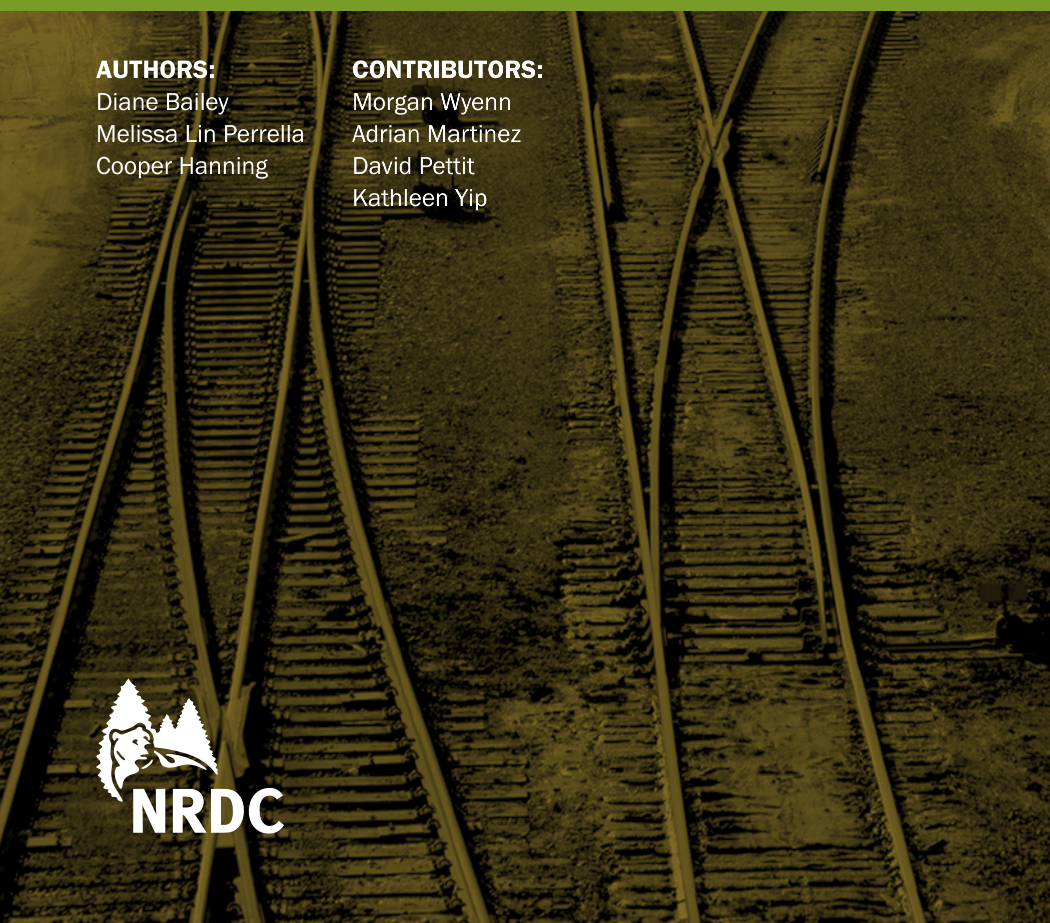
CLEAN CARGO

A GUIDE TO REDUCING DIESEL AIR POLLUTION FROM THE FREIGHT INDUSTRY IN YOUR COMMUNITY



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Acknowledgments:

The NRDC's Clean Cargo series was made possible by the generous support of The Kresge Foundation, which is dedicated to improving the health of communities and workers affected by the freight transportation industry.

The authors would also like to thank the reviewers of this toolkit: Andrea Hricko, Martha Matsuoka, Kim Knowlton, George Peridas, and Christina Swanson.

We are also grateful for contributions from Rich Kassel, Deb Niemeier, Dana Rowan, Alex Karner, Amanda Peterson, Shilpi Chhotray, Andrea Spacht, Alex Kennaugh and Jessica Lass.

TABLE OF CONTENTS

CLEAN CARGO: ACTIONS TO MODERNIZE AMERICA'S FREIGHT INDUSTRY AND PROTECT COMMUNITIES

Freight transportation promises communities an influx of jobs and other economic benefits. But along with the flow of trucks, trains, and ships, comes traffic congestion, noise, and air pollution that takes a heavy toll on human health. Nationwide, communities in proximity to ports, rail yards, highways, and warehousing hubs are the most vulnerable to this pollution and pay with their health while dirty industries continue to rely on toxic, fossil-fuel powered vehicles. Fortunately, solutions exist to protect our health and environment from these dangers.

In this Clean Cargo series, we provide a brief summary of the health effects of air pollution created by the freight transportation system and outline available measures for cleanup. We detail specific cleanup measures for trucks, rail yards, ports, warehousing hubs and construction areas with a summary of best measures and practices in each sector. Each sector factsheet also includes real-world clean cargo examples showing how the cargo industry has already begun adopting limited reforms, and providing evidence that cleaner solutions can work in communities like yours.

This information can be used to help advocates articulate a specific vision for cleaner air in their neighborhoods. Community leaders may utilize these materials as they encourage government agencies to adopt clean-air policies or regulations, negotiate community benefits agreements, and draft settlement agreements that aim to protect residents from air pollution. These materials can also assist communities as they advocate for public health protections under the National Environmental Policy Act (NEPA), which allows the public to propose mitigation and alternatives in connection with many freight transportation projects.

HEALTH EFFECTS

Most of the equipment used in freight transportation—including trucks, trains, ships, and cranes—is powered by diesel engines. These engines emit fine particulate matter (particles that are 2.5 microns or less in diameter or "PM2.5"), nitrogen oxides (NOx), and volatile organic compounds (VOCs) along with many other toxic chemicals. Most of the PM emitted by diesel engines consists of tiny particles, called ultrafine particles that are less than 0.1 micron in diameter.

HEALTH EFFECTS OF PARTICULATE MATTER

Numerous studies have documented a wide range of adverse health impacts from exposure to PM, including increased rates of respiratory illness and asthma, cardiovascular disease, heart attacks, strokes, emergency room visits, and premature death.[1] Near-roadway exposure to particulate matter has also been linked to birth defects, low birth weights, and premature births.[2] Emerging studies have shown a potential connection between exposure to fine PM and diabetes, as well as cognitive decline and other serious impacts to the brain.[3]

Small particles (PM2.5) can get deep into your lungs, and from there can even get into your bloodstream, causing a wide range of health impacts.

HEALTH EFFECTS OF NITROGEN OXIDES

NOx can have a toxic effect on the airways, leading to inflammation, asthmatic reactions, and worsening of allergies and asthma symptoms.[4] In addition, NOx reacts with VOCs in sunlight to form ozone—also known as smog. This layer of brown haze contributes to decreased lung function and increased respiratory symptoms, asthma, emergency room visits, hospital admissions, and premature deaths.[5] Ozone can also cause irreversible changes in lung structure, eventually leading to chronic respiratory illnesses, such as emphysema and chronic bronchitis.[6]

ENCROACHMENT OF FREIGHT ON COMMUNITIES

In addition to air pollution, health and climate impacts, freight transportation can have profoundly negative impacts on the quality of life for nearby communities. Industrial freight operations increase levels of noise, traffic, light, and vibrations. The imposition of freight in a residential area can carry blight with it—imagine living next to tall stacks of rusted-out shipping containers and chain link fences. It is not uncommon to see heavy-duty trucks lining neighborhood streets, posing a safety threat to residents, idling engines outside residents' windows. In short, the semi-traffic associated with freight hubs often changes a neighborhood for the worse. The Trade Health and Environment Impact Project has a number of resources that explore these impacts and provide recommendations for advocates seeking to improve the effect of global trade on local communities.

See: www.TheImpactProject.org

HEALTH EFFECTS OF DIESEL EXHAUST

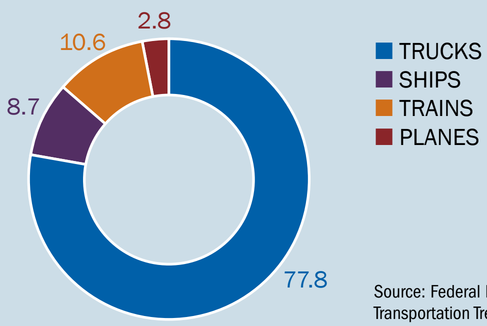
The soot in diesel exhaust—diesel PM—is especially toxic, not only due to the very small size of the soot particles (see above), but also because these particles contain roughly 40 different toxic air contaminants, 15 of which are recognized carcinogens (cancer-causing agents).[7] In fact, diesel PM itself has been identified as a carcinogen by the World Health Organization as well as the State of California,[8] which lists it as a "Toxic Air Contaminant." Dozens of studies have shown a high risk of lung cancer in occupations with high diesel exposures, including rail workers, truck drivers, and miners. Recent studies of miners indicate that the most heavily exposed workers have a risk of lung cancer approaching that of heavy smokers; studies also show that elevated risks of lung cancer apply not only to workers but to the general population in areas with high levels of diesel PM (e.g., near freeways and busy freight corridors).[9] Moreover, diesel pollution is estimated to contribute to roughly 60,000 or more premature deaths attributable to outdoor air pollution in the U.S.[10]

People who live or go to school near ports, rail yards, distribution centers, and other diesel "hot spots" face disproportionately higher exposure to diesel exhaust and associated health impacts, including increased risks of asthma and other respiratory effects, cancer, adverse birth outcomes, adverse impacts to the brain (including potentially higher risk of autism),[11] heart disease, and premature death.[12]

CLIMATE EFFECTS

Burning fossil fuels, including diesel fuel, produces greenhouse gases (GHGs) like carbon dioxide. These gases trap heat in Earth's atmosphere, and this is changing our global climate system.[13] The U.S. is one of the biggest emitters of GHGs, and freight movement constitutes roughly one quarter (24.7 percent) of transport-related emissions and 6 percent of all greenhouse gas emissions in the U.S.[14] Diesel engines used in freight are also a major source of black carbon, now thought to be one of the leading warming pollutants in addition to greenhouse gases. Black carbon soot can travel far from it source, absorbing sunlight, radiating heat, and speeding up the unprecedented melting taking place in the Arctic and glacial regions.[15]

FREIGHT-RELATED GREENHOUSE GAS EMISSIONS (% OF TOTAL)



Source: Federal Highway Administration, "National Freight Transportation Trends and Emissions," 2001.

