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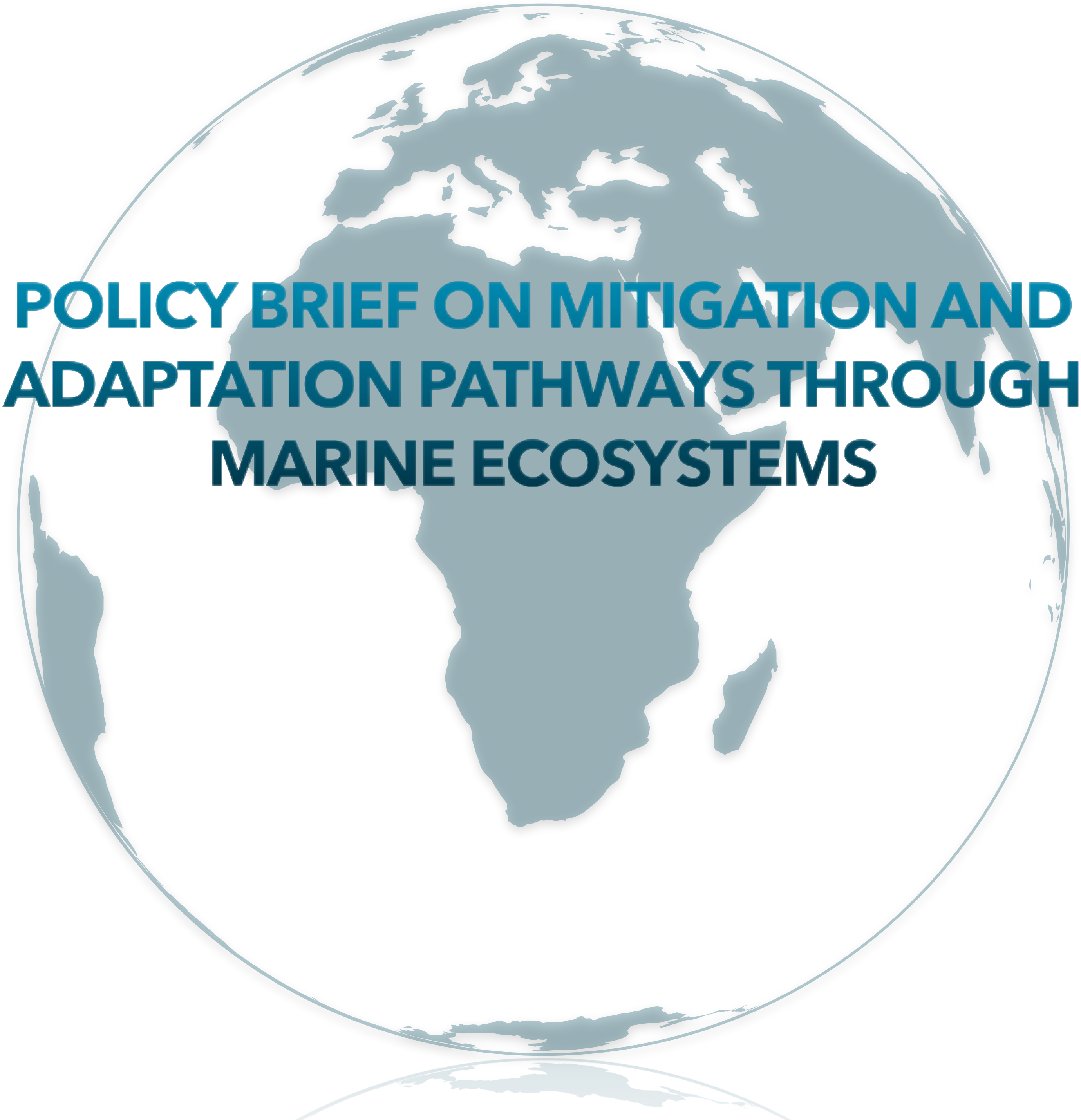
CLIMATE RESILIENCE BY 2050



