Summary for Decision-makers

The Ocean as a Solution to Climate Change

Five Opportunities for Action

The ocean is on the front lines of the battle against climate change. It already has absorbed 93 percent of the heat trapped by human-generated carbon dioxide (CO_2) emissions. It absorbs 25-30 percent of annual CO_2 emissions that would otherwise remain in the atmosphere and increase global warming.

It has become a victim of climate change, putting everyone at risk. The ocean is getting warmer and becoming more acidic—a direct result of the extra CO_2 being dissolved into it. These changes are damaging marine ecosystems (e.g., killing coral reefs), shifting the location and size of commercial fish stocks, and compromising the ability of the ocean to provide food, livelihoods, and safe coastal habitation on which billions of people depend.

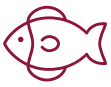
Deep cuts in greenhouse gas emissions across terrestrial sources are needed if this pressure on the ocean is to subside. These measures include dramatic reduction in fossil fuel use, implementation of climate-smart agriculture, cessation of deforestation, and restoration of degraded forests and other natural ecosystems, among others.

However, new analysis[1] has identified five ocean-based climate action areas that can help in the fight against climate change. These are:

OCEAN-BASED RENEWABLE ENERGY: reduce barriers to scaling up offshore wind (fixed and floating turbines) and invest in new, innovative ocean-based energy sources such as floating solar photovoltaics, wave power, and tidal power.

OCEAN-BASED TRANSPORT: implement available technologies to increase energy efficiency now (e.g., improved hull design), and support the development of low-carbon fuels as part of a broader decarbonisation of ocean industries and energy supply chains, including port facilities. Start with decarbonising the domestic fleet, such as coastal ferries.

COASTAL AND MARINE ECOSYSTEMS: conserve existing “blue carbon” ecosystems (mangroves, seagrass beds, and salt marshes) to prevent further release of GHG emissions and scale up restoration efforts. Expand farmed seaweed as an alternative fuel and feed source.

