**What if ships generated their own energy and helped reduce emissions at sea?**

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# Deep-Sea Energy

Within Reach | Transitional | **Visionary**

Ocean-powered ships use temperature differences between surface and deep seawater to generate their own renewable energy while autonomously identifying and following optimal routes, contributing to a more sustainable future for marine transport.

### UNCERTAINTIES

Systems, Technology

### MEGATREND (Most significant)

Energy Boundaries

### TRENDS

Ideation, IP & Entrepreneurship
Net Zero
Transforming Energy
Transforming Logistics

### TECHNOLOGIES

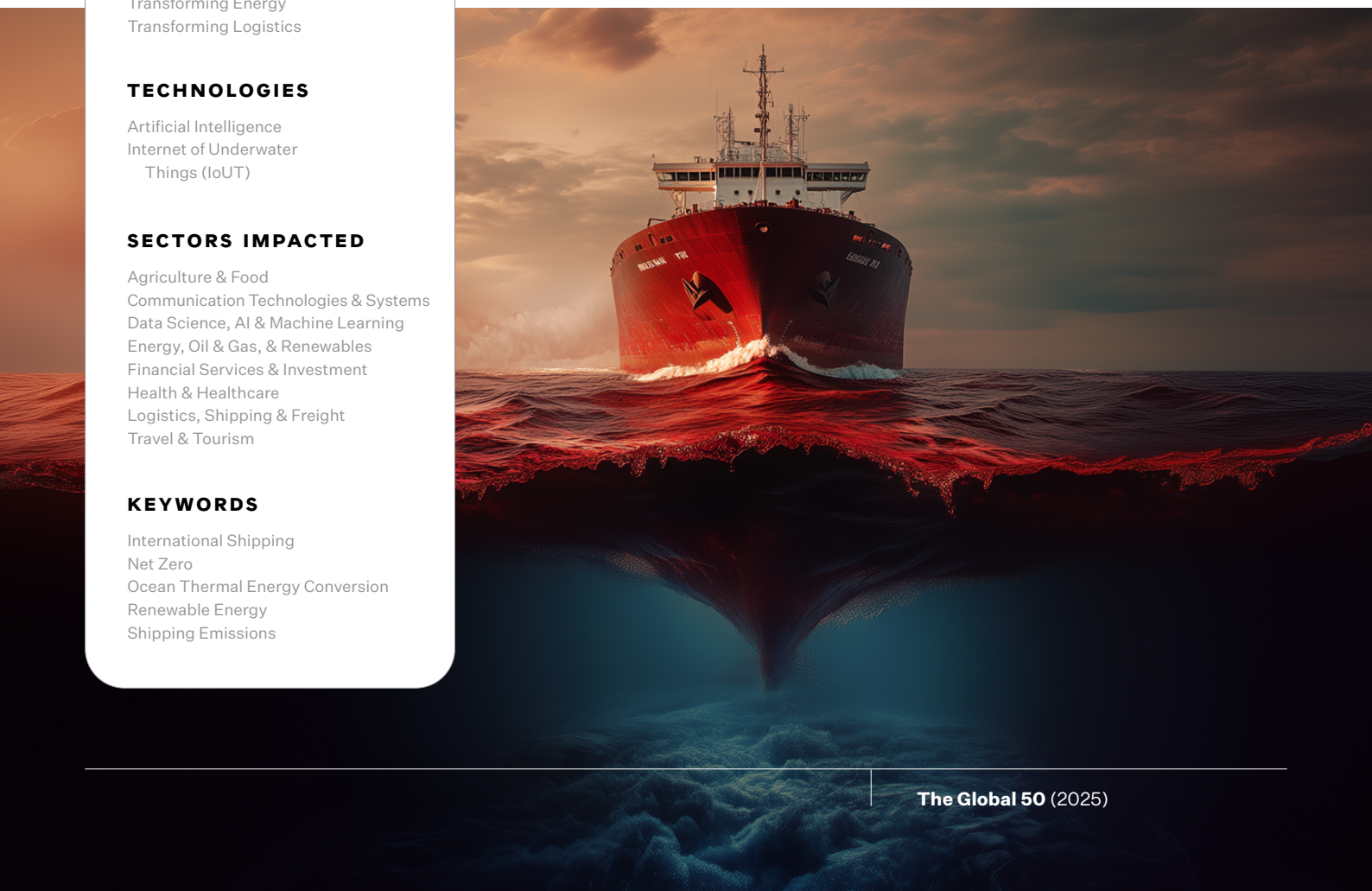
Artificial Intelligence
Internet of Underwater Things (IoUT)

