

# Feasibility of the Northern Sea route with the effect of emission control measures

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## Abstract

Despite shortening voyages between Asia and Europe by the Northern Sea Route (NSR) over the Suez Canal route (SCR), increased NSR's traffic intensifies vessel-based emissions to the Arctic Sea. This study investigates NSR's feasibility with a combination of operational and regulatory emissions control (EC) measures against the SCR and NSR's status quo without EC measures to derive sustainable policy without harming the NSR's economic feasibility. A mixed-integer nonlinear optimization model decides optimum speeds and heavy fuel oil (HFO)-banned areas for minimizing cost and emissions via NSR. Some scenarios indicate fewer emissions and costs from NSR with EC measures than NSR's status quo and SCR when emissions taxes are enforced on both routes. EC measures affect NSR's feasibility depending on ice conditions (ice-free, medium ice, and heavy ice scenarios) and slow steaming potential. A trade-off between economic and environmental objectives encourages combining operational and regulatory EC measures to support NSR's feasibility.

## Keywords

Northern Sea Route, Emission control measures, Speed optimization, HFO-banned areas, Suez Canal Route, Economic feasibility