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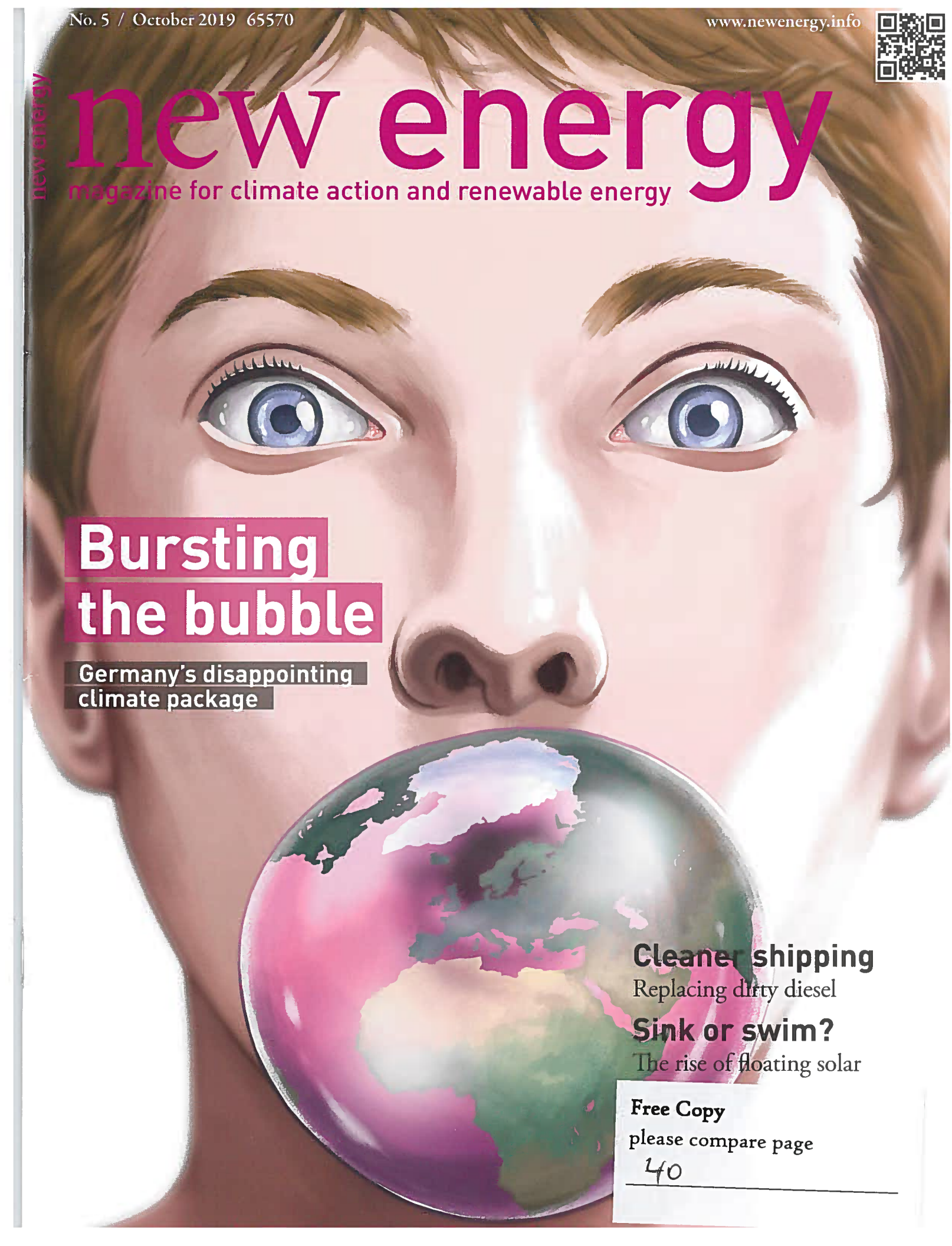


Bursting the bubble

Germany's disappointing climate package

Cleaner shipping
Replacing dirty diesel

Sink or swim?
The rise of floating solar

Plain sailing: the two-masted schooner "Avontuur" transports coffee from Mexico to Europe without contributing to climate change.

Sea change for the shipping sector

Diesel-powered shipping is a major contributor to global emissions of air pollutants and carbon dioxide — but with the rise of new drive technologies running on wind, gas or electricity, change is in the air.