POLICY BRIEF ON MITIGATION AND ADAPTATION PATHWAYS THROUGH MARINE ECOSYSTEMS

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CLIMATE CHANGE AND ENVIRONMENTAL HAZARDS

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CLIMATE CRISIS

Climate change and its consequences are an urgent matter at the present time (Welthungerhilfe, n.d.). The impacts of climate related hazards are concerning for all living organisms (Welthungerhilfe, n.d.). The importance of marine ecosystem solutions is the primary focus of this policy brief. Besides it aims to provide a five-part approach that encourages stakeholders, social and political structures equally as institutions to gain further knowledge, take rapid action and minimise aforementioned threats up to climate resilience until 2050. Different ocean based climate mitigation and adaptation pathways are proposed, each including one outstanding case example which lead to a critical reflection of these concepts and various continuing challenges.

MARINE-LED CLIMATE RESILIENCE BY 2050

Climate resilience in general refers to the robustness of a social, economic or natural ecosystem and its individual parts towards climate change. Different key components of climate resilience determine the ability and effectiveness to foresee and prepare (risk management and preparedness), absorb (absorptive capacity), adapt to (adaptive capacity) and recover (coping capacity) from climate related hazards. Resilience involves ensuring that the fundamental structures and functions of a system are maintained, restored, or even enhanced throughout the process. (Lavell, 2012)

The ocean covers almost three quarters of the earths surface (IPCC, 2019), provides 50% of the O_2 contained in the atmosphere (Friends of Ocean Action, n.d.) , stores 25% of CO_2 emissions worldwide and 90% of overabundance heat in the atmosphere, is consequently considered as a carbon sink, stabiliser of climate and a big player in terms of decreasing greenhouse gas emissions (United Nations, n.d.). In 2050 ocean based resolutions can potentially close 35% of the emission gap (Hoegh-Guldberg et al. 2019). Therefore the health of the ocean itself, and its biodiversity are indispensable for a climate resilient 2050 (United Nations, n.d.). Presently the ocean faces numerous stressors (orraa, 2024): Sea level rise (medium confidence), coral bleaching (high confidence) and ocean acidification (high confidence), irreversible losses and damages to marine ecosystems but also socioeconomic consequences (high confidence) are caused due to global warming (IPCC, 2022). With high confidence ocean marine ecosystems experience a higher extend of losses and damages than explored in previous studies (IPCC, 2022) which may lead to the release of further greenhouse gases (NO_2, CH_4) (Bindoff et al., 2019). Mentioned impacts demonstrate the urgency to reduce greenhouse gas emission and to set net zero emission targets (Hoet, 2020) to minimise global warming to 1,5°C above pre industrial level until 2050 (Hoegh-Guldberg et al., 2019). If all current approaches would be implemented until then global mean temperature would increase up to 2,7°C (Umweltbundesamt, 2021). Besides the presented arguments underpin the potential marine ecosystems hold, if financial, political, social and educational investments in mitigation and adaptation pathways towards a more sustainable and resilient climate are pursued (IPCC, 2019).

MITIGATION

To prevent a collapse of marine ecosystems, mitigation pathways are eligible to reduce human made climate change and the release of greenhouse gases (NASA, 2024). Mitigation is a proactive action which aims to intensify absorptive capacities, risk management and preparedness (United Nations Environment Programme, 2022). Following picture illustrates seven different ocean based pathways that are ready to be implemented now with different scales of mitigation potential in Gt CO_2e/year.