FREIGHT SOURCES OF AIR POLLUTION

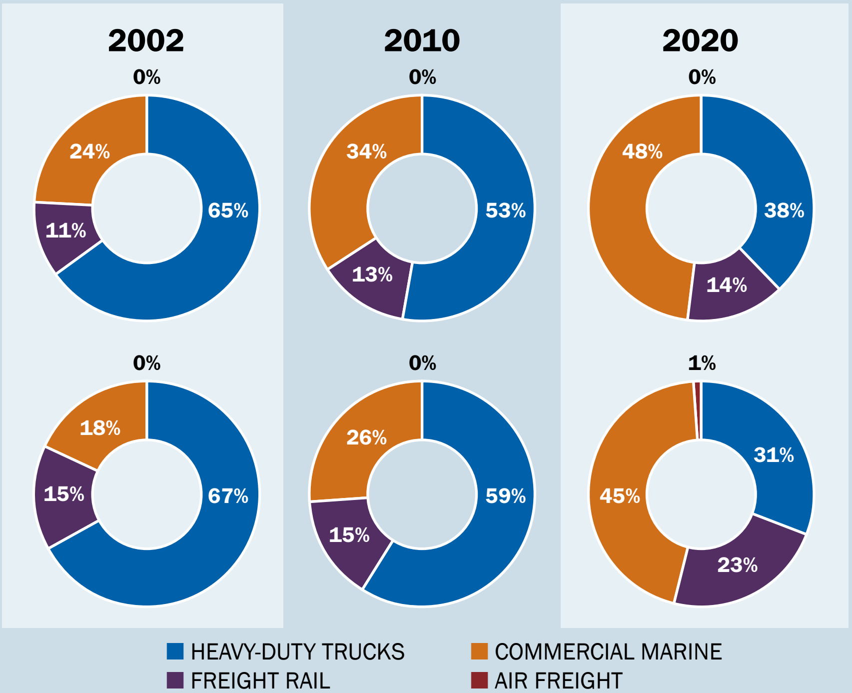
HEAVY-DUTY DIESEL TRUCKS

U.S. annual freight volumes have more than tripled since 1965, from 1.2 million ton-miles to more than 4 million ton-miles.[16] Nearly one-third of the total is handled by heavy-duty diesel trucks.[17] Large trucks constitute only 4 percent of the vehicles on U.S. roads and travel only 7 percent of overall miles,[18] but they emit 19 percent of transportation-related GHGs, 33 percent of NOx, and 23 percent of PM-10 (that is, particles that are 10 microns or less).[19] Large trucks are responsible for 5 percent of overall U.S. GHG emissions.[20]

FREIGHT RAIL

Railroads accounts for only 0.6 percent of total U.S. greenhouse gas emissions (and 2.2 percent of transport-related pollution). However, they are unusually dirty, accounting for 7.5 percent of NOx emissions and 4.1 percent of PM10 emissions.[21] Emissions standards for locomotives lag behind those for trucks. As a result, intermodal rail yards (which facilitate cargo movement between diesel-powered locomotives, trucks, and cargo equipment) create significant air pollution related health risks for nearby commnities.

NATIONAL FREIGHT SECTOR EMISSIONS



Source: Bureau of Transportation Statistics, "National Transportation Statistics 2011;" Federal Highway Administration, "National Freight Transportation Trends and Emissions, 2011."

COMMERCIAL MARINE

Ships are a more fuel-efficient method of moving freight than trucks. However, they employ dirty engines that burn bunker fuel and emit large amounts of NOx, SO2 and PM pollution. The bunker fuel that most ships burn is among the dirtiest fuel available, with sulfur levels more than 1,000 times greater than the diesel fuel used by trucks and locomotives.[22] Fortunately, this is beginning to change with cleaner marine fuel requirements in California and elsewhere throughout North American coastal waters via the designation of Emission Control Areas (ECA) by the International Maritime Organization.[23] In spite of these efforts, ships produce the greatest share of the PM10 attributed to the U.S. freight sector, growing from 26 percent in 2010 to 44 percent in 2020, despite carrying only 18 percent of freight. Furthermore, the ports where ships load and unload cargo are home to large numbers of trucks and cargo-handling equipment which serve to concentrate emissions in small areas of our port cities.

AIR FREIGHT

Shipping by air is the least efficient means of moving freight and is much more expensive than other alternatives. Consequently, it accounts for just a fraction of 1 percent of total freight moved but can be more than 100 times more polluting than other transportation modes for GHGs.[24]

CLEANUP STRATEGIES

Fortunately, there are many strategies that can be used to reduce the carbon footprint and air pollution impacts of freight transport. In these materials, we discuss a number of initiatives that can be adopted to clean-up freight transportation operations and reduce community exposure to diesel pollution. Determining which measures to advocate for in a particular situation may depend on a number of variables such as the type of project, the extent of the air quality and health impacts of the project, community leverage, cost, political will, and market forces. Further, a strategy that works well in one area may not be the best fit for another area.

When advocating for clean-up strategies for your community, it may be helpful to distinguish between strategies that can be implemented quickly from those that require construction of new infrastructure or further research and development. For example, while older diesel trucks can be cleaned up today through engine replacements or retrofits, shifting to electrified rail will require longer to employ since the infrastructure is not yet in place in most U.S. cities. Similarly, while ship operators should be encouraged to use cleaner fuel today, additional infrastructure investments may be necessary before shoreside power can be required at many ports. Ideally, the most effective freight clean-up plans include short term actions that immediately reduce pollution, and long-term measures that may require additional investment and resources but will result in greater public health benefits. These materials provide a menu of options that can be adopted right away as well as others that can be phased in over a longer term. From these options, advocates can develop specific clean-up strategies tailored to fit their local needs based on the following recommendations.

SHIFT THE MODE OF TRANSPORT

Moving freight using more energy-efficient means can reduce overall pollution while transporting the same amount of cargo. Trains are more efficient than trucks, moving more goods while emitting fewer greenhouse gases.[25] However, old, highly-polluting locomotives can concentrate toxic emissions in neighborhoods near tracks and rail yards, leaving some communities to bear a disproportionate burden, especially when locomotives are allowed to idle for long periods of time. Increasing rail cargo can have significant environmental benefits as long as the cleanest locomotives are used, including, in some cases, electrified rail lines.

ELECTRIFY FREIGHT

Shifting from fuel combustion to electric power along any part of the supply chain reduces pollution and greenhouse gas emissions. All elements of freight transport can benefit from electrification. Ships can connect to shore-based electric power and turn off their engines when in port.[26] Plug-in and hybrid-electric trucks and cargo-moving equipment are currently available and in use in some ports and cities in the U.S.[27] Electric freight rail is widely used throughout Europe and Asia.[28] Hyrbrid electric tugboats can also be used.

DIESEL CLEANUP IS EXTREMELY COST-EFFECTIVE

In the U.S., it is estimated that the health benefits of reducing PM2.5 emissions will be $270,000 to $1.1 million per ton of PM2.5 by the year 2030. The cost of new diesel-engine controls is estimated at less than $13,000 per ton of PM2.5 reduced. That means that the benefits of diesel PM controls could outweigh costs by at least a factor of 20, and perhaps much more.

Further, many funding programs are available to help offset the cost of cleaner, more efficient upgrades. The latest information on these programs can be found at **www.epa.gov/cleandiesel/grantfund.htm**.

Source: US EPA, "Report to Congress on Black Carbon," March 2011, yosemite.epa.gov/sab/sabproduct.nsf/0/05011472499c2fb28525774a0074dade!OpenDocument&TableRow=2.0#2.

INCREASE FUEL EFFICIENCY

All segments of the freight system can be made more efficient so they run farther on a gallon of fuel. Important efficiency measures for all modes of transport include eliminating unnecessary idling and redesigning vehicles and vessels to reduce drag. Trucks can be built with aerodynamic fronts and fitted with panels to reduce drag, and ships can use improved hull and propeller designs to move through the water more easily.[29] Lighter-weight components can be used on trucks, ships, locomotives, and cargo equipment to further reduce fuel use.

USE NEW ENGINES

Modern standards have made virtually all diesel engines made today dramatically cleaner than previous models. Replacing old diesel engines with cleaner, newer models can significantly reduce smog-forming NOx emissions as well as PM. For example, the Port of Los Angeles reports that it reduced truck emissions by 80 percent by requiring the use of newer truck engines in the port.[30]

FILTER DIESEL EMISSIONS

Diesel engines can be fitted with diesel particulate filters, which reduce emissions of harmful PM by more than 90 percent. These are included with all new truck engines and can be retrofitted onto existing ones. New locomotives and cargo equipment will be outfitted with these filters beginning in 2015 and 2014, respectively.

BEYOND CLEANUP MEASURES

In addition to the cleanup strategies articulated here, efforts to estimate emissions from freight projects and monitor air pollution levels are an important complement to ensuring that cleanup strategies are appropriate and effective. Proponents of any new freight project need to take the time to characterize the existing baseline emissions as well as the additional emissions that new or expanded projects would bring. Where emission inventories do not currently exist, existing freight projects would also benefit from an inventory to help inform the selection of cleanup measures. However, the absence of an emission inventory should not delay implementation of cleanup measures where they are under way.

Emission monitoring— that is, measuring the levels of air pollution at breathing level—can help determine the extent of health hazards and document increases in pollution or improvements. Air monitoring in a community can be most effective when multiple monitors are placed in locations upwind of a freight pollution source and downwind as close as possible to the nearest impacted residence, school, or sensitive land use. Information from air monitors and emission inventories can be used to map pollutant levels across a community.

Reducing port pollution levels directly is always a top priority. However, offsite mitigations—including use of indoor air filters and outdoor barriers like vegetation—can also reduce community exposure. Studies show greatly increased pollutant levels and health impacts in close proximity to freeways and other major diesel freight facilities. These scientific findings prompted the California Air Resources Board (CARB) to recommend a suite of guidelines in 2005 urging local governments to specify safe distances of separation between housing and other sensitive sites and busy roadways, ports, rail yards, and distribution centers, among other pollution sources.[31] The guidelines cited traffic-related studies showing serious health risks attributable to living and going to school within 1,000 feet of these types of diesel sources. Since then, policies have been developed to require more health-protective land use planning near major sources of diesel pollution, including a public health ordinance in San Francisco that requires indoor air filters for some new housing projects where particulate levels are high; school siting guidelines for the Los Angeles Unified School District; several regional project environmental screening policies; and several urban general plans discouraging housing within 500 feet of freeways and similar diesel sources.[32]

See the sector fact sheets for targeted cleanup strategies and examples of clean technology already in use.

GOLD STANDARDS FOR TRUCKS: A CLEANER, LOW-CARBON FLEET

Diesel trucks emit large amounts of unhealthy air pollution and climate-changing greenhouse gases, which damage our health and environment. This pollution can be particularly harmful to the health of people who live in areas with heavy truck traffic, including ports, rail yards, warehouses, and distribution centers. Fortunately, there are many ways to make trucks cleaner and reduce their carbon footprint.

CLEAN TRUCK MEASURES

For Large Truck Fleets:

- Switch to electric and hybrid-electric trucks for drayage (short distance transport).
- Use advanced logistics and site configurations.

For All Trucks:

- Meet U.S. EPA 2010 emission standards, or install filters.
- Meet U.S. EPA SmartWay efficiency standards.
- Limit idling to no more than 5 minutes.

