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Technology Assessment

Status of Zero-Emission Technologies (as of 2019)

The Bay Area Air Quality Management District recently assessed options for replacing diesel-fueled vehicles and equipment with zero-emission technologies.

Online research, including reports from the California Air Resources Board, the San Pedro Ports, and Sandia National Laboratory are the primary sources of information used in this assessment, which will be periodically updated as new information becomes available. Please check back for updates.

The Air District's report, *Summary of Available Zero-Emission Heavy Duty Technologies* *(589 Kb PDF, 25 pgs)*, contains background and current status information about zero-emissions technologies for medium- and heavy-duty vehicles and equipment..

Light-Duty Vehicles

In the Bay Area, there are nearly six million on-road motor vehicles registered, with more than 100,000 of these being zero-or near zero emissions. As of 2018, with incentives provided at federal, state, and local levels, fully zero-emission battery electric cars are commercially available and the full lifecycle cost of ownership is nearly the same as conventional equivalent vehicles. Multiple manufacturers (e.g., GM, Nissan, Tesla, Toyota, Volkswagen) offer at least one vehicle model, and many more models are expected to come into the market in the coming years. Light-duty

The zero-emission light-duty vehicles that are commercially available as of 2018 are listed in the document, *Available Zero-Emission Light Duty Vehicles* (173 Kb PDF, 1 pg).

Medium- and Heavy-Duty Buses and Trucks

Much progress has been made on zero-emissions technology for medium- and heavy-duty on-road vehicles.

The zero-emission medium- and heavy-duty trucks and buses that are commercially available as of 2018 are listed in the document, *Available Zero-Emission Trucks and Buses* (479 Kb PDF, 2 pgs).

Buses

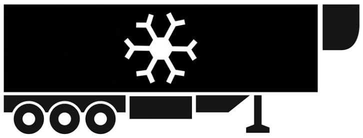
Battery electric buses are commercially available for use in transit, schools, and shuttles. Recent advancements in battery and wireless inductive charging technologies are also making wide adoption of battery electric buses more feasible and cost-effective. Other zero-emission bus technologies, including hydrogen fuel cells, are actively being tested and demonstrated in the Bay Area. Many Bay Area transit agencies have started to test or deploy zero-emission buses, such as the San Francisco Municipal Transportation Agency and San Mateo County Transit District, who have committed to fully electric bus fleets by 2035 and 2033, respectively.

Medium- and Heavy-Duty Buses and Trucks

Today, medium-duty battery-electric delivery trucks are commercially available. These are well suited for local applications as their typical up to 100-mile range allows the vehicle to return to base for refueling. Zero-emission technologies for other medium-duty applications and heavy-duty trucks are being developed and demonstrated with a limited number of models. In California and the Bay Area, several early tests and demonstrations of zero-emission medium- and heavy-duty trucks are being conducted, including battery-electric delivery trucks operating in urban areas, and battery-electric heavy-duty trucks operating in and around the Port of Oakland.

Many vehicle manufacturers are developing zero-emission medium- and heavy-duty vehicles, and some are already producing vehicles at low volume. Among the larger automotive companies, Daimler has announced that it expects to begin production on a fully electric heavy-duty truck in 2020.

Transport Refrigeration Units

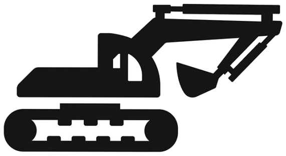


A transport refrigeration unit (TRU) is defined as a refrigeration system powered by a diesel integral (inside housing) internal combustion engine designed to control the environment of temperature-sensitive products that are transported in trucks and refrigerated trailers. TRUs may be capable of both cooling and heating. Zero-emissions technologies (battery electric, plug-in electric, fuel cell, cryogenic, etc.) for TRUs are commercially available; however, these options have specific infrastructure and operational requirements that need to be considered by fleet operators.