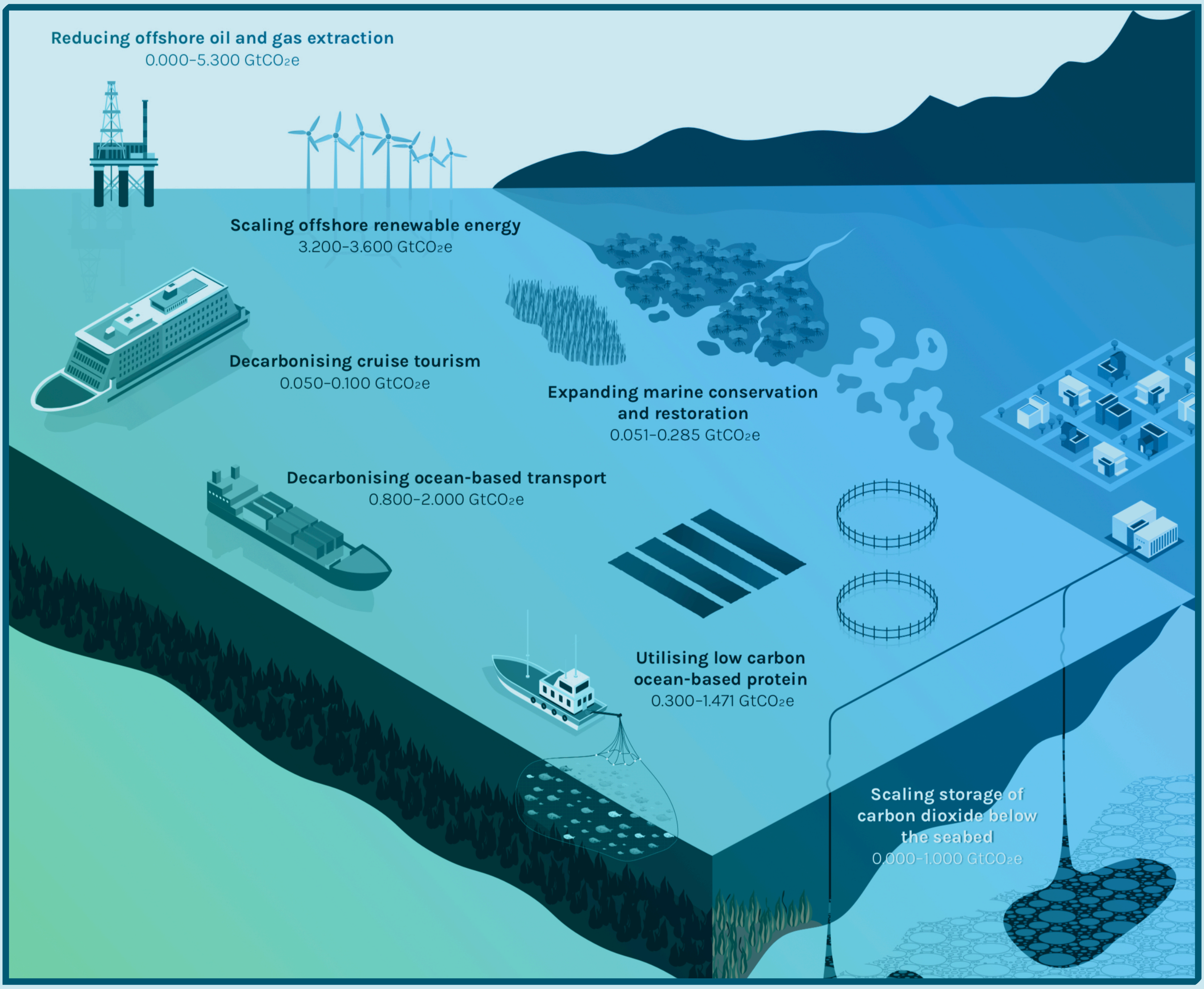

Figure 1: Annual emission reduction potential in 2050 for solutions that are ready to implement now (Hoegh-Guldberg et al., 2019, p. 10)