By Jan Oliver Löfken

The coffee that went on sale at the Teikei café in Hamburg's Marktstraße this autumn has travelled a long way. Grown and harvested under fair trade rules in the highlands of Mexico, the beans caught a zero-emission, climate-neutral ride to Europe on the schooner "Avontuur". Their journey then continued by rail, before a final stretch on a cargo bike. "We want to transport our coffee in the cleanest way possible," says Hermann Pohlmann, who founded Teikei – which means 'cooperation' in Japanese – three years ago. The initiative has since accrued around 1,000 members in Germany and Switzerland, who enjoy what is arguably the most consistently fair trade coffee available anywhere in the world.

"This year we imported 20 tonnes of coffee. Next year it could be twice as much," Pohlmann says. For now, the Avontuur – a gaff schooner almost 100 years old – is big enough to meet demand, but interest in sustainable coffee is on the rise. The two-masted vessel, operated by the company Timbercoast, is 43 metres long, with a carrying capacity in excess of 100 tonnes and a sailing speed of around six knots (eleven km/h) – meaning it takes rather longer to cross the Atlantic than its gargantuan container-carrying cousins up to 400 metres long. "The trip from Mexico to Europe took around three months, although there were some stopovers along the way," Pohlmann recounts.

The Avontuur is not the only sailing vessel offering zero-emission transatlantic cargo shipping, harking back to a time before the advent of steam navigation in the 19th century. Since 2009, the "Tres Hombres" – built in 1943 – has been sailing back and forth between South America and Europe. Carrying dried cod from Norway, wine from France and olive oil from Portugal, it makes its way to Brazil, before returning laden with barrels of rum, sacks of coffee and other fairly traded goods from the Caribbean and the Amazon Basin. Of course, these amounts can only cover a tiny portion of the demand for premium fair trade produce. Compared to the global maritime freight sector, their role is symbolic at best: goods totalling over eleven million tonnes are currently traded by sea each year – around 100,000 times the combined capacity of the two sailing ships.

150 million containers

Over 90,000 ships – from oil tankers and bulk freighters to ferries, cruise ships and container behemoths – currently ply the world's oceans, accounting for around 90 percent of all freight transport. Over 150 million containers are moved in this way each year. What is more, according to an estimate in the Review of Maritime Transport, published by the United Nations Conference on Trade and Development (UNCTAD), this already gigantic amount is growing by three to four percent each year. Maritime shipping is powered almost exclusively by diesel engines. Away from coastal areas, they burn cheap high-sulphur fuel oil. Under current regulations, a sulphur content of up to 3.5 percent is allowed – some 3,500 times the permissible amount for road traffic in Europe. Besides the vast amounts of particulate matter pumped into the air, maritime shipping is responsible for around 13 percent of global sulphur dioxide emissions. The figure for nitrogen oxide is as high as 15 percent. In addition to these pollutants, ships running on diesel contribute to climate change with two to three percent of global carbon dioxide emissions – roughly the same amount as Germany.

The prospect of clean – or even climate-neutral – shipping is therefore a distant one. Nevertheless, change is in the air. For some years, the use of dirty fuel oil has been banned in many coastal waters. Instead, ships must use low-sulphur marine diesel oil in these areas. From 1 January 2020, the sulphur limit for ships sailing on the high seas will be slashed to 0.5 percent under International Maritime Organization (IMO) regulations, while in the North and Baltic Seas a threshold of 0.1 percent has been in place since 2015. Moreover, more and more ships are being fitted with exhaust scrubbing systems that could soon make many of the pollutants that are currently a cause for concern, such as particulate matter or nitrogen and sulphur oxides, a thing of the past. However, in this case ▶

Cylindrical sails: the diesel engine of the Finnish ferry "Estraden" is supplemented by two Flettner rotors

Photos: Timbercoast / Christoph Bogner, Norsepower

cleaner does not necessarily mean more climate-friendly: the switch from heavy fuel oil to marine diesel oil makes little difference in terms of the carbon dioxide emitted. Nevertheless, by 2050 the IMO hopes to halve the sector's carbon emissions compared to 2008 levels.

