

## Popular science summary of the PhD thesis

PhD student	Martina Reche Vilanova
Title of the PhD thesis	Wind Propulsion Systems for Commercial Ships: Modelling, Design, and Economic Optimization
PhD school/Department	Department of Civil and Mechanical Engineering (Construct)

## Science summary

\* Please give a short popular summary in Danish or English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology:

Shipping is the backbone of global trade, moving over 80% of the world's goods across the seas. But this comes at a cost to the environment, as maritime transport is responsible for about 3% of total annual anthropogenic greenhouse gas emissions. As the industry seeks sustainable solutions, Wind Propulsion Systems (WPSs) are making a comeback, with a growing number of installations worldwide demonstrating their potential to reduce emissions and fuel costs.

Yet, the widespread adoption of WPSs in commercial shipping is not plain sailing. Each WPS performs best under specific routes, ships, and operational constraints, making it difficult to determine the most cost-effective solution. Without careful evaluation, installations may fail to achieve expected savings or underperform, slowing the transition to greener shipping.

This PhD research addresses these challenges by developing a novel optimization framework for WPS deployment. The model evaluates cost-benefit trade-offs to identify the best WPS installation design for different operational needs, balancing fuel savings, emissions reduction, and investment costs. This framework supports informed decision-making for shipowners and operators and ensures fair comparisons between WPS technologies. The results highlight that there is no one-size-fits-all solution; instead, success depends on a tailored approach. Optimized designs can significantly shorten payback periods and boost profitability, while poor designs can extend payback times by over 150%.

This research paves the way for smarter, data-driven WPS deployment, unlocking its full potential and accelerating the transition to a sustainable, cost-effective shipping industry.

Please email the summary to the PhD secretary at the department