### SECTORS IMPACTED

Agriculture & Food
Communication Technologies & Systems
Data Science, AI & Machine Learning
Energy, Oil & Gas, & Renewables
Financial Services & Investment
Health & Healthcare
Logistics, Shipping & Freight
Travel & Tourism

### KEYWORDS

International Shipping
Net Zero
Ocean Thermal Energy Conversion
Renewable Energy
Shipping Emissions



## WHY IT MATTERS TODAY

Marine transport supports up to

**90%**

of global trade, and **greenhouse gas** emissions will increase by

**50% to 250%**

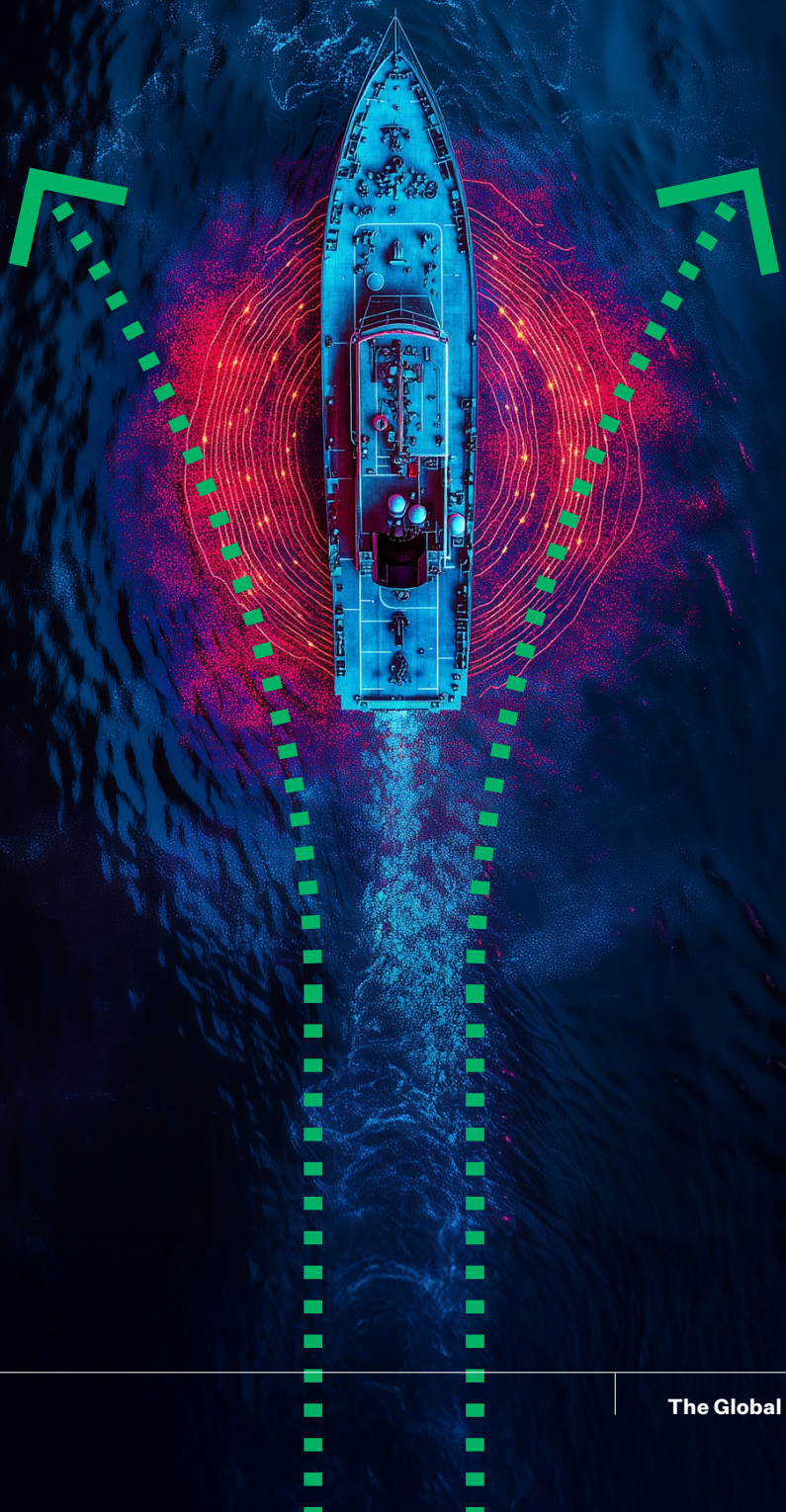
by 2050 **if no action is taken**

Up to 90% of global trade depends on international shipping.[729] The International Maritime Organization projects that maritime trade will increase by 40–115% by 2050 compared to 2020.[730] If no action is taken, greenhouse gas emissions from the shipping industry could rise by 50–250%.[731]

