The economics of cold ironing

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In this age of globalisation, ports – and the goods flowing through them – have become a mainstay of the U.S. economy. Although containerisation is a highly successful component of the evolving international trade, it has created its own backlash; the burgeoning volume of containerised cargo has generated an increased level of concern about the environmental effects of ever-expanding port operations.

The ports of Los Angeles and Long Beach have led the movement to require cleaner performance from cargo operations. "Cold ironing" – providing ships with shoreside power so vessels can turn off their engines while hotelling in port – is one of the key elements of the clean air action plan (CAAP) recently adopted by the two ports. As explained in a CAAP fact sheet, the plan envisions that "all major container cargo and cruise ship terminals at the ports would be equipped with shoreside electricity within five to ten years so that vessels can shut down their diesel-powered engines while at berth."

The requirement for cold ironing is expected to spread beyond Southern California to other environmentally sensitive areas. In the past, the capital costs of cold ironing have often made it seem unattractive, but the overall life-cycle costs (compared to the cost of using shipboard fuels) have not been rigorously evaluated. The following analysis examines the financial and environmental issues surrounding cold ironing.

Figure 1. Electrical cable reel on ship.


Figure 2. Plugs being deployed from ship.


Figure 3. Shoreside electrical plugs.

Cold ironing infrastructure

In order to allow for cold ironing, marine terminals must be equipped with extra electrical capacity, conduits, and the "plug" infrastructure that will accept power cables from a vessel. A large container ship typically requires approximately 1,600 kilowatts (kW) of power while at berth, but the power requirements can differ substantially, depending on the size of the vessel and the number of refrigerated containers on board.

Although cold ironing for container ships in Los Angeles initially entailed the use of a barge to deliver the power, the future standard relies on permanent shoreside power. Figures 1 through 3 show key elements of the cold ironing infrastructure (photos courtesy of Cavotec).

Designing and constructing a terminal that is equipped for cold ironing will cost more than a conventional terminal that does not have the capability to deliver shoreside power. The cost of constructing the shoreside infrastructure, and the cost of retrofitting the vessels calling at the berth, must both be included. These extra costs will obviously differ considerably by location; this analysis uses US$1.5 million per berth for the shoreside infrastructure, based on recent documented costs for a cruise ship installation in Seattle. Assuming a 30-year design life and applying a six per cent interest rate, this translates to a shoreside construction cost equivalent to US$110,000 per year per berth.

The vessels calling at the berth will also need to be equipped with the required electrical infrastructure to take advantage of shore power while hotelling. Based on recent published estimates, this analysis assumes five vessels are required to provide a weekly trans-Pacific service, at a cost of US$400,000 per vessel, or US$2 million for the fleet of five. With a 20-year vessel design life and six per cent interest, this equates to an annual cost of US$170,000 for vessel modifications to a fleet of five vessels. Adding this to the shoreside infrastructure cost yields a total annual construction cost per berth of US$280,000.

Figure 4. Recent escalation in fuel prices (January 2006-September 2008).

Operators interviewed in Los Angeles do not believe that extra longshore labour will be required to plug and unplug vessels. They expect to use ILWU mechanics or other labourers already present at the terminal to perform these functions. Nevertheless, this analysis addresses two cases: one with no additional labour and one with one additional person-shift at typical ILWU labour rates at each end of the vessel call (one to plug in and one to unplug the vessel). A labour cost of US$500 per person-shift is assumed.

Energy cost

The relative cost of on-board fuel versus electricity will be a key driver in the cost comparison between cold ironing and conventional operations. Although some vessels have burned bunker fuel while in port, the current tendency is for vessels to switch to marine distillate (MDO) while in port. In fact, local regulations in many places require MDO to be used while in the harbour area. MDO burns cleaner than bunker fuel, but it is approximately twice as expensive. Furthermore, the cost of MDO has undergone a dramatic recent price increase, as shown in Figure 4. From June 2007 to June 2008, the cost of a metric tonne of MDO in the United States rose from approximately US$600 to US$1,200. For the purposes of this paper, we have used two different MDO costs in our calculations: a "worst" case of US$1,200/MT and a "best" case of US$800 per MT.

Large diesel engines typically burn fuel at a rate of 200 grams per kilowatt hour (g/kW-hr). A vessel at berth for 24 hours and requiring 1,600 kW of power will burn 7,700 kg of fuel (7.7 metric tonnes). At the prices prevailing in June 2008, the fuel bill for one day's call would come to over US$9,000.