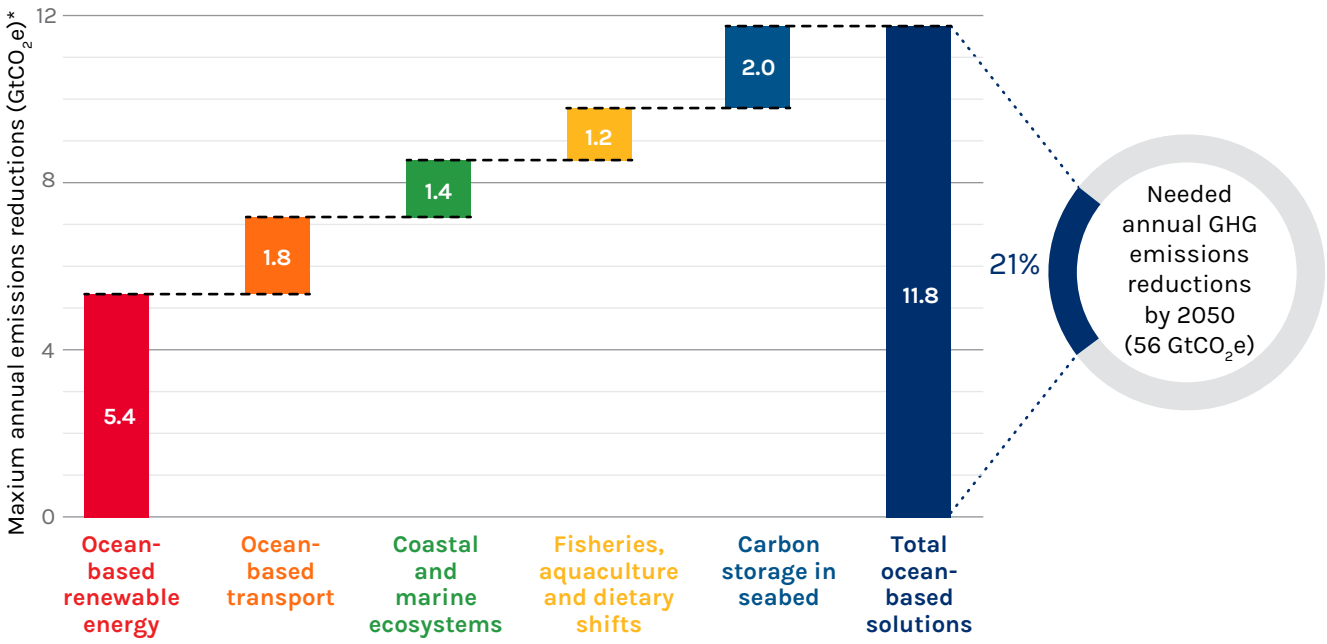


FISHERIES, AQUACULTURE, AND DIETARY SHIFTS: reduce the emissions intensity of fisheries and aquaculture operations through optimising wild catch and shifting to low carbon feed options. Shift diets toward low carbon marine sources such as sustainably harvested fish, seaweed, and kelp as a replacement for emissions intensive land-based sources of protein.

CARBON STORAGE IN THE SEABED: invest in the research necessary to minimise environmental impacts of long-term storage of carbon in the seabed and remove regulatory and economic barriers.

Full implementation of these ocean-based climate solutions could deliver one-fifth (up to 21 percent) of the annual greenhouse gas emissions cuts the world needs by 2050 to keep global temperature rise below 1.5 degrees Celsius (Figure 1). Emission reductions of this magnitude are equivalent to the annual emissions from all coal-fired power plants worldwide or taking 2.5 billion cars off the road.

Figure 1. Contribution of Five Ocean-based Climate Action Areas to Mitigating Climate Change in 2050 (Maximum $GtCO_2e$)



** To stay under a 1.5°C change relative to pre-industrial levels*
Source: Authors

Ocean-based climate solutions need to be part of the global response to climate change. These ocean-based climate solutions are a new pathway to a low-carbon, climate-resilient future.

Pursuing these ocean-based climate action areas can generate a number of co-benefits, as well. Economic benefits include new local employment opportunities, coastal resilience, and new economic sector growth. Social benefits include reduced mortality due to improved local air quality, positive health impacts from shifting diets towards low carbon ocean-based protein, enhanced global food security, potential to ensure greater gender parity as ocean-based industries expand, and improved income opportunities and livelihoods in coastal areas. Environmental benefits include biodiversity protection and reduced ocean acidification.

Realising the scale of the mitigation potential of these five areas will require greater political will, clear policy signals to support private sector investment and engagement, new public finance mechanisms, and technology deployment and transfer. Table 1 outlines a set of short- and medium-term priorities.

Table 1. Short- and Medium-term Policy, Research, and Technology Priorities Necessary to Deliver on Mitigation Potential of Ocean-based Climate Action Areas

	OCEAN-BASED ENERGY		
	POLICY	RESEARCH	TECHNOLOGY
Short-term Priorities (2020–2023)	▪ Undertake marine spatial planning ▪ Develop national targets to increase the share of renewable energy in the national energy mix ▪ Provide a stable economic and regulatory framework to stimulate investments in required infrastructure for an accelerated deployment of ocean-based energy systems	▪ Understand the impacts (positive and negative) of both fixed and floating offshore wind installations on marine biodiversity ▪ Undertake a detailed mapping of global renewable energy resources and technical potential	▪ Advance storage capacity and design ▪ Improve performance, reliability, and survivability, while reducing costs
Medium-term Priorities (2023–2025)	▪ Develop strategic national roadmaps for zero-carbon economy in 2050 ▪ Develop appropriate legislation and regulation	▪ Understand the potential benefits of co-location with other ocean-based industries (e.g., desalination plants and aquaculture) ▪ Explore the potential for installing large scale floating solar installations at sea (under wave conditions) ▪ Quantify the potential of Ocean Thermal Energy Conversion (OTEC)	▪ Advance technology that can move technologies into deeper water sites (e.g., development of floating offshore wind technologies) to open access to larger areas of energy resources

Table 1. Short- and Medium-term Policy, Research, and Technology Priorities Necessary to Deliver on Mitigation Potential of Ocean-based Climate Action Areas (Continued)

