A FRESH LOOK AT SHORE POWER

THE BENEFITS FOR CONTAINERSHIPS

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In the first few decades after the Ideal X ushered in the container shipping age with its first voyage in 1956, emissions from ships and container terminals were not a big concern. This began to change in the 1990s and early 2000s, as evidence mounted that communities living near container terminals were breathing in air that contained far more pollutants than the regional averages. In 2002, the Port of Los Angeles lost a lawsuit for lack of mitigation measures regarding the expanded China Shipping Terminal. As a result of this event, the shore power era for containerships was born.

WHAT ARE EMISSIONS?

Emissions typically fall into two broad categories: greenhouse gas or local health risk. Carbon dioxide (CO2) is the primary greenhouse gas emission. These types of emissions are invisible and not directly harmful to human health, but have a profound impact on the overall global climate. Local health risk emissions such as particulate matter (PM) or nitrogen oxides (NOx) are responsible for a variety of undesirable health outcomes such as asthma and lung cancer in areas near the emissions source. Because their auxiliary engines are fueled with bunker fuel with limited exhaust filtration, container ships emit large amounts of both types of emissions.

SAFETY MEASURES

Figure 1 shows the dramatic improvements that the Port of Los Angeles (POLA) has made in terms of emissions since they began to seriously address the issue. This figure describes annual emissions of NOx for 2005 vs 2017. These statistics are taken from the POLA's series of air emission inventory reports (1).

The year 2005 represents the pre-mitigation era in Los Angeles and Long Beach. In 12 years, as port volumes grew by over 25%, POLA was able to reduce NO_x emissions by 60% overall. Vessel emissions were reduced in this time by 42%. Note that vessel emissions reflect both transiting emissions as well as hoteling emissions at berth. By 2017, approximately 70% of all containerships were using shore power while at berth. The tactics used by POLA to generate the changes shown in Figure 1 are a useful road map for any port wishing to reduce air emissions from operations. One of the most important tools used to achieve this dramatic drop in emissions is the use of shore power, which allows vessels to turn off auxiliary engines at berth.

But doesn't the use of shore-side electricity instead of ship-board fuel simply shift emissions elsewhere? The short answer to this is that electricity shifts some emissions, but eliminates the majority of emissions, and the fraction

eliminated increases every year as local grid power becomes cleaner. California, for example, has recently approved a measure to require 100% of power to be from renewable sources by 2045. Results also vary considerably by state as the mixture of source fuels for the grid changes regionally in the US.

In 2017, 70% of vessels at the Port of Oakland (2) used shore power. The average vessel was plugged in for 18.5 hours and used an average of 1.15 MW of power during that time. In total, the port used 23,735 MW-hr of shore power electricity to eliminate 31,372 tons of CO2 that would otherwise have been emitted by ships.

CO_2 IN ELECTRIC POWER

In California, according to the EPA's 2016 eGRID database, this amount of electric power generation will emit 5,371 tons of CO2. This represents an 83% net reduction in CO2 from shore power. The

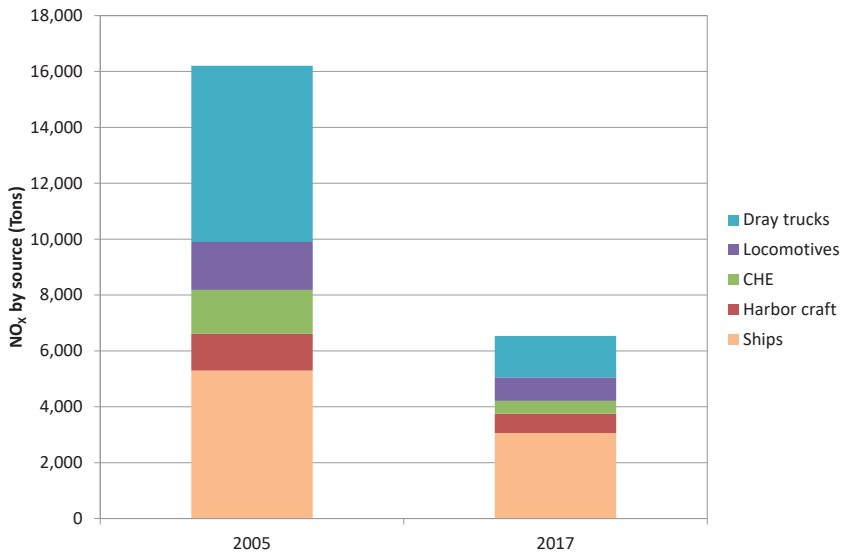

Figure 1. POLA NOx Emissions for 2005 vs 2017

NOx reduction story is even better, with 98% of NOx eliminated. This is due to the fact that stationary power plants have superior exhaust scrubbing technologies compared to containerships, so the local health pollutants per unit of energy are much lower. CO2 is dependent on the basic chemistry of fossil fuel combustion. Oil burned in a power plant will have similar CO2 emissions per unit of energy as oil burned in a containership generator, but much less NOx emitted.