ELIMINATE TAILPIPE EMISSIONS: ELECTRIFICATION AND MODE SHIFTING

Hybrid diesel-electric trucks are significantly cleaner than conventional diesel trucks.* Electric trucks eliminate toxic air pollution from tailpipes and are much quieter. They perform best when used for drayage (transporting goods over short distances), like moving containers between shipping facilities and distribution centers or rail yards.

Trucks are highly inefficient over long distances. Cargo traveling hundreds of miles or more should travel by rail, barge, or other more efficient means. Shifting freight from trucks to trains reduces greenhouse gas emissions over the same distance traveled.[33] It also reduces traffic congestion and wear and tear on public highways. While mode shifting can result in less overall emission productionproduced, it's no silver bullet. Transporting goods by rail and barge also results in air pollution and can have significant health impacts. As a result, precautions must be taken to ensure that mode shifting does not merely move the pollution to another community. For example, if cargo will be moved by train rather than by truck, the locomotives used must meet stringent emissions standards, and any new rail yards that are built to facilitate this traffic should not be sited near communities, schools, or other sensitive receptors. (*See "Gold Standards for Rail Yards.*)

*We do not cover alternative fuels here because hybrid and electric options are a more cost-effective approach to reducing greenhouse gas, soot, and other emissions from trucks.

Images from webcams that capture the lines of trucks entering a Port of Oakland terminal.

EXAMPLES OF CLEAN CARGO

- The Port of Los Angeles has been operating and testing 18 zero-emission plug-in and fuel-cell trucks. The trucks are made by Balqon and Vision of California.[34]
- FedEx has a fleet of all-electric trucks (43 and counting) making deliveries in New York, Los Angeles, Chicago, Memphis, London, and Paris. The trucks can operate for eight hours in stop-and-go traffic while producing zero emissions. The company also uses 365 hybrid diesel-electric trucks and roughly 380 natural gas vehicles.[35]
- Coca Cola has one of the largest heavy-duty hybrid electric truck fleets in North America, with 650 vehicles. It also recently added six all-electric Smith Newton trucks to its fleet. Other companies using these all-electric trucks include Pacific Gas and Electric, Staples, Frito-Lay, AT&T, and Kansas City Power & Light.[36]
- Berentzen Distillers in Stadthagen, Germany now sends all of its products to its distribution warehouse via rail instead of truck. A constant flow of vehicles on a 25-mile stretch of local roads has been replaced by a single train running on existing tracks. Berentzen now spends less on shipping and has removed the equivalent of 5,000 trucks from the road each year.3[7]

CHILDREN AND THE ELDERLY are especially vulnerable to the negative health impacts of air pollution. High truck traffic near schools and residential areas poses a threat to these sensitive groups. Dozens of epidemiological studies have shown that living or going to school within 500 feet of a busy freeway increases the risk of asthma, respiratory illness, cancer, heart disease, adverse birth outcomes, and premature death. New research has also linked significant exposure to high levels of traffic pollution to diabetes, autism, lower IQ, and changes to the brain similar to those caused by Alzheimer's disease.

Source: Health Effects Institute, Special Report 17: "Traffic Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects," January 2010.

RETIRE OR UPGRADE OLD TRUCKS

A new truck meeting U.S. Environmental Protection Agency (EPA) 2010 emissions standards is about 100 times cleaner than older models when it comes to smog-forming pollution and soot. Trucks that comply with the 2010 federal emission standards produce fewer toxic pollutants and greenhouse gases. They emit 90 percent less nitrogen oxides than a truck from 2006 and can get 5 percent better fuel economy.[38] Ports, rail yards, and warehousing operations can require the use of cleaner trucks in their facilities.

Older trucks can be retrofitted with special diesel particulate filters (DPFs) that substantially reduce diesel PM and other unhealthy pollutants.* Facilities can require proof that trucks are well-maintained and equipped with these filters. But DPFs cannot reduce carbon dioxide, and even with filters, older trucks are not as clean as those built to meet the 2010 truck emission standards.

EXAMPLES OF CLEAN CARGO

- In addition to the Port of Los Angeles Clean Truck program highlighted in the box, several other ports have clean truck programs that require or incentivize modernization of port truck fleets including the ports of Long Beach, Oakland, New York/New Jersey, Houston, Charleston, and Seattle.[40]

- The State of California requires that trucks shuttling containers between major rail yards and ports (drayage trucks) be no older than model year 1994 and equipped with a diesel particulate filter; beginning in 2014, all drayage trucks in California will have to meet EPA emissions standards set for 2007 or newer models.[41]

THE PORT OF LOS ANGELES'S CLEAN TRUCK PROGRAM is a model worth following for any freight facility trying to control air pollution. Starting in October 2008, the program banned super-polluting pre-1989 trucks from entering terminals, while providing truck owners with more than $50 million in financial incentives to switch to cleaner trucks. By 2012, all trucks serving the Port of L.A. had to meet 2007 federal emissions standards for heavy duty trucks, resulting in an 80 percent reduction in truck emissions. The environmental, safety, and security features of the program have largely prevailed in the face of legal battles, and should be replicated at other ports.

Source: The Port of Los Angeles. http://www.portoflosangeles.org/ctp/idx_ctp.asp

*Note that retrofitting trucks and other equipment with soot filters requires a commitment to vigilant ongoing maintenance to ensure that the filters are operating well. For example, some fleet managers have found that vehicles that leak oil experience frequent filter clogging that can damage the device and in severe cases where dashboard warning lights are ignored, create excessive backpressure leading to engine damage.

IMPROVE FUEL ECONOMY

Trucks built with lighter materials and a streamlined design can haul the same amount of cargo with less fuel and emit less pollution. Some simple fittings that can be added to trucks, like aerodynamic shields, make them more fuel-efficient. A package of add-on fittings and replacing conventional double wheels with lighter-weight “single-wide” tires can reduce fuel use by 8 percent.[42] Automatic tire inflation also improves fuel economy and reduces emissions by keeping truck tires rolling with less resistance. Automatic tire inflation systems can be installed on existing truck and trailer fleets.

EXAMPLES OF CLEAN CARGO

- The U.S. EPA certifies the most fuel-efficient trucks and truck fleets under its SmartWay program. Terminal operators are able to secure a SmartWay designation by adopting efficiency practices such as low-rolling resistance tires, auxiliary power units that avert the need to idle the main engine, and aerodynamic fittings.
- A total of 1,895 truck carriers have joined the SmartWay partnership.[43] Since 2004, SmartWay partners have collectively saved $6.1 billion and cut their greenhouse gas emissions by 16.5 million metric tons.[44]

REDUCE IDLING

Idling trucks emit a large amount of pollution. An idling tractor-trailer burns almost a gallon of fuel every hour.[45] Strict idling limits can curtail emissions from trucks that are waiting, loading, unloading, or parked. Trucks can be outfitted with auxiliary engines or batteries to operate onboard equipment (such as heating or cooling) while the main engine is off. Many new trucks are already equipped to power their engine block heaters and climate control systems using an electric connection (the same way an RV plugs in at a campground).

EXAMPLES OF CLEAN CARGO

- In at least seven states, truck stops—such as the Jubitz Truck Stop in Portland, Oregon—are installing electrical hookups for trucks.[46] These hookups enable drivers to turn off their engines at night and plug-in to power engine block heaters and in-cab amenities such as air-conditioning and appliances.

- Scores of state and local jurisdictions across the U.S. have adopted anti-idling ordinances.[47]

LOGISTICAL IMPROVEMENTS

Improved cargo handling practices (logistics) can reduce the amount of time trucks have to wait for paperwork, loading, and unloading, and thus limit the amount of time trucks idle or otherwise run their engines and emit pollution. Automated gate technology gets trucks in and out faster. Moving the entrance gate from the border of a facility to a spot deeper in the industrial area can keep idling trucks farther from surrounding neighborhoods. Logistics companies can make scheduling adjustments in order to reduce the number of trucks traveling empty. Approximately 28 percent of all truck miles in the U.S. are driven without any loads, and about 20 percent of all containers passing through ports globally are empty.[48]

EXAMPLES OF CLEAN CARGO

- Cleaner, Smarter Business Practices SynchroNet operates a Virtual Container Yard that tracks and notifies members when there are empty inbound containers and matches them in real-time with customers in need of those containers.[49] The service reduces empty truck miles, alleviates traffic congestion, reduces the cost of moving goods, improves turn-around times, and reduces diesel emissions.

- The Martin-Brower company delivers supplies to fast-food restaurants using 570 trucks spread across 23 distribution centers. Using Paragon scheduling and mapping software to make sure each truck is used optimally, Martin-Brower has been able to deliver supplies to customers more frequently while cutting the overall mileage of its fleet.[50]

GOLD STANDARDS FOR WAREHOUSES AND DISTRIBUTION CENTERS: A SMARTER WAY TO STORE AND HAUL GOODS

Warehouses and distribution centers attract large amounts of diesel truck traffic and often employ heavily polluting freight-handling equipment and refrigeration units. These facilities are substantial sources of air pollution and greenhouse gases, which harm our health and contribute to global climate change. The following recommendations can help minimize air quality, public health, and climate impacts at distribution and warehousing operations. *See "Gold Standards for Trucks" and "Gold Standards for Clean Construction" for recommendations on cleaning truck fleets and assuring clean construction of a distribution center or warehouse.*

CLEAN WAREHOUSE MEASURES

- Require use of the cleanest and most fuel -efficient diesel trucks.
- Provide electric hookups for refrigeration units and to eliminate truck idling.
- Use the cleanest available—and, where possible, zero-emissions—yard equipment and transport refrigeration units.
- Locate new warehouses a safe distance from residential areas, and meet LEED green building standards.

CLEAN UP DIESEL TRUCKS

In a single day, a warehouse can attract hundreds and sometimes thousands of diesel trucks, which produce hazardous pollution and greenhouse gases while moving to and from the facility. Companies can require visiting trucks to use new technology that makes the trucks cleaner and more fuel-efficient. Similar to the strategies outlined in "Gold Standards for Trucks," we recommend the following measures:

- **Insist on new trucks:** Vehicles meeting the latest U.S. EPA Clean Truck Emissions Standards are 80 to 90 percent cleaner than those made just a few years ago. Warehouses and distribution centers should require trucks to comply with these standards.

- **Use efficient carriers:** Shippers in the EPA's SmartWay partnership commit to send at least half of all goods with truck and rail carriers that increase fuel efficiency by implementing a package of aerodynamic and weight-savings measures, and work to improve warehouse operations to reduce idling and unnecessary trips.

- **Reduce idling:** Idling trucks emit greenhouse gases and hazardous air pollutants as they load and unload or wait for a spot at the dock. Distribution centers should institute zero-idling policies. Climate-controlled driver comfort stations offer waiting drivers a comfortable alternative to sitting in their cab with the engine running. Trucks and loading docks can also be outfitted with electrical connections to power the cab while the truck is parked.