	OCEAN-BASED TRANSPORT		
	POLICY	RESEARCH	TECHNOLOGY
Short-term Priorities (2020–2023)	▪ Redesign the Energy Efficiency Design Index (EEDI) formula to avoid vessels being suboptimised for the test only, to ensure that instead vessels are being optimised for minimised fuel consumption in real operation at sea. ▪ Adopt policy measures to go beyond Ship Energy Efficiency Management Plan (SEEMP) to incentivise the maximisation of operational efficiency of new and existing ships ▪ Adopt policies that can reduce the broader GHG emissions of shipping instead of CO_2 only, including well-to-tank emissions (WTW) of ship fuels	▪ Identify and rectify of market and nonmarket barriers and failures to enable larger uptake of more energy-efficient technologies and cooperation patterns ▪ Ensure continuous research on ship design, including hull forms and propulsion, with a focus on reducing energy usage per freight unit transported ▪ Increase focus on utilisation of wind, waves, ocean currents, and sun to reduce use of externally provided energy, i.e., both the carbon and non-carbon-based fuels carried on board	▪ Develop the necessary high efficiency hull forms and propulsion methods ▪ Develop and implement hybrid power systems, including combustion engines, fuel cells, and batteries technologies ▪ Develop and implement wind assistance technologies ▪ Develop more advanced weather routing systems to better utilise wind, waves, ocean currents, and tides to reduce the use of both carbon and non-carbon fuel carried on board
Medium-term Priorities (2023–2025)	▪ Develop policy to enable the business case for the adoption of low and zero carbon fuels by shipping (e.g. a carbon price) ▪ Commit to the timetable for shipping's transition to low- and zero-carbon fuels ▪ Develop national incentives for decarbonising domestic transportation ▪ Commit to decarbonisation of national energy systems faster or as fast as the transition in the international fleet	▪ Develop cost-effective production of low- and zero-carbon fuels, both from renewables and from carbon based in combination with carbon capture and storage (CCS) ▪ Develop cost-efficient hybrid setups on seagoing vessels to utilise the best of combustion, fuel cells, and batteries to reduce fuel consumption and local pollution ▪ Ensure safe storage and handling on ships and at the ship-shore interface of hydrogen/ammonia ▪ Ensure safe and efficient use of hydrogen and ammonia in internal combustion engines and fuel cells	▪ Advance technologies for producing hydrogen, both from renewables and carbon-based fuels ▪ Invest in technologies to store hydrogen (including cryogenic storage of liquid hydrogen, or carriers able to store at high-energy density) ▪ Invest in fuel cells for conversion of future fuels into on-board electricity, and internal combustion engines designed to operate on hydrogen/ammonia

Table 1. Short- and Medium-term Policy, Research, and Technology Priorities Necessary to Deliver on Mitigation Potential of Ocean-based Climate Action Areas (Continued)

	COASTAL AND MARINE ECOSYSTEMS		
	POLICY	RESEARCH	TECHNOLOGY
Short-term Priorities (2020–2023)	▪ Enhance protection measures for mangroves, seagrass, salt marsh, and seaweed beds to prevent any further losses due to human activities ▪ Provide incentives for restoration of "blue carbon" ecosystems, through payments for ecosystem service schemes, such as carbon and nutrient trading credits ▪ Include quantified nature-based solutions within nationally determined contributions (NDCs) and other relevant climate policies for mitigation and adaptation ▪ Protect coral reefs as important and integrated coastal defence systems for ensuring the protection of coastal blue carbon ecosystems	▪ Undertake national-level mapping of blue carbon ecosystems ▪ Address biophysical, social, and economic impediments to ecosystem restoration to develop restoration priorities, enhance incentives for restoration, and increase levels of success ▪ Improve the IPCC guidance for seagrasses and other wetland ecosystems ▪ Develop legal mechanisms for long-term preservation of blue carbon, especially in a changing climate ▪ Understand the impacts of climate change on rates of carbon capture and storage, or the potential for restoration	▪ Advance biorefining techniques, allowing sequential extraction of seaweed products
Medium-term Priorities (2023–2025)	▪ Enhance and adopt carbon accounting methodologies for mangroves, seagrasses and salt marsh within national GHG inventories (IPCC 2013) ▪ Improve methods for monitoring mitigation benefits to enable accounting within national GHG inventories, and biennial transparency reports (BTRs)	▪ Undertake global-scale map of seaweed ecosystems ▪ Develop IPCC-approved methodological guidance for seaweed ecosystems ▪ Develop methods to fingerprint seaweed carbon beyond the habitat	▪ Develop and pilot offshore and multiuse sites, including seaweed aquaculture, in the open ocean