Marine transport impacts human health. Ship emissions are contributing to deteriorating air quality on land, despite being released at sea, as these pollutants can drift hundreds of kilometres.[732] While these numbers can fluctuate, marine transport is responsible for approximately 13% of nitrogen oxide and 12% of sulphur oxide emissions, both of which pose significant risks to human health.[733] Additionally, such pollution accelerates ocean acidification, threatening marine food chains and the human food supply chain.[734]

Air pollution from shipping disproportionately impacts certain communities and regions. Populations living near major shipping routes experience the highest concentrations of shipping-related air pollution, making them more at risk of adverse health effects and economic strain.[735] Achieving net-zero emissions in shipping by 2050 will require both advances in renewable technologies and design improvements for energy efficiency.[736]

**Smart routing systems** help vessels identify routes with sufficient temperature differentials



## THE OPPORTUNITY

**BENEFITS**

Clean energy in marine transportation; reduced environmental impact; energy transfer to land-based communities; removal of the need for refuelling.

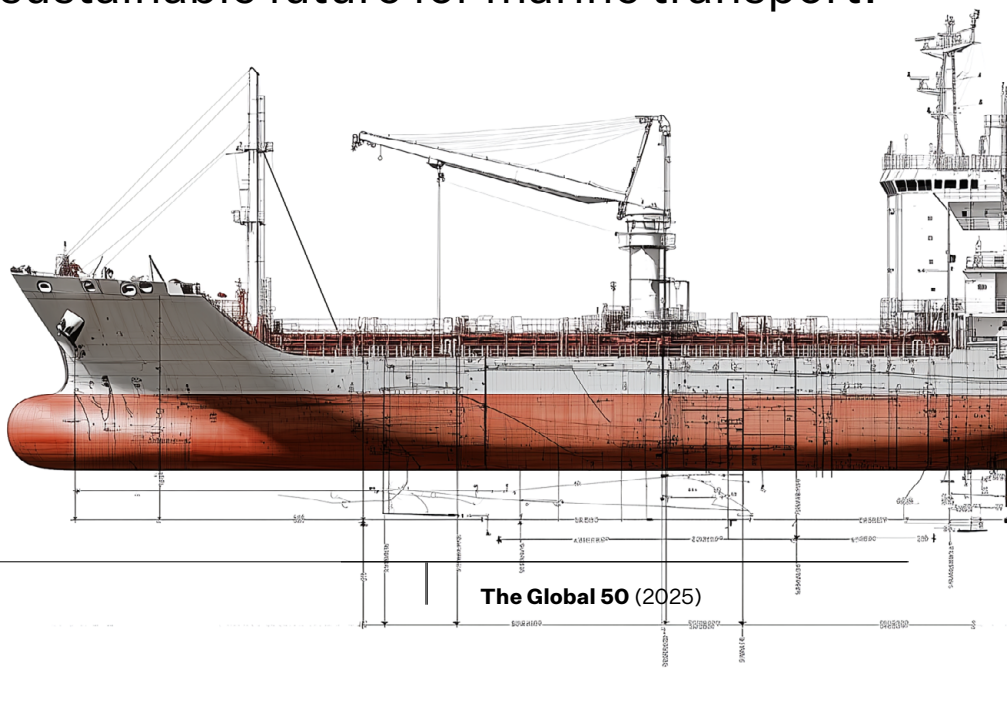
**RISKS**

Higher offshore maintenance costs; significant upfront capital investment; significant engineering challenges; shipping delays.

Ships are equipped with modular ocean thermal energy conversion (OTEC) systems, optimised and integrated into the vessel's design to generate electricity while at sea. Using satellite data[737] and deep-sea temperatures measured by the Internet of Underwater Things (IoUT),[738] the system activates when it detects a temperature difference of at least 20°C between the warm surface seawater and cold deep seawater,[739] driving turbines to generate electricity.[740]

While technically challenging, integrating OTEC systems into marine vessels offers a promising pathway towards renewable energy generation[741] and offers a more sustainable future for marine transport.[742] Smart routing systems help vessels identify routes with sufficient temperature differentials. With advanced energy storage solutions and next-generation battery technologies, vessels can store surplus power to meet their energy needs in areas that do not have sufficient temperature differentials or that have only limited energy access.

**An engineering opportunity and challenge, integrating ocean thermal energy conversion (OTEC) into marine vessels** offers a more sustainable future for marine transport.



**The Global 50** (2025)