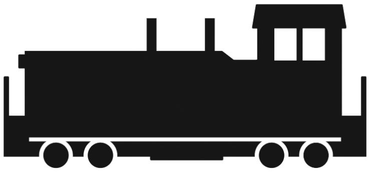
Today, there are several options for deploying zero-emission technologies for cargo handling equipment. Automated electric equipment, electric rubber-tired or rail-mounted gantry at container terminals, fuel cell and battery-electric fork lifts, yard trucks at distribution centers, electric aircraft ground-support equipment, battery-electric belt loader, and electric baggage tugs are commercially available. Zero-emission technologies for container top/side picks currently are not yet commercially available, although two electric container top picks are currently being demonstrated at the Port of Los Angeles.

Construction and Earthmoving Equipment

Zero-emission technologies are in early commercialization stage for smaller construction equipment. The technology for providing full battery-electric heavy-duty machinery will require further technological improvements and is yet to meet parity with conventional powertrains.



Locomotives

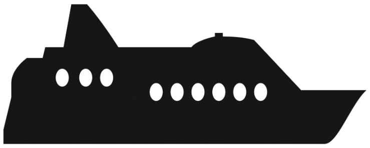


While electric train and rail technology is commercially available, it would currently be cost prohibitive to widely deploy this technology for long-haul freight and passenger use. In the near-term, the most technologically feasible and cost-effective advanced technology available for reducing toxic and criteria pollutant emissions is the installation of a compact after-treatment system (e.g., combination of Selective Catalytic Reduction and Diesel Oxidation Catalysts) onto new and remanufactured diesel-electric freight interstate line-haul locomotives. Emissions in communities that are disproportionately impacted by diesel emissions can be further reduced by augmenting this control equipment with a combination of on-board batteries and geo-fencing technologies.

Zero-emission technologies are commercially available for switch yard operations (e.g., a railway electrification system that provides power through overhead or third line power line). Battery electric technologies are also being tested for switch yard locomotives in other parts of the United States.

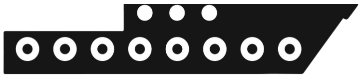
Ocean-Going Vessels

As of 2018, technologies (e.g., shore-side power, fuel cells, and emissions capture and control systems) are commercially available that enable vessels at dockside to achieve zero and near-zero emissions. Other than nuclear power, no other zero-emissions technology has been developed for vessels at sea, although some early demonstration projects are underway, such as an all-electric autonomous container ship that is being planned in Norway.



Commercial Harbor Craft

No zero-emission technologies are commercially available for harbor craft. Dedicated battery-electric systems are being developed for larger ships but have not yet been adopted for commercial harbor craft. Several demonstration and early commercialization projects are



administered by the Bay Area Air District in partnership with Golden Gate Zero Emission Marine Inc. Another demonstration project funded by the U.S. EPA will convert an existing ferry to full electric in Alabama. Proton Exchange Membrane or Polymer Electrolyte Membrane systems have been used in harbor craft demonstrations in New York, electric ferries are being built and operated in Norway, and a hybrid tugboat has been demonstrated at the Ports of Los Angeles and Long Beach.

Stationary Engines

According to the Bay Area Air District's emissions inventory, there are approximately 7,600 stationary diesel engines registered in the Bay Area. However, there are alternatives to stationary diesel engines that are cost-competitive, especially when paired with financing and incentives.

Hydrogen fuel cells are a cost-competitive alternative to diesel engines for 5-10 kilowatt loads, especially when paired with currently available federal tax incentives. Batteries are appropriate alternatives for smaller or portable applications, particularly ones with lower power draws and shorter load durations.

While there are some cost-competitive zero emissions options in the lower kilowatt range, it should be noted that 92 percent of backup generators currently registered within the Bay Area operate in the 35 kilowatt range and above. As certain building electrical loads come down, due to energy efficiency and management practices - and as batteries become more reliable, more energy dense, and cheaper - they will become a more viable option for larger back-up applications within the next 15 years. This may be especially true when batteries are teamed with renewable power solutions and regulations requiring carbon pricing or market based carbon control programs such as California's AB32 Cap and Trade program.