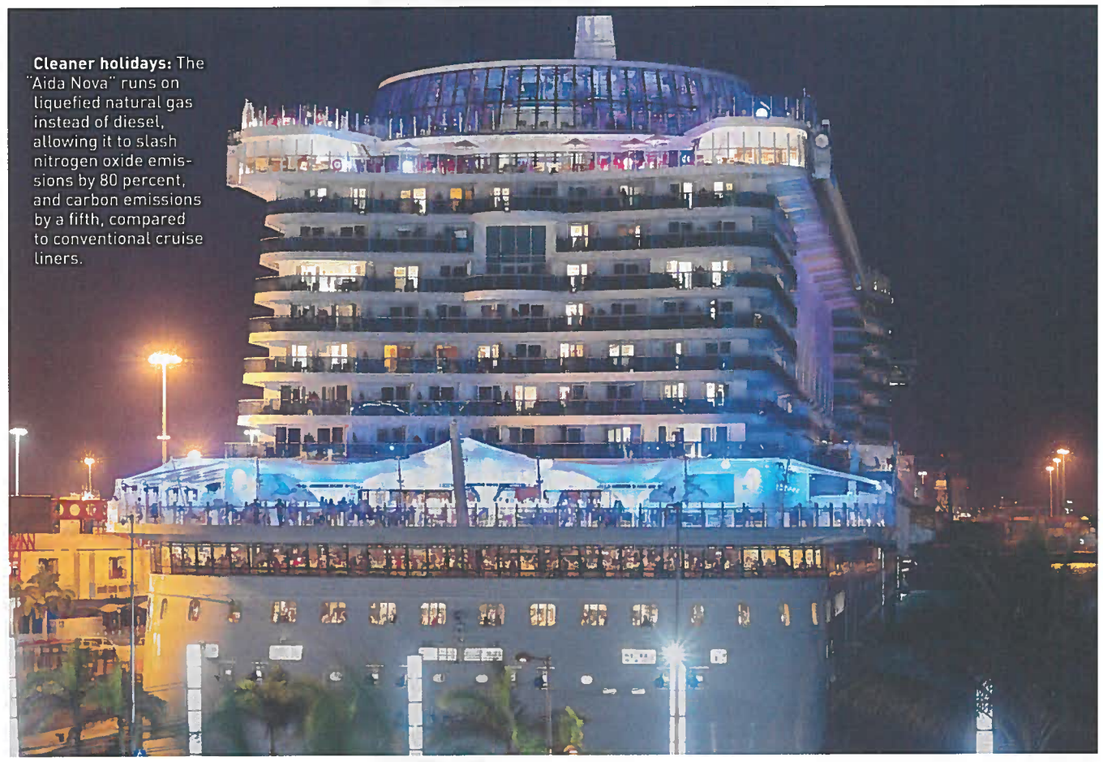
The first step towards achieving this goal is likely to be liquefied natural gas (LNG). The cruise liner "Aida Nova", launched in late 2018, shows how much of a difference replacing diesel with LNG can make. According to figures from Aida Cruises – a subsidiary of the US-based Carnival Corporation, the global market leader in the cruise sector – the 337-metre long leisure vessel with room for over 6,000 passengers emits no sulphur dioxide, soot or particulate matter, and produces 80 percent less nitrogen oxide emissions than its diesel-powered counterparts. Carbon dioxide emissions are around one fifth lower.

"After cruise ships, freight vessels running on LNG will follow soon," says Keno Leites of Thyssen/Krupp Marine Systems in Hamburg, revealing that the first models are already under construction. Given that LNG is already traded on a large scale, and more and more ports are equipped with LNG storage facilities, use of the new fuel could spread relatively quickly. "Rotterdam already has it, as do Singapore and the Scandinavian region. Hamburg is dragging its feet, but other ports are already in the planning stages," says Leites. The transition could make sense financially too: "LNG costs around the same as cheap heavy fuel oil, so it is more cost-effective than marine diesel oil," says Leites. "Using LNG as fuel significantly reduces emissions of particulate matter and nitrogen and sulphur oxides," confirms Lars Langfeldt, an expert on alternative forms of ship propulsion at the classification society and maritime consultancy firm DNV GL. "But the carbon emissions are still there."

