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Workgroup Recommendations and Other Potential Control Measures
Diesel Initiatives Workgroup

DI004 – Providing Electric Power to Ships (Cold Ironing) at the Ports

DESCRIPTION

Cold ironing is a process where shoreside electrical power is provided to ocean-going vessels, allowing them to shut down auxiliary diesel generators while they are docked. Marine cargo vessels have diesel propulsion engines and auxiliary diesel generators used to power refrigeration, lights, pumps and other functions (activities referred to as "hotelling") while the vessel is docked at a port. This technology has been used by the military at naval bases for many decades and is also in use at a few locations worldwide. The technology was first applied to cruise ships, since the cruise ships return to the same location on a regular basis. Cold ironing has now been implemented for container ships at the China Shipping facilities in Los Angeles as well as Princess Cruise Lines in Juneau, Alaska.

There are currently no international requirements to mandate cold ironing of marine vessels. The recently proposed worldwide treaty known as Annex VI of 1997 to MARPOL—The International Convention for the Prevention of Pollution of Ships does address emission controls for hotelling vessels. Annex VI would reduce NOx, Sox and particulate emissions from international cargo vessels by imposing emission controls on diesel engines rated at more than 130kW(approximately 175 horsepower) manufactured after January 2000. This requirement covers the quality of fuel used for main propulsion engines, not auxiliary engines. The MARPOL agreement has not yet been ratified and is being proposed under the auspices of the International Maritime Organization (IMO). The California Air Resources Board believes it has legal authority to regulate marine vessels within a certain distance from shore, but particularly when docked and contributing to local and regional non-attainment.

Cold ironing could result in significant reductions in emissions of both NOx and PM2.5 at the ports. If funding were available to offset the cost of installation, cold ironing might be implemented voluntarily by one or more shippers and could have long-term financial rewards. This funding might become available from a variety of sources including the utility companies that provide shorepower, federal grants, or state enforcement settlements.

IMPLEMENTATION

Much of the information in this paper is derived from a recent report by ENVIRON International Corporation on behalf of the Port of Long Beach, California [(1)], as well as more recent reports by Starcrest Consulting prepared for The Port Authority of New York and New Jersey[(3,4)]. Implementation of cold ironing technology requires capital investment both to run power lines and construct the shorepower facilities at docks, as well as to adapt marine vessels to receive the shorepower. The ENVIRON report concludes that cold ironing is "generally cost-effective with vessels that spend a lot of

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time at the port, and therefore have high annual power consumption" while docked at a port.

In Long Beach, as at the Ports of Newark and Elizabeth, the dominant vessel type is container vessels. Half of the vessels that used Long Beach called only once and less than 10 percent called more than six times in a one year period. These "frequent flyers" who called more than six times in a one year period did account for more than 40 percent of all vessel calls, indicating that these vessels may be suitable candidates for cold ironing.

COST

The first large-scale cold ironing installation in the world was completed in 2002 and is being used for Princess Cruise vessels in Juneau, Alaska. Princess spent approximately $5.5 million to construct the shore side facilities and to retrofit the vessels to accept shorepower (approximately $500,000 each). Princess estimates the cost of shorepower to be approximately $1,000 per vessel per day more than the cost of running the on-board diesel generators, while Starcrest estimates a total of $14,000 for operating costs per call per vessel (although there is no further explanation of the basis for this figure). While there is a labor cost to connect the ocean-going vessels to shoreside power, it is estimated that this cost would be in the vicinity of $100 per hour for 2-3 electricians for about 2 hours, or in the range of $400-600. There is an additional cost for electricity if it is more expensive than on-board diesel fuel, but this cost will fluctuate with the cost of fuel. It is likely that this figure has dropped as the price of diesel fuel has risen faster than the cost of electricity in recent months and is expected to continue to do so for some time.

The costs of installing cold ironing will vary greatly depending on the costs of upgrading transmission and distribution infrastructure, constructing in-port and in-terminal facilities, retrofitting the vessels, and operating and maintaining the facilities. Data available from several sources indicate that the cost of installing power at shore would be in the range of $1 million, while the cost to upgrade a single ship would also be in the range of $1 million.

In order to calculate annualized costs and emission reductions associated with cold ironing, there are various assumptions that need to be made. For example, a calculation of reductions in tons of NOx, $PM_{2.5}$, or both, would need to consider not only the lifetime of the capital improvements (shoreside infrastructure and vessel retrofit), but would need to factor in how many vessels would be using the same shoreside infrastructure. For example, retrofitting more than 1 vessel will spread the annualized cost of the shoreside infrastructure. Additionally, while the Starcrest report calculates the cost of cold ironing to be ($14,000 per visit)(9 visits per year)(25 years)=$3.15 million, this calculation does

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not consider the time value of money, so a better method would be to use a net present value analysis.

EFFECTIVENESS

There is some data available to assess the effectiveness of cold ironing. The ENVIRON report states that the most recent emission inventory for the combined Ports of Long Beach and Los Angeles show NOx emissions of 33.0 tons per day, with one third of this total or 11.0 tons per day coming from auxiliary engines operating in hotelling mode. A similar percent of diesel particulates come from hotelling and could potentially be significantly reduced through the use of cold ironing. Starcrest reports hotelling emissions as a percent of all emissions from ocean-going vessels to range from 11.7% for $PM^{2.5}$ to 15.4% for NOx. The reasons for differences between the inventories in Long Beach/Los Angeles and NY/NJ need to be investigated further.

Vessels operated by the China Shipping Company began use of cold ironing at the Port of Los Angeles in 2004. NYK's Yusen Terminal in Los Angeles has begun to install cold ironing infrastructure and at least five other shipping lines have signed agreements to install this technology. Estimates by the Port of Los Angeles [(2)] include reductions of 1 ton per day in port for NOx and PM combined (depending on ship size) compared to ships using conventional marine fuel.

COST EFFECTIVENESS

Implementation of cold ironing technology requires a considerable capital investment both to run power lines and construct the shorepower facilities at docks, as well as to adapt marine vessels to receive the shorepower. The ENVIRON report concludes that cold ironing is "generally cost-effective with vessels that spend a lot of time at the port, and therefore have high annual power consumption".

ENVIRON studied 12 vessels of varying sizes and functions and developed cost-effectiveness estimates for conceptual designs for cold ironing. Costs were also estimated to provide shorepower. These figures were then used to calculate the cost-effectiveness of cold ironing on a cost per ton of emissions reduction for each study vessel, with ENVIRON stating that the estimates were based on many assumptions and not reviewed by stakeholders.

Starcrest reports a variety of cost-effectiveness figures comparing cold ironing to other emission reduction methods. These estimates will be useful during the remaining steps of the State Implementation Plan (SIP) process.

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It is noted that cost-effectiveness would improve in the case of new terminals or new vessels, due to the lack of operational, safety, and engineering challenges associated with retrofitting shorepower into existing port facilities. Cost-effectiveness would also be improved by targeting the use of cold ironing at vessels that make repeat calls at the same location, such as cruise ships or auto-carriers, or at terminal operators that have their own shipping fleet.

SOURCES

1. "Cold Ironing Cost Effectiveness Study", ENVIRON International Corporation, prepared for Port of Long Beach, California, March 30, 2004.
2. www.portoflosangeles.org/environment
3. "Ocean-Going Vessel Dwelling Emissions for Year 2000", Starcrest Consulting Group, LLC, December, 2005.
4. "Analysis of Vessel Dwelling Emissions and Offset Reduction Measures", Starcrest Consulting Group, LLC, December, 2005.

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