The use of ocean renewable energy is an option with high potential (IPCC, 2019) including offshore wind, tidal barrages and floating solar (Hoegh-Guldberg et al., 2019). Reducing emissions in transnational shipping, abandoning the extraction of offshore fossil fuels, shifting farming, fishing and tourism to more sustainable industries, storing CO_2 in subsoils (Hoegh-Guldberg et al. 2019) and carbon sequestration by i.e. high level Marine Protected Areas (MPAs) are feasible strategies. MPAs restrict human action (Friends of Ocean Action, n.d.), i.e. overfishing, diving, boating and tourism (National Geographic Society, 2024), which result in social and ecological benefits (Jacquemont et al., 2022). Higher efficiency is achieved the longer a MPA exists (Jacquemont er al., 2022). Blue Carbon ecosystems (e.g. mangroves, tidal marshes, sea grass, coral reefs) and acidity/pH buffering (Jacquemont et al., 2022) are further components of an ocean based comprehensive mitigation strategy.

PILOT PROJECT - PROJECT GREENSAND

The world's first transnational offshore CO_2 storage (CCS) is established on March 8th 2023 by the government of Denmark through the Energy Technology Development and Demonstration Program (EUDP) and is hosted by Project Greensand, INEOS and Wintershall Dea. CO_2 is stored in sediments in the North Sea from which fossil fuels ones were extracted, also because the science and knowledge of these locations reaches back several years and provides a solid basis for CCS. Furthermore the geological condition of the soil (sandstone) is an advantage to store large amounts of carbon. The CCS technology is known for over 40 years. CO_2 from high intensive emission industries is most eligible to be captured, due to the constant emitted amount of CO_2. At the moment CO_2 from Antwerp in Belgium is captured, afterwards transformed into liquid and transported by ship to the storage base called Nini West in Denmark where it is brought 1800m through wells below the sea ground. Nini West is located 200km away from the shore and is a former oil field. (Project Greensand, 2023).

According to a statement on their website, the project is able to store following amounts of CO_2:

2025/2026
1,5 MILLION TONS CO_2/YEAR

2030
8 MILLION TONS CO_2/YEAR

>13% OF DENMARK'S ENTIRE CO_2 EMISSIONS/ YEAR

TOTAL EMISSIONS FROM 725.000 DANES/YEAR

CCS HAS CAPACITY TO STORE CO_2 EMISSIONS EMITTED IN DENMARK WITHIN NEXT 500 YEARS AT CURRENT EMISSION LEVEL

Further storage locations are identified as well as the development of monitoring technologies that will prospectively be used in the future. Up to now there is no significant impact on marine ecosystems. (Project Greensand, 2023)

ADAPTATION

The most efficient way to face climate change is to combine mitigation and adaptation. Adaptation is a reactive process (United Nations Environment Programme, 2022) where a system adapts to already existing and still changing circumstances (NASA, 2024). Especially local adaptation measures by communities and governments have positive effects on adaptive and coping capacities of a system (NASA, 2024) and consequently contain the ability to increase their resilience (Jacquemont et al., 2022). Possible adaptation actions are coral gardening and transplantation, the removal of algae (United Nations Environment Programme, 2022), restoration and conservation of coastal vegetation and ecosystems (Bindoff et al., 2019) towards Blue Carbon ecosystems that support coastal protection in terms of wave attenuation and sedimentary accretion (Jacquemont et al., 2022). Furthermore biodiversity by ensuring a good health condition and reproduction of flora and fauna is crucial (Jacquemont et al., 2022). This diversity can be achieved by genetic manipulation (United Nations Environment Programme, 2022) and interventions in phenotypic plasticity additionally to MPAs (Jacquemont et al., 2022). Resulting species richness stabilises the system and constitutes its resilience (Jacquemont et al., 2022).

