

Committing before the vote: How a small port might plan alternative-fuel bunkering under uncertainty

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Abstract

Background:

Maritime decarbonization instruments primarily target vessels rather than ports. Nevertheless, ports encounter an implicit obligation to provide alternative bunker fuels, for which no established instrument prices exist, resulting in uncertain compliance costs.

Purpose/Objectives:

This study quantifies the financial obligations required of ports to meet alternative-fuel supply demands, identifies the necessary assets, and analyzes the principal factors influencing these requirements.

Methods:

A two-stage stochastic mixed-integer program allocates modular bunkering capacity across four fuels over 2027–2050, under three regulatory branches and correlated prices. The obligation enters as a chance constraint whose scope is varied; solving with and without it gives the subsidy requirement.

Results:

At the Port of Bergen, the committed portfolio combines methanol and shore power; ammonia and hydrogen enter only where the duty is drafted fuel by fuel. At a common 37% service level, required support rises from 2.50 to 6.53 million USD as the scope narrows. Carbon instruments move expected returns by about USD 1 million.

Conclusions:

At a port whose fleet suits electrification, obligation design appears a more immediate compliance lever than carbon pricing, which continues to act on the bunkering fuels. Because port revenue capture is commercially confidential, results are given as thresholds and comparative statics rather than absolute magnitudes.