of drivers as employees instead of independent contractors, longer trailers, or truck only lanes.

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