SHEBA HOPE REEF

The cat food company SHEBA created the world's biggest coral reef restoration program in shape of the word 'Hope' (Figure 2) in cooperation with Mars Inc. and 44 other partners (Mars, 2021):

Figure 2: The SHEBA Hope Reef from above (Read, 2021)

The Mars Assisted Reef Restoration System (MARRS) restores and rehabilitates a coral reef in Indonesia on the west coast of the island Sulawesi since 2019 for an estimated project duration of ten years (Mars, 2022). Coral bleaching and dead corals were the initial situation (Mars, 2022) due to previous overfishing (Mars, 2021) with explosive material that destroyed the reef (National Geographic, 2024). The used rehabilitation technique proceeds by laying hexagonal-shaped steel constructions (reef star) with already attached coral fragments directly into areas with sparse growth of corals (Williams et al., 2018). Corals are then able to (re)grow, embed to the soil which enhances its stabilisation and biodiversity by attracting other living organisms (National Geographic, 2024). Local communities are highly involved in the project (National Geographic, 2024). They are given the opportunity to produce reef stars by themselves with regional materials (National Geographic, 2024). To this day already $10 million have been invested (Read, 2021). Until now, according to Sheba's website they achieved following milestones (Mars, 2022):

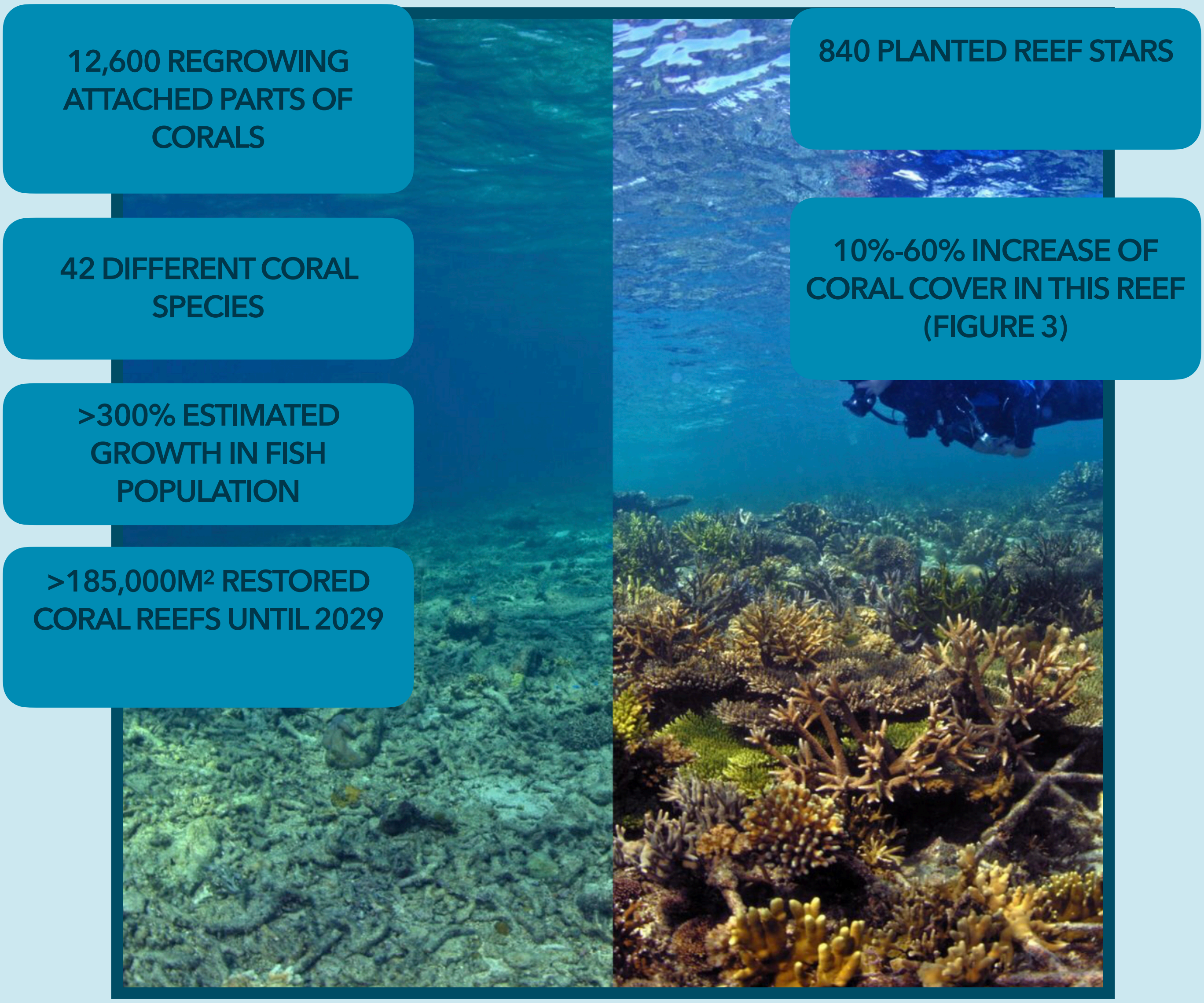

Figure 3: Before and after comparison SHEBA Hope Reef (National Geographic, 2024)

CRITICAL REFLECTION AND CHALLENGES

Regarding the project Greensand the geological condition of the soil is an advantage to store large amounts of carbon (Schünemann, 2023) therefore this mitigation strategy is not suitable for every geographical location. Although the technique of CCS is already known there are few experience values by reason of few projects of this level. Bilateral agreements across regions and countries are needed to achieve a high level constructed project (Schünemann, 2023). Programmes of this size and complexity require not only financial resources for realisation but a vast package of investments, i.e. time, manpower, know-how, technology and time (Hoegh-Guldberg et al., 2019). Regions with financial boundaries and less developed approaches have limited access to the aforementioned (Hoegh-Guldberg et al., 2019). It is not to be withheld that CCS can be used for improved oil recovery which may cause additional CO_2 emissions if it is used to extract further fossil fuels out of depleted stocks (Hoegh-Guldberg et al., 2019). This is to be avoided in any case to not exacerbate the climate crisis. On the other hand until 2050 CCS projects have the ability to avoid additional Gt CO2e/year if the pace of currently implemented and planned projects continues to increase (Hoegh-Guldberg et al., 2019).