EXAMPLES OF CLEAN CARGO

- The Dr Pepper Snapple Group replaced 1,100 trucks and other commercial vehicles serving its distribution centers with models that have electronic speed control and five-minute idle shutdown technology.[51]

- 247 shippers, such as Tyson Foods, and Ace Hardware, have joined the EPA SmartWay partnership, pledging to use the most efficient freight carriers for at least half of their goods.[52]

- Stonyfield Farm requires that all shipping companies carrying its yogurt products be certified SmartWay shippers.[53] It has also begun using its delivery trucks to bring supplies back to the manufacturing plant, leading to fewer trucks serving its facilities and a 7 percent reduction in the carbon footprint of that facility.[54]

WAREHOUSES AND DISTRIBUTION CENTERS—AND THE POLLUTION THAT FREIGHT BUSINESSES BRING WITH THEM—DO NOT BELONG IN OR NEAR RESIDENTIAL AREAS

Where such facilities are already located in close proximity to residential areas, schools, playgrounds, daycare centers, and hospitals (within 1,000 feet or so), they should incorporate measures to reduce their negative impact on local communities. A mitigation fund controlled by the neighboring community could help address some of the impacts, supporting the implementation of such measures as vegetation and other barriers, filtration devices and window upgrades for nearby buildings, and on-site air quality monitoring.

ELECTRIFY EQUIPMENT

Forklifts, yard tractors, and other equipment at warehouses run steadily and never leave the site, which means their emissions accumulate nearby. All equipment should use electric battery or fuel cell engines. Where this is not possible, any remaining diesel equipment must employ the best available control technology to reduce emissions of PM and NOx, such as diesel particulate filters, cleaner fuels, and more efficient engines.

EXAMPLES OF CLEAN CARGO

- FedEx currently runs 500 forklifts and 1,600 airport ground-support vehicles with electricity or alternative fuels.[55]

- Balqon sells an electric yard tractor, the Nautilus XE20,[56] designed to shuttle containers or semi-trailers around terminals, yards or staging areas. The tractors can travel at speeds of up to 25 miles per hour, towing loads of up to 40 tons, and are currently in use at the Port of Los Angeles.[57]

TURN OFF REFRIGERATION UNITS

Warehouse operators have the ability to minimize truckers' use of transport refrigeration units that rely on secondary diesel engines. Any diesel refrigeration units that remain in use should meet the cleanest emissions standards (see box below).* [58]

- Store goods indoors: Perishable goods should never be stored in trucks or rail cars that require use of diesel-powered refrigeration units. Indoor warehouse space must be of sufficient size to store the refrigerated goods passing through the facility.
- Use electricity, not fuel: The cleanest warehouses use electricity to power refrigeration units while trailers load and unload or wait for a place at the dock. In the same way many campgrounds offer electric hookups to RVs, warehouses can require that all trucks plug-in to electric supplies and turn off all diesel engines.

EXAMPLES OF CLEAN CARGO

- The Willow Run Foods distribution center in Kirkwood, New York, outfitted its trucks and loading dock with electric transport refrigeration units. The trucks use grid power while they are loading and unloading. This cuts unhealthy air pollution on site and replaces inefficient secondary engines with clean electricity.[59]
- In response to California's regulations on transport refrigeration units, most of the 170,000+ units operating in the state have reduced their particulate matter pollution and will continue to get cleaner through 2018.[60]

CLEAN COOLING

Many warehouses and distribution centers handle perishable goods, which must be kept cool. The refrigerated trucks and rail cars that visit these facilities are equipped with transport refrigeration units (TRUs) powered by secondary diesel engines. These engines run constantly to keep the trailer or car cool even when the truck's main engines are off. When refrigerated trucks assemble at a distribution center, so does all of the extra pollution from their secondary diesel engines, which can significantly increase cancer risks to surrounding communities.

California has enacted strict standards calling for ultralow emissions from TRUs beginning in 2012. Widely available retrofit exhaust controls can be used to meet these standards today, and new engines meeting the clean standards are expected on the market shortly.

*TRUs can use diesel engines that meet the most modern (tier 4) U.S. EPA non-road engine standards.

Aerial views of mixed industrial freight and residential land uses in San Diego, where Cesar Chavez Park is surrounded by diesel refrigeration units, trucks, rail lines and a marine terminal.

BUILD A GREEN WAREHOUSE

New distribution and warehousing facilities should never be built in or near residential areas due to the air pollution and health effects discussed above. Warehouse operations also contribute to climate change—not only through greenhouse gas emissions from the trucks and fossil-fueled equipment, but from the buildings as well. Warehouses should be built to meet the standards of the Leadership in Energy and Environmental Design (LEED) Green Building Rating System.™ They should include energy efficient lighting, heating, and cooling measures as well as stormwater management, vegetative cover, and the use of locally sourced materials where possible.[61]

EXAMPLES OF CLEAN CARGO

- Patagonia's distribution center in Reno, Nevada, received a LEED Gold rating for its environmentally friendly design. The center optimizes energy and water use and was built with recycled and locally sourced materials.[62]

GOLD STANDARDS FOR RAIL YARDS: MODERN LOCOMOTIVES AND CLEANER YARDS

Rail yards attract many trucks and trains, which emit large amounts of toxic air pollution and harm the health of nearby communities. Detailed health assessments of some major California rail yards found extremely high cancer risk from the operations, with elevated cancer risk extending as far as eight miles away.[63] In addition to diesel trucks and trains, the equipment used to move freight throughout a rail yard can be highly polluting. The following strategies can be used to reduce emissions of hazardous air pollution from rail yards as well as reduce the yards' carbon footprint.

CLEAN RAIL YARD MEASURES

- Electrify urban rail lines and use the cleanest locomotives available.
- Require use of the cleanest and most fuel-efficient diesel trucks.
- Limit idling of trucks and trains
- Enhance efficiency of rail yard operations
- Provide electric hookups for refrigeration units.
- Use the cleanest available—and, where possible, zero-emissions—yard equipment and transport refrigeration units.
- Locate new rail yards a safe distance from residential areas, and optimize site designs to minimize impacts to nearby communities.

ELECTRIFY URBAN RAIL LINES

Electric locomotives produce zero tailpipe emissions and are the best way to reduce air pollution from rail yards. Electrified freight lines are commonly found in Europe and may be found in some portions of the U.S. as well. Hybrid diesel-electric locomotives can switch from diesel power to electricity provided by a third rail or overhead wires. In the U.S., electrifying urban portions of freight rail corridors would reduce exposure to toxic air pollution for the greatest number of people.

EXAMPLES OF CLEAN CARGO

- The Black Mesa and Lake Powell Railroad in Arizona is electrified along its entire 78-mile length. Three zero-emissions freight trains run on the railway daily, drawing power from overhead electric lines.[64] Electric freight railways operate in Texas and Iowa as well.[65]

- Switzerland has electrified 93 percent of its national freight and passenger railway network.[66]

- More than 70 percent of Russia's freight rail network is electrified.[67]

- Passenger trains traveling to New York City are required to switch from diesel to electric power in the tunnels entering Manhattan and leading to Grand Central Terminal and Penn Station. These electric trains are manufactured by General Electric.[68]

ROAD V. RAIL

Trains are more efficient than trucks, emitting 89 percent less greenhouse gas, 69 percent less PM, and 78 percent less NOx than trucks for each ton-mile of goods hauled. In fact, rail companies report a near doubling in fuel efficiency over the past few years due to operational changes that have optimized train efficiency. However, trains are still very polluting because locomotive emissions standards lag far behind those for trucks. Moreover, containers are typically delivered to and from rail yards on trucks, which add emissions to the footprint of each container. Trains can help reduce our overall greenhouse gas emissions, but without proper mitigations, they will continue to pollute nearby neighborhoods.

Source: Federal Highway Administration, "National Freight Transportation Trends," July 2011..
Personal communication, Harold Holmes, California Air Resources Board, March 2012.

USE CLEANER LOCOMOTIVES

Locomotives may produce about half of all harmful diesel particulate matter emissions in rail yards.[69] To make matters worse, locomotive engines are incredibly long-lasting, which means many older, high-polluting locomotives are still in operation throughout the U.S. Emissions standards for locomotives lag behind the standards for trucks and even off-road equipment. New Tier 4 standards, comparable to those for modern trucks, will not start to be phased in until 2015; these Tier 4 locomotives will emit 80 percent less NOx and 90 percent less PM than a train engine built in 2008.[70] Where Tier 4 locomotives are not yet available, diesel particulate filters (DPFs) and selective catalytic reduction (SCR, a common catalyst based technology used to reduce NOx emissions) can be installed on existing locomotives to achieve emissions reductions similar to those of certified Tier 4s.[71]

Switch locomotives move rail cars around rail yards. They spend much of the day idling and rarely leave the yard, so they are prime candidates for cleanup. GenSet switch locomotives have three small engines rather than one big engine. The engines can power up as needed, rather than constantly running at full power, which can significantly reduce emissions. Hybrid diesel-electric switch locomotives use batteries to store electricity produced by a small diesel generator. These are 16 percent more fuel-efficient than standard switch locomotives and reduce PM and NOx pollution by 80 percent.[72]

EXAMPLES OF CLEAN CARGO

- The BNSF (Burlington Northern Santa Fe) Railway uses 74 GenSet switch locomotives in Texas and California rail yards. These locomotives reduce idling emissions in rail yards.[73]
- Union Pacific uses Green Goat hybrid-electric switch locomotives in some of their Texas and California rail yards. The onboard batteries are recharged with a diesel engine.[74]

- General Electric is developing an Evolution Hybrid Locomotive that will recapture braking energy and store it in onboard batteries for later use, cutting carbon emissions by 10 percent.[75]

- Diesel particulate filters are being tested and proven for use on locomotives in California. Union Pacific uses these filters on two retrofitted locomotives at its rail yard in Long Beach, while BNSF is using one retrofitted locomotive at its Oakland rail yard.[76]

USE CLEANER TRUCKS

Much of the air pollution in rail yards comes from the many tractor-trailers loading and unloading cargo. A study of health risks from rail yards in California found that shifting to cleaner trucks and cleaner switch locomotives was a "key factor" in reducing cancer risks by 75 percent to residents near the BNSF San Bernardino rail yard between 2005 and 2010.[77] New trucks must comply with fairly clean emissions standards (roughly ten times cleaner than a decade ago), so allowing only new trucks at a facility is one of the best ways to reduce truck emissions.[78] *See "Gold Standards for Trucks" for more information.*

LIMIT IDLING

Strict prohibitions on idling trucks and trains, which preclude unnecessary idling should be enforced at rail yards. A number of technologies are available that can reduce the amount of time diesel engines are operating and emitting pollution. For example, locomotives can be equipped with automatic idling controls, which can significantly improve air quality and save fuel by shutting off locomotive engines when they are at rest. Trucks and locomotives can be outfitted with auxiliary engines or batteries to operate onboard equipment while the main engine is off.[79] Locomotives can be connected to electric power to keep the engine coolant and oil warm while the engine is off.[80] Alternatively, locomotives can be outfitted with a special overhead ventilation hood to capture emissions while idle.