Table 1. Short- and Medium-term Policy, Research, and Technology Priorities Necessary to Deliver on Mitigation Potential of Ocean-based Climate Action Areas (Continued)

	FISHERIES, AQUACULTURE, AND DIETARY SHIFTS		
	POLICY	RESEARCH	TECHNOLOGY
Short-term Priorities (2020–2023)	▪ Eliminate harmful fisheries subsidies (SDG14.6) ▪ Strengthen international tools to eliminate IUU fishing (SDG14.5) ▪ Avoid the transport of fish by air ▪ Reduce discards ▪ Reduce and eliminate hydrochlorofluorocarbons (HCFCs) in refrigerants ▪ Create incentives for shifting diets towards low-carbon protein (e.g., fish) and other food (e.g., seaweed) diets ▪ Create incentives to improve fishery management ▪ Create incentives for lower trophic-level aquaculture ▪ Devise sustainable finance mechanisms for small-scale fishery transitions to sustainable fishing	▪ Develop disaggregated global data sets for GHG emissions from wild catch fisheries and marine aquaculture ▪ Impacts of scaling marine aquaculture and associated sustainability considerations (e.g., low carbon and climate resilient, environmentally safe) ▪ Enhance understanding of how climate change and ocean acidification will impact aquaculture and fisheries	▪ Extend surveillance technologies for tracking fishing in the ocean and along coastal areas
Medium-term Priorities (2023–2025)	▪ Create incentives to switch from high-carbon land-based sources of protein to low-carbon ocean-based sources ▪ Improve fisheries management to focus on optimising biomass per harvest	▪ Explore potential impact of a carbon tax on red meat and other carbon intensive foods	▪ Develop and bring to scale high-technology digital aquaculture

	SEABED CARBON STORAGE		
	POLICY	RESEARCH	TECHNOLOGY
Short-term Priorities (2020–2023)	▪ Invest in pilot projects to further explore potential environmental impacts ▪ Incentivise public/private partnerships	▪ Map global geophysical potential ▪ Understand the impacts of long-lasting containment of CO_2 in a deep seafloor environment	▪ Few major technical advances are required as seabed storage is already deployed at industrial scale
Medium-term Priorities (2023–2025)	▪ Develop national strategies and targets ▪ Develop regulatory frameworks to ensure environmental impact assessments and associated precautions are put in place.	▪ Understand the impacts of long-term storage on marine ecosystems ▪ Explore the integrity of long-term storage technologies (leakage)	▪ Scale up technologies in ways that are economically feasible

The High Level Panel for a Sustainable Ocean Economy

Established in September 2018, the High Level Panel for a Sustainable Ocean Economy (HLP) is a unique initiative of 14 serving heads of government committed to catalysing bold, pragmatic solutions for ocean health and wealth that support the Sustainable Development Goals (SDGs) and build a better future for people and the planet. The Panel consists of the heads of government from Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau, and Portugal, and is supported by an Expert Group, Advisory Network, and Secretariat that assist with analytical work, communications and stakeholder engagement. The Secretariat is based at World Resources Institute.

The report that this brief summarises was prepared in support of the work of the HLP. The arguments, findings, and recommendations made in the report represent the views of the authors only. While the HLP supports the general thrust of the findings and recommendations, members have not been asked to endorse the report, and should not be understood as having done so.

For more information, including the full report, visit **www.oceanpanel.org**

ENDNOTE

1. Ove Hoegh-Guldberg, Ken Caldeira, Thierry Chopin, Steve Gaines, Peter Haugan, Mark Hemer, Jennifer Howard, Manaswita Konar, Dorte Krause-Jensen, Elizabeth Lindstad, Catherine E. Lovelock, Mark Michelin, Finn Gunnar Nielsen, Eliza Northrop, Robert Parker, Joyashree Roy, Tristan Smith, Shreya Some, and Peter Tyedmers. 2019. *The Ocean as a Solution for Climate Change: Five Opportunities for Action*. World Resources Institute. Report. Washington, D.C. Available at www.oceanpanel.org/climate