According to Langfeldt, LNG alone will not be enough to achieve the IMO's 2050 climate targets – this will require climate-neutral fuels or fully electric drives. And while development of the necessary technologies is gathering pace, they are still a long way from mass production. Considering that shipping companies tend to upgrade their fleets every 20 to 25 years, there is only time for one more generation before 2050. "Hydrogen and fuel cells are promising technologies," says Langfeldt. "But they will be limited to niche applications to begin with, as hydrogen storage takes up a huge amount of space." And on cruise ships and freighters, space is at a premium. Roughly speaking, LNG tanks have to be three times the size of diesel tanks to store fuel with the same energy content. And using hydrogen for fuel requires another threefold increase in tank volume – even when the gas is compressed to 350 bar.

A pilot project will soon seek to show that hydrogen can be reliably used to power ships. The research cluster "e4ships – Fuel Cells in Maritime Applications," an alliance of German shipyards, shipping companies, fuel cell manufacturers, suppliers and classification societies, plans to test fuel cells for this purpose. The cells convert green hydrogen, generated from wind or solar power, into electrical current which powers the ship's engines. In October, work will begin on the push boat "Elektra", intended for freight transport on the waterways between Hamburg and Berlin from late 2020. "For inland shipping, hydrogen could be the next big thing," says Keno Leites, who is also a spokesperson for e4ships. Applications at sea are also in the works. However, he believes it is unlikely that electric drives powered by fuel cells will be adopted by freight shipping any time soon. "Initially, the target markets are cruise ships, ferries or yachts."

Green freighter: the push boat "Elektra" will run on electricity from a hydrogen-powered fuel cell.



Cleaner holidays: The "Aida Nova" runs on liquefied natural gas instead of diesel, allowing it to slash nitrogen oxide emissions by 80 percent, and carbon emissions by a fifth, compared to conventional cruise liners.

Photos: EBMS, Islandstock / Alamy Stock Photo

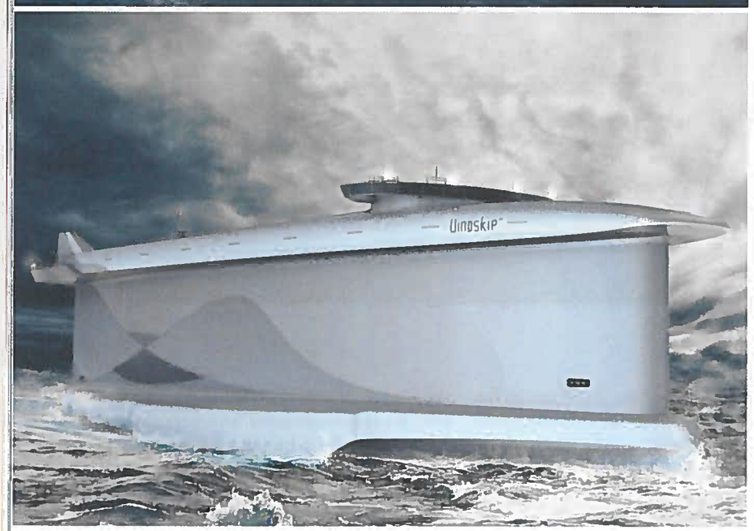
Hydrogen-powered island hopping

From 2021, a sea-going ferry running on hydrogen will begin operation between Scotland's Orkney Islands. The vessel is being developed under the EU project "Hyseas III" by the Ferguson shipyard in Scotland, in cooperation with other partners. Seven fuel cell modules, each with a capacity of 100 kilowatts (kW), powered by over half a tonne of compressed hydrogen, will provide enough electricity for a range of at least 100 km. "With excellent weather conditions and optimal operation, a range of 200 to 300 km is conceivable," says Juan Camilo Gómez Trillos, who is responsible for the economic, social and environmental analyses of the Hyseas III project at the German Aerospace Centre's Institute of Networked Energy Systems, a partner in the project. Pilot projects like this one could help dispel doubts about the viability of hydrogen-powered electric drives. "Pure hydrogen still raises red flags for the IMO and many shipping companies. It is associated with massive safety concerns," Leites concedes. Nevertheless, he believes that the technology can be "safely mastered, in principle".