The SHEBA Hope reef demonstrates the importance of a wide network, able to develop and conduct a large restoration project. A great range of influence, for example internet presence and marketing is needed for crowdfunding, project partners and the support of local communities which can be recruited by social and informing strategies. Generally programmes can benefit from policy support in terms of an efficient interchange between governments, scientists, NGOs and stakeholders. Unbureaucratic access to transnational finance markets, private investors and collaborations primarily for approaches targeting zero carbon should be provided amongst the support of sustainable ocean economy, marine ecosystem and biodiversity funding (Hoegh-Guldberg et al., 2019). Furthermore fast disbursement and opportunities for refinancing, access to modern technology such as regulatory frameworks are likely to unburden the uncertainties projects imply (Hoegh-Guldberg et al., 2019) to achieve a climate resilience by 2050. There is also a need for reliable and high-quality data bases to take actions on an informed basis (European Commission, 2021).

CONCLUSION: A CALL TO ACTION

This policy brief has highlighted marine ecosystem pathways as a key factor for climate resilience by 2050 apart from proactive coordinated commitment across sectors, regions and disciplines from institutions, NGOs, social and political associations and authorities and stakeholders. It calls for a collective effort: Crucial action is required with a holistic strategy (Hoegh-Guldberg et al. 2019) that is supported by nexus approaches (European Commission, n.d.) to limit global warming to 1,5°C above preindustrial levels (Hoegh-Guldberg et al. 2019). Pursuing high level strategies have positive benefits for mitigation and adaptation (Jacquemont et al., 2022). Offered pathways demonstrate feasible pathways to reduce emissions, blue carbon and enhance the resistance of marine ecosystems towards climate-related hazards. Geological, geographical, social and financial boundaries such as policy gaps and support must be addressed to ensure scalability and efficiency of mitigation and adaptation pathways. Ultimately other social, economic and sustainable practices not only addressing marine ecosystems are needed to achieve climate resilience until 2050 and safeguard the earth for future generations. Solely concerted and firm effort can overcome the challenges of the climate crisis and constitute a blue economy and resilient future.