How does this story change in other states besides California? Figure 2 shows the CO2 emitted from shore-side grid power versus vessel power in five major maritime states: Washington, California, Texas, Georgia, and New Jersey. Data for state-wide grid emissions from the eGRID database is shown for the most recent year available, 2016, as well as 2004 in order to show the reduction in emissions over time in all states shown. The rate of CO2 emitted from combustion of on-board fuel is also shown for comparison purposes.

Figure 2 shows that there is a substantial difference in the grid power emission rates between states with large ports. Washington State uses a great deal of hydroelectric power and has by far the lowest CO2 intensity. At the other end of the spectrum are Texas and Georgia, states which still use a significant amount of coal fired power plants. In all cases however, the level of emissions per unit of electricity has dropped significantly over the 12 year period. This is due to trends in shifting from coal plants to natural gas, and to increasing use of renewable power. These trends are expected to continue indefinitely in the US, and also worldwide.

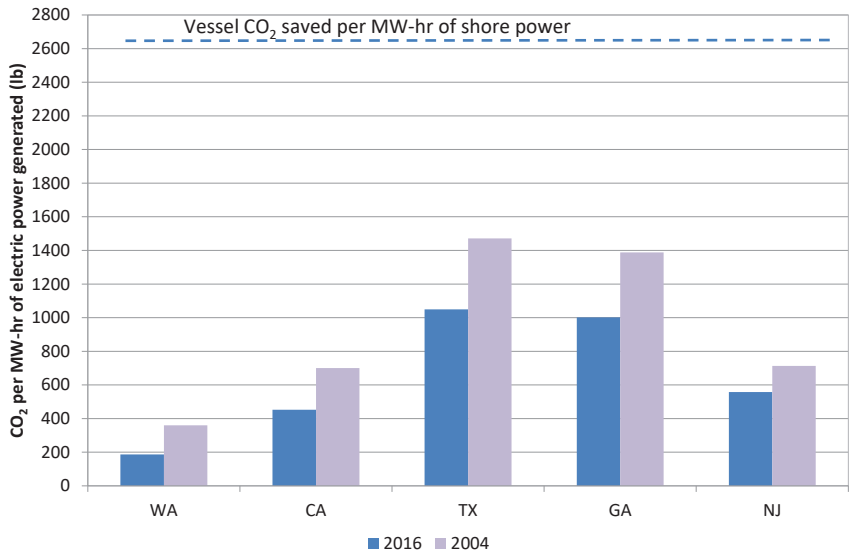

Figure 2. CO_2 Emissions by State vs Vessel Emissions

CONCLUSION

It is very clear that when ports use shore power, the majority of CO2, and the vast majority of NOx and other health risk type emissions, are not simply shifted but completely eliminated. Experiences in California show that the use of shore power is a proven way for ports to reduce a great deal of emissions from container terminal operations, and should only get more effective over time as source power becomes greener.

Another relevant trend to consider when analyzing shore power is the rising cost of ship-board fuel due to stricter regulations on fuel content. In the case of Oakland, each ship call is using 21,000 kW-hr of electricity. A typical rate for industrial power in the US is approximately US$0.10 per kW-hr (with some areas significantly less than this), for a cost of $2,100 per vessel call for electricity. If shore power was not used, this vessel would have burned approximately eight metric tons of fuel in order to run on-board auxiliary engines while at berth. The price of fuel can fluctuate considerably over time but if we consider a rate for refined fuel of $600 per metric ton, the price of fuel burned while at berth would be approximately $4,800 per call; more than double the price of electric power. If a single berth handles three calls per week, the net annual cost savings for shore power is approximately $400,000.

Of course shore power requires significant capital investments both on the berth and the vessel, but as this example calculation shows, there is likely to be a significant benefit in vessel operating cost on top of the substantial emissions savings, making shore power an increasingly appealing option for ports worldwide.

REFERENCES

1: https://www.portoflosangeles.org/environment/air-quality/air-emissions-inventory
2: http://www.portofoakland.com/files/PDF/Port_Oakland_2017_Emissions_Inventory.pdf

ABOUT THE AUTHOR

Mark Sisson leads AECOM's marine analysis group. He is responsible for business development, project execution, and oversight of research and development of AECOM's simulation models. Mark has over 20 years' experience managing and executing a wide range of marine and rail terminal planning, simulation, and analysis projects. Typical projects involve supervision of field data collection, model development, and presentation of analysis results. Sisson received his BS in Civil Engineering at California State Polytechnic University and his MS in Civil Engineering from Northwestern University and is a registered professional engineer in the state of California, US.

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