For shorter distances, electric drives can do without fuel cells altogether. On short-range ferries, for instance, electricity can be provided by batteries. Since 2015, the ferry "Ampere" has served Norway's Sognefjord. Studies show that in addition to cutting carbon emissions by 95 percent in comparison to a conventional diesel ferry, the technology has also brought down operating costs to a fifth of their previous level. Somewhat larger is the 60-metre electric ferry "Ellen", which relies on batteries with a storage capacity of 4.3 megawatt hours (MWh) to cover a 40-km route between the Danish islands of Ærø and Als. However, for longer distances batteries cannot compete with hydrogen and fuel cells. "Batteries are extremely bulky – they're just too heavy. And for ranges in excess of 100 nautical miles, they're also too expensive," says DNV GL expert Langfeldt.

Industry insiders like Keno Leites therefore anticipate a "high degree of differentiation" when it comes to the drive technologies of the future. The de facto monopoly of diesel engines is coming to an end. The characteristics of different applications – such as ferries, cruise ships or cargo vessels – will determine whether batteries, fuel cells or combustion engines running on liquefied gas or synthetic, climate-neutral fuels are the best option. There will also be a place for wind as a form of propulsion – and not just in classical sailing ships, but in combination with other drive technologies.

Pioneering ideas in this field include the kite rigs developed by Hamburg- ▶



Winds of change: the Dyna-Rigs of the 88-metre yacht "Maltese Falcon" (top), which allow highly automated operation, could be installed on freight ships in future. The "Vindskip" (bottom) – shown here as an artist's impression – is designed to catch the wind with its hull, which will rise almost 47 metres above the surface.

based company Skysails over ten years ago. Attached to the bow of a ship, the rigs were meant to substantially reduce ships' electricity and fuel consumption at high sea. However, in spite of successful tests, the part of the Skysails group behind the project filed for insolvency in 2016. Another concept that may be more likely to take hold is the Flettner rotor, a cylindrical rotor sail that relies on the Magnus effect to harness the power of the wind, propelling the ship in a manner similar to the lift created by an aircraft wing. One of the first vessels to successfully use the technology, which can reduce fuel consumption by 15 to 20 percent, was the "E Ship 1", built by Aurich-based wind turbine manufacturer Enercon in 2010. In 2014, Finnish company Norsepower followed suit with its ferry "Estraden", in which two rotor prototypes – each 17 metres high and 3 metres in diameter – support the ship's engine. The Scandinavian shipbuilder Scandlines also recently placed an order for a rotor sail for one of its ferries. Norsepower is even planning to equip a tanker with two Flettner rotors.

Meanwhile, Norwegian company Lade AS is working on an eccentric-looking vessel that will be powered by a combination of wind propulsion and LNG. The "Vindskip", measuring just under 200 metres in length, will rise almost 47 metres clear of the water. Instead of sails, the ship's towering hull will catch the wind to provide additional propulsion, thereby saving fuel.

Other solutions closer to the implementation stage include sailing ships in a more classical design. French carmaker Renault has commissioned Nantes-based company Neoline to build a 136-metre long cargo sailing ship for bulky loads, including containers. A sail area of 4,150 square metres will assist the ship's diesel-electric propulsion system. The vessel could be launched as soon as 2021 – around the same time that Danish shipping company Ultrabulk plans to begin trials of six vertical sails on the deck of a tanker ship.

Meanwhile, Teikei founder Hermann Pohlmann hopes that more ships will follow the example of the Avontuur, plying the seas propelled solely by the power of the wind. According to his sources, Timbercoast – the company that operates the Avontuur – has plans for another sailing vessel able to carry much greater loads. "And in Costa Rica, the Canadian company Sailcargo is currently building the 'Ceiba' using nothing but wood, with a planned capacity of around 250 tonnes," Pohlmann adds.

If demand for Teikei's coffee continues to rise, this is exactly what Pohlmann will need. Ten years from now, the initiative hopes to have boosted its modest imports of Mexican fair trade coffee from 40 to 2,500 tonnes. "This would drastically reduce transport costs per kilo," Pohlmann explains. It currently costs Teikei EUR 2.20 per kilo to import coffee with the Avontuur – around ten times the rate for standard container freight. Accordingly, for cost reasons alone this means of transport is likely to remain a niche segment in the global shipping sector for the foreseeable future. Nevertheless, it shows that climate-friendly goods transport across the oceans is possible. ◀