References

Bindoff, N.L., W.W.L. Cheung, J.G. Kairo, J. Arístegui, V.A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M.S. Karim, L. Levin, S. O'Donoghue, S.R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson, 2019: Changing Ocean, Marine Ecosystems, and Dependent Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 447–587. https://doi.org/10.1017/9781009157964.007.

European Commission (2021) *Communication from the commission to the European Parliament, the council, the European economic and social committee and the committee of the regions on a new approach for a sustainable blue economy in the EU Transforming the EU's Blue Economy for a Sustainable Future,* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:240:FIN (3.1 Ocean knowledge) (Accessed: 05/03/2024)

European Commission (n.d.) *Water-Energy-Food-Ecosystem Nexus.* Available at: https://international-partnerships.ec.europa.eu/policies/climate-environment-and-energy/water-energy-food-ecosystem-nexus_en#:~:text=The Nexus approach identifies mutually,integrity and sustainability of ecosystems. (Accessed: 05/03/2024)

Friends of ocean action (n.d.) *Impact Pillar: Building a resilient ocean.* Available at: https://www3.weforum.org/docs/FOA_Resilient_Ocean_2021.pdf (Accessed: 05/03/2024)

Hoegh-Guldberg, O., Northrop, E. et al. (2023) *The ocean as a solution to climate change: Updated opportunities for action,* Special Report, Washington, DC: World Resources Institute. Available at: https://oceanpanel.org/publication/ocean-solutions-to-climate-change (Accessed: 05/03/2024)

Hoet, E. (2020) *What does Net Zero really mean?,* Climate Partner. Available at: https://www.climatepartner.com/en/knowledge/insights/what-does-net-zero-really-mean (Accessed: 05/03/2024)

IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–35. https://doi.org/10.1017/9781009157964.001.

IPCC, 2022: Summary for Policymakers [H.-O.Pörtner, D.C.Roberts, E.S.Poloczanska, K.Mintenbeck, M.Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O.Pörtner, D.C.Roberts, M.Tignor, E.S.Poloczanska, K.Mintenbeck, A.Alegría, M.Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001.

Jacquemont J., Blasiak R., Le Cam C., Le Gouellec M., Claudet J. (2022) *Ocean conservation boosts climate change mitigation and adaptation,* One Earth. Available at: https://doi.org/10.1016/j.oneear.2022.09.002 (Accessed: 05/03/2024)

Lavell, A., M. Oppenheimer, C. Diop, J. Hess, R. Lempert, J. Li, R. Muir-Wood, and S. Myeong, 2012: Climate change: new dimensions in disaster risk, exposure, vulnerability, and resilience. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 25-64.

Mars (2021) *Sheba Hope Grows,* Available at: https://www.buildingcoral.com/hope (Accessed: 05/03/2024)

Mars (2022) *The reef story,* Available at: https://www.shebahopegrows.com/uk/the-reef-story (Accessed: 05/03/2024)

NASA (2024) *Responding to Climate Change*. Available at: https://climate.nasa.gov/solutions/adaptation-mitigation/#:~:text=Mitigation%20–%20reducing%20climate%20change%20–%20involves,these%20gases%20(such%20as%20the (Accessed: 05/03/2024)

National Geographic (2024) *Rettung für Korallen: Das Hope Reef in Indonesien*. Available at: https://www.nationalgeographic.de/photography/2021/10/bezahlter-inhalt-rettung-fuer-korallen-das-hope-reef-in-indonesien (Accessed: 05/03/2024)