EXAMPLES OF CLEAN CARGO

- The Montana Rail Link uses Auxiliary Power Units (APUs) to reduce fuel use and emissions. The APUs eliminate the need for idling by circulating heated coolant through the engine block, compressor, expansion tank and oil cooler to keep the entire locomotive's water system warm during shutdowns.[81]

- Alaska railroad has a locomotive emission reduction plan, under which the EMD Auto Engine Start Stop (AESS) system is used to shut locomotive engines off after 10 minutes of idling and starts it back up automatically when engine controls are used or when the temperature drops too low.[82]

- The Advanced Locomotive Emissions Control System made by Advanced Cleanup Technologies is a hood that fits atop idle locomotives in rail yards to collect and filter toxic emissions. Several locomotives can be attached at once.[83] Despite its effectiveness, however, few, if any, railroads have adopted its use.

IMPROVE OPERATIONS

Eliminating inefficient practices at rail yards can reduce unnecessary emissions and health impacts. Improving logistics and scheduling can reduce the number of trucks and trains waiting at a rail yard for loading and unloading. Automating truck entry gates and locating them inside the facility can reduce the number of vehicles idling in nearby neighborhoods. Moving maintenance and fueling stations as far away from residential areas as possible can also be helpful.

EXAMPLES OF CLEAN CARGO

- After demands by local residents, Union Pacific relocated a truck entry gate from near the local high school to the other side of the facility at one of its California rail yards, reducing the students' exposure to pollution from the trucks serving the facility.[84]

- BNSF has introduced automatic gate technologies that have reduced truck idling by 50 percent at several rail yards in Texas, Illinois and California.[85] BNSF has also committed to incorporating similar technologies at a rail yard it has proposed to build in Edgerton, Kansas.[86]

USE CLEANER YARD EQUIPMENT AND REFRIGERATION UNITS

Cargo-handling equipment produces nearly a quarter of all the diesel particulate matter at four major California rail yards.[87] Rail yard equipment includes cranes, trucks (called yard hostlers) and forklifts to move containers and cargo within the yard. These are usually powered by diesel engines, but all can be powered with electricity. Rail-mounted gantry cranes derive their power from an electrified rail, and trucks and forklifts can operate on battery power or with clean fuel cells.[88] Since this equipment will spend its entire life in the rail yard, the benefits of cleaning it up accrue quickly to nearby communities.

Refrigerated rail cars and trucks are cooled with auxiliary diesel engines called transport refrigeration units. These units can be highly inefficient, and, since they must run 24 hours a day, they emit large amounts of air pollution even while the trains and trucks carrying them are stopped. In the San Bernardino, California, rail yard, these refrigeration units are so prevalent that the California Air Resources Board estimates they produce almost 15 percent of total diesel particulate matter emissions from the yard.[89]

EXAMPLES OF CLEAN CARGO

- BNSF has installed all-electric wide-span cranes at its North Seattle rail yard and has committed to doing the same for its proposed rail yard in Edgerton, Kansas. The cranes' wide reach also reduces the number of hostler trucks needed to shuttle containers around the yard.[90] Most of BNSF's existing rail yards, however, continue to use older, diesel-powered cranes.

In response to recent regulations from the California Air Resources Board, transport refrigeration units at rail yards in the state are much cleaner than they were just two years ago. In that period, statewide particulate matter emissions from transport refrigeration units dropped approximately 30 percent.[91]

GOLD STANDARDS FOR PORTS: GREEN SHIPPING FOR THE 21ST CENTURY

Marine ports in the U.S. are major hubs of economic activity and major sources of pollution. Enormous ships with engines running on the dirtiest fuel available, thousands of diesel truck visits per day, mile-long trains with diesel locomotives hauling cargo, and other polluting equipment and activities at marine ports cause an array of environmental impacts that can seriously affect local communities and the environment. The following recommendations should be implemented to reduce global warming and air pollution from port operations.

CLEAN PORT MEASURES

- Require clean marine fuels with sulfur limits of 1,000 parts per million (ppm).
- Outfit all wharves with shoreside electrical power and require ships and harbor vessels to plug-in.
- Provide incentives for the cleanest marine vessels.
- Implement marine vessel speed limits.
- Electrify rail lines where possible.
- Develop efficient on-dock rail that moves containers from ship to train without the need for transport by trucks.
- Use the cleanest locomotives available.
- Require use of the cleanest and most fuel-efficient diesel trucks.
- Provide electric hookups for refrigeration units, and eliminate truck idling.
- Use the cleanest available—and, where possible, zero-emissions—yard equipment and transport refrigeration units.
- Locate new port terminals a safe distance from residential areas, and optimize sites for proximity to transportation infrastructure and ocean shipping lanes.

CLEAN MARINE FUELS

Ships tend to run on the dirtiest grade of diesel fuel available, known as bunker fuel, which is significantly dirtier than the diesel used in cars and trucks. As a result, the marine transport sector contributes roughly 15 percent of global NOx and up to 8 percent of global SOx emissions.[92] Shipping emissions of fine PM are estimated to contribute to 60,000 premature deaths globally.[93]

The U.S. recently approved the International Maritime Organization's treaty, which will greatly reduce ship emissions through the use of cleaner fuels in designated Emissions Control Areas (ECA), including almost all the waters off North America.[94] The designation limits marine fuel sulfur to 10,000 ppm, and in 2015 this limit will be tightened further to 1,000 ppm (for comparison, land-based diesel fuel in the U.S. must meet a 15 ppm sulfur limit). By 2020, the ECAs are expected to reduce NOx emissions by 23 percent, SOx emissions by 74 percent, and emissions of PM2.5 by 86 percent. While the total cost of the marine pollution reductions from this treaty is approximately $3.2 billion, air quality improvements are expected to save 14,000 lives, relieve 5 million people of respiratory symptoms annually, and have a monetized total savings of $110 billion in the U.S. in 2020.[95] The EPA's final engine and fuel standards for ships, issued in 2009, complement the ECA regulations.[96] In the meantime, California has required vessels that visit the state's ports to use cleaner fuels in advance of the ECA requirements, and some major shippers have voluntarily begun to use cleaner fuel before being legally required to do so.[97]

EXAMPLES OF CLEAN CARGO

- The largest shipping line, Maersk, switched from dirty bunker fuel to low-sulfur distillate fuel in 2006 to reduce vessel-related emissions by 400 tons at the ports of Los Angeles and Oakland. Both the main and auxiliary engines in Maersk's ships switch to the cleaner fuel when they are within 24 nautical miles of the ports. The switch has resulted in a 92 percent reduction in sulfur oxides, a 73 percent reduction of PM, and a 10 percent cut in nitrogen oxides.[98]

- Another large shipping line, APL, started using low-sulfur fuels in Los Angeles and Seattle in 2007. Since then, the program has been extended to Vancouver, Hong Kong, New York, New Jersey, and Singapore.[99]

- In 2006, Washington State Ferries (WSF) started fueling its entire fleet with ultralow-sulfur diesel (ULSD). The switch came as a result of a yearlong pilot program in which WSF fueled one of its vessels with ULSD to determine the feasibility of using the clean-burning fuel.[100]

- Beginning in 2007, all ferries, tugboats, and other harbor craft in California were required to use lower-sulfur diesel (comparable to land-based diesel).[101]

- Beginning in July 2009, California required all ships visiting California ports to use marine fuel with no higher than 1.5 percent sulfur. To date, the regulations have withstood legal challenge from the shipping industy.

- Beginning in August 2012, ships visiting U.S. ports have had to use marine fuel with no greater than 1 percent sulfur and that limit will drop to 0.1 percent in January 2014.[102]

THE SAN PEDRO BAY PORTS CLEAN AIR ACTION PLAN (CAAP), A MODEL GREEN PORT PLAN

In 2006 the ports of Long Beach and Los Angeles adopted a collaborative action plan aimed at significantly reducing the health risks posed by air pollution from port-related ships, trucks, harbor craft, terminal equipment, and trains. Developed with the participation of the South Coast Air Quality Management District, the California Air Resources Board, and the U.S. Environmental Protection Agency, the plan's strategies include the ports' Clean Trucks Programs, vessel pollution reduction programs, and inclusion of fuel-saving technologies such as hybrid tugboats.

The 2010 CAAP Update established long-term goals for emissions and health-risk reductions for both ports. The Update requires the ports to track their progress in achieving CAAP standards with annual emissions inventories, which are available to the public.

Source: San Pedro Bay Clean Air Action Plan, www.cleanairactionplan.org/about/default.asp.

CALIFORNIA SHIPS PLUG IN

The 2007 regulation requiring most ships docking at major California ports to plug in is providing major air quality and health benefits throughout the state. When the regulation is fully phased in by 2020:

- Up to 242,000 metric tons of CO_2 will be reduced;
- NOx emissions will go down 4,700 tons per year;
- 85 tons of diesel PM emissions will be eliminated each year;
- 280 premature deaths will be avoided;
- 8,200 cases of asthma and respiratory illness will be prevented; and
- $1.9 ***billion*** in health benefits will be saved.

Also, without this regulation, nearly one million people living near the Ports of Los Angeles and Long Beach would face cancer risks exceeding 100 per million due to pollution from ships at dock (e.g. roughly 100 additional cases of cancer would be likely).

Source: California Air Resources Board, Staff Report: Initial Statement of Reasons (ISOR) for "Shorepower" regulation, 2007. http://www.arb.ca.gov/regact/2007/shorepwr07/isor.pdf.

SHORESIDE POWER

Ships continue to run their engines when they are stopped in port loading and unloading cargo and performing maintenance in order to provide power for all of the ship's onboard services (e.g., lights, pumps, refrigeration). The constant operation of the engines wastes fuel and spews pollution as the ships idle alongside communities. Shore power connections allow any ship to switch off its diesel engines while docked and plug-in to the local electric power grid.[103] Connecting a ship to electric lines when it is moored at port significantly reduces pollutants that contribute to smog, soot, and global warming. In 2007 the California Air Resources Board adopted a regulation requiring that all container, cruise, and refrigerated cargo vessels use shore power while at berth, beginning in 2014 and phasing in through 2020 (*See California Ships Plug In Box*).[104]

EXAMPLES OF CLEAN CARGO

- The Port of Los Angeles unveiled the world's first electrified container terminal in June 2004, as a result of a legal settlement with several organizations, including residents from the port area, the Natural Resources Defense Council, and the Coalition for Clean Air.[105]
- As part of the San Pedro Bay Ports Clean Air Action Plan (CAAP), the Port of Los Angeles plans to implement shore power at all container and cruise terminals, and a selected liquid bulk container terminal by 2014.[106]
- The Port of Seattle started providing shore power infrastructure to cruise ships in 2005, as part of a collaborative effort with Princess Cruises and Holland America Cruise Line.[107] The use of shore power for cruise vessels is particularly effective because they tend to have high hoteling loads (that is, onboard electricity needs for air conditioning, lighting, pumping, etc.).

