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Winds of change – the new tech steering commercial shipping towards a more sustainable future

Cargo ships and cruise liners may soon be harnessing the power of wind and waves to reduce their carbon emissions thanks to EU-funded researchers.

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In August 2023, a five-year old cargo ship, Pyxis Ocean, made history when it set sail from Shanghai, China, heading towards the southern Brazilian port of Paranaguá. A journey of nearly 25 000 km.

What was historic about the journey was that, instead of running solely on heavily polluting bunker fuel, the Pyxis Ocean would be the first ship of its kind to supplement fuel power with wind power. It was testing out the pioneering WindWings® – 37.5-metre-high, foldable steel and fibreglass "sails" able to harness energy from the wind to propel the immense bulk carrier through the water.

Back to the future

Designed by the UK company BAR Technologies, built by Norway-based Manta Marine Technologies and fitted in China to a ship chartered by international company Cargill, WindWings® are the result of an ambitious international collaboration – the CHEK project – that received funding from the EU to help commercial shipping chart a course towards a lower carbon future.

'It was quite a challenge at the time,' said Suvi Karirinne, director of the Vaasa Energy Business Innovation Centre (VEBIC) at the University of Vaasa, Finland, who coordinated the endeavour.

The *Pyxis Ocean's* maiden journey provided the first real-world test of WindWings® – and an opportunity to assess whether a return to this traditional method of propelling ships could be the way forward for moving cargo at sea.

In May 2024, DNV Maritime Advisory, an internationally recognised certification and testing authority, confirmed that when sailing in favourable conditions, the two WindWings® installed on the Pyxis Ocean reduced the

energy consumption of the main engine by 32% per nautical mile.

The WindWings® technology is expected to be widely adopted over time and is already set to be incorporated into 20 new vessels lined up for installation in 2025 and beyond.

Cleaner shipping

As much as 90% of the world's goods and raw materials are transported by sea – which is not as clean a means of transportation as one might think. A loaded container ship can burn as much as 150 tonnes of heavy fuel per day, which is unsustainable from an environmental perspective.

Shipping is a major source of carbon emissions – around 2% of the global total, according to the International Energy Agency. In April 2018, the International Maritime Organization agreed to reduce *emissions*by at least 50% by 2050 compared with a 2008 baseline.

To help achieve this goal, CHEK experts have been working together to come up with innovative design solutions that could be integrated into existing commercial vessels.Their ultimate goal is to create zero-emission vessels by synergistically combining different options.

Synergistic integration

The team of experts set out to integrate a range of different technologies and concepts into two vessel types: a bulk carrier and a cruise ship. Some of these designs were tested in real-world conditions on the Pyxis Ocean and a passenger cruise ship belonging to MSC Cruises, a global cruise line company.

By harnessing the synergies between different operational, power supply and drag reduction technologies, they have come up with a range of solutions that can be adapted for use in other vessel types such as tankers, container ships, general cargo ships and ferries.

Proposed innovations include, among others, hydrogen powered engines, ultrasonic anti-fouling devices and advanced route planning systems that consider the prevailing atmospheric and maritime conditions to provide the most energy-efficient route.

If applied together, the CHEK experts believe that the advances they have developed and tested could reduce ships' energy use by 50% and their greenhouse gas emissions by 99%.

'There is no silver bullet technology for maritime decarbonisation,' said Karirinne, who believes that the progress can best be achieved through the integration of both new and already existing innovative technologies.

Improving efficiency

'Shipping needs to reduce its emissions,' said Anders Öster, research manager at Wärtsilä, a Finnish engineering company. 'That's why we need to find solutions to make ships more efficient, and to decarbonise their propulsion.'

In addition to taking part in CHEK, Öster coordinated another international research project called SeaTech, which also received funding from the EU to improve the efficiency of commercial shipping.

The SeaTech research, conducted between 2020 and late 2023, included both shipping companies and academic partners such as the University of Southampton in the UK, the National Technical University of Athens and the University of Tromsø in Norway. It developed two key technologies that can be retrofitted to existing ships and thereby have a rapid impact on the sector's emissions.

Wave power

Inspired by the movement of whales and dolphins through water, the researchers attached a dynamic underwater wing, similar to the front fins of a hammerhead shark, to the front of the 10-metre-long model ship.

The wing, which harnesses wave power to help drive the ship forward, was tested both in wave tanks and in the Aegean Sea. The researchers found that it generates thrust, particularly in choppy seas, allowing engines to reduce their output.

‘These wings take the energy from waves and thrust the ship forward,’ says Öster. ‘They also stabilise the ship’s movements.’

In addition, the SeaTech team used sensors and software to control the combustion process in a ship’s gas-powered engine, improving its efficiency.

‘Compared to diesel engines, our gas engine emitted one-third less CO2,’ said Öster. The two innovations work particularly well together, he says, because the engine control software can respond quickly to the same conditions that determine the power output of the wings. The result is more than the sum of its parts, says Öster.

‘One plus one equals three when we combine these technologies. By taking different technologies and combining them, we strengthen their performance.’

The researchers found that, taken together, the two technologies could reduce diesel-powered ships’ CO2 emissions by 46%.

Economic advantage

The next challenge will be to persuade the shipping industry to adopt these innovations. Karirinne believes the results will speak for themselves.

Although the shipping industry can be quite conservative, according to Karirinne, it is also very competitive. In addition, the extension of the EU’s Emissions Trading System (EU ETS) in January 2024 to cover CO2emissions from all large ships has provided further impetus for change.

She expects that CHEK technologies will be welcomed by shipping operators as they can significantly reduce costs thanks to reductions in fuel consumption – and thus CO2 emissions.

‘These technologies aren’t just attractive because they reduce emissions, there’s also a societal and economic need for them,’ she said.

The rate of adoption will depend both on the perceived economic advantage and on how easily the respective innovations can be implemented. It may be some time before all cargo ships are fitted with giant sails, but SeaTech’s engine developments are being retrofitted to ships already.

‘Shipping is considered a hard-to-decarbonise sector,’ says Karirinne. ‘But we have shown examples of how to do it. It is possible, and there are options. We just need to use them.’

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