In contrast to the price of fuel, which is fairly consistent worldwide, the price of electricity varies greatly depending on local circumstances. Rates for cold ironing applications may need to be negotiated on a case-by-case basis, but the magnitude of power use will likely result in rates similar to those charged to

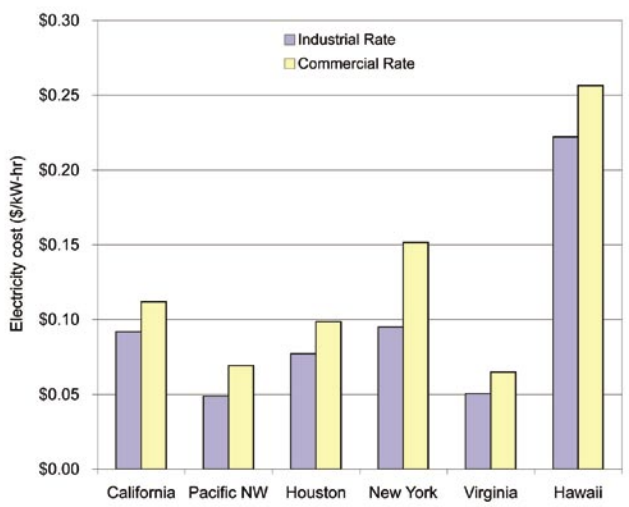

Figure 5. Electricity prices in selected U.S. maritime areas.

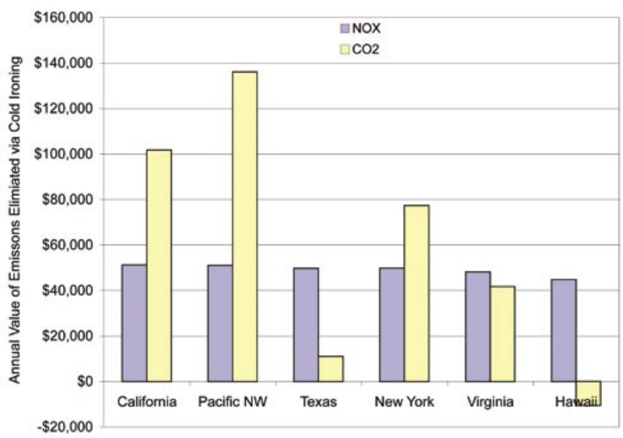

Figure 6. Cost of emissions from on-board fuel vs. grid power.

TABLE 1: SUMMARY OF ANALYSIS CASES

	Fuel cost per metric ton	Electricity cost	Extra labour cost per call vs. conventional	Cost of extra emissions
Conventional worst case	US$1,200	NA	NA	Per Figure 6
Conventional best case	US$800	NA	NA	US$0
Cold ironing worst case	NA	Commercial rate	US$1,000	NA
Cold ironing best case	NA	Industrial rate	US$0	NA

commercial or industrial users. Figure 5 charts the electricity rates for various maritime areas in the United States.

If a vessel calling in California is charged the commercial rate of US$0.11 per kW-hr, the bill for a 24-hour call drawing 1,600 kW will be US$4,200 – less than half the price of burning MDO on board.

Emission "costs"

Although vessel operators at U.S. ports do not pay an explicit penalty for emitting pollution while at berth, port authorities are spending a great deal of money on programmes designed to reduce local pollution caused by discharges such as nitrogen oxide (NO_x). The clean truck programme in Southern California, which requires replacing or retrofitting 16,000 harbour trucks over a period of five years, is one good example of this. And within the United States, the notion of taxing the discharge of greenhouse gases such as carbon dioxide (CO_2) appears to be gathering momentum.

Incorporating these trends with direct fuel costs allows the calculation of the virtual cost of using conventional on-board fuel for hotelling versus plugging in to the local electric grid. Figure 6, using emission factors from the U.S. Environmental Protection Agency, shows this virtual cost for major port areas in the United States. The indicated "costs" for NO_x and CO_2 of US$600/tonne and US$37.50/tonne, respectively, represent typical costs for retrofitting or replacing equipment to reduce production of the pollutants.

Virtually any source of electricity will emit much less NO_x than shipboard engines, but the savings in CO_2 emissions vary greatly by region. California and the Pacific Northwest states generate a large percentage of their electric power from nuclear,

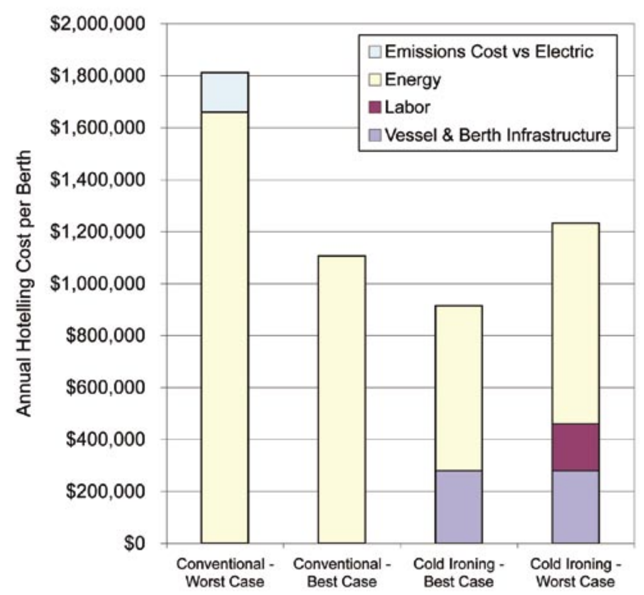

Figure 7. Cost comparison in California.

hydroelectric, and other renewable sources that emit little or no greenhouse gases. In contrast, Texas and Hawaii generate most of their power with fossil fuels. Plugging in a ship in Hawaii will actually increase the CO_2 emissions per call versus using MDO on board ship.