COLD-IRONING BY THE U.S. NAVY

The U.S. Navy has been using shore power for several decades at bases all over the world; they call it "cold-ironing". Its unique electrical cable connection system allows it to avoid any compatibility issues in different ports of call.[112] The transfer of power from the auxiliary generators on board the ships to shore power is synchronized to avoid blackouts. For example, a destroyer-class ship that has two auxiliary gas-turbine generators running in parallel when entering the port, turns just one off when the ship is docked. Personnel then connect the ship to electrical and other utility needs, a process that takes about 60 to 90 minutes. Once the transfer of power to the shore is complete, the second generator on board the ship is shut down.[113]


Shore-power connection on a navy ship

Source: http://www.arb.ca.gov/regact/2007/shorepwr07/tsd.pdf

- As mitigation to meet Title V federal air quality permitting conditions for the Air Quality Management District in Southern California, the Port of Long Beach and British Petroleum have installed shoreside electric power and outfitted two BP tanker vessels with the wiring and plugs to use it. This is the first step in the upgrading of the port's infrastructure to provide shore power at ten of its berths.
- In 2009 the Port of Los Angeles installed electrical plug-ins for shore power for Crowley Maritime tugboats. In a collaborative effort, Crowley purchased and installed the electrical connections to the boats and transformers.[108] The Port of L.A. was responsible for providing the electrical power to the dock.[109]
- The Port of Oakland has installed electrical plug-ins for shore power on a new tugboat wharf, enabling tugboats to shut off their engines while berthed.[110]
- The Port of Stockton provides electrical hookups at one of its docks used regularly by tugboats.[111]

CLEANER VESSELS

Ports can require or incentivize shippers to use cleaner vessels. There are a variety of technologies and modifications that can reduce marine vessel emissions. One such technology is selective catalytic reduction (SCR), which has been used extensively for power plants and more recently has been incorporated into heavy-duty diesel trucks, to achieve NOx emissions reductions of more than 80 percent.[114] Other promising NOx reduction technologies include direct water injection and the use of humid air motors. These technologies lower engine temperatures and can eliminate up to 70 percent of NOx emissions. Scrubbers are commonly employed to reduce SOx emissions; these use a wet limestone mixture to absorb sulfur particulates and capture as much as 90 percent of sulfur emissions. Slide valve technology for marine propulsion engines can reduce PM by 25 percent and NOx emissions by 30 percent.[115] Other promising control technologies include direct water injection, fuel water emulsion, exhaust gas recirculation, and continuous water injection. These technologies are currently being explored through the Technology Advancement Program at the ports of Los Angeles and Long Beach.

The accumulation of marine plants and animals on a ship's underwater hull reduces vessel efficiency; proper maintenance and cleaning of hulls and propellers can reduce fuel use and associated emissions.[116] Advanced vessel coatings, such as self-polishing resin systems, can provide a smoother surface.[117] The new coatings can be applied only to new vessels, but improved hull designs incorporating features such as ducktails, air injectors, and interceptor planes can be added to vessels as retrofits.[118] Combining an optimized hull form and a contra-rotating propeller with diesel-electric hybrid motors* allows some ships to move 60 percent more freight than their all-diesel counterparts, all while using the same amount of fuel and saving SOx, NOx, and CO_2 emissions.[119]

*This design is more efficient than that of conventional ships. The diesel engine powers the vessel's generators, which in turn power the electric motor. Then the motor powers the propellers.

EXAMPLES OF CLEAN CARGO

- In 2002 and 2003, Totem Ocean Trailer Express introduced the first two cleaner-burning, diesel-electric ships in the U.S., using efficient hull and propeller technology in addition to diesel-electric hybrid engines.[120,121]

- The Port of Long Beach currently operates two hybrid tugboats. The first tug was a new build; the second was a retrofit of an existing tug from its fleet. Use of the hybrid tugs will save more than 100,000 gallons of diesel fuel, 1.7 tons of diesel PM, 53 tons of NOx, 1.2 tons of reactive organic gases, and 1,340 tons of CO_2 per year.[122] Benefits also include noise pollution reduction and protecting crew from hearing loss.[123]

- Japanese shipbuilder IHI Marine United has developed a series of technologically advanced ships running on liquefied natural gas (LNG), some of which produce no sulfur dioxide, 20 to 25 percent less carbon dioxide, and 80 percent less nitrogen oxides than conventionally fueled container ships. Additionally, these vessels consume 30 percent less fuel than conventional ships, thanks to hull modifications, more efficient engine systems, and high-capacity batteries that store energy collected from solar panels.[124,125]

VESSEL SPEED REDUCTION FOR SHIPS

Ships can also reduce their emissions by slowing down. Like cars, ships become less fuel-efficient when they travel faster. Instituting speed limits for ships in the areas close to shorelines reduces emissions and exposes communities to less pollution.

EXAMPLES OF CLEAN CARGO

- The Port of Long Beach's Green Flag Program rewards vessel operators with lower docking fees and environmental recognition if they observe a 12-knot speed limit within a 20-nautical-mile radius of the port for a 12-month period. More than half the ships visiting Long Beach observe the speed limit; if all vessels participated in the program, NOx emissions would be reduced by 550 tons a year.[126]

- A 2001 memo of understanding between the U.S. EPA, the California Air Resources Board, the ports of Los Angeles and Long Beach, the South Coast Air Quality Management District, the Pacific Merchant Shipping Association, and the Marine Exchange of Southern California called for marine vessels to voluntarily reduce speed to 12 knots within a 20-nautical-mile radius of the ports. While the terms of the memo expired in 2004, the majority of vessels coming into the ports continue to operate at reduced speed and participate in speed-reduction incentive programs.[127]

ON-DOCK RAIL

Truck traffic associated with freight transport from ports can be substantially reduced by bringing rail lines directly to the locations where ships unload, known as on-dock rail. According to the Port of Tacoma, each full outbound train replaces 250 to 300 trucks, reducing both road congestion and pollution.[128] Avoiding these short drayage truck trips to shuttle cargo from the dock to off-dock facilities offers a substantial benefit to cargo owners, who save on operating costs and fees.[129] On-dock rail works best for freight destined to leave the region, since local freight usually travels by truck.[130]

Ports may be reluctant to dedicate terminal space for on-dock rail that could otherwise be used to process more containers.[131] Rail companies may also discourage development of on-dock rail yards because such yards may compete with existing "off-dock" rail yards located close to ports.[132] Limited capacity on rail lines serving port terminals and the configuration and size of those terminals can also present challenges for constructing an on-dock rail yard. Still, the many examples below show on-dock rail is feasible and has been adopted widely. Moreover, when on-dock rail can replace polluting diesel truck trips to off-dock yards located close to residential communities, on-dock rail should be prioritized as an important solution.

EXAMPLES OF CLEAN CARGO

- The Port of Tacoma has four on-dock rail yards that have cut the number of trucks on city streets and highways, reducing roadway congestion and diesel emissions and improving cargo-handling speed and efficiency.[133]

- The Port of Virginia signed a 20-year lease with APM Terminals in 2010 that links the port's activities to Norfolk Southern Railway and CSX Transportation. Six on-dock rail tracks have the capacity to store 42 double-stack rail cars.[134]

- The Port of Los Angeles has on-dock rail at all but one of its container terminals (and that one has rail in the developmental stage). The on-dock rail was cooperatively designed by the port, its customers, and transcontinental railroads, with tracks that accommodate a variety of cargo-handling equipment to maximize operating efficiency.[135] It is located in the backland area of the port terminals, thereby minimizing land use and avoiding disruption of vessel operation. The Port of Los Angeles currently handles about one-third of the containers that are "destined for rail" on-dock (instead of at "near-dock" facilities), according to the Alameda Corridor Authority.

- The on-dock ExpressRail system for Port Elizabeth (part of the Port of New York and New Jersey) was built in 1991. It was expanded with a new terminal in 2003, and again in 2007. In 2010, the entire ExpressRail system, including all three terminals, handled more than 376,000 containers, or 12 percent of all containers passing through the Port of New York and New Jersey.[136] While this proportion is considerably higher than in 1992, when only 3.5 percent of containers were handled by on-dock rail, it is still less than the 25 to 30 percent goal that was set for 2010.[137]

- Other American ports with on-dock rail include the Port of Seattle, whose on-dock rail at three terminals reportedly reduces truck travel by 200,000 miles per year;[138] and the ports of New Orleans, Tampa, and Jacksonville.[139]
- In Canada, the Port of Prince Rupert is the closest major North American port to Asia with direct on-dock access to the Canadian National Rail network.[140]
- Worldwide, other ports are implementing on-dock rail, such as the system that opened at Pusan Newport International Terminal in Busan, South Korea, in late 2010.[141]

OTHER STRATEGIES FOR CLEAN PORTS

Trucks, cargo-handling equipment, and locomotives operating at shipyards emit a significant amount of port-related greenhouse gases. These can be cleaned up with the wide range of measures detailed in our Clean Cargo fact sheets on trucking, warehousing, and rail yards. In addition, several other important measures can effectively reduce port pollution, including improved logistics, zero-emissions container movement systems, and automated container-handling systems.

Improved logistics can limit unnecessary truck trips and associated diesel engine idling. Automated container handling can replace the use of diesel-powered cargo-handling equipment entirely. The ports of Los Angeles and Long Beach have been actively investigating zero-emissions container movement systems including magnetic levitation (Maglev) systems, other fixed-guideway technologies, and several rubber-tired zero-emissions concepts.[142]

EXAMPLES OF CLEAN CARGO

- The Port of Boston's main container facility, Conley Terminal, uses an efficient gate processing system that is configured to allow fast, continuous, and simultaneous loading and unloading of several container vessels at a time. The terminal's system allows dispatchers to process trucker requests within a few minutes, direct truckers to the exact location of the container, and reduce turnaround times for container pickup and drop-off, resulting in fewer trips back and forth, less idling time, and less queuing at the gate.[143]
- Battery-powered, automated guided vehicles ("AGVs") are being used at several major international ports including Rotterdam and Singapore; the Port of Long Beach is currently adding these.[144] These vehicles can shuttle containers around a yard for 12 hours on a battery pack, which can be switched out easily.[145]

NEW TERMINAL SITE SELECTION

New port terminal developments can be designed to incorporate best practices, taking advantage of the latest technology and most suitable siting to minimize community and environmental impacts. In addition to incorporating the measures and practices detailed above, new developments should be sited close to existing transportation infrastructure, far from residential areas, and as close to harbor entrances and ocean shipping lanes as possible. Selecting a site near harbor entrances reduces impacts of channel dredging and ship traffic through fragile marine estuaries. Development should occur within close proximity to existing land transportation infrastructure to minimize land-side transport pollution. The reuse of abandoned industrial or military sites is favored, since these sites are typically close to main rail lines; such reuse also avoids the conversion of undeveloped land. All new sites should include on-dock rail facilities, to minimize truck turns and cargo lifts that contribute to port pollution.[146]

EXAMPLES OF CLEAN CARGO

- In 2008 Helsinki, Finland moved its port to a site two kilometers from the nearest residential areas, to protect the local communities from air pollution, noise, and vibration and to address other environmental impacts.[147] The port implemented other noteworthy practices: requiring overnight vessels to dock at berths located farthest from housing; using shore power for all passenger and car ferries; and tunneling some segments of the road and rail lines underground to protect sensitive natural habitat. The port is now close to major transportation connections, reducing congestion and eliminating unnecessary transport miles.[148]

- The Dharma Port Company Limited is working with the World Conservation Union on an environment management plan for the development and operation of a port on the eastern coast of India.[149] To mitigate impacts of port siting and construction, the developers have installed a dust suppression system with atomized water sprinklers using recycled water. They also plan to minimize dredging and lighting impacts on turtles and build pier-mounted jetties with minimal disturbance to the seabed.

