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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

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Corrigendum to *Alternatives to heavy fuel oil use in the Arctic: Economic and environmental tradeoffs* (Working Paper 2017-04)

INTRODUCTION

The International Council on Clean Transportation (ICCT) published Working Paper 2017-04 titled *Alternatives to heavy fuel oil use in the Arctic: Economic and environmental tradeoffs* in April 2017.[1] The working paper compared the economic and environmental tradeoffs of switching from residual fuels to alternative fuels in Arctic, as defined by the International Maritime Organization's Polar Code (IMO Arctic). Residual fuels included heavy fuel oil (HFO) and <0.5% sulfur (S) fuel that complies with the upcoming 2020 global fuel sulfur standard. Alternative fuels included distillate fuels and liquefied natural gas (LNG).

Among the ICCT's conclusions were:

(1) "…a total cost of approximately $9 million to $11 million (2015 USD) to switch all of the ships in the Arctic fleet that use HFO or <0.5% S residual fuel to operate on distillate in 2020 and beyond."

1 Roy, B. & Comer, B., (ICCT: Washington, DC 2017) *Alternatives to heavy fuel oil use in the Arctic: Economic and environmental tradeoffs,* https://www.theicct.org/publications/alternatives-heavy-fuel-oil-use-arctic-economic-and-environmental-tradeoffs

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(2) "The price of LNG is expected to be less than that of HFO and <0.5% S residual fuel in 2020 and 2025; however, most ships in the Arctic fleet would need to be converted to operate on LNG, which is a potentially expensive undertaking in the short term. However, it is not out of the question for ships to convert to operate on LNG in the medium term if the price of LNG remains low and the ship owners accept the payback period."

These conclusions hold. However, the equation in section 3.5 contains an error that underestimated the fuel cost savings reported in Table 4 of the working paper associated with switching from HFO or <0.5% S residual fuel to LNG.

CORRECTION

The incorrect equation in section 3.5 of the working paper is as follows:

$$CS = Q_r \times \left(\frac{ED_r}{ED_a}\right) \times (P_a - P_r)$$

Where,

r = residual fuel (HFO or <0.5% S residual fuel)

a = alternative fuel (distillate or LNG)

CS = the cost to switch from fuel r to fuel a

Q_r = the quantity of fuel r demanded by the IMO Arctic fleet

ED_r = the energy density (MJ/kg) of fuel r

ED_a = the energy density (MJ/kg) of fuel a

P_a = the price of fuel a

P_r = the price of fuel r

The correct equation is as follows:

$$CS = Q_r \times \left[\left(\frac{ED_r}{ED_a}\right) \times P_a - P_r\right]$$

The definition of the variables is the same.

Table 4 should be corrected as follows, with deletions in ~~red strike out~~ and additions in green underline:

Table 4. Costs (positive values) and benefits (negative values) of switching from residual fuels to distillate or LNG.

	2015	2020	2025
Alternative fuel needed (tonnes)			
HFO to distillate	249,043	31,214	32,152
HFO to LNG	199,235	24,971	25,721
<0.5% S residual to distillate	—	228,901	235,779
<0.5% S residual to LNG	—	183,121	188,623
Change in fuel price (2015 USD/tonne)			
HFO to distillate	240 (+55%)*	139 (+32%)	162 (+32%)
HFO to LNG	–119 (–27%)	–21 (–5%)	–96 (–19%)
<0.5% S residual to distillate	—	20 (+4%)	23 (+4%)
<0.5% S residual to LNG	—	–141 (–25%)	–235 (–37%)
Total change in fuel cost (2015 USD)			
HFO to distillate	$59,770,320	$4,338,746	$5,208,624
HFO to LNG	~~-$23,708,965~~ -$45,325,826	~~-$524,391~~ -$3,227,528	~~-$2,469,216~~ -$5,710,195
<0.5% S residual to distillate	—	$4,578,020	$5,422,917
<0.5% S residual to LNG	—	~~-$25,820,061~~ -$51,136,483	~~-$44,326,405~~ -$74,647,631

*Values in parentheses are percent change in fuel price (2015 USD per tonne) versus the price of HFO or <0.5% S residual fuel in that year.

IMPACT OF CORRECTIONS ON CONCLUSIONS

These corrections do not affect the overall conclusions of the working paper, but they do magnify the cost savings of switching from residual fuels to LNG, which are related to conclusion (2).