National Geographic Society (2024) *Marine Protected Area*. Available at: https://education.nationalgeographic.org/resource/marine-protected-area/ (Accessed: 05/03/2024)

Ocean Risk and Resilience Action Alliance Inc. (orraa) (2024) *Driving investment into ocean resilience*. Available at: https://oceanriskalliance.org/what-we-do/ (Accessed: 05/03/2024)

Project Greensand (2023) *Celebrating a world first*. Available at: https://www.projectgreensand.com/en/first-carbon-storage (Accessed: 05/03/2024)

Read, J. (2021) *The SHEBA Hope Reef Brings Hope To Coral Reefs Everywhere—You Can Help Too*, Forbes. Available at: https://www.forbes.com/sites/johannaread/2021/05/05/the-sheba-hope-reef-brings-hope-to-coral-reefs-everywhere-you-can-help-too/ (Accessed: 04/03/2024)

Schünemann, A. (2023) *Wintershall Dea startet mit Projekt Greensand erste CO2- Speicherung in der dänischen Nordsee,* Wintershall Dea, Esbjerg. Available at: https://wintershalldea.com/de/newsroom/pi-23-05-0 (Accessed: 05/03/2024)

Umweltbundesamt (2021) *Emissions Gap Report 2021: Klimazusagen reichen nicht aus*. Available at: https://www.umweltbundesamt.de/themen/emissions-gap-report-2021-klimazusagen-reichen (Accessed: 05/03/2024)

United Nations Environment Programme (2022) *Coastal Ecosystem Based Adaptation - Briefing* Note 9. Available at: https://wedocs.unep.org/20.500.11822/40407 (Accessed: 05/03/2024)

United Nations (n. d.) *The ocean – the world's greatest ally against climate change,* Climate Action. Available at: https://www.un.org/en/climatechange/science/climate-issues/ocean#:~:text=The ocean generates 50 percent,the impacts of climate change (Accessed: 05/03/2024)

Welthungerhilfe (n.d.) *Klimaresilienz stärken - International handeln,* Available at: https://www.welthungerhilfe.de/informieren/themen/klimawandel/klimaresilienz (Accessed: 05/03/2024)

Williams, S. L. , Sur, C., Janetski, N., Hollarsmith, J. A., Rapi, S., Barron, L., Heatwole, S. J., Yusuf, A. M., Yusuf, S., Jompa, J., Mars, F. (2018) *Large-scale coral reef rehabilitation after blast fishing in Indonesia*, published by Wiley Periodicals, Inc. on behalf of Society for Ecological Restoration. Available at: https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/rec.12866?download=true&campaigns=[{"position":"ereader-last-page","uri":"uri:707b1a3c-73e6-4188-b21f-2b05b70307d8"},{"position":"ereader-first-page","uri":"uri:7691ea89-90f5-4086-9241-486673caed61"}] (Accessed: 05/03/2024)

Images

Figure 1

Hoegh-Guldberg, O., Northrop, E. et al. (2023) *The ocean as a solution to climate change: Updated opportunities for action,* Special Report, Washington, DC: World Resources Institute. Available at: https://oceanpanel.org/publication/ocean-solutions-to-climate-change (Accessed: 05/03/2024)

Figure 2

Read, J. (2021) *The SHEBA Hope Reef Brings Hope To Coral Reefs Everywhere—You Can Help Too*, Forbes. Available at: https://www.forbes.com/sites/johannaread/2021/05/05/the-sheba-hope-reef-brings-hope-to-coral-reefs-everywhere-you-can-help-too/ (Accessed: 05/03/2024)

Figure 3

National Geographic (2024) *Rettung für Korallen: Das Hope Reef in Indonesien*. Available at: https://www.nationalgeographic.de/photography/2021/10/bezahlter-inhalt-rettung-fuer-korallen-das-hope-reef-in-indonesien (Accessed: 05/03/2024)