- The Port of Shanghai has made significant efforts to green its operations, including moving some terminals, retrofitting 131 rubber-tired gantry cranes (RTGs) with electric motors, creating an emissions inventory, and investigating and testing shore power use.[150]

GOLD STANDARDS FOR CLEAN CONSTRUCTION: A GREENER WAY TO BUILD

The construction of cargo facilities, whether port terminals, roadways, rail yards, or warehouses, can have environmental and health impacts comparable to or even greater than those of the operation of the completed project. However, many steps can be taken to minimize air quality, public health, and climate impacts of these construction projects. In addition to the following measures, special precautions should be taken at construction sites within 1,000 feet of a sensitive site (such as schools, daycare centers, playgrounds, and hospitals). These sites should be notified of the project, in writing, at least 30 days before construction begins.[151]

CLEAN CONSTRUCTION MEASURES

- Require use of the cleanest construction equipment and diesel work trucks.
- Provide electric hookups for onsite power needs instead of using generators, where possible, and when necessary, use the cleanest generators available.
- Strictly limit all equipment and truck idling.
- Use alternative fuels or electrify equipment where possible.
- Provide advance notification of the project to nearby sensitive sites such as homes and schools.

CLEAN CONSTRUCTION EQUIPMENT AND WORK TRUCKS

Virtually any construction equipment can be retrofitted with diesel particulate filters and other exhaust controls. In some cases, older engines can be swapped out for cleaner, newer models. Much cleaner construction equipment, meeting U.S. EPA Tier 4 standards comparable to those governing modern on-road trucks, is becoming available. Where Tier 4 equipment is not available, the cleanest engines should be used and the best available control technology (BACT)* for emissions reductions of PM should be added, or alternative fuels should be used.** On-road trucks used at construction sites, such as dump trucks, should meet current emissions standards or be equipped with diesel particulate filters. Any trucks hauling materials such as debris or fill should be fully covered while operating off-site (i.e., in transit to or from the site) in order to reduce the levels of dust.

GENERATORS

Diesel generators can be a very significant source of pollution at construction sites. Where access to the power grid is possible, this should be established instead of using stationary or mobile power generators. Where access to the power grid is limited, on-site generators should meet a standard of 0.01 gram per brake-horsepower-hour for PM, or be equipped with best available control technology for reduction of PM emissions.

*Here, BACT refers to the "most effective verified diesel emission control strategy" (VDECS), which is a device, system, or strategy that is verified pursuant to Division 3, Chapter 14 of Title 13 of the California Code of Regulations to achieve the highest level of pollution control for an off-road vehicle.

** This could include natural gas or biodiesel (derived from vegetable oils or animal fats, meeting the requirements of ASTM D 6751). However, biodiesel must be proven to be sourced from sustainable feedstocks including waste grease, fats or oil, and, under certain circumstances, farmed oils that can be proven to be sustainable.

RECOMMENDATIONS TO LIMIT GLOBAL WARMING POLLUTION FROM CONSTRUCTION

Construction sites can be major contributors to global warming pollution. To save fuel and limit greenhouse gas emissions, all nonessential idling of equipment and vehicles onsite should be strictly limited. Where possible, use of the lowest-carbon fuels available (such as biodiesel or other alternative fuels) should be substituted for traditional diesel fuel. In San Francisco, for example, most city departments, including public works, are required to use biodiesel blends of 20 percent or more in their construction equipment.[152] Just as connecting to the power grid is a superior alternative to diesel generators, other equipment, including cranes and forklifts, should be electrified to the greatest extent possible.

EXAMPLES OF CLEAN CARGO

- The Port of Los Angeles has a clean construction policy applying to all projects, requiring best management practices to reduce air emissions; these include a five-minute idling limit and the use of progressively cleaner equipment and trucks phasing in through 2015.[153]
- San Francisco requires city construction projects to use biodiesel fuel in 20 percent or higher blends (B20), and equipment must meet at least Tier 2 standards or operate with the best available control technology. Chicago, Cook County (Illinois), and the Illinois Department of Transportation have various clean construction policies, as do many other municipalities, including Pittsburgh, Providence, and New York City.[154]
- The Los Angeles International Airport Community Based Agreement (LAX CBA) between the LAX Coalition for Economic, Environmental and Educational Justice and the Los Angeles World Airports (LAWA) was adopted by the City of L.A. in 2004. The CBA mandated best available controls for construction equipment during the airport's expansion.[155]

ADDITIONAL MEASURES TO PROTECT COMMUNITIES

Freight activities produce elevated levels of outdoor air pollutants, most notably particulate matter (PM) and ozone precursors, which are associated with increased risks of premature death, respiratory illnesses, cancer, and heart disease.[156] In addition, freight facilities like ports, rail yards and distribution centers can create poor indoor air quality in nearby communities, especially where homes are older and draftier or rely on outdoor ventilation.[157] While elevated levels of air pollutants can be acute in nearby communities, freight emissions have also been shown to worsen regional air quality.[158]

COMMUNITY MITIGATION AND ACTION

Off-Site Mitigation Measures:

- Improve air quality with indoor air filtration.
- Reduce exposure to pollution with vegetation and buffers

Additional Measures:

- Establish and document baseline levels of pollution with emissions inventories.
- Document pollutants levels in a community with air quality monitoring.
- Create community maps to document environmental injustice and raise awareness

Reducing freight pollution levels directly is always a top priority; however, other measures can be employed to reduce community exposure, including use of indoor air filters and outdoor barriers in the form of vegetation and other materials. Communities can also benefit from emissions inventories, air monitoring, and the mapping of pollution sources within a community. This data can be used to select the best on- and off-site mitigation measures to reduce community exposure. These tools are also an important way to empower communities to reduce their exposure to pollution and become more knowledgeable. However, without a concerted effort to mitigate or otherwise address pollution at its source, these off-site measures do not improve outdoor air quality.

OFF-SITE MITIGATION

AIR FILTRATION

Substantial improvements to indoor air quality can be made inside homes, schools, daycare and senior centers, and other buildings through the use of air filters. The best way to remove PM from indoor air is through a mechanical air filter, such as a high-efficiency particulate air (HEPA) filter.* Filters can be installed in individual rooms or in a heating, ventilation, and air-conditioning (HVAC) system to improve the air quality in an entire building. In addition to air filters, indoor air quality can be improved through thoughtful placement of air intakes, whether during initial building design or in retrofits; locating these air intakes as far as possible from pollution sources is ideal.

*Another filter option is an electronic air cleaner, which uses electrostatic attraction to capture particles. Note that some electronic air cleaners produce ozone, which is a health hazard. If an electronic device is preferred, it is important to use the type with plates to prevent the ionized particles from adhering to walls and furniture. For additional information on the use and effectiveness of residential indoor air cleaners, see: www.epa.gov/iaq/pdfs/residential_air_cleaners.pdf.

THE SPECS ON AIR FILTERS

The effectiveness of a filtration system is scored from 1 to 20 using a minimum efficiency reporting value (MERV). True HEPA filters are those with a rating of 17 and above, with removal efficiencies of more than 99.9 percent for particles from 0.1 µm and up.

For residential applications, EPA recommends MERV 6 or better; these filters have a removal efficiency of at least 35 to 50 percent for 3–10µm particles. For schools, EPA recommends MERV 8 to 13, with removal efficiencies greater than 70 percent for 3–10 µm particles and removal efficiencies of 1–3 µm particles from 0 to more than 90 percent. Note that recommended filter efficiencies vary. For example, the Bay Area Air Quality Management District risk reduction measures require filters of MERV 13 or higher, which remove more than 90 percent of particles from 1–3 µm.

Sources: US EPA, "Residential Air Cleaners (Second Edition), a Summary of Available Information," 2009. Bay Area Air Quality Management District, "Healthy Community Development Guidelines," 2012.

A handful of studies have evaluated the performance of filtration systems in homes and schools, finding that they can be effective at removing pollutants and improving health outcomes. Residential HEPA filters have been found to improve respiratory symptoms for individuals with asthma and allergies.[159] A study of schools in Las Vegas found that installing improved filtration systems was effective at reducing concentrations of indoor black carbon (the main constituent of diesel PM) by 77 to 98 percent, compared with 45 to 75 percent reductions achieved by the schools' original ventilation systems.[160]

Another study of schools, in Los Angeles, compared three air filtration systems designed to capture PM and volatile organic compounds. The study examined 1) replacement of medium-performance panel filters in the HVAC system serving most classrooms (with a typical minimum efficiency reporting value, or "MERV" rating around 7) with high-performance panel filters (rated MERV 16); 2) installation of a filter in each classroom's register, where the HVAC air supply enters the room (downstream of the panel filter); and 3) installation of a stand-alone system that operates independently of the HVAC system.[161] The L.A. study examined the effectiveness of each approach and combination of approaches, finding that the combination of a register system and a high-performance panel filter was most effective at reducing ultrafine particles (particles < 0.1 µm), black carbon, and PM2.5. However, the study also found that using just a high-performance panel filter was nearly as effective as the combination. Removal of PM10 proved more difficult because it is easily re-suspended. Data for VOCs were usable from only one school; removal efficiencies were estimated to be 28 percent, 58 percent, and 86 percent for the register system, standalone system, and standalone system with the HVAC panel filter, respectively. However, the limited number of samples and the variation of VOCs due to indoor sources make it difficult to apply these findings to other situations.