Texas and Hawaii both have climates that make solar and wind power very attractive. Port authorities in states such as these could generate a substantial fraction of their power through zero-

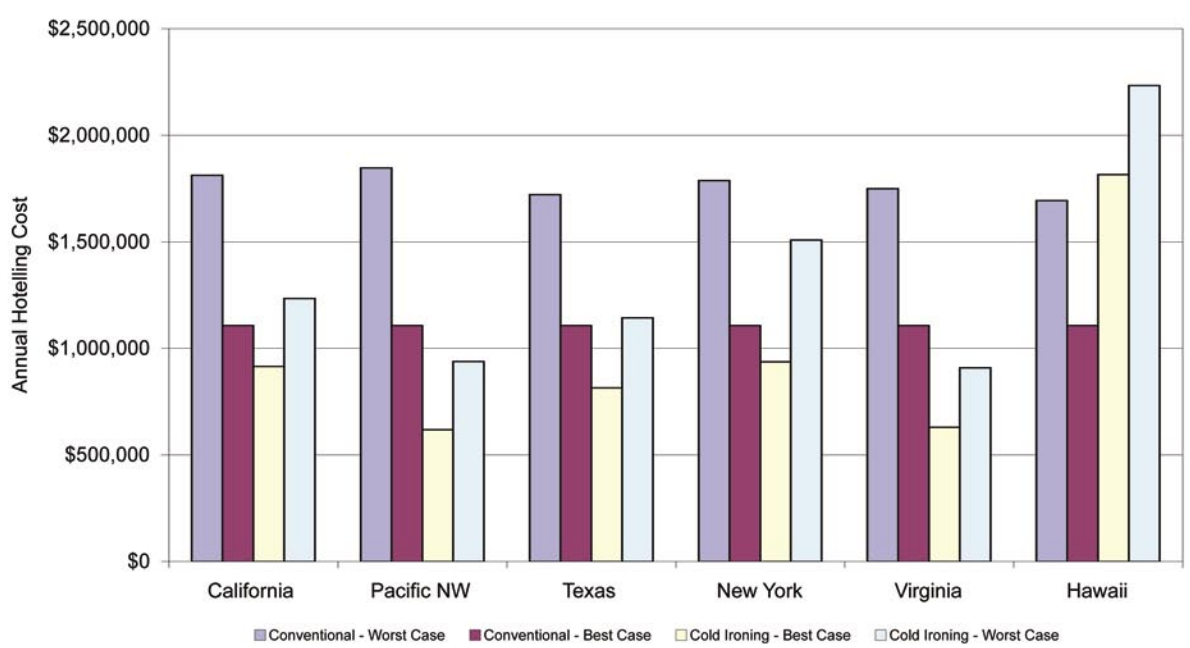

Figure 8. U.S. vessel hotelling costs.

emission renewables if they so chose. Solar and wind power are especially attractive in Hawaii due to the very high cost of grid power, which is largely generated from fuel oil.

Overall cost summary

For the sake of analysis, best- and worst-case values were developed for both conventional operations and cold ironing, as summarised in Table 1. The conventional best-case scenario is based on the mean of fuel prices in June 2007 and June 2008.

Figure 7 shows the cost comparison for California ports. These calculations assume one berth at 50 per cent utilisation with a mean vessel call duration of 24 hours, resulting in 180 calls per berth per year.

Figure 7 shows that the energy cost for fuel or electricity is the primary driver for overall cost. Over the life of the asset, the capital costs to convert vessels and berths to utilise cold ironing constitute a small fraction of the costs. Even the addition of two ILWU labour shifts per vessel call would not add a massive amount of cost to the bottom line.

Figure 8 shows overall costs for six major port areas in the United States.

U.S. vessel hotelling costs

Figures 7 and 8 make a compelling financial case for cold ironing, except in Hawaii. In New York, cold ironing may be economically justifiable, depending on how closely actual costs track against the stated assumptions in this article. In the Pacific Northwest and Virginia, even the worst-case cold ironing scenario is cheaper than the best-case conventional scenario, while in California and Texas cold-ironing is likely to be more affordable given prevailing MDO prices.

Both environmental and economic implications affect the decision to equip ports and vessels for cold ironing. Given the seriousness of the environmental concerns, however, the decision may be made by political mandate. This analysis shows that, in many cases, such a requirement will ultimately be financially beneficial to port operators and shippers.

ABOUT THE AUTHORS

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