The cost of air filtration systems depends on the type and scale of the system, local installation and maintenance costs, and the extent of retrofits required. The Port of Long Beach Community Mitigation Grant Program has helped to install filtration systems in schools by providing funds ranging from about $10,000 to $545,000. Grants for filter replacements in schools range from approximately $4,000 to $90,000.[162] The program has also provided funds to install filters in a children's hospital ($287,550) and in a community center ($291,000). These values provide an indication of at least a portion of the costs of larger-scale air filtration installations and maintenance. The cost is lower for residences, which are much smaller. Depending on their size, design, and efficiency rating, replacement filters can cost in the $30–50 range for lower-MERV (8 to 11) home systems; more permanent electrostatic filters start at around $70.[163]

Air filtration is a good mitigation measure for PM when used in conjunction with other measures to target at-risk and sensitive community members. It is not, however, a cost-effective way to improve air quality in all buildings throughout a region, nor does it help with outdoor air quality. Filtration systems also require maintenance and filter replacement or cleaning, which if not done properly can compromise the filter's effectiveness.[164] Additionally, the effect of filtration systems on pollution exposure depends on the amount of time that occupants spend indoors as well as the frequency with which they close windows and use their filtration and HVAC systems. The effectiveness of air filtration systems also depend on how they are operated. For example, in the Las Vegas school study it was found that HVAC systems were turned off overnight and restarted early in the morning. This practice actually brings outdoor air into the building at precisely the time of day when its quality is worst, a practice that clearly is not recommended.[165]

VEGETATION

There is growing evidence that vegetation can reduce PM exposure in locations near roadways, provided the vegetation is close enough to the pollution source to create a good buffer and the plants themselves have certain features. Most effective at removing particulates and absorbing pollution are large-statured, hardy trees with a long life that also have:

- large surface area (leaves, bark, shoots) and rough and/or sticky surfaces;
- a fine, complex foliage structure that promotes large in-canopy airflow, which helps to slow particle transmission (conifers are a good example);
- low biogenic volatile organic compound (BVOC) emission rates; and
- year-round foliage.[166]

Tree plantings force wind over the canopy, which creates turbulence on the upwind and downwind sides; this turbulence encourages deposition in the vegetation. Some research suggests that tree plantings may be particularly efficient for removing fine and ultrafine particles, which pose the greatest health hazards.[167] Wind tunnel experiments simulating PM removal by redwoods found increasingly higher removal rates with smaller particles. Tree plantings also carry additional benefits, such as cooling through shade and improved management and filtration of stormwater runoff.

THE REAL VALUE OF TREES

The U.S. Forest Service has developed an open-source suite of software modules, i-Tree, which provides an assessment of the benefits of urban forests. This type of software tool can quantify environmental benefits at a landscape scale and a street-level scale, and of individual trees at the parcel level. For example i-Tree estimated the following benefits of street trees in Minneapolis: $6.8 million in energy savings, $9.1 million in reduced storm water runoff, $7.1 million increase in property value, and $1 million improvements to air quality.

Source: http://www.itreetools.org/about.php

I-TREE RECOMMENDATIONS FOR BEST TREES THAT REMOVE AIR POLLUTION*

HOUSTON:
Big Leaf Maple
White Alder
River Birch
Bitternut Hickory
Pecan
Atlantic White Cedar
Sugarberry
Northern Hackberry
Blue Chinese Fir
Monterey Cypress
Oregon Ash
Black Walnut
Tulip Tree
Mulberry
Hornbeam
Silk Bay
Canela
Lingue
Aquacatillo
California Sycamore
Black Cherry
Cork Oak
Coast Redwood
American Basswood
Winged Elm
California Laurel

CHICAGO:
Japanese Fir
Red Maple
Ohio Buckeye
Horse Chestnut
Yellow Birch
Incense Cedar
European Hornbeam
Northern Hackberry
Turkish Hazelnut
American Beech
White Ash
Black Walnut
European Larch
Tamarack
Tulip Tree
Cucumber Tree
Dawn Redwood
Norway Spruce
Eastern White Pine
Black Cherry
Douglas Fir
Durmast Oak
Sassafras
American Basswood
Little Leaf Linden
Eastern Hemlock
American Elm
Japanese Zelkova

*Including a variety within each species

HARD BARRIERS

Hard barriers, such as sound walls near roads, are another strategy for reducing exposure to air pollution. However, only a handful of studies have been done, and the effect of hard barriers on dispersion of air pollution is not well understood. Benefits of hard barriers are likely to vary with the characteristics of the barrier, topography, weather, and pollutant type and source, in some cases, resulting in increased pollutant levels and in others, reducing pollution by up to 50 percent.[169]

A 2012 EPA study tested ultrafine particle levels on either side of three barriers in North Carolina, two groups of trees and one hard barrier. Researchers found that a 6-meter wall consistently resulted in lowered concentrations of particles in a variety of wind and weather conditions at a distance of 10 meters, while the effects of tree stands were less clear.[170] However, the EPA study did not measure concentrations at a greater distance from the road barrier. One 2010 study that measured pollution with and without barriers at two sites in Southern California found that PM, NO2, black carbon, and CO levels dropped immediately adjacent to the barrier, only to surge at 80 to 100 meters. These pollutants again reached background levels at 250 to 400 meters (compared with 150 to 200 meters where no barriers are present).[171] Additionally, a 2008 study measured air pollution at one site in North Carolina, finding that CO and PM decreased by 20 to 50 percent behind a barrier during some wind conditions but measured higher in other wind conditions.[172]

SEPARATION OF PORT ACTIVITIES AND COMMUNITIES

Separating port-related pollution sources from places where people live, work, and play is another approach to preventing pollution exposure. Although this strategy may have limited applicability for communities already in close proximity to pollution sources or for those who work in ports, it has been successful when port-related truck traffic is of concern in a community, and it can be employed in future siting decisions.[173] In general, it is ideal to maintain a safe distance between residential and commercial land uses and land uses with significant emissions, such as ports, heavily emitting transport corridors, and facilities devoted to port-related activities such as warehouses and rail yards.[174] This is especially true in the case of sensitive populations, such as those served by daycare centers, schools, and elderly housing.

Determining a safe distance is difficult, however. A 2010 synthesis of 41 studies measuring air pollution near roads found that most pollutants return to background levels at distances of 160 to 570 meters from the edge of a road, but in any particular area, "safe" distances from pollution sources depend on site-specific physical and natural conditions and pollution levels.[175] For instance, one study in the Los Angeles area found elevated air pollutants up to 2,000 meters downwind and as much as 600 meters upwind of a major freeway.[176] The elevated levels of ultrafine particulates, polycyclic aromatic hydrocarbons, and nitric oxide documented so far from the freeway were attributed to low winds, high humidity, and a surface temperature inversion.

The California Air Resources Board (CARB) recommended a suite of guidelines in 2005 urging local governments to specify safe distances of separation between housing and other sensitive sites and busy roadways, ports, rail yards, and distribution centers, among other pollution sources.[177] The guidelines cited traffic-related studies showing serious health risks attributable to living and going to school within 1,000 feet of these types of diesel sources. Since then, several policies have been developed to require more health-protective land use planning near major sources of diesel pollution, including a public health ordinance in San Francisco that requires indoor air filters for some new housing projects where particulate levels are high, school siting guidelines for the Los Angeles Unified School District, several regional project environmental screening policies, and several urban general plans discouraging housing within 500 feet of freeways and similar diesel sources.[178]

ADDITIONAL MEASURES: COMMUNITY TOOLS

There are a number of tools that communities can ask for which can strengthen their advocacy campaigns, and complement efforts to improve local and regional air quality and reduce exposure to emissions. Emission inventories, community monitoring, and community mapping can all help communities increase their awareness of and involvement in emission reduction and mitigation activities.

EMISSIONS INVENTORIES

Emissions inventories are used to establish a baseline of annual emissions. Emissions rates can be used to estimate adverse health effects, track the progress of mitigation measures, and shed light on the air quality impacts of changes in land use or emissions sources.

In 2009, the U.S. EPA issued guidance for conducting emissions inventories for ports.[179] Port-specific inventories should indicate which port activities are the heaviest emitters, helping to prioritize emissions reductions and identify the most cost-effective mitigation measures. Within ports, the majority of emissions typically originate from oceangoing ships, followed by harbor craft, cargo-handling equipment, trucks, and rail,[180] although the contribution of each source will ultimately vary by port. For example, a 2006 inventory of the Port of New York and New Jersey indicated that the majority of emissions came from oceangoing vessels, followed by cargo-handling equipment, trucks, harbor craft, and then rail.[181] Similar emissions inventories have been completed for the ports of Houston, Los Angeles, and Long Beach, among others.[182]

COMMUNITY AIR QUALITY MONITORING

Air quality monitoring is a key means for identifying which pollutants are of concern for specific communities. Well-placed monitors (e.g., upwind and downwind of a particular source) can be useful for estimating the air quality effects of a pollution source of interest. Outdoor air monitoring at specific locations and times allows community members to have a better sense of the pollutant concentrations impacting them, reflecting cumulative exposure to the combination of sources nearby. Monitoring pollution in real time can also inform a community about the pollution load at various times of day and can be used to advise residents of extreme conditions so they may reduce their exposure by staying indoors, using filtration systems, and avoiding strenuous exercise. In some cases, an environmental agency or corporation might undertake air quality monitoring to verify the effectiveness of mitigation measures.

The design and placement of monitoring is critical. We recommend measuring levels of fine particulates and where possible, ultra-fine particulates; however, depending on the specific placement of monitors, it may be desirable to sample a range of additional pollutants. Exposure levels can vary widely even within a relatively small region, depending on the proximity of a sampling site to emission sources and the region's topography and weather, which affect the formation and transport of pollution.[183]

Programs such as Global Community Monitor's Bucket Brigade allow concerned residents to request and implement air quality monitoring in their area.[184] The Bucket Brigade utilizes a variety of methods to monitor air quality. Depending on the equipment selected for a particular community, VOCs, sulfur compounds, particulate matter (including PM2.5), heavy metals, polycyclic aromatic hydrocarbons (PAHs), and diesel may all be measured. Community monitoring ensures that problem areas with potentially high pollution concentrations are effectively watched for the health of residents and workers in the area.

COMMUNITY MAPPING

Community mapping is an important way to identify the location of communities where environmental justice is an issue—that is, low-income and minority communities that may experience disproportionate levels of pollution exposure. The Pacific Institute's Crossroads Report, for example, identifies schools, parks, health centers, and residences that are within a "health safety buffer" distance from heavy freight areas, including ports and truck routes.[185] For buildings within the buffers, mitigation measures such as air filtration or vegetative barriers (discussed above) between the source and the sensitive population may help to improve air quality for occupants. Planners can also use mapping tools to maintain separation of emissions-generating activities and sensitive receptors in buffer areas where land is zoned for sensitive uses but facilities are not yet constructed.

While community mapping can identify potential areas of concern, additional factors such as the height and temperature of emissions sources, wind speed and direction, weather patterns, and topography all affect how pollution is formed and dispersed. For best results, a combination of air quality monitoring and modeling should be used to map and characterize local air pollution and to attribute emissions to particular sources. Modeling is important for filling in the gaps where direct sampling is infeasible due to expense or access, as well as for projecting changes in emissions that are expected to occur from particular mitigation measures or increases in emissions sources such as truck traffic. Modeling can draw from available information, such as data from existing air quality monitors, information about current and future freight activities (e.g., traffic volumes), weather and topography. By using monitoring data, models and mapping, air quality improvement policies can target areas where mitigation strategies will be most effective.

It is important to note that completing a pollution inventory, mapping, or monitoring report does not by itself improve air quality. However, these tools are important for determining potential risks and effective mitigation measures, developing action plans, and verifying the effectiveness of those measures and overall community progress toward clean air. We recommend these tools in combination with strong air